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Preface

The massive expansion of central bank balance sheets to contain the worst financial crisis in living memory raises questions about the theory and practice of monetary policy. The persistence in many advanced countries of large fiscal deficits and the prospect of high public debt/GDP ratios for many years is likely, at some point, to create policy dilemmas not only for central banks but also for public debt managers. Some countries have already had to cope with higher sovereign risk.

Worries about both “fiscal dominance” and “financial repression” have certainly gained ground. Whatever view is taken of this, the boundary between monetary policy and government debt management has become increasingly blurred. Policy interactions have changed in ways that are difficult to understand. The current delineation of policy mandates may need to be reassessed.

The aim of this BIS-OECD workshop was to better understand these issues. To do so, we called on people who use different methodologies – theoretical, empirical and historical. Theoretical perspectives draw on a long and rich body of monetary theory, but the theory is far from settled. Analysis of the history of fiscal/debt/monetary policy interconnections shows how such linkages have varied across countries and over time – there is no “one size fits all”. And careful review of empirical studies shows that precise estimates of the impact of large-scale central bank purchases of government bonds need to be treated with caution.

There is also great uncertainty about the impact of increased government debt on inflation, on interest rates and on future growth. Much will depend on future policies. Do monetary policies need to be better coordinated with other macroeconomic or financial policies? Could government financing decisions and financial sector regulation drive the long-term interest rate too low, at least in the short-term? What medium-term risks could this create? What could be the implications for the efficiency and stability of the financial system?

The papers and discussions in this volume do not, of course, converge on simple answers to any of these questions. Indeed, opposite views are expressed. The aim rather is to stimulate discussion about the complex interactions between fiscal deficits, government debt management and monetary policy in unusual macroeconomic circumstances. Some of these interactions are new, but many would be very familiar to an earlier generation of central bankers faced with heavy government debts and thin financial markets. Particular thanks are due to Stephen Cecchetti. He not only contributed to the analysis, but also encouraged us to bring together researchers and others who hold quite different views.

Hans J Blommestein
OECD

Philip Turner
BIS

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List of participants

William A Allen
Cass Business School

Hans J Blommestein
Organisation for Economic Co-operation and Development

Jagjit S Chadha
University of Kent

Christophe Chamley
Boston University

Robert E Cumby
Georgetown University

Elisa Faraglia
University of Cambridge

Lex Hoogduin
University of Amsterdam and Duisenberg School of Finance

Anja Hubig
Humboldt University of Berlin

Yvan Lengwiler
University of Basel

Alessandro Missale
University of Milan

Lucrezia Reichlin
London Business School

Eric T Swanson
Federal Reserve Bank of San Francisco

Geoff Tily
UK Post Keynesian Study Group

Bank for International Settlements

Stephen Cecchetti
Economic Adviser
and Head of the Monetary and Economic Department

Philip Turner
Deputy Head, Monetary and Economic Department
and Director of Policy, Coordination & Administration

Morten Bech
Senior Economist, Monetary Policy

Torsten Ehlers
Economist, Financial Stability and Markets for Asia & the Pacific

Richhild Moessner
Senior Economist, Macroeconomic Analysis

Fabrizio Zampolli
Senior Economist, Macroeconomic Analysis

Threat of fiscal dominance?
Workshop summary

Richhild Moessner and Philip Turner[1]

Abstract

A long period of high public debt-to-GDP ratios will alter the interactions between fiscal policy, monetary policy and government debt management. But opinions differ on exactly how. Four perspectives were explored in this workshop: historical analysis of policies in financial crises; macroeconomic theory; the theory of sovereign debt management; and the quantitative assessment of recent central bank balance sheet policies.

Keywords: Monetary policy, central banks, sovereign debt management, policy coordination, Keynes, rational expectations

JEL classification: E43, E44, E63 and E61

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[1] This is a summary of views expressed during the workshop, prepared under the responsibility of the authors. It does not necessarily reflect the views of the BIS. We are grateful to Bill Allen, Torsten Ehlers and Fabrizio Zampolli for helpful comments and discussions.

Introduction

The massive expansion in central bank balance sheets to fight the worst financial crisis in living memory was at first widely regarded as exceptional and temporary. And indeed many central banks, uncomfortable with the volume and nature of their asset purchases, began from the second half of 2009 to talk about their "exit strategy". But no early reversal proved possible. The balance sheet of the central bank may even come to be regarded as a second policy tool (that is, in addition to setting the short-term policy interest rate). This development will create very great challenges for central banks.[2]

This workshop focused on central bank purchases of government debt, which have been a key element of such policies. The fiscal policy context of governments needing to finance large deficits could have major implications for the consequences of such policies.

For many, a long period of large fiscal deficits and very high public debt-to-GDP ratios raises the spectre of fiscal dominance. It will in any case accentuate the links between fiscal policy, monetary policy and government debt management. The aim of this workshop was to analyse these macroeconomic interactions and to explore the controversial issues they raise from many different perspectives.

The workshop started with the historical record. Bill Allen's paper looked at how the links between government debt management and monetary policy in the United Kingdom have evolved over the past 80 years. The workshop also covered some aspects of the history of monetary theory, and Geoff Tily put particular emphasis on the contribution of Keynes. Open market operations in long-term government debt were central to Keynes's analysis of monetary policy in the *Treatise* and in the *General Theory*. Lex Hoogduin considered in addition the contribution of Hayek.

In the second session, the workshop explored some key points of macroeconomic theory. Fabrizio Zampolli reviews the theories that could justify using government debt management as an instrument of monetary policy. He reviews the argument for the irrelevance of open market operations under the New Keynesian paradigm. He considers too reasons why such operations may indeed trigger important portfolio rebalancing in the private sector. A key aspect of this highlighted by Bob Cumby is the choice that households make between bonds and money. Jagjit Chadha considers recent DSGE models incorporating financial frictions.

Papers in the third session of the workshop looked specifically at sovereign debt management. Government debt managers are often directed to take account of many objectives that are similar to those in the private sector. Examples include: minimising debt service costs; limiting refixing risks (ie the interest rate that must be paid to secure new funding); and reassuring financial markets of the country's creditworthiness. Hans Blommestein and Anja Hubig refer to this as the "microportfolio approach", and consider how this might change in a post-crisis world.

Debt managers could also be assigned quite different objectives derived from broader public policy considerations. But there are big disagreements about what such objectives might be. One could be tax smoothing in the face of macroeconomic shocks, the fiscal insurance theory: Alessandro Missale examines this perspective. The inherited structure of public debt could itself affect fiscal policy choices: Elisa Faraglia develops this line of reasoning. In the discussions, a large number of other possible policy objectives surfaced. One such aim could include the elastic supply of risk-free assets to serve as safe havens for private agents in a

[2] Caruana (2011) summarises four major policy risks created by enlarged central bank balance sheets: inflation; financial instability; distortions in financial markets; and conflicts with government debt managers. Hannoun (2012) argues that crisis-driven policy responses have put monetary policy frameworks under enormous pressure.

crisis. There are plausible financial stability grounds for this. Another aim could be to ensure that commercial banks have an adequate supply of shorter-term paper to meet liquidity risks.

A final session looked at recent balance sheet policies of central banks and their effects on government bond yields. Jagjit Chadha finds that UK quantitative easing had had a significant effect on the bond market. Torsten Ehlers takes explicit account of the specific pattern of US Treasury issuance, and finds that central bank purchases had limited the upward pressure on long-term rates of heavy government borrowing. Eric Swanson compares the effects of the Federal Reserve's recent balance sheet policies with the effects of its balance sheet policy in 1961. He finds that policy was constrained in the 1960s by fears that pushing the US long-term interest rate too low would lead to an outflow of gold. Morten Bech and Yvan Lengwiler find that central bank purchases of bonds not only reduced long-term interest rates, but also led to lower interest rate volatility.

History: monetary theory and practice

Central bank balance sheet policies – with a specific focus on quantities, rather than interest rates, as instruments – have historically been key elements of standard monetary policy. This can be seen for example in the case of the United Kingdom. Until 1971, liquid asset and cash ratios were regularly applied in the United Kingdom as a policy tool to control monetary growth. The Bank of England managed sovereign debt at the time as one of its central tasks. Decisions about debt management were seen as an integral part of monetary policy and as having important macroeconomic consequences (Goodhart (2012), Sayers (1967) and Turner (2011)). In the late 1970s and early 1980s, for instance, a deliberate policy of *overfunding* the budget deficit (that is, issuing more long-term debt than needed for financing the deficit) came to be seen as a way of controlling the expansion of M3. Allen (2012) argues that short-term interest rate management proved to be ineffective in controlling M3; but issuing long-term debt to non-banks was effective.

Allen (2012) shows that several episodes in the United Kingdom since 1919 have demonstrated a close relationship between debt management and monetary policy. This relationship has two main aspects. The first is about prices: the objective of affecting interest rates at all maturities is important because different agents are affected by different interest rates. The second aspect is about quantities, notably the liquidity of the balance sheets of central banks. In the past, the Bank of England used a Liquid Asset Ratio to control bank lending. Their view was that, by selling less liquid, longer-dated government debt to banks, they could absorb their liquid assets and so tighten monetary policy. He explains, however, that the way that the central bank saw policy working was not necessarily the way it actually worked. The authorities could not determine whether banks or non-banks bought bonds – and in any case any sale would trigger a chain of portfolio adjustments. By mid-1985, however, banks were no longer constrained by a Liquid Asset Ratio, and "the Treasury's willingness to use debt management to support monetary policy was exhausted".

In the course of the Great Moderation of the 1990s, central banks in most advanced economies (but not in emerging market economies) abandoned quantitative monetary policy tools or targets. Central banks instead concentrated on the short-term interest rate as their sole monetary policy tool. Open market operations in long-term markets were no longer central. Sovereign debt management came to be regarded as having little to do with monetary policy.

The large scale of central bank purchases of government bonds since the onset of the 2007 crisis has undermined this separation. Quantitative easing in the United Kingdom since 2009 can be seen as underfunding the UK's Public Sector Net Borrowing Requirement. This is the mirror image of the overfunding policy of the past that Allen describes. The aim today is to boost the growth of M3.

Tily (2012) reviews the theoretical (and frequently practical) contributions of Keynes to the debt management/monetary policy interactions in the United Kingdom that Allen analyses. Tily argues that uncertainty – not measurable risk – is the critical component of Keynes's monetary and macroeconomic theories. "The rate of interest twenty years hence", Keynes wrote, "is uncertain … [that is,] there is no scientific basis on which to form any calculable probability whatever. We simply do not know". Because of this non-quantifiable uncertainty about the future, Keynes did not trust financial markets to produce the long-term interest rate the real economy required. In the 1930s, Keynes argued that the authorities underestimated their ability through debt management operations to control interest rates right across the maturity spectrum. The freedom to set short-term rates that leaving the Gold Standard gave was not enough. He thought that open market operations could have an effect on long-term interest rates both by changing the volumes of money and of bonds, and by influencing expectations in an uncertain world.

Hoogduin and Wierts (2012) discuss the policy responses to the current crisis from the perspective of the debate between Hayek and Keynes. Hayek believed that unemployment was not mainly caused by a lack of aggregate demand due to monetary or fiscal causes. In his view, it instead reflected disequilibrium in the real structure of the supply-side of the economy. Very low interest rates distort the choice between current and future consumption. A deliberate policy of keeping interest rates very low could also have distributional (and therefore political) implications. Such a policy shifts the burden of adjustment from debtors to creditors (especially pension funds). "What is the counterfactual?" asked one participant. If low interest rates avert widespread default by debtors, said one participant, creditors would be better off.

Another difference of view that one participant stressed was that Keynes, who shared Hayek's liberal belief in market forces to regulate *real* economic activities, believed that stronger State intervention was needed for *financial* markets, international as well as domestic.

Chamley, in his comment on these three papers in this volume, notes that changing the composition of government debt has a first order effect on the yield curve. But in a Modigliani-Miller world, private traders could undo the trading of the government, leaving aggregate real investment unaffected. He also stressed how the trading of government assets by the government or by the central bank can be a useful commitment device to a future policy, and so influence private sector behaviour now.

In the general discussion of the workshop, several participants agreed with Axel Leijonhufvud's much-cited view that the economy was self-stabilising only within certain limits, but not outside them (Leijonhufvud, 1968). It was argued that the Great Depression had taken the economy outside normal limits, and the same may have happened in the recent Great Recession. In that case, the economy needed to be guided back within normal limits. But it was unclear how long this would take or which policies would work best. The discussion also brought to the surface some dissatisfaction with our current models of monetary/financial linkages.

During the discussion, Lex Hoogduin also emphasised that Keynes linked liquidity to fundamental uncertainty (as distinct from quantifiable risk) and confidence. Having assets available which are perceived as safe increased confidence: liquidity and safety were closely linked. He argued that one could have government bonds as assets perceived as safe, and into which private agents could flee to safety in a crisis. One participant mentioned that a loss of safe assets had been experienced in many earlier crises in the emerging economies as confidence in the government eroded. This had led to a flight into safe assets abroad, and to domestic activity being driven to well below normal levels. Safe assets were useful as a crisis-related buffer. Another participant argued that it would be nice to have perfectly safe assets, but none existed. He thought that the zero risk weights on government bonds applied by financial regulators were not justified: they exaggerated public sector creditworthiness over private sector creditworthiness. There was a need for searching for relatively low-risk private sector assets, and a great opportunity was being missed by not treating self-liquidating commercial bills as liquid assets for regulatory purposes.

Macroeconomics of debt management and monetary policy

The second session of the workshop explored some macroeconomic theories on the links between monetary policy and government (or sovereign) debt management. Zampolli (2012) provides an overview of the literature on the macroeconomic effects of central bank open market operations and sovereign debt management. He discusses how economists' perspectives on portfolio balance effects have changed over the years. In the 1950s, both James Tobin and Milton Friedman regarded portfolio balance effects as very relevant for the working of monetary policy. The imperfect substitutability of assets (long-term bonds and capital, or bonds of different maturities) meant that open market operations that disturbed investors' portfolios affected the relative prices of assets. The "preferred habitat" approach of Culbertson (1957) provided a theoretical basis for imperfect substitutability: different bond holders have distinct preferences for certain maturities and there are limits to arbitrage by speculators.

In the 1970s, however, portfolio rebalancing effects had fallen out of favour as too partial equilibrium in character. Certain general equilibrium models, akin to Ricardian Equivalence, suggested the irrelevance of open market operations. The private sector could undo what the government debt managers did. And empirical work suggested only small quantitative effects in advanced economies with broad financial markets. New Keynesian models generally embody this "irrelevance approach".

The extraordinary balance sheet policies of central banks have forced a re-examination of this consensus. Zampolli therefore reviews some recent evolutions in the New Keynesian tradition based on frictions in financial intermediation and recent developments in the term structure theory of interest rates based on "preferred habitat" theories.

Cumby presented an analysis that looked at the choice households make between holding money and holding bonds (Canzoneri, Cumby and Diba (2012)). He showed how many striking conclusions follow from the fact that government bonds provide liquidity. He demonstrated how changes in fiscal policy will affect the natural rate of interest. Therefore the natural rate of interest will be very variable as governments try to cut budget deficits. He stressed that large deviations of the natural rate of interest from its steady state that result from fiscal adjustment would be very persistent.

Chadha drew on Caglar et al (2011) to explain the development of recent DSGE models that incorporate financial frictions. Such models allow for several interest rates and have liquidity premia in financial markets. Hence balance sheet measures have effects which they do not have in the basic New Keynesian model. The authors find that in these models the scale of quantitative easing needed to avoid a liquidity trap at the zero lower bound is large by historical standards, partly because most financial assets are close substitutes. One important drawback of current DSGE models of monetary policy is that they do not explicitly model default of households, firms or financial intermediaries (Goodhart and Tsomocos (2009), Galati and Moessner (2011)). It is not clear how this problem can be overcome in a satisfactory manner.

Stephen Cecchetti in his comments emphasised the importance of using macroeconomic models which incorporate financial frictions that create market imperfections both atemporally and intertemporally, in order for both private and public sector debt to matter. He also noted that while the commonly made modelling assumptions about rational expectations, information structures and optimisation can give unique equlibria, these assumptions are actually wrong and equilibria are not unique. Moreover, Cecchetti suggested that representative agent macroeconomic models built on microeconomic foundations are not capable of addressing the questions in greatest need of being answered. He drew an analogy with theories about the level of the sea: concentrating on microeconomic foundations is like developing theories of fish movements and interactions, and ignoring the moon.

In the general discussion that followed, Christophe Chamley said that a critique of DSGE models is that in real life agents have to operate without the common knowledge that is typically assumed in such models. As a consequence, the rational expectations equilibrium in these models may not be a sufficiently realistic description of the real world economies. He cited the notion of "eductive" learning developed by Roger Guesnerie (Guesnerie (2005) and Evans et al (2011)). Agents decide on the basis of their assessment of what other investors will decide – about which they have imperfect information. If each agent has a sufficiently good knowledge of the structure of the economy and believes that other agents behave in a rational (ie self interested) way, the rational expectations equilibrium will soon prevail. It seems plausible to assume that agents will coordinate in this way if the structure of the economy is well understood and transparent. The alternative framework is "adaptive" or statistical learning. Statistical forecasts are continuously updated on the basis of forecast errors, which seems more plausible when the economy is more complex but sufficiently stable.

Chamley pointed out, however, that even the conditions highlighted by this literature may be too restrictive in practice. One possibility is the existence of strong strategic complementarities (ie when payoffs to an agent are affected by the decisions of others). This may lead to multiple equilibria even under common knowledge. In this case, agents may not necessarily be able to coordinate on a good equilibrium. They may end up in a socially sub-optimal equilibrium. Examples of lack of coordination due to strategic complentarities abound in macroeconomics. Critics can argue that the original mission of macroeconomics was the study of coordination failures and how policy could remedy that – something that the recent DSGE literature has mostly neglected, reneging on its original mission.

Even if the economy is sufficiently stable most of the time, there may be periods in which it undergoes severe changes, as during a crisis. In normal times, agents may be able to coordinate on the rational expectations equilibrium as most macroeconomic relationships can be easily predicted and are well understood. In the aftermath of a crisis, however, the working of the economy becomes too complex to understand and to predict. When the economy is in a deep recession, for example, there may be no investment because agents do not know whether there is an equilibrium with high investment. They do not know because the economy provides information only for small changes but not for large "jumps" which are the essence of multiple equilibria. These equilibria depend on agents' beliefs about the true model of the economy and their beliefs about what other agents are thinking. Beliefs about the true model of how the economy works may determine the equilibrium and prove self-confirming.

Tily echoed these remarks, saying that this was one of Keynes's original insights. Keynes held that the economy had to be viewed as a system of multiple equilibria – his was not a partial equilibrium model. Only the government, in his view, could act once business confidence had broken down. One participant said that the essence of the current crisis was a breakdown of financial relations and private credit supply following the greatest explosion of private debt – not government debt – since the Great Depression. How far public policies can help the process of expectation coordination, and so move the economy to a better equilibrium, remains a question of strong debate. Policymakers themselves are not omniscient; they too must learn about the complex economy.

Sovereign debt management and economic theory

During the era of the Great Moderation in the 1990s, sovereign debt management came to be seen – for practical purposes – as being separable from monetary policy. Nevertheless, the logical link between debt management and monetary policy is inescapable – and in the past these two dimensions of official policy were seen to be closely linked.

Blommestein and Hubig (2012) look closely at the actual mandates of many Debt Management Offices (DMOs), namely to minimise borrowing costs subject to risk constraints. This is also a natural objective for any private sector manager required to engage in portfolio choice under uncertainty. But most governments are less liquidity-constrained than private borrowers. Because they can raise taxes and print money, they worry much less about refinancing risks. Even with fiscal and monetary policies taken as given, and not made subordinate to borrowing imperatives, the government with its own currency is still a dominant player in its own market. It can therefore directly affect the yield curve, and does not have to take interest rates as given. And governments have wider objectives than private agents: what difference does this make for portfolio choices of public debt managers? Blommestein and Hubig suggest that a different model may be needed for public debt managers in crisis times than in normal times.

Missale (2012) and Faraglia, Marcet and Scott (2012) look at the links between debt management and fiscal policy from quite distinct viewpoints. Missale (2012) looks at both the maturity choice of debt and the price indexation of debt from the perspective that medium-term fiscal policy should be guided by a kind of tax-smoothing rule. He argues that long-maturity debt provides the government with insurance against macroeconomic shocks. In particular, it reduces interest rate risk faced by the government, which would reduce government default risk. One participant at the workshop wondered whether the government needed such insurance: the government is surely the ultimate insurer? Another questioned this line of reasoning on the grounds that economic theory does not provide clear guidance on which sector in a given economy is best placed to undertake maturity transformation: should it be the government, the banks or households? The answer may depend on specific circumstances and can vary over time. For instance, issuing long-term rather than short-term government bonds to banks shifts interest rate risk from the government to banks. Banks would face reduced interest rate risk if they were to hold short-dated rather than long-dated government paper. How does one decide in what circumstances it would be better for government, not the private sector, to assume interest rate risks by issuing short?

Missale also argues that the absence of an accounting framework that correctly measures risk exposures precludes optimal debt management. He complains in particular about the excessive attention paid to current budget deficits in the evaluation of fiscal performance. This view recalls the work of Auerbach et al (1991), who suggested the use of generational accounting instead of a focus on fiscal deficits. Their approach might well be useful in designing and implementing a theory-based accounting framework suggested by Missale.

Faraglia, Marcet and Scott (2012) go in the opposite direction from that of Missale. They go from inherited debt to the path of fiscal policy. A government with debt has an incentive to “twist” interest rates to lower funding costs by promising a tax cut when bonds mature. This is a time-inconsistent promise and raises the issue of commitment in fiscal models. Their model does not assume complete markets, under which the buy-back strategy of the government has no implication for interest rates. With incomplete markets, the government has more power to “twist” interest rates. There is also a need for reflecting on making fiscal theory more realistic, and refining the assumption of commitment of a social planner to future tax rates made in this paper.

There is an interesting analogy between the micro versus macro approaches to debt management and the micro versus macro approach to financial regulation. Macroprudential frameworks are currently being developed (see Galati and Moessner (2011) for a survey), and the development of a macro approach to sovereign debt management faces similar challenges. These include the question of which objectives government debt management should be assigned from a macro perspective. There is also the question of coordination with monetary policy. For example, Moessner in her comments in this volume asked whether they should provide longer-maturity assets perceived as safe, so as to make "safe assets" available in a crisis for private agents to hold, or flee into, and which pension funds and insurance companies can hold.

Another pertinent question is whether it would be better for debt managers to avoid the use of (often opaque) swaps in order to modify the maturity of their debt. In the United States, for instance, the Treasury does not use swaps. One participant argued that buying and selling government bonds at different maturities to modify duration would be more transparent; and it would also avoid the counterparty credit risk exposure of the swap contracts (see also Piga (2001)). During the general discussion, there was a lively debate about why sovereign debt managers should use interest rate swaps of different maturities. Another participant argued that governments had an advantage issuing at long maturities, so that it was cheaper to issue at long maturities and then swap to paying interest rates prevailing at shorter maturities. But the first participant replied that in that case the government had crowded out other borrowers at long maturities. It was mentioned that in the recent financial crisis there had been a heavy demand for short-term government paper so that it was easy for debt managers to issue short-term debt, and then use swaps to convert to long maturities. In this way, demand in the market could be matched. One participant argued that this amounted to trading swap margins.

Another pertinent question requiring further analysis was whether greater reliance should be placed on issuing index-linked debt. Historically, central banks had resisted the introduction of inflation-linked debt. The Radcliffe Report in 1958 recommended that the United Kingdom introduce such bonds. But it was only the prospect of nominal yields of nearly 16% on conventional 20-year bonds in 1981 that forced their introduction in the United Kingdom. They are now broadly accepted. Most economists welcome inflation-linked paper: giving investors protection against inflation risks helps make markets more complete and can lower long-term borrowing costs. But some still worry that it could increase fiscal vulnerability, in the case of an unexpected surge in inflation.

Recent balance sheet policies

Central bank balance sheets in the advanced countries have increased by a factor of three or four in the past few years. In addition, central banks have bought, on a very large scale, the long-dated paper (government bonds but also mortgage-backed securities) that they would normally avoid. The impact of these policies on relative prices depends on asset substitutability. This will in turn depend on expectations about future relative prices. Perfect certainty of investors about the "normal" level of long-term rates would greatly limit the efficacy of such policies. But if expectations about the future path of interest rates become unanchored – whether they become more dispersed, more unstable over time or simply more uncertain – the investors will regard the short-dated and long-dated government bonds as imperfect substitutes. In addition, financial firms engaged in interest rate arbitrage face capital and other constraints. The crisis may have reduced the supply of interest rate arbitrage, especially from large international banks. In conditions of imperfect substitutability and constraints on arbitrage, shifting government debt issuance from long to short government bonds should flatten the yield curve. Central bank purchases of long-term government bonds have the same effect.

The consensus is that such policies have been effective, but there is disagreement about the size of such effects and about their permanence. Bernanke et al (2004) concluded from their analysis that:

"We believe that our findings go some way toward refuting the strong hypothesis that nonstandard policy actions, including quantitative easing and targeted asset purchases, cannot be successful in a modern industrial economy. However, the effects of such policies remain quantitatively quite uncertain".

This is still the consensus emerging from the recent literature, namely that quantitative easing seems effective, but that the size of the impact is uncertain. And the relative importance of the channels through which quantitative easing operates – such as the portfolio rebalancing, signalling and bank reserves channels – remains unclear (Goodhart (2012), Krishnamurthy and Vissing-Jorgensen (2011)). For large-scale asset purchases, the relative importance of the scarcity (available local supply) channel associated with the traditional preferred habitat literature and the duration channel associated with interest rate risk have been studied in D'Amico et al (2011).

Blommestein and Turner (2012) argue that studies of the effectiveness of quantitative easing should also take account of the aggregate change in the structure and maturity of sovereign debt, including that due to changes in sovereign debt issuance by treasuries or DMOs. Many studies take the pattern of government debt issuances as exogenous. But there is evidence that decisions by debt managers on the maturity of debt issuance have, historically, not been exogenous with respect to monetary and fiscal policies.

It is interesting to consider what central banks could have done as an alternative to asset purchases. One possible alternative (or supplement) would be for monetary policymakers not just to announce the current desired level of short-term interest rates, but also to provide some form of forward guidance on future policy rates. Indeed, FOMC members decided to provide their forecasts of policy rates starting with their meeting in January 2012.

The three papers in this session discuss the impact of balance sheet policies. One question is whether the analysis should centre on the asset side of the central bank (ie the market prices of the assets the central bank buys) or on the liability side (ie the expansion in monetary reserves that follows from asset purchases). Some analyses stress the initial impact of asset purchases on market prices. Others suggest that it is the impact of increased bank reserves (the liability side of the central bank's balance sheet) that stimulates an expansion in broad money.

Ehlers (2012) studies the effects of the Federal Reserve's Maturity Extension Program ("Operation Twist 2"). He does not consider only the Federal Reserve purchases at each segment of the yield curve. He also carefully reviews the pattern of increasing issuance by the Treasury – which many other studies ignore. He finds that new Treasury issuance is a heavy counterweight to central bank asset purchases, which can be seen as offsetting the otherwise adverse impact on government bond prices of a pronounced increase in sovereign debt levels. Swanson (2011) discussed the findings of his Brookings Papers article, in which he compares the effects of the Federal Reserve's balance sheet policy in 1961 ("Operation Twist") with the effects of its recent balance sheet policies, and studies what can be learnt from the earlier experience for the recent episode. He points out that US fears in the 1960s that pushing the long-term interest rate too low would lead to an outflow of gold was a constraint on policy.

Bech and Lengwiler (2012) look in greater detail at the effects of quantitative easing, and the financial crisis more generally, on the dynamics of the yield curve. They consider short, medium and long maturities separately. They find that shocks hitting nominal long-term interest rates have increased in recent years: they find evidence that Federal Reserve purchases reduced the interest rate volatility at the long end.

Breedon, Chadha and Waters (2012) show that the first bout of quantitative easing in the United Kingdom lowered the net supply of long-term bonds by 14% of GDP and hence five-year forward, five-year maturity rates fell by just over half of a percentage point. They also find that these operations made all bond markets (including corporate bonds) more liquid. But they find little evidence for any broader consequences on other asset prices or monetary aggregates. Although the counterfactual is hard to assess – how much lower would asset prices or money growth have been in the absence of quantitative easing – the absence of a discernible effect on other possible transmission mechanisms has led most analysts to concentrate on the impact on bond yields.

Commenting on the article by Swanson, Reichlin noted that, in an event study analysis, expectations of future policy rates and how a policy is communicated, can both affect the market's reaction to the policy announcement (Reichlin, 2011). It was difficult to separate such effects and isolate the portfolio balance effect. Moreover, she noted that the results on the effects of balance sheet policies on interest rates other than government bond yields were less clear.

An issue raised during the general discussion at the workshop was that the effects of balance sheet policies should also be measured via changes in quantities, not just changes in prices. There was still much research to be done on this. For example, if people selling gilts to the Bank of England bought corporate bonds instead, and the proceeds of the corporate bond issues were used to repay debt to banks, then quantitative easing would help to ease strains on bank liquidity. It was necessary to measure the portfolio rebalancing effects of quantitative easing, and distinguish them from the signalling that the central bank intended to keep policy rates lower for longer.

Conclusion

The workshop did not seek any convergence of view on current, difficult policy questions. Indeed, differences of view on methodology, on theory and on the interpretation of recent policies made for a very stimulating day. There was, however, broad agreement about the relevance of a fundamental question: how will the high public debt-to-GDP ratios that many advanced countries will face for many years change macroeconomic policies? Different answers to this question often lie behind disagreements about the frameworks that should guide the implementation of policies in the decade ahead.

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Financial crises and monetary policy

Government debt management and monetary policy in Britain since 1919

William A Allen[1]

Abstract

The enormous increase in the United Kingdom's national debt during the two world wars of the 20th century meant that government debt management, which had hitherto been regarded as a matter of 'budgetary convenience', acquired great macroeconomic significance. The paper examines and compares four episodes in the management of the national debt since 1919 and in each case explores the relationship between debt management and monetary policy. In some episodes, debt management and monetary policy were mutually supportive, but in 1932–38, they were not. In the past few years the macroeconomic significance of government debt management has increased again, and the paper discusses the current policy of quantitative easing from the perspective of the earlier episodes.

Keywords: Government debt management, monetary policy, central banking, United Kingdom

JEL classification: E5, H6, N1

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1. Introduction

This paper discusses several episodes in British government debt management since 1919 in order to cast some light on the relationship between government debt management and monetary policy. The end of the First World War brought with it a change in the significance of debt management. The United Kingdom had a vastly enlarged national debt and, as Hicks (1963, page 180) explains, ‘debt management became a matter of national balance, not merely of budgetary convenience’. And in 1959, 14 years after the end of the Second World War, the Radcliffe committee was in no doubt about the macroeconomic importance of debt management:

> *Thirdly, monetary policy must take its influence upon the structure of interest rates as its proper method of affecting financial conditions and eventually, through them, the level of demand. There is no doubt that it has, and can, exert this influence through the management of the National Debt which, if burdensome to the financial authorities in other respects, affords in this respect an instrument of singular potency. In our view debt management has become the fundamental domestic task of the central bank. It is not open to the monetary authorities to be neutral in their handling of this task. They must have and must consciously exercise a positive policy about interest rates, long as well as short, and about the relationship between them.*[2]

The use of government debt management as a weapon of macroeconomic policy was also analysed in the United States after the Second World War (see, for example, Wallich 1946 and Tobin 1963). And Operation Twist, undertaken in 1961, was an attempt to reshape the yield curve by altering the maturity of outstanding government debt.[3]

In the UK, things changed a lot in the three decades following the Radcliffe report. In 1995, the Treasury and the Bank of England conducted a review of debt management policy. The report (page 8) commented that ‘debt management is not a major tool of monetary policy; nor is monetary policy the main objective of debt management, although the Government and the Bank of England take monetary policy considerations into account to ensure consistency, particularly when formulating the Government’s strategic issuance policy’. In 1998, the Bank of England held a conference on ‘Government debt structure and monetary conditions’. It did so in response to a question from the then-Governor about whether decisions about monetary policy should be influenced by the government’s debt management policy, responsibility for which had recently been transferred from the Bank of England to the newly-created Debt Management Office, which was and is constitutionally part of HM Treasury. The conference concluded that government debt management had only a minor relationship with monetary policy:

‘Taking in turn each of the three channels through which government debt structure might influence monetary conditions:

- ‘Effects of the quantity of debt:…new issuing techniques and new capital markets since the 1980s have all helped to reduce concerns about how the quantity of debt impinges on monetary control, to the point where the two issues could now be seen as almost distinct.
- ‘Effects of the composition of debt: Changes in the composition of debt might affect expected asset returns and the incentives facing the central bank. But the

2 Committee on the Working of the Monetary System (1959, paragraph 982).

3 For a recent review of Operation Twist, see Alon and Swanson (2011).

consensus at the conference appeared to be that the size of these effects was small, at least in response to marginal shifts in government portfolios.

- 'Effects from the ownership of debt: For the United Kingdom, the available evidence was consistent with the view that there was little impact of debt sales to banks on either money supply growth or bank lending.'[4]

In other words, by the 1990s, conventional opinion had reverted to the pre-1918 view that debt management was 'a matter of budgetary convenience'.

Much more recently, interest in the macroeconomic aspects of government debt management has been revived in the wake of the banking crisis, as debt issuance by governments has increased and as private credit markets have contracted. Turner (2011) provides an excellent review of the issues.

This paper discusses four episodes in British monetary history between 1919 and the 1990s in which there clearly was a close relationship between government debt management and monetary policy. The episodes are:

(i) The inter-war period.

(ii) The immediate aftermath of the Second World War.

(iii) The period after the 'reactivation of monetary policy' in 1951.

(iv) The period of 'overfunding' of the government deficit in the 1980s.

In addition, the paper measures the main debt management actions in these episodes and compares them with the recent quantitative easing conducted by the Bank of England.

The vast deficits incurred during the two world wars of the 20th century threatened the sustainability of government debt. Had the debt become unsustainable, which it did not, there would of course have been very serious consequences for monetary policy. How a loss of confidence in government debt was avoided is a very interesting question, but it is beyond the scope of this paper.

2. The inter-war period

Sterling-denominated government debt amounted to about 120% of GDP at the end of the First World War.[5] Much of it was short-term. Howson (1975, page 161) estimates that private sector holdings of the national debt were £6.6 billion at the end of March 1919, of which £865 million was in the form of Treasury bills and a further £937 million in the form of bonds with less than 5 years to maturity (see Table 1). Nearly £2 billion was in the form of bonds with over 25 years to maturity; almost all of this was represented by the 5% War Loan issued during the war, which could be called by the government from 1929 onwards and had a final maturity date in 1947.

The overriding objective of monetary policy from 1919 to 1931 was, first, to restore the gold standard at the pre-war parity (which happened in 1925), and then to maintain it. After 1931, when the gold standard was abandoned, the new objective of monetary policy was to secure

4 See Chrystal (1998, page 9).

5 In 1919, private sector holdings of national debt were £6.6 billion (Howson 1975, appendix 2, table 1) and GDP was £5.5 billion (www.measuringworth.com).

a recovery in prices so as to stimulate expansion of business and employment.[6] Short and long-term interest rates from 1919–38 are shown in Figure 1.

Restoring the gold standard at the pre-war parity after the First World War was a tall order, in the light of the inflation that had taken place during the war. In order to secure the necessary deflation, interest rates were kept at a higher level than purely domestic considerations would have dictated, and unemployment was generally high. The country made a bad start in 1919–20, when there was an inflationary boom supported by rapid growth in money and credit. Bank deposits expanded at an average rate of 12% a year in 1919 and 1920, and loans, advances and other accounts at an average rate of 35.6% a year (see Table 2). The growth was facilitated by the government's willingness to take ways and means advances from the Bank of England when it could not sell enough Treasury bills at it desired yields to meet its needs, and by the commercial banks' large holdings of liquid assets (45.6% of total assets at the end of 1918, of which 19.4% consisted of Treasury bills – see Table 2), which they could run off at their discretion in order to finance commercial lending. The boom was ended by a sharp rise in interest rates in 1920, but the episode made it clear that debt management policy was intimately connected with monetary policy, in the sense that a large amount of liquid government debt could support an inflationary boom.

In the circumstances, it was understandable that the Treasury and the Bank of England regarded it as important to reduce the amount of short-term debt outstanding. Although the boom and bust of 1919–20 had been contained, it had caused some economic instability, and containing it had required an increase in Bank Rate to 7%, which implied a large increase in the cost to the Treasury of servicing its heavy short-term debts.

The policy of 'funding' – ie extending the average maturity of the outstanding debt - was pursued throughout the 1920s with some success, so that by 31 March 1930 the amount of Treasury bills and under-five-year bonds held by the private sector was less than half of what it had been eleven years earlier, even though the total debt had increased (see Table 1).

The UK abandoned the gold standard in September 1931, under pressure from both depressed economic conditions and the drain of liquidity from the UK which followed the banking crises in Austria, Hungary and Germany earlier that year. At that point, the earlier objectives of monetary policy became obsolete, and with a floating exchange rate it became possible for the UK to pursue policies directed towards domestic objectives. With unemployment very high[7] and nominal GNP having fallen by 5.1% between 1930 and 1931, it was abundantly clear that monetary policy needed to be eased, and so it was, as a policy of 'cheap money' was adopted. The Exchange Equalisation Account, introduced in June 1932, was (and still is) a device which enabled the Treasury (rather than the Bank of England) to buy and sell gold and foreign exchange so as to manage fluctuations in the exchange rate. In practice, the EEA was used in 1932–33 mainly to buy gold both to finance debt repayments and to prevent the pound from appreciating too much. And, also in June 1932, Bank Rate was reduced to 2%.

The main event in debt management policy after the abandonment of gold was the War Loan conversion of 1932. Although the issue had been callable since 1929, the Treasury had not previously seen any attractive opportunities for conversion.[8] Nevertheless, as interest rates

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6 See the statement by the Chancellor of the Exchequer, Neville Chamberlain, to the House of Commons on the Finance Bill, 9 May 1932, http://hansard.millbanksystems.com/commons/1932/may/09/finance-bill#S5CV0265P0_19320509_HOC_269.

7 Feinstein's data (1972), used by Benjamin and Kochin (1979) in their attempt to characterise UK unemployment in the interwar period as voluntary, and quoted by Ormerod and Worswick (1982), puts unemployment in 1932 at 22.1%. Matthews, Feinstein and Odling-Smee (1982, page 81) estimate that the average unemployment rate in 1920–38 was 10.6%.

8 See Howson (1975, pages 71–74).

fell, the probability of conversion as seen by the market increased and the expected maturity of the issue shortened. The reduction in short-term interest rates to 2% opened up the possibility of a conversion of the entirety of War Loan (the total of which was the equivalent of 49% of 1932's GNP) to a bond bearing a much lower coupon, and War Loan was converted in 1932 to a new issue, 3½% War Loan, redeemable in 1952 or after (ie it had no final redemption date; needless to say, it is still outstanding at the time of writing).[9] The War Loan conversion saved about £30 million a year (0.7% of GDP) in debt servicing costs; it also substantially lengthened the average maturity of the outstanding debt. Other debt management actions reinforced the maturity lengthening. In Table 1, the War Loan conversion appears as a large switch between the '15–25 years' column (since the last possible redemption date of 5% War Loan was in 1947) and the 'repayable only by government option' column. In addition, from 1932 to 1937, the total of Treasury bills and under-5-year bonds also fell, even though the EEA's acquisition of gold and foreign exchange was routinely financed by new Treasury bill issues.

The saving in debt servicing costs was obviously highly desirable, but the lengthening of the maturity of the outstanding debt was not consistent with the objective of promoting economic recovery. Commercial banks' loans, advances and other accounts fell by 17.8% from the end of 1931 to the end of 1933 (see Table 2); the monthly London clearing bank data show a fall in advances from £912 million in August 1931, just before the gold standard was abandoned, to a low point of £738 million in January 1934, a fall of 19.1%. From 1934 onwards commercial banks' loans (all banks) recovered, but they did not get back to their end-1930 levels until 1939. According to Capie and Webber (1985), UK commercial banks' deposits (all banks) had fallen by 5.8% during 1931; they increased by 11.4% during 1932, but changed little in 1933 and 1934.[10] In the magisterial assessment of Nevin (1955, page 119), 'Movements in the money supply during the period 1933–39 are not *a priori* consistent with the statements of official spokesmen that the authorities were pursuing a policy of cheap money'. What was going on?

In some degree, the weakness of bank credit after the abandonment of the gold standard can no doubt be explained by low demand for credit in depressed business conditions. But the supply of credit was also inhibited by the following factors:

(a) Shortage of liquid assets

The effects of official debt management policy in restricting the supply of Treasury bills was compounded by the contraction of the supply of commercial bills, which was the result of declining prices and declining volumes of trade. The banks' holdings of Treasury and commercial bills fell from £450 million at the end of 1932 to £300 million at the end of 1936 (see Table 2). Bearing in mind that the London clearing banks maintained a minimum ratio of cash and liquid assets to deposits, the shortage of bills will have constrained balance sheet growth and commercial lending.[11]

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9 The conversion was announced on 30 June 1932 and holders had until 30 September to choose to be repaid in cash. If they did not respond, they were deemed to have opted to convert into the new 3½% issue. See Sayers (1976, pages 430–440).

10 See Capie and Webber (1985, table III.4). The quoted percentage changes are from fourth-quarter average to fourth-quarter average. Capie and Webber provide data for bank liabilities but not assets.

11 Nevin and Davis (1970, pages 142–146) discuss the origins of the minimum liquid asset ratio, and how far it represented a choice of the London clearing banks and how far an imposition by the Bank of England.

(b) The availability of large amounts of longer-term government securities at relatively attractive yields

Commercial banks, like other holders of War Loan, were subjected to heavy 'moral suasion' to accept the conversion offer of 1932.[12] And the yields were relatively attractive: for example, in the fourth quarter of 1932, 2½% Consols (an undated issue) yielded 3.35% on average, whereas Treasury bills yielded just 0.86%. Banks' holdings of gilts increased by £226 million (53%) in 1932, and continued to increase in the following years (Table 2). Between 1932 and 1938, banks invested three quarters of the increase in their deposits in gilts.

(c) The oligopoly in banking

The London clearing banks agreed among themselves in the 1930s that the normal minimum rate for advances would be 5% during the cheap money period, regardless of the Bank Rate. Nevin and Davis (1970, page 175) comment that:

> *Throughout the decade [the 1930s] the normal minimum was kept at 5 per cent, although it appears that the fall in market rates produced a decline in bank advance rates from between 5 and 6 per cent in 1931 to between 4½ and 5½ per cent in the mid-1930s. The rate charged would vary, of course, according to the credit and standing of the customer and the nature of the loan and the collateral offered.* [13]

Bank rate declined from 3.97% on average in 1931 to 2% from mid-1932 onwards. It is impossible to believe that lower lending rates would not have done something to stimulate the demand to borrow and thus the economic recovery.

Could a different debt management policy have made a difference? The amounts of debt outstanding, and in particular the scale of the War Loan conversion, were so enormous relative to GNP that debt management policy could not fail to have large macroeconomic effects. A policy of borrowing more at the short end, eg through Treasury bills, would have meant that the banks were not constrained from lending by a shortage of liquid assets. Moreover, it would have meant that the supply of longer term government debt was less ample, and the yields somewhat less attractive to the banks. In those circumstances, it might have been harder for the London clearing banks to maintain their cartel, and lending rates might have been lower.

It seems clear that debt management policy and monetary policy pursued consistent objectives from 1919 to 1931, but that from 1931 onwards debt management policy was not well-adapted to the changed objectives of monetary policy.[14] Nevertheless, it has also to be said that the long average maturity of the national debt probably made the management of the government's finances in the Second World War much easier.[15]

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[12] See Sayers (1976, pages 441–445).

[13] Nevin and Davis (1970, page 175) also report that 'According to the Chairman of the Midland Bank in 1934, a reduction of 1 per cent in the rate charged on advances by that bank would have entailed either a one-third cut in salaries or an almost complete suspension of dividend payments.' See also Collins (1988, page 254).

[14] This is not an original conclusion, having been reached by Nevin (1955, especially pages 149–154) and Howson (1975).

[15] See Nevin (1955, page 151).

3. The immediate aftermath of the Second World War

At the end of the Second World War, as at the end of the First World War, the UK had a vastly enlarged national debt, much of it short term. The ratio of private sector holdings of sterling government debt to GDP was about 170%. In the first couple of years after the war, the government's objective was not to lengthen the maturity of the debt, but to entrench a pattern of low yields. This objective reflected the widespread expectation of a return to depressed economic conditions after the war, and the perceived success of the 'cheap money' policy in stimulating economic recovery in the 1930s. The Treasury commissioned a National Debt Enquiry in early 1945, which recommended that the government should establish a term structure of yields on government securities, and allow the maturity structure of the government's debt to be determined by investors.[16] The level of interest rates should be:

> *fixed from time to time in the light of experience and should pay attention primarily to (a) the effects of Government policy on the market for borrowing by private institutions, companies and individuals and on the problem of controlling and maintaining the desired rate of investment at home and abroad, (b) to social considerations in the wider sense, and (c) perhaps especially to the burden of interest charges on the Exchequer and other State funds and on Local Authorities.*[17]

In effect, the proposal was to continue the wartime method of financing the government. However, whereas long-term yields had been pegged at 3% during the war, the Labour government elected in July 1945 aimed to reduce them to 2½% – 'ultra-cheap money'. The principal proponent of the policy was the Chancellor of the Exchequer, Dr Hugh Dalton.

The attempt to get long-term yields down to 2½% was made by refusing to offer government securities at yields higher than those which the government deemed acceptable.[18] Issues by non-government borrowers were subject to official control. The result of the policy was an increase in short-term financing of the government, as investors concluded that 2½% was not an adequate long-term yield against the background of extensive pent-up demand and ample liquidity, both in the banking system and elsewhere. The attempt resulted in the authorities becoming net buyers of gilts (including redemptions), as Table 3 shows. The 2½% objective was abandoned in 1947, when the Treasury's instinctive preference for 'sound financing' overcame its loyalty to the ultra-cheap money policy, though net purchases of gilts continued until 1948. Table 4 shows how yields rose during 1947 to levels well above 2½% at the long end, and Figure 3 shows interest rates and long-term gilt yields from 1945–61.

The effect of these operations on the maturity structure of government debt is shown in Table 5. The total of Treasury bills in the market increased by £1,026 billion in the three years after 31 March 1945; however there was a fall of £568 million in Treasury Deposit Receipts.[19] It is true that the amount of over-15-year gilts outstanding increased by £2,936 million in the six

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[16] See Fforde (1992) and Howson (1993, pages 45–54). At this time, the Treasury, not the Bank of England, was in effective control of both short-term interest rates (determined by the rate on Treasury bills) and debt management policy. The Bank of England was not invited to participate in the National Debt Enquiry, whose members did include the famous economists Lord Keynes, James Meade and Lionel Robbins.

[17] As quoted by Howson (1993, page 52).

[18] Fforde (1992, pages 330–359) and Howson (1993, chapter 3) provide detailed accounts of the episode.

[19] Treasury Deposit Receipts, introduced in 1940, were deposits placed by banks with the Treasury on the latter's instructions. They were not negotiable and matured after six months, but the holder could request repayment at any time for the purpose of subscribing to gilt issues, or for emergency purposes. They were therefore less liquid than Treasury bills.

years from 31 March 1945 (see Table 5), but £2,107 million of that amount was accounted for by gilts issued as compensation to owners of securities of companies that were nationalised in that period (in the transport, coal, electricity, gas, iron and steel, and telecommunications industries, as well as the Bank of England). In nationalising private companies, the government exchanged one long-term security (gilts) for others (equities and corporate bonds). The nationalisation programme therefore cannot be said to have changed the maturity structure of the government's balance sheet.

There was thus a significant shortening in the average maturity of government debt in the ultra-cheap money period 1945–48. And when proper adjustment for the nationalisation programme is made, it becomes clear that there was no real lengthening over the entire period of the Labour government (1945–51), despite the overhang of short-term debt at the end of the war (compare the adjusted figures for 1951 with those for 1945).

The large volume of liquid government debt outstanding at the end of the war, and its expansion during the ultra-cheap money period, facilitated rapid expansion of money and credit, as Table 6 shows. Bank credit expanded by more than 20% in both 1946 and 1947, and deposits increased by 16.2% in 1946. Inflation began to rise despite widespread price controls and rationing.

The period 1945–47 was one in which debt management policy was indistinguishable from monetary policy, and the structure of interest rates throughout the yield curve was managed as a single enterprise. Moreover the criteria for determining interest rates were clearly articulated. The experience showed, however, that pegging long-term bond yields at a level determined by the government, based on a mistaken economic forecast, and not endorsed by the market, was not a sustainable policy. The time for cheap money had passed.

4. The reactivation of monetary policy after 1951

The strength of demand after the war and the emergence of inflationary pressures made it clear to the incoming Conservative administration that a tighter monetary policy was needed.[20] Pursuing a tighter monetary policy was difficult, however, for two reasons. First, increases in short-term interest rates automatically caused increases in government expenditure on debt servicing and an automatic fiscal easing. Second, the banks had large stocks of Treasury bills which they could easily liquidate to finance commercial loans. Controls on bank lending, in the form of official 'requests', could contain the pressure to some degree, but their continuing effectiveness could not be taken for granted. Short-term interest rates would have to rise.

Against this background it is understandable that the main objective of debt management policy after 1951 was to sell more gilts, run down the stock of Treasury bills, and thereby extend the average maturity of the outstanding debt. However, the desire to spare the Treasury increased debt servicing costs as interest rates rose implied imposing costs on someone else, and government securities were a notoriously bad investment for nearly three decades. The price of 3½% War Loan, which had been issued in 1932, fell from 103 7/16 at the end of 1946 to 77 5/8 at the end of 1952 to 56 at the end of 1962, as Figure 2 shows.[21] Had exchange controls not been in operation, and had bank balance sheet expansion not been restrained by controls, the fall in prices would have been faster. At the same time, the

[20] The Chancellor of the Exchequer was Mr R A Butler.

[21] Therefore it would not have been in the Treasury's interest to consider calling the issue at the first option date on 1 December 1952.

retail price index rose steadily, as Figure 2 also shows. The national debt-to-GDP ratio fell from 241 per cent in 1948 to 111 per cent in 1962, a fall of 54%, but it would have been only 23% in the absence of inflation, on the wholly unrealistic assumption that other things would have been equal.

An example of the way in which funding policy imposed losses on the private sector is provided by the very large Serial Funding operation of November 1951. Bank Rate, which had been unchanged at 2% since 1932 (apart from a short-lived increase on the outbreak of war), was increased to 2½% on 8 November.[22] In order to absorb surplus liquidity, and reduce the cost to itself of raising short-term interest rates, the Treasury simultaneously offered three new government securities, with 1-, 2- and 3-year maturities, known as Serial Funding stocks. They were issued in exchange for Treasury bills and were aimed principally at banks and discount houses, who were subjected to 'moral suasion' to subscribe. The total sold on first issue was £1 billion, which thus absorbed more than a quarter of the Treasury bills outstanding outside the public sector (as estimated by the Radcliffe committee).They were sold at yields of 1.245%, 1.495% and 1.750% per cent respectively for 1, 2 and 3-year maturities.[23] The increase in Bank Rate from 2½ to 4% in March 1952 caused the prices of the Serial Funding stocks to fall heavily and imposed large losses on the holders.[24] The resentment engendered by this episode among the leveraged and undiversified discount houses persisted until at least the late 1980s, as the author can testify.[25]

The authorities had some limited success in lengthening the maturity of the outstanding debt. As Table 7 shows, the volume of Treasury bills held in the market fell sharply in the year ending 31 March 1952 as a result of the Serial Funding operation, although the reduction was partly reversed in the following few years. Moreover, the banks' holdings of gilts increased sharply in 1952–54 (see Table 6).

Gilt-edged issues in the 1950s were concentrated at short and medium maturities, and there were few long-term (over 15-year) issues, as Table 7 shows. Why was this? Fforde's history of the Bank of England demonstrates that the main concern of monetary policy at that time was to restrain bank credit, and gilt sales helped achieve that objective by absorbing liquid assets (Treasury bills) from the banks and thereby reducing their cash and liquid asset ratios and their capacity to lend.[26] Debt management policy thus rested heavily on the London clearing banks' minimum ratio of roughly 30% of cash and liquid assets (including Treasury bills but not gilts) to deposits. From that standpoint, gilt sales to banks were highly desirable and it would have been natural for new issues to have been at short/medium maturities, with bank investors in mind.

However, this cannot be a complete explanation. Sales of long-term gilts to non-banks, such as pension funds, would have absorbed bank deposits and reduced the banks' liquidity ratios in a different way; they would have been no less effective in achieving the objectives of monetary policy. But sales of long-term gilts were quite small, and the amount of over-15 year gilts outstanding[27] fell from £8.6 billion at the end of March 1951 to £6.6 billion

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[22] For an account of the tightening of monetary policy in November 1951, see Fforde (1992, pages 398–412). The account makes it clear that debt management was an integral part of monetary policy.

[23] Source: Pember and Boyle (1976).

[24] The rise in Bank Rate to 4% is described by Fforde (1992, pages 445–448). On a very rough calculation, the total losses of investors in serial funding stocks over the three years they were in issue will have been 0.06% of one year's GDP.

[25] See also Cleaver and Cleaver (1985, page 86) and Kynaston (2002, page 48).

[26] See Fforde (1992, chapter 10).

[27] Other than those held by the National Debt Commissioners.

ten years later (see Table 7). It was in the 1950s that the 'cult of the equity' became fashionable among fund managers. Equities were attractive not only because of their positive attributes but also because of the negative attributes of gilts. George Ross Goobey, an influential fund manager who was the leading advocate of equities, put it as follows:

> *In the actuary's calculations it is assumed that the capital value of the investment is sacrosanct, but this does not necessarily mean that the value of each investment is sacrosanct. What is intended is that the capital value of the fund must not be reduced in one way or another. Even in the most respectable funds, of course, we do get capital depreciation. How many funds, for instance, in the old days invested in Daltons at par? It will be a long while before we see them back at what they were purchased at – if ever. Yet we have criticism of investment in Ordinary stocks and shares on the grounds that one is going into this class of security with the contemplation that certain of them may create a loss.*[28]

Although the authorities were concerned to sell gilts to banks in order to absorb bank liquidity and thereby contain credit growth, there was nothing, except official requests to restrain lending, to stop banks selling gilts in order to finance additional bank advances. That is exactly what the banks did after lending controls had been withdrawn in 1958 (temporarily, as it turned out) and replaced with Special Deposits, which were an instruction to banks to place funds with the Bank of England.[29] Banks' holdings of gilts fell by £1.1 billion (45.0%) between 1959 and 1961, and advances to customers increased by £1.4 billion (55.9%). Special Deposits were £0.2 billion at the end of 1961.The banks' cash and liquid assets ratio actually increased by 1.5 percentage points in 1959–61 (data are from Table 6).

The objective of monetary policy in the 1950s was to contain private sector demand sufficiently to keep aggregate demand and supply roughly in balance, and thereby protect the exchange rate parity and contain inflation. Debt management and official controls were regarded as weapons of monetary policy, along with variations in short-term interest rates, which were used rather sparingly, perhaps because of their effects on the government's debt servicing costs. The policy was barely sufficient to protect the exchange rate parity; there were a number of crises and the pound had ultimately to be devalued (in 1967) after a long struggle. The heavy reliance on controls on bank lending stifled competition in banking and eventually became unsustainable.

5. Overfunding

The inflationary experience of the 1970s led to a desperate search for a method of managing an effective anti-inflationary monetary policy. The result was monetary targets, which were initially adopted in 1976. The target was for the growth rate of broad rather than narrow money. The Bank of England knew at the time that the demand for broad money was not a stable function of income and short-term interest rates, and short-term interest rates were not an effective means of controlling broad money growth.[30] The choice of a broad rather than a narrow target was made partly on the grounds that it was superficially easier to relate

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[28] See Ross Goobey (1956, pages 29–30). 'Daltons' was the market's name for the 2½% undated stock issued in January 1947 by Dr Dalton in pursuit of ultra-cheap money. Mr Ross Goobey was right: the price of Daltons has not returned to par since they were issued; moreover, the currency in which the price is expressed has been greatly inflated.

[29] See Capie (2010, pages 253–257).

[30] See Hacche (1974) and Allen (1981).

monetary growth to the budget deficit in the case of broad money than in the case of narrow money, so a broad money target offered a better prospect than a narrow one of influencing fiscal policy.[31]

The stakes were raised with the advent of the Thatcher administration in 1979. The new government, anxious above all to subdue inflation, introduced a Medium Term Financial Strategy whose centrepiece was a sequence of decreasing targets for the annual growth of broad money over five years. This was based in the idea that a commitment to reducing monetary growth was a necessary condition for bringing inflationary expectations down.

Short-term interest rate management, as already noted, was not effective in controlling broad money. Debt management, however, was effective. By selling government securities to non-banks, the Bank of England (which was the government's debt manager) could exert some control on broad money growth by absorbing from the non-bank private sector liquidity created by bank credit. Table 8 shows how overfunding of the budget deficit offset the expansionary effects of bank credit on broad money growth. For the purpose of controlling broad money, the maturity of the debt that was sold was largely immaterial, except that sales of shorter-dated debt were more likely to be to banks and therefore not to contribute to containing broad money growth, and that of course the shorter the term of the debt sales is the sooner they need to be refinanced. The maturity structure of debt sales is shown in Table 9.

Overfunding meant selling more than enough long-term debt (mainly gilts and National Savings instruments) to finance the government, so that the stock of Treasury bills was run down to the minimum amount compatible with keeping the market in existence, and the Bank of England built up a large holding of commercial bills, those being the assets which it chose to buy in order to relieve shortages of cash in the market. This was known as the 'bill mountain', which reached £15.1 billion, or 4¾% of GDP, at the end of March 1984,[32] at times within financial years exceeding £20 billion. These developments are shown in Table 10.

Despite the difficulties of meeting monetary targets, the rate of inflation and inflationary expectations fell sharply in the first half of the 1980s, and long gilts were, for the first time for many years, an attractive investment, particularly during 1982 (see Figure 4).

The inflationary expectations of the government were higher than those of the market, and long gilts were accordingly unattractive to the government as an issuer; it was partly for that reason that index-linked gilts were introduced in 1981. Nevertheless, there were also substantial sales of long conventional (ie not index-linked) gilts; in addition, there were sales of convertibles ie short-dated stocks convertible at the holder's option and at a pre-determined price ratio into longer maturities. The available data are shown in Table 9.

There was scope for debate about whether overfunding indirectly caused additional bank lending and was therefore less effective than it appeared to be in containing monetary growth. Certainly there was evidence of some amount of 'round-tripping' operations in which companies drew bills which could be sold to the Bank of England, and placed the proceeds on deposit with a bank, earning a positive interest margin. However it is hard to dispute that overfunding was effective in draining liquidity from the economy.

Overfunding was brought to an end in 1985 by Chancellor of the Exchequer Nigel Lawson.[33] In his memoirs, he comments that

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[31] The constraints normally imposed by the International Monetary Fund on Domestic Credit Expansion had the same quality. See Fforde (1983).

[32] See Coleby (1983) for further discussion.

[33] At the same time, the broad money target was supplemented with, and thus diluted by, an additional monetary target for the monetary base (M0).

> *By the time of my Mansion House Speech of 17 October 1985, the position had become ridiculous. The bill mountain had grown to fresh heights; yet M3 [the targeted broad monetary aggregate] had in the latest twelve months grown by 14 per cent compared with a 5 to 9 per cent target rate. The conclusion I reached was that overfunding should be abandoned and net sales of gilts confined, as in the old days, to financing the Budget deficit.*[34]

In effect, the volume of gilt sales, and the maturity structure of the government's balance sheet, was being determined by the rate of bank credit extension, which was in turn determined by the banks and not the government. This was too much for the Treasury. The coordination of debt management policy with monetary policy had reached its outer limit.

6. Measurement of debt management policy initiatives

There is no comprehensive one-dimensional measure of debt management policy, since any shift in the distribution of debt between any pair of maturities across the entire maturity spectrum, or any shift in the distribution of debt between different types (eg having different tax status), in principle represents a change in policy.

However it is possible to measure the effect of debt management actions crudely by their effect on the volume of Treasury bills and other short-term government debt outstanding in the market. This section sets out such a measure for the main debt management actions in the episodes described above, and compares them with the recent quantitative easing conducted by the Bank of England. The results are summarized in Table 11.

(a) The War Loan conversion

Measurement is difficult in this case. The 5% War Loan was widely expected to be called before long and its price therefore could not rise much above par. It had a liquid market and behaved like a short-dated government security, though banks could not treat it as a liquid asset. In the conversion operation, £1,921 million of the £2,085 million outstanding was converted into 3½% War Loan 1952 or after, and the remainder of £163 million was redeemed for cash. Thus £2,085 million of a quasi-short-dated government securities disappeared, equivalent to 49.4% of GDP, and £163 million of new Treasury bills were created to finance cash redemptions, equivalent to 3.9% of GDP.

(b) Ultra-cheap money

In the three years after 31 March 1945, the total of Treasury bills held in the market increased by £1,026 million, or 9.6% of average GDP. The total of Treasury Deposit Receipts fell by £568 million (5.3% of GDP) over the same period, however.

(c) Reactivation of monetary policy

Section 4 and Table 7 show that the effect of the debt management component of post-1951 monetary policy was at its strongest after the Serial Funding operation of November 1951. Later debt management operations were largely aimed at refinancing the Serial Funding

[34] Lawson (1992, page 459).

issues and their successors as they matured. The Serial Funding operation absorbed £1 billion of Treasury bills, equivalent to 6.8% of GDP, and that is the measure of its scale.

(d) Overfunding

In measuring the scale of overfunding, it is necessary to include not only the fall in Treasury bills outstanding but also the accumulation of commercial bills by the Bank of England. Between the end of March 1978 and the end of March 1984, the estimated total was £12.4 billion, or 4.9% of average GDP.

The recent quantitative easing has involved the purchase of £198.3 billion of gilts by the Bank of England in exchange for deposits in the Bank of England, which may be regarded as liquid assets. The scale of the operation is 13.9% of average GDP in 2009–10, and this is the amount shown in Table 11. It is clear from Table 11 that, on the chosen measure, the recent quantitative easing is the largest debt management action since 1932.

7. Comparison of debt management policy initiatives

Both the National Debt Enquiry (1945) and the Radcliffe Committee (1959) attached great importance to government debt management as a weapon of macroeconomic policy. Both reports recommended that in implementing debt management policy the authorities should have an objective for the level of interest rates, not just at short maturities but at all maturities (see, for example, the Radcliffe committee's recommendation quoted in section 1 above). The authorities did indeed have an objective for interest rates at all maturities in the ultra-cheap money period of 1945–47, though they were unable to achieve it. At other times, however, their policy was quantity-driven. Thus, in the 1950s the immediate objective was to keep down the stock of Treasury bills and contain the scale of liquid assets available to banks, and in the 1980s it was to absorb from the non-bank private sector the liquidity created by bank lending.

There were at times problems in managing the pace of official gilt sales, particularly when gilt prices were falling and yields rising (see Goodhart 1998, pages 56–61, and Capie 2010, pages 468–482 and 689–695). Those problems had their origin in the microstructure of the gilt market, in which market-making services were provided within the stock exchange by a small number of jobbing firms which had relatively little capital and were in no position to underwrite a government auction. Analysis of this issue is beyond the scope of this paper; moreover, the problem disappeared with the 'Big Bang' in the London stock exchange in 1986 and the advent of broker-dealers in the gilt market.

It is possible to discern two distinct channels through which government funding operations *were thought to* support monetary policy at different times. One of them (the 1950s model) was through the effect of funding operations on the stock of Treasury bills and bank liquidity. Until 1971, the London clearing banks were, in effect, required to maintain a minimum ratio of cash and liquid assets to deposits of about 30 per cent. For this purpose, bills, including Treasury bills, counted as liquid assets, but gilts did not. Therefore selling gilts to absorb Treasury bills made the banks less liquid and effectively tightened monetary policy. This channel depended on selling gilts to banks and was based on the idea that a reduction in credit expansion, rather than in monetary growth, constituted a tightening of monetary policy.

The second channel (the 1980s model) depended on selling gilts to non-banks, which paid for them by drawing down bank deposits, and which, as a result of purchasing gilts, had smaller money balances. The liquidity of the banks and their ability to lend were not much affected because the supply of commercial bills, which could be sold to the Bank of England, proved to be very elastic. The second channel was based on the idea that a reduction in monetary growth, rather than credit expansion, constituted a tightening of monetary policy.

The workings of these two channels of influence are summarized in Table 12, together with a summary of the workings of quantitative easing (discussed in section 8).

The distinction between the two channels is more about the way in which the monetary authorities saw their policy working than about the way in which it actually worked. For one thing, the Treasury and the Bank of England could not of course determine who would be the buyers of the gilts they sold. And more fundamentally, as noted by Tobin (1963) and Friedman (1992), any sale of gilts in exchange for bills will have led to adjustments in relative yields and set off a chain of portfolio adjustments in both banks and non-banks; the Treasury and the Bank of England were however never able to measure or estimate these adjustments. The biggest difference between the 1950s and the 1980s was that the main banks observed the 30% minimum cash and liquid assets ratio in the 1950s, whereas by the 1980s, liability management had become normal practice and banks were no longer bound by any liquid asset ratios. It was in that environment that the Treasury's willingness to use debt management to support monetary policy was exhausted in 1985. This was the background to the UK debt management review of 1995 and the Bank of England conference of 1998, which were mentioned in the introduction.

8. Bank liquidity, quantitative easing and central bank independence

After the financial crisis, and with the advent of minimum liquid asset ratios imposed by regulators as part of Basel III, the environment has changed again.[35] Until the recent crisis, highly-rated banks could fund lending readily by interbank borrowing. The liquidity provided by government debt was of minor significance, as the debt management review of 1995 and the Bank of England conference of 1998 concluded. During the crisis, however, it suddenly became a matter of immense significance as banks could not borrow readily in commercial markets and needed emergency liquidity assistance from central banks, and as government debt was one of the assets regarded as safe even during the crisis.[36] Now, after the crisis, banks still cannot borrow nearly as readily to finance lending, and this is one reason why monetary and debt management policies are now once more interconnected. Another reason is the liquidity provisions of Basel III. These provisions make it unattractive to finance lending by short-term inter-bank borrowing, since liquid assets have to be held against 100% of inter-bank liabilities falling due within a month. Moreover, they require banks to hold their minimum quantities of liquid assets in large part in the form of government debt or other sovereign claims.

It has become common for debt management agencies to be assigned the objective of minimising the cost of the debt to the public finances, subject to not taking unacceptable risks.[37] The objective is an understandable one, and is consistent with the pre-1918 view of debt management in the United Kingdom as 'a matter of budgetary convenience' (see

[35] The Basel III Liquidity Coverage Ratio will not become formally effective until 2015, and the Net Stable Funding Ratio not until 2018, but they have already begun to affect banks' behaviour.

[36] See Allen and Moessner (2011, section 5).

[37] The stated objective of UK debt management is "to minimise, over the long term, the costs of meeting the Government's financing needs, taking into account risk, while ensuring that debt management policy is consistent with the aims of monetary policy." See H M Treasury (2011, page 10). The objective has been unchanged since the financial year 1998–99, immediately after responsibility for debt management had been transferred from the Bank of England to the newly-created Debt Management Office. The reference to monetary policy has been a dead letter for many years, and there are no institutional means of implementing it, since monetary policy is managed autonomously by the Bank of England, and the Debt Management Office is part of the Treasury.

reference to Hicks above). It is impossible to know in advance which debt management strategy will minimize cost, or, after the event, to assess the degree to which cost minimisation has been achieved, except over very long periods of time. Therefore the objective cannot provide very precise guidance to debt managers. For example, the debt management policy of the 1930s achieved a massive and much-needed reduction in debt servicing costs. Even though the cost saving would, as it turned out, have been greater if more Treasury bills and fewer gilts had been issued, that was not certain at the time the policy was implemented, and the policy actually pursued was entirely defensible at that time on cost minimisation grounds. Yet the analysis of this paper, and that of earlier commentators, suggests that it was not ideally adapted to promoting economic recovery. In present conditions, therefore, it is questionable whether cost minimisation is on its own a sufficient objective for debt management agencies.

The recent adoption of quantitative easing by the Bank of England and other central banks is a form of debt management (the replacement of gilts with deposits in the central bank) and is *ipso facto* tacit acknowledgment of the importance of debt management. In an economic sense deposits in the central bank are obviously much more liquid than, say, 30-year gilts; in that economic sense, quantitative easing obviously does provide more liquidity to the economy.

However, banks' decisions about liquid asset holdings are largely driven by regulation (or anticipation of future regulation), and in current circumstances this is what matters for portfolio behaviour. From the regulatory viewpoint, quantitative easing has no immediate effect on the supply of liquid assets to banks, because gilts are defined as liquid assets for regulatory purposes; thus quantitative easing involves exchanging one liquid asset (deposits in the central bank) for another (gilts), and does not affect the total amount of liquid assets available. However, quantitative easing may nevertheless induce a shifting of liquid assets (as defined for regulatory purposes) from non-banks to banks. Sales of gilts by non-bank investors such as pension funds leave gaps which may be partly filled by newly-issued corporate securities, the proceeds of which may be used to repay bank loans. To the extent that this happens, bank liquidity ratios improve.[38]

It is too soon to assess the effects of quantitative easing (short- and long-term interest rates since 2007 are shown in Figure 5: Yields on 2.5% Consols and 3-month Treasury bills, 2007–11).

However, quantitative easing is thought of as a policy weapon to be used in exceptional circumstances, when short-term interest rates are so low that they can go no lower. Debt management continues, whatever the level of short-term interest rates, and its renewed importance for monetary policy is likely to persist even after interest rates have begun to rise.

The conclusion that debt management is once more highly relevant to monetary policy raises an awkward question about the independence of central banks from governments, and of governments from central banks. If, as in the past, government debt management is to be an integral part of monetary policy, who is to manage it? The possibilities are:

(i) For governments to delegate debt management to independent central banks. However, since governments could not dismiss central bankers for poor debt management performance, or easily recruit an alternative debt manager, they would not find this option attractive.

[38] If the non-bank sellers of gilts to the Bank of England simply leave the proceeds on deposit in the bank, the bank's liquidity is increased, but its liquidity requirement under the Basel III Liquidity Coverage Ratio may also increase, by an amount depending on the nature of the depositor and the maturity of the deposit.

(ii) For governments to take decisions about debt management (possibly after discussion with their central banks), and leave it to central banks to react as they see fit, as they do in the case of fiscal policy. However this leaves open the possibility that the central bank might want to conduct very large operations in government debt, but find that the financial risks involved would be so great that it was unable to do so without a government guarantee, and therefore unable to pursue the monetary policy that it thought best adapted to the needs of the time without government support. This involves a compromise of central bank independence.

(iii) For monetary and debt management policies to be managed jointly by the central bank and the government. This too would compromise central bank independence.

None of these possibilities is entirely satisfactory. Quantitative easing has the attraction, from the central bank's point of view, that it can be conducted without any coordination with the debt management office, and therefore avoids raising the question of independence directly. But the Bank of England needed an indemnity from the Treasury for any losses incurred in its recent quantitative easing operations. Had the Treasury not agreed with the policy, there would have been no indemnity and no quantitative easing. The Bank obtained the indemnity, and solution (ii) was adopted. The question will need to be answered permanently if debt management comes again to be treated as an enduring integral part of monetary policy, even after short-term interest rates have risen from the floor.

Statistical annex

Note on data

Statistics on debt management are not easy to come by for all periods of the 20th century. For much of the time, the Treasury and the Bank of England were anxious not to disclose information about their operations, normally wanting the market to think they had sold more debt than they actually had. Until the extensive recommendations of the Radcliffe report about collection and publication of statistics had been implemented, not much information was therefore available from official sources. The stockbrokers Pember and Boyle published an admirable compendium of information called 'British Government Securities in the Twentieth Century' in two volumes, covering 1900–1950 and 1951–1975 respectively (see Pember and Boyle, 1950 and 1976). They provide information about the maturity structure of government debt in issue, and of gilts (but not other government securities) held by the National Debt Commissioners (an internal government fund). However, they do not provide (and did not have) information about debt held by other bodies within the public sector, such as the Issue Department of the Bank of England, whose holdings and transactions were kept secret. Therefore the total debt figures they report overstate the holdings of debt outside the public sector.

Howson (1975) contains estimates relating to the inter-war period, and I have used them in this paper. As regards the post-war period, the Radcliffe report included some very useful statistical information on government financing. The government debt data used in this paper for the period 1945–1951 are taken from the Radcliffe data. For the period after 1951, I use the Pember and Boyle data, supplemented with some information from Radcliffe. During the overfunding period of the 1980s, more official data were published (thanks to Radcliffe) and I use them.

Estimates of nominal GDP for the period up to 1947 are taken from Officer (2011). For 1948 onwards, the estimates of the Office for National Statistics are used.

Note on terminology

'British government securities' are debt securities of all kinds issued by the British government. There were also some securities issued by nationalized industries and guaranteed by the government; for the purposes of this paper, they are indistinguishable from British government securities.

'Gilt-edged securities' are bonds issued by the British government with original maturities of a year or more and listed on the London stock exchange. They are thus a subset of British government securities[39]. Treasury bills are discount instruments which can have maturities as long as a year but have normally been issued with maturities no longer than six months. They are not listed on the London stock exchange.

The British government's financial year begins on 1 April, so that, for example, the financial year 1946–47 ran from 1 April 1946 to 31 March 1947.

[39] Some issues by borrowers other than the British government were also treated by the stock exchange as gilt-edged, but this complication is irrelevant to the present paper.

Table 1

Private-sector holdings of national debt, 1919–39

As at 31 March each year (£ millions)

	Gilts					Other debt			Total
	< 5 years	5–15 years	15–25 years	> 25 years	Repayable only by govt option	Floating debt	Other internal debt	External debt	
1919	937	1,027	56	1,954	237	865	248	1,293	6,617
1920	861	860	64	2,648	236	901	300	1,222	7,092
1921	841	811	79	2,593	236	935	309	1,129	6,933
1922	572	1,167	77	2,545	486	762	373	1,085	7,067
1923	693	774	2,067	686	905	514	375	1,156	7,170
1924	1,053	312	2,142	672	890	483	385	1,126	7,063
1925	951	292	2,213	657	914	486	390	1,122	7,025
1926	1,000	155	2,283	643	974	487	396	1,111	7,049
1927	733	212	2,352	631	1,097	535	396	1,101	7,057
1928	502	344	2,386	641	1,225	474	385	1,095	7,052
1929	472	194	2,402	613	1,360	507	388	1,085	7,021
1930	443	307	2,099	905	1,346	426	380	1,074	6,980
1931	366	397	2,070	897	1,323	446	409	1,067	6,975
1932	399	337	2,073	891	1,310	520	409	1,091	7,030
1933	112	558	259	885	3,263	654	409	1,060	7,200
1934	276	553	474	879	3,229	644	419	1,037	7,511
1935	184	557	284	1,008	3,191	612	311	1,037	7,184
1936	101	549	281	958	3,522	660	311	1,037	7,419
1937	67	533	732	754	3,163	561	303	1,033	7,146
1938	65	900	464	753	3,156	683	313	1,032	7,366

Source: Howson (1975)

Table 2

UK banks' assets and deposit liabilities, 1918–38

(£ millions, ends of year)

	Cash, money at call and short notice	Discounts	o/w Treasury bills	o/w commercial bills	Investments	o/w govt securities	Loans, advances and other accounts	Total assets/ liabilities	Deposits
1918	623.9	389.8	196.8	193.0	531.9	421.9	640.8	2,221.9	2,024.5
1919	594.3	320.7	172.1	148.6	617.0	513.6	1,055.4	2,611.8	2,398.2
1920 (a)	584.8	400.2	164.4	235.8	571.0	469.8	1,177.4	2,771.2	2,537.7
1920 (b)	551.5	392.9	159.5	233.4	508.2	417.5	1,115.3	2,604.1	2,397.6
1921	546.6	520.7	290.7	230.0	530.1	451.9	991.4	2,620.1	2,420.0
1922	523.4	353.4	207.3	146.1	610.4	516.1	939.7	2,461.2	2,261.2
1923	506.2	315.3	158.8	156.5	573.3	489.6	978.0	2,408.0	2,210.2
1924	525.7	269.2	115.9	153.3	526.9	441.6	1,039.1	2,397.9	2,194.2
1925	528.5	256.0	110.2	145.8	469.0	390.4	1,099.1	2,390.6	2,184.3
1926	528.3	265.1	123.4	141.7	453.5	374.9	1,145.8	2,432.6	2,222.9
1927	584.3	263.8	127.6	136.2	436.3	353.8	1,162.3	2,487.9	2,274.7
1928	591.3	287.6	128.3	159.3	441.8	373.1	1,199.1	2,570.9	2,351.7
1929	571.6	253.1	117.9	135.2	439.8	357.7	1,222.7	2,535.8	2,314.5
1930	570.7	371.0	190.5	180.5	507.5	420.6	1,125.1	2,622.9	2,396.0
1931	501.6	290.5	207.7	82.8	516.8	427.8	1,071.7	2,440.2	2,225.5
1932	546.9	450.0	349.6	100.4	754.7	654.3	924.4	2,722.2	2,509.6
1933	542.9	341.7	265.7	76.0	881.1	774.2	881.3	2,697.8	2,484.9
1934	583.3	267.6	187.7	79.9	919.0	811.4	916.8	2,744.9	2,525.9
1935	609.0	317.6	198.8	118.8	967.9	847.8	939.3	2,891.3	2,672.8
1936	677.0	300.4	196.9	103.5	1,026.5	904.7	1,016.4	3,072.2	2,855.8
1937	635.9	294.3	175.5	118.8	1,005.1	885.3	1,124.0	3,113.2	2,887.7
1938	613.9	244.3	143.9	100.4	996.0	875.8	1,121.9	3,034.3	2,810.4

Notes:

(a) Including Southern Ireland.

(b) Excluding Southern Ireland.

Source: Sheppard (1971, table (A) 1.1).

Table 3

Net official sales of gilts, 1945–49

(£ million)

Quarter	Net official sales (+)
1945Q2	141
1945Q3	166
1945Q4	655
1946Q1	30
1946Q2	200
1946Q3	-91
1946Q4	-40
1947Q1	-107
1947Q2	-25
1947Q3	-104
1947Q4	-81
1948Q1	-253
1948Q2	-32
1948Q3	-19
1948Q4	28
1949Q1	90

Source: Central Statistical Office (1961, table 1).

Table 4

Government bond yields, 1945–47 (%)

End of	Short	Medium	Long	Consols
Jul-45	2.41	2.64	2.96	2.83
Aug-45	2.39	2.66	2.95	2.82
Sep-45	2.45	2.63	2.98	2.82
Oct-45	2.55	2.62	2.98	2.70
Nov-45	2.56	2.68	2.99	2.76
Dec-45	2.54	2.70	2.97	2.73
Jan-46	2.34	2.55	2.78	2.71
Feb-46	2.24	2.50	2.68	2.70
Mar-46	2.28	2.40	2.69	2.67
Apr-46	1.96	2.17	2.51	2.60
May-46	2.13	2.38	2.62	2.50
Jun-46	2.15	2.39	2.60	2.57
Jul-46	2.09	2.36	2.53	2.58
Aug-46	2.04	2.33	2.52	2.59
Sep-46	2.05	2.23	2.48	2.56
Oct-46	1.68	2.05	2.28	2.54
Nov-46	1.78	1.97	2.27	2.53
Dec-46	1.73	1.99	2.29	2.54
Jan-47	1.55	1.91	2.22	2.54
Feb-47	1.74	2.04	2.36	2.58
Mar-47	1.90	2.23	2.52	2.64
Apr-47	1.97	2.19	2.48	2.63
May-47	1.92	2.16	2.47	2.62
Jun-47	2.08	2.35	2.66	2.68
Jul-47	2.53	2.75	3.00	2.78
Aug-47	2.60	2.69	2.97	2.99
Sep-47	2.69	2.78	2.99	2.99
Oct-47	2.41	2.59	2.79	2.90
Nov-47	2.42	2.76	2.98	2.87
Dec-47	2.54	2.91	3.00	3.01

Short	2.5% Nat War Bonds 1952/54
Medium	2.5% Funding 1956/61
Long	3% Savings 1960/70
Consols	2.5% Consols

Source: Howson (1993, table 3.4)

Table 5

Market (ie non-official) holdings of government debt, 1945–52

£ millions (% of total holdings in italics)

31 Mar	Treasury bills	Treasury Deposit Receipts	Gilts < 5 years	Gilts 5–15 years	Gilts > 15 years and undated	Small savings	Tax Reserve certificates	Total
1945	2,099	1,859	1,297	2,649	5,691	2,273	683	16,551
	12.7	*11.2*	*7.8*	*16.0*	*34.4*	*13.7*	*4.1*	
1946	2,731	1,559	966	3,071	6,623	2,565	648	18,163
	15.0	*8.6*	*5.3*	*16.9*	*36.5*	*14.1*	*3.6*	
1947	2,993	1,457	1,300	2,610	7,024	2,783	529	18,696
	16.0	*7.8*	*7.0*	*14.0*	*37.6*	*14.9*	*2.8*	
1948	3,125	1,291	1,736	1,869	7,925	2,775	426	19,147
	16.3	*6.7*	*9.1*	*9.8*	*41.4*	*14.5*	*2.2*	
1949	2,521	1,136	2,401	1,188	8,405	2,713	359	18,723
	13.5	*6.1*	*12.8*	*6.3*	*44.9*	*14.5*	*1.9*	
1950	3,245	465	2,100	1,172	8,627	2,669	318	18,596
	17.4	*2.5*	*11.3*	*6.3*	*46.4*	*14.4*	*1.7*	
1951	3,576	284	1,724	2,320	8,226	2,644	386	19,160
	18.7	*1.5*	*9.0*	*12.1*	*42.9*	*13.8*	*2.0*	
1951 (1)	3,576	284	1,724	2,320	6,119	2,783	529	17,335
	20.6	*1.6*	*9.9*	*13.4*	*35.3*	*16.1*	*3.1*	

Note: (1) adjusted to exclude nationalisation compensation issues.

Source: Central Statistical Office (1961, tables 2b, 3 and 4), Howson (1993, page 199 ff)

Table 6

UK banks' assets and deposit liabilities, 1945–66

(£ billions, ends of calendar year)

	Cash, money at call and short notice	Treasury Deposit Receipts and Special Deposits	Discounts	o/w Treasury bills	Investments	o/w gilts	Loans, advances and other accounts	Total assets/liabilities	Deposits
1945	1.2	1.6	0.4	0.3	1.9	1.8	0.9	6.1	5.8
1946	1.4	1.6	0.6	0.5	2.2	2.0	1.1	7.1	6.8
1947	1.5	1.3	0.8	0.7	2.3	2.1	1.4	7.4	7.1
1948	1.3	1.4	0.8	0.6	2.2	2.1	1.5	7.7	7.3
1949	1.4	0.8	1.1	1.0	2.2	2.1	1.7	7.7	7.3
1950	1.4	0.5	1.4	1.3	2.2	2.1	1.9	7.8	7.5
1951	1.4	0.1	1.0	0.8	2.6	2.5	2.2	7.8	7.5
1952	1.4		1.3	1.2	2.8	2.6	1.9	7.9	7.6
1953	1.4		1.5	1.4	2.9	2.8	1.9	8.2	7.8
1954	1.4		1.3	1.2	3.0	2.9	2.1	8.5	8.2
1955	1.4		1.4	1.3	2.6	2.5	2.0	8.1	7.8
1956	1.4		1.5	1.3	2.6	2.4	2.1	8.2	7.8
1957	1.5		1.6	1.5	2.6	2.5	2.1	8.5	8.1
1958	1.5		1.4	1.2	2.7	2.5	2.5	8.7	8.4
1959	1.6		1.4	1.2	2.2	2.0	3.3	9.3	8.9
1960	1.8	0.2	1.2	1.0	1.7	1.6	3.8	9.5	9.0
1961	1.9	0.2	1.4	1.2	1.6	1.4	3.9	9.7	9.2
1962	2.0		1.4	1.1	1.7	1.6	4.2	10.1	9.5
1963	2.1		1.4	1.0	1.7	1.5	4.9	10.8	10.2
1964	2.1		1.2	0.8	1.5	1.3	5.5	11.3	10.6
1965	2.4	0.1	1.3	0.8	1.6	1.4	5.7	12.1	11.3
1966	2.7	0.2	1.2	0.7	1.6	1.4	5.7	12.2	11.4

Source: Sheppard (1971, table (A) 1.1).

Table 7

Government debt by type of instrument, 1950–61

(£ billions; figures in italics are percentages of the total amount of gilts outstanding as at 31 March of each year)

	Treasury bills (1)	Ways and Means advances from Bank of England	Gilts (2)					Other
31 Mar			< 5 years	5–15 years	15–25 years	> 25 years and undated	Total gilts	
1950	3.2	0.4	2.3	1.3	2.8	6.0	12.4	8.2
			18.9	*10.5*	*22.4*	*48.3*		
1951	3.6	0.4	1.8	2.4	3.3	5.3	12.8	7.9
			13.9	*18.8*	*25.8*	*41.5*		
1952	2.3	0.3	3.1	2.1	3.5	5.2	13.9	7.8
			22.6	*14.8*	*25.2*	*37.4*		
1953	2.7	0.3	3.4	2.7	3.0	5.3	14.3	7.6
			23.6	*18.6*	*20.7*	*37.1*		
1954	2.8	0.3	3.2	3.4	2.9	5.4	15.0	7.5
			21.4	*23.0*	*19.5*	*36.2*		
1955	2.9	0.3	3.2	3.6	2.8	5.5	15.1	7.3
			21.4	*23.9*	*18.3*	*36.5*		
1956	2.9	0.3	3.7	4.7	2.4	4.8	15.7	7.2
			23.8	*30.0*	*15.6*	*30.6*		
1957	2.6	0.3	4.3	4.0	2.6	5.1	16.0	7.4
			26.6	*25.2*	*16.5*	*31.7*		
1958	2.9	0.3	3.5	4.5	2.7	5.1	15.8	7.3
			22.0	*28.6*	*16.9*	*32.5*		
1959	4.9	0.3	2.9	5.0	2.5	4.8	15.3	7.5
			19.3	*32.7*	*16.4*	*31.6*		
1960	5.2	0.2	2.7	5.2	2.1	5.1	15.1	7.7
			18.2	*34.3*	*13.6*	*33.9*		
1961	4.6	0.3	4.5	4.9	1.3	5.3	16.0	7.6
			28.4	*30.5*	*8.0*	*33.1*		

Notes:

(1) Estimated market holdings up to 1958 (sources: CSO 1961; Radcliffe Committee Principal Memoranda of Evidence vol I, table III); including public sector holdings after 1958 (source Pember and Boyle, 1976).

(2) Excluding holdings of National Debt Commissioners but including holdings of other public sector bodies (source Pember and Boyle, 1976).

Table 8

Overfunding and broad money growth, 1977/78 to 1984/85

	1977/78	**1978/79**	**1979/80**	**1980/81**	**1981/82**	**1982/83**	**1983/84**	**1984/85**
Target set for sterling M3 (% increase)	9 - 13	8 - 12	7 - 11	7 - 11	6 - 10	8 - 12	7 - 11	6 - 10
£ billions								
Actual growth in sterling M3	6.2	5.3	6.4	10.3	9.7	9.8	7.6	12.0
Increase in bank lending to UK private sector	3.7	6.3	9.3	9.2	14.9	14.4	15.4	18.8
PSBR	5.5	9.2	9.9	12.7	8.6	8.9	9.8	10.1
UK non-bank residents' net purchases of public sector debt	6.9	8.5	9.2	10.8	11.3	8.4	12.6	12.4
Net funding (overfunding +, underfunding -)	1.4	-0.7	-0.7	-1.9	2.7	-0.5	2.8	2.3

Source: Temperton (1986), tables 2.2 and 3.11.

Table 9

Net and gross official sales of gilts, 1978/79 to 1989/90

(£ millions)

	Net official sales		**Redemptions (1)**		**Gross official sales**				
						Conventional			
FY	**Index-linked**	**Conventional**	**Index-linked**	**Conventional**	**Index-linked**	***Total***	**1–5 years**	**5–15 years**	**> 15 years and undated**
1978/79	**-**	**6,454**	-	-1,700	-	*7,956*	2,192	1,441	4,323
1979/80	**-**	**9,433**	-	-3,657	-	*12,634*	2,659	2,969	7,006
1980/81	**-**	**12,453**	-	-2,566	-	*15,673*	3,030	6,831	5,812
1981/82	**1,906**	**5,959**	-	-4,677	1,906	*8,730*	3,285	4,217	1,228
1982/83	**2,621**	**5,306**	-	-5,363	2,621	*7,882*	3,841	4,035	6
1983/84	**1,931**	**11,511**	-	-3,686	1,931	*13,432*	6,551	5,941	940
1984/85	**1,833**	**11,053**	-	-5,034	1,833	*13,424*	4,861	6,164	2,399
1985/86	**709**	**5,216**	1	-6,006	708	*10,972*	3,286	3,102	4,584
1986/87	**2,569**	**5,884**	-	-8,563	2,569	*12,132*	2,558	5,124	4,450
1987/88	**63**	**6,956**	-886	-5,452	949	*12,462*	3,879	4,917	3,666
1988/89	**751**	**-13,328**	-193	-8,322	944	*-5,757*	-655	-1,691	-3,411
1989/90	**-476**	**-15,792**	-439	-9,492	-37	*-5,824*	-669	-3,626	-1,529
			Maturity changes on conversion						
			1–5 years	**5–15 years**	**> 15 years**				
1978/79			-	-	-				
1979/80			- 1	-	1				
1980/81			-	-	-				
1981/82			-2	2	-				
1982/83			-1 320	817	503				
1983/84			- 294	-	294				
1984/85			-313	-	313				
1985/86			-11	- 5	16				
1986/87			-1 015	332	683				
1987/88			-386	3	383				
1988/89			-343	-	343				
1989/90			-	-	-				

Note: (1) And official purchases.

Table 10

Government financing and the Bank of England balance sheet, 1978/79 to 1989/90

(£ billions)

	Bank of England cash flows							Offsetting operations			
	Central government net cash requirement	**Net gilt sales (-)(1)**	**Other debt sales (ex treasury bills, -)**	**Currency circulation (-)**	**Reserves**	**Other flows**	**Total**	**B of E commercial bill holding**	**Treasury bills in market (-)**	**Total bills**	**Level of B of E commercial bill holding**
Financial years											
1978/79	7.8	-6.3	-2.9	-0.1	-1.3	N/A	-2.8			2.8	
1979/80	8.1	-9.0	0.6	-0.1	0.6	N/A	0.2			-0.2	
1980/81	12.7	-13.1	-2.6	-0.6	0.8	-0.5	-3.4	2.5	1.1	3.6	8.4
1981/82	7.6	-6.0	-4.9	-0.2	-1.3	-0.1	-4.8	4.1	0.0	4.1	12.5
1982/83	12.7	-5.3	-4.1	-1.2	-1.6	0.3	0.9	-1.0	-0.3	-1.3	11.5
1983/84	12.2	-11.5	-3.0	-0.3	0.1	-0.5	-3.0	3.6	-0.1	3.5	15.1
1984/85	10.2	-11.1	-3.9	-0.9	-0.5	6.7	0.5	-2.7	0.2	-2.5	12.4
1985/86	11.0	-5.2	-2.5	-0.7	1.1	0.1	3.7	-2.0	-0.1	-2.2	10.4
1986/87	10.5	-5.9	-2.6	0.3	1.5	0.7	4.4	-3.3	-0.6	-3.7	7.1
1987/88	1.4	-7.1	-2.3	-1.9	11.4	-1.0	0.6	2.5	-0.8	1.7	9.5
1988/89	-9.7	13.3	0.0	-0.8	1.5	1.9	6.2	-5.7	-0.5	-6.2	3.8
1989/90	-5.6	15.8	1.4	-0.8	-5.8	-0.5	4.6	1.1	-5.7	-4.6	4.9

Source: ONS and Bank of England Bankstats, table 16 (1978/79 and 1979/80), Bank of England Bankstats table 17 (other years).

(1) Net of gilts sold to Bank of England on repurchase agreements.

Table 11

Comparison of debt management actions

Action	Scale (% of GDP or GNP; + = expansionary, - = contractionary).
War Loan conversion (1932)	-49.4 (disappearance of 5% War Loan) +3.9 (Treasury bills)
Ultra-cheap money (1945–48)	+9.6 (increase in Treasury bills) -5.3 (disappearance of Treasury Deposit Receipts)
Serial Funding (1951)	-6.8
Overfunding (1978–84)	-4.9
Quantitative easing (2009–10)	+13.9

Notes and sources: see text.

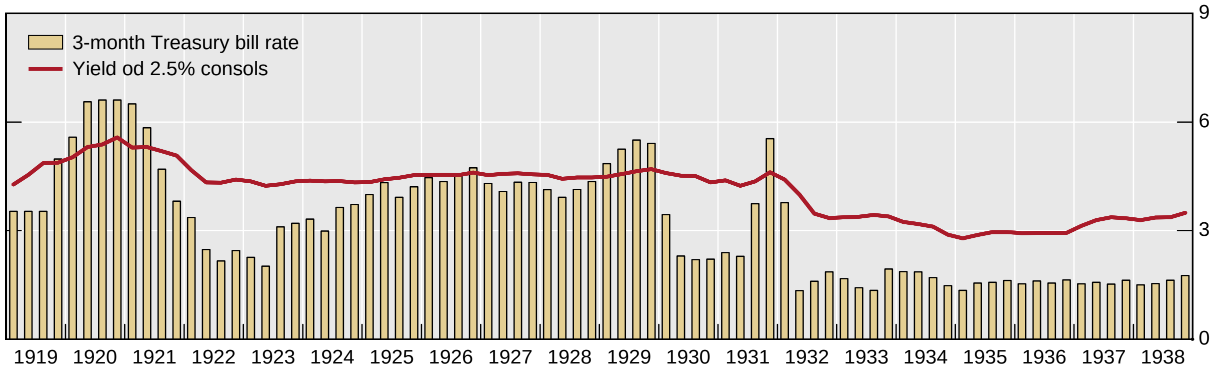
Table 12

Channels of influence of debt management policy

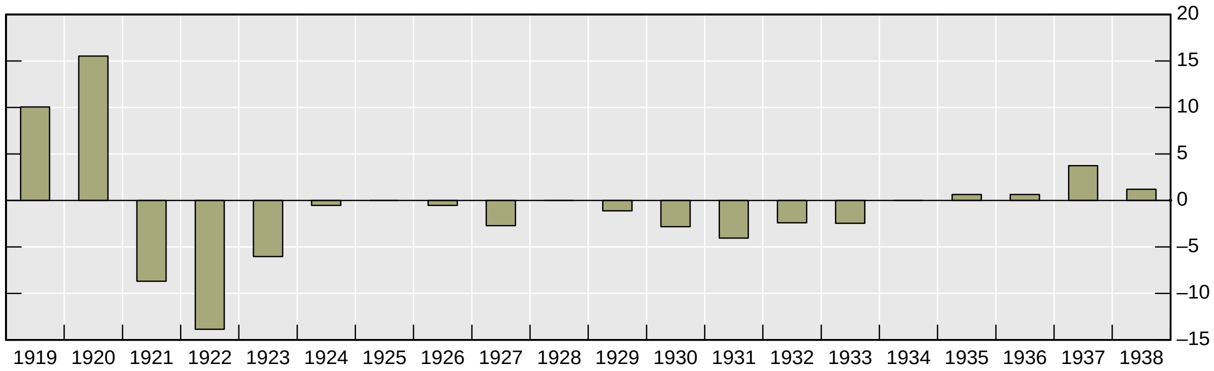
Period	Bank liquidity regulation	Effects on quantities	Effects on market prices
Up to 1971	30% liquid asset ratio. 'Liquid assets' include Treasury and commercial bills but not gilts.	Gilt sales absorb Treasury bills and squeeze banks' liquid assets, causing them to restrict commercial lending.	Gilt yields rise relative to other yields.
1980s – 1990s	None.	Gilt sales to long-term investors absorb money balances and restrict funds available for investment in equities, corporate bonds, foreign assets. Bank-liquidity squeeze relieved by official purchases of commercial bills.	Expected returns on gilts rise relative to other expected returns. Exchange rate strengthens.
2009 onwards	FSA regime (individual liquidity assessments) + anticipation of Basel III. 'Liquid assets' include gilts and Treasury bills but not commercial bills.	Quantitative easing replaces gilts with deposits in Bank of England. Both count as liquid assets for Basel III LCR. But QE may lead to gilt sales by long-term investors who replace gilts with corporate bonds or equities, facilitating debt repayments to banks and improvements in banks' liquidity ratios. Long-term investors may also use QE cash to buy foreign assets.	Gilt yields fall relative to other yields. Exchange rate weakens.

Figure 1

Yields on 2.5% Consols and 3-month Treasury bills, 1919–38

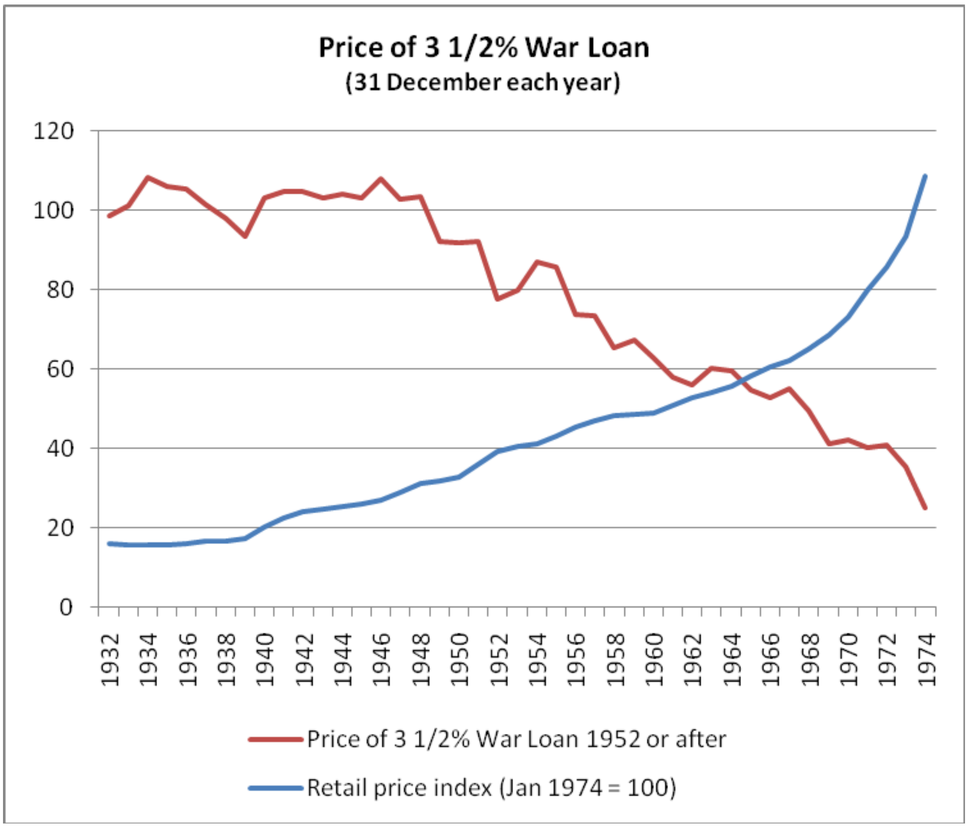


Change in retail price index



Sources: Howson (1975); national data.

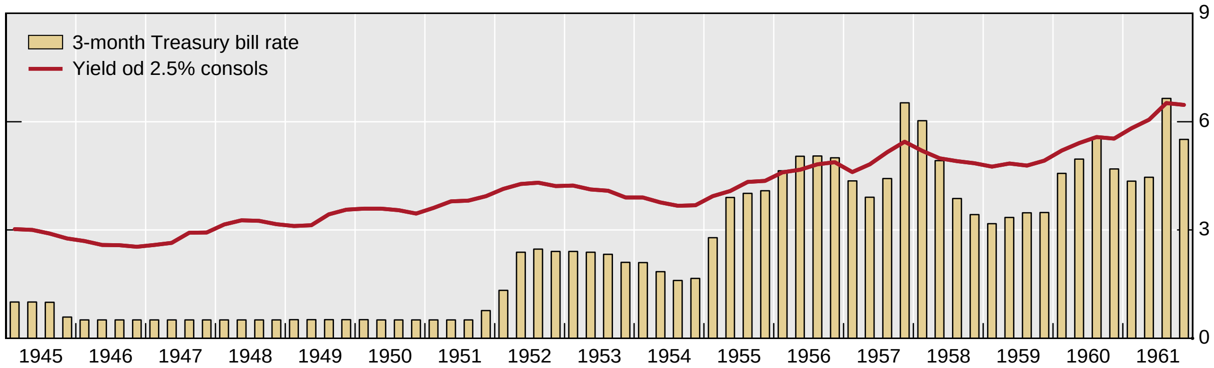
Figure 2



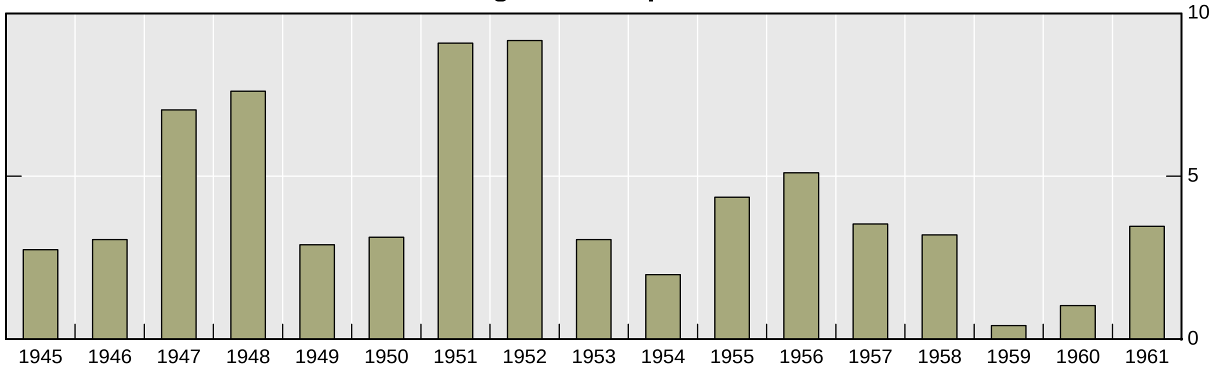
Sources: Pember and Boyle (1950 and 1976), ONS.

Figure 3

Yields on 2.5% Consols and 3-month Treasury bills, 1945–61



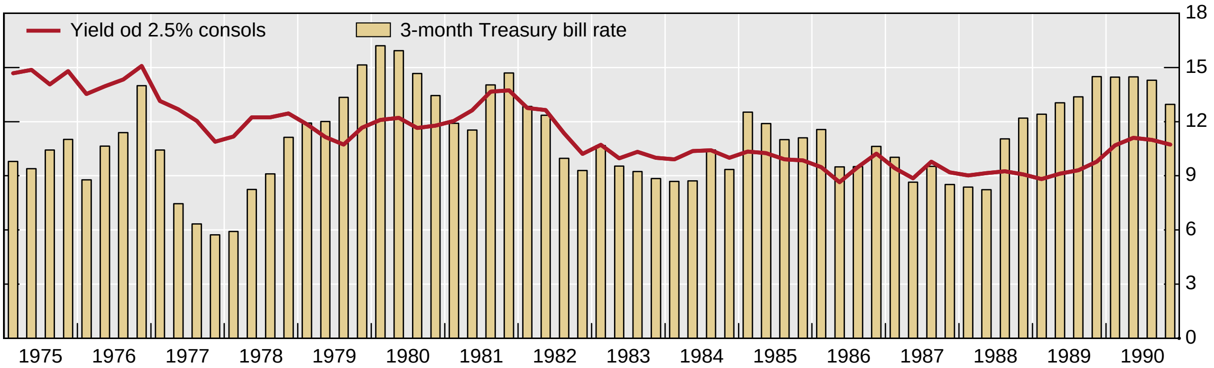
Change in retail price index



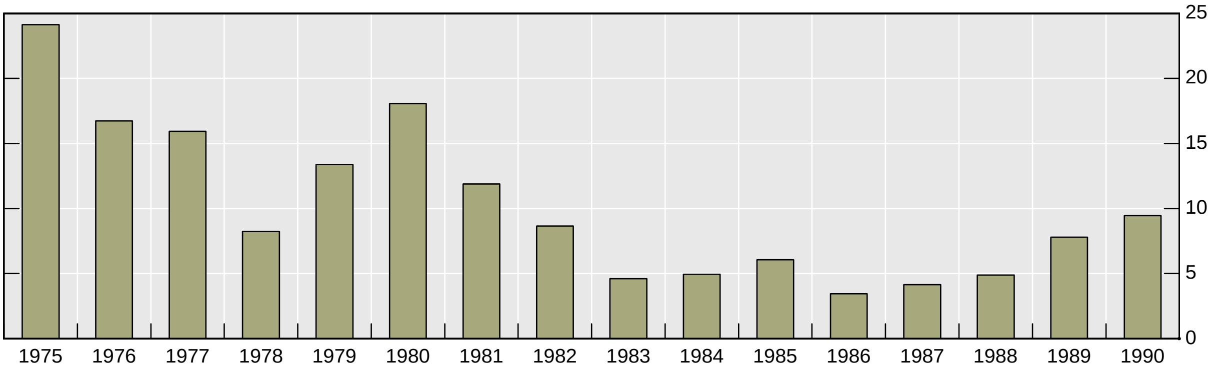
Source: BIS.

Figure 4

Yields on 2.5% Consols and 3-month Treasury bills, 1975–90



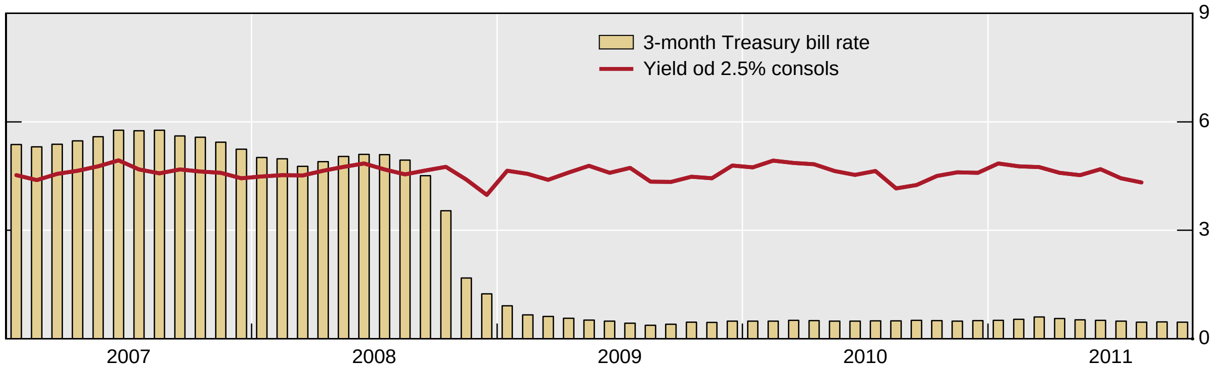
Change in retail price index



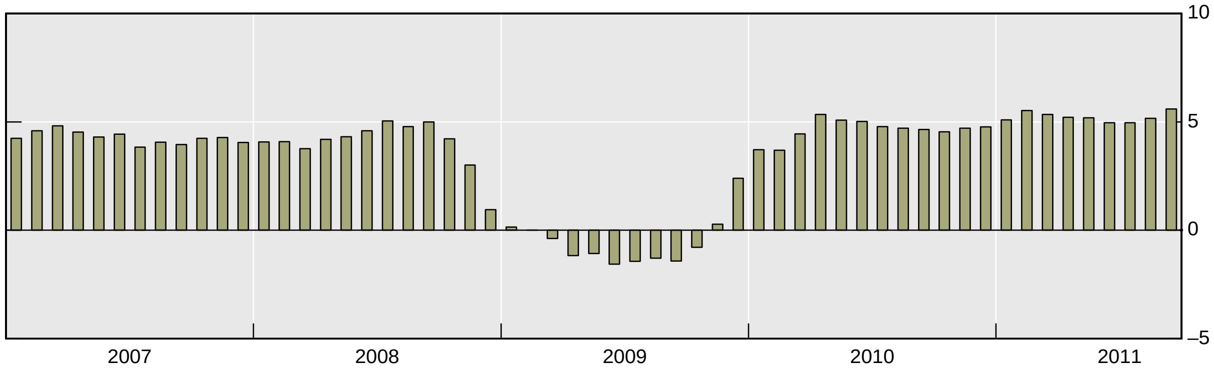
Source: BIS.

Figure 5

Yields on 2.5% Consols and 3-month Treasury bills, 2007–11



Change in retail price index



Source: BIS.

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Keynes's monetary theory of interest

Geoff Tily[1]

Abstract

> Now there is no part of our economic system which works so badly as our monetary and credit arrangements; none where the results of bad working are so disastrous socially; and none where it is easier to propose a scientific solution.
>
> (J M Keynes: speech to the Liberal Party, December 1923, *The Collected Writings of John Maynard Keynes* XIX, Vol I, pp 158–9)

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[1] UK Post Keynesian Study Group. E-mail: geofftily@gmail.com.

1. Introduction

This paper examines the evolution of Keynes's monetary theory of interest and associated policy mechanisms. The discussion draws heavily on and develops the approach of Tily (2010 [2007]), which details what are regarded as fundamental and grave misunderstandings of both his analytical approach and his policy approach. From a practical perspective, Keynes's primary concern was the arrangement of domestic and international monetary systems to permit the full and stable utilisation of resources, and to prevent crisis, rather than the use of fiscal policy in the event of crisis.

The theory of liquidity preference and practical policy to set the rate of interest across the spectrum are central to the discussion. But while these are the core of the discussion, it is positioned in a broader view of Keynes's economic theory and policy. This strategy follows from Keynes's understanding of the monetary nature of the world economy. Taken as a whole, Keynes's schemes reflected the gradual development of his theoretical and technical understanding of the operation of monetary systems. Ultimately, his work encompasses policy measures for national economies based on credit or bank-money systems, and the means to their operation within a wider economic system of a "world between nations".

His case should be set against the existing theoretical and practical schemes that are founded on international capital (ie savings), with banks viewed only as intermediaries rather than creators of money. The paper does not examine the consequences of operating the world economy according to a theory of a system that does not exist (and probably has never existed). This is the fuller purpose of Tily (2007), though the outcome is now [at the start of 2012] obvious.

The central discussion on the liquidity preference theory of interest (section 3) is preceded by a discussion on the theoretical and policy background before the publication of the *General Theory* (section 2). The developments in policy around the time of the publication of the *General Theory* are then examined (section 4) as further backdrop to a full theoretical and practical assessment of his debt management policies that enabled control of the spectrum of interest rates (section 5). Shorter sections then address the relation between his monetary theory and fiscal policies (section 6) and his policies for the international arrangement of monetary systems (section 7). Last, the outcome of these policies are then examined, through an assessment of interest rates over the 20th century to the present, and this leads to a brief discussion of the revival of Keynes's monetary policies in recent contributions to the literature (section 8).

Central to the historical presentation is the idea that Keynes's thought developed in two distinct stages. In the first, his theories concerned money as a means of exchange but were still classical in nature. *A Treatise on Money* was the culmination and fullest statement of this analysis, but it also marks the point of departure to the second stage. With the *General Theory*, a theory of money as a store of value provided the fundamental break with classical analysis, and was genuinely a revolution in economic thought.

2. Keynes's theory and policy before the *General Theory*

Cambridge

Keynes was, from his first contributions, a monetary economist. His later celebrations of Alfred Marshall's contributions to the development of monetary theory show that Keynes considered his work to be in direct succession to Marshall's own.

Having attended Marshall's lectures on money in 1905, in 1908–09 Keynes was lecturing on "Money, Credit and Prices". While his full lecture notes have not been published, the available material is sufficient to conclude that Keynes's understanding of credit creation was substantial.[2] Some years later, Keynes colourfully summed up his perspective in a rejoinder to Edwin Cannan (1924), the LSE economist:[3]

> Professor Cannan is unsympathetic with nearly everything worth reading – as it seems to me – which has been written on monetary theory in the last ten years. Yet the almost revolutionary improvement in our understanding of the mechanism of money and credit and of the analysis of the trade cycle, recently effected by the united efforts of many thinkers,[4] may prove to be one of the most important advances in economic thought ever made. The ideas are new. They are only just beginning to be capable of complete or clear expression. It is natural that middle-aged bankers should feel shy. But it is not natural that Professor Cannan should write as though none of all this existed, as though his own subject were incapable of development and progress, and as though the last word had been said years ago in elementary text-books. (*Collected Writings* XI, p 419)

India

Equally, from the very beginning, Keynes's work was aimed at practical ends. The dominant economic policy issue of the day was the monetary developments in India in the wake of the bimetallist controversy. In 1893, India had suspended its silver standard and adopted an innovative exchange policy that Keynes saw as the first manifestation of *exchange or currency management systems*. His choosing to begin his Civil Service career in the India Office was no coincidence.

Keynes successfully championed these systems for the greater part of his life. He held that central banks should preserve exchange parities through purchases and sales in the currency market, rather than through interest rate action. Under these systems in India, the rupee was not convertible to gold internally but was convertible into other currencies at a fixed exchange rate in terms of gold. Fundamentally, these arrangements did not involve the manipulation of the discount rate, which was then freed to be aimed at internal rather than external considerations.

Keynes's contributions to the economics literature, therefore, began on this theme. His first major *Economic Journal (EJ)* article was published in March 1909, under the title "Recent Economic Events in India" (*CW* XI, pp 1–22). In May 1910, he gave a series of six lectures to the London School of Economics (LSE) that would become his first book: *Indian Currency and Finance*.

Even at this early stage, Keynes was regarded as an expert in these matters. In 1913, just as he was finalising his book for publication, he was invited to be the Secretary of the Royal Commission on Indian Currency and Finance. Elizabeth Johnson, the editor of the early volumes of Keynes's *Collected Writings (CW)*, sums up the final report as follows: "The

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[2] That Keynes is not even associated with monetary analysis is one of many severe distortions of the mainstream account (one that was ruthlessly exploited by the "monetarists"). This distortion has survived even into some post-Keynesian literature.

[3] Skidelsky (1992, p 163) offers a biographical sketch: "… Cannan had done his economics at Oxford, not Cambridge, and was equally suspicious of Marshall, mathematics and monetary reform. He was … a 'Johnsonian debunker' of all new-fangled theories, who 'oversimplified and probably ridiculed too much'. Cannan was both a socialist and an orthodox economist, a quite usual combination at the Fabian-inspired LSE of the 1920s … Both his economics and his socialism made him suspicious of Keynes's monetary theory. …The central point of his monetary theory was his denial that banks can create credit".

[4] Keynes's footnote: "Mr Bellerby has lately assembled in his Control of Credit, published by Messrs P S King (3s.) for the International Association on Unemployment, an impressive collection of opinions from many sources".

report was a vindication of the gold-exchange standard system; it left no doubt that in the minds of the commissioners the much-urged adoption of a gold currency would not serve the best interests of India" (*CW* XV, p 269). Although this was no small triumph for the 30-year-old Keynes, it was short-lived. "The war of 1914–18 put to one side all the Commission's recommendations" (*CW* XV, p 151).

The *Collected Writings of John Maynard Keynes*

Unless otherwise indicated, the references to Keynes in this article are to the 30-volume edition of his *Collected Writings* (*CW*) published by Macmillan/Cambridge University Press for the Royal Economic Society.

(IV)	*A Tract on Monetary Reform* [1923]
(V)	*A Treatise on Money*, vol 1: *The Pure Theory of Money* [1930]
(VI)	*A Treatise on Money*, vol 2: *The Applied Theory of Money* [1930]
(VII)	*The General Theory of Employment, Interest and Money* [1936]
(IX)	*Essays in Persuasion* [1931]
(XV)	*Activities 1906–14: India and Cambridge*
(XII)	*Economic Articles and Correspondence: Investment and Editorial*
(XIV)	*The General Theory and After*, part 2*: Defence and Development*
(XI)	*Economic Articles and Correspondence: Academic*
(XIX)	*Activities 1922–9: The Return to Gold and Industrial Policy*, 2 vols
(XX)	*Activities 1929–31: Rethinking Employment Unemployment Policies*
(XXI)	*Activities 1931–9: World Crises and Policies in Britain and America*
(XXIII)	*Activities 1940–3: External War Finance*
(XXV)	*Activities 1940–44: Shaping the Post-War World: The Clearing Union*
(XXVII)	*Activities 1940–46: Shaping the Post-War World: Employment and Commodities*
(XXVIII)	*Social, Political and Literary Writings*
(XXIX)	*The General Theory and After: A Supplement* (to vols XIII and XIV)

From the First World War to Versailles

While the First World War brought monetary progress in India to an abrupt halt, it led to developments in British monetary policy in accord with Keynes's views. As a senior civil servant in HM Treasury, Keynes was personally involved in these developments. Britain (as well as other countries) modified its internal gold standard, and the foreign exchange policy turned to exchange management. From 1915, J P Morgan was instructed to buy and sell sterling in order to preserve an exchange rate of $4.76.[5] The J P Morgan arrangements meant that the short-term rate of interest was freed from its role in preserving the exchange parity and could, in theory at least, be operated more in accord with the requirements of domestic wartime policy. He witnessed, for the first time, conflicting views between HM Treasury and the Bank of England about exactly what that policy should be.

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[5] Despite his interest in exchange *mechanisms*, Keynes attached immense importance to the preservation of the sterling–dollar exchange *rate* as the cornerstone of allied finance for the duration of the war.

At the end of the war, Keynes was put in charge of financial business at the Versailles Conference. These responsibilities appear to have left him in the background when the British authorities unpegged the dollar exchange value of sterling and introduced an embargo on gold exports (on 20 March and 1 April 1919 respectively). And of course his official involvement in *any* policy ended with his resignation at the end of the peace conference in June 1919.

Throughout history, financial policy has been prominent in post-war policy debate. The Versailles Conference foreshadowed conferences at Brussels and Genoa, which set in motion a return to a global gold standard. In Britain, the 1918 Cunliffe Committee had already recommended that the UK return to gold at the pre-war parity of $4.86.

A Tract on Monetary Reform and *A Treatise on Money*

Published on 11 December 1923, Keynes's *A Tract on Monetary Reform* was his polemic against the gold standard and the boldest statement to date of his case for domestic and international monetary reform.

> In truth, the gold standard is already a barbarous relic. All of us, from the Governor of the Bank of England downwards, are now primarily interested in preserving the stability of business, prices, and employment, and are not likely, when the choice is forced on us, deliberately to sacrifice these to the outworn dogma, which had its value once, of £3 17*s* ½*d* per ounce. Advocates of the ancient standard do not observe how remote it now is from the spirit and the requirements of the age. A regulated non-metallic standard has slipped in unnoticed. It exists. Whilst the economists dozed, the academic dream of a hundred years, doffing its cap and gown, clad in paper rags, has crept into the real world by means of bad fairies – always so much more potent than the good – the wicked ministers of finance. (*CW* IV, pp 137–8)

For internal policy, Keynes recommended that the discount rate should be aimed at *credit control*: "Thus the tendency of today – rightly I think – is to watch and to control the creation of credit and to let the creation of currency follow suit, rather than, as formerly, to watch and to control the creation of currency and to let the creation of credit follow suit" (*CW* IV, p 146). The domestic money supply would, as a consequence, be disengaged from gold. Note also that Keynes's case was not centred on the desirability of one or other exchange *parity*, but rejection of the gold standard as a *system* for the regulation of an economy based on bank money.

From the theoretical perspective, however, the *Tract* took the existence of credit and the credit cycle as given or commonly known. In the (1930) *Treatise* he then took a step back and sought to explain and formalise these processes. The first book contained a detailed and still profoundly valuable analysis of the evolution and nature of money. He recognised that classical economics was the economics of a commodity money economy; a new theory was necessary for a credit or bank-money economy. Yet while his work was a clear departure from existing theories, especially with the macroeconomic approach of the "fundamental equations", it remained underpinned by classical doctrine. Economic fluctuations arose as market rates of interest departed from natural rates of interest, a classical idea that he attributed to Wicksell. Nonetheless the work brought the long-term rate of interest to centre stage for the first time, with Keynes wrapping up:

> I am writing these concluding lines in the midst of the world-wide slump of 1930 … Thus I am lured on to the rash course of giving an opinion on contemporary events which are too near to be visible distinctly; namely, my view of the root causes of what has happened, which is as follows. The most striking change in the investment factors of the post-war world compared with the pre-war world is to be found in the high level of the market-rate of interest. (*CW* VI, p 377)

Even as the book was published, in terms of both theory and policy, matters began to move very fast.

The collapse of the gold standard and the beginning of currency management

As he was completing the *Treatise*, Keynes had regained the access to policymaking circles that he had lost after the First World War. He had been brought into the new Economic Advisory Council and various associated sub-Committees. He was also taking a leading role in the (Macmillan) Committee on Finance and Industry. As a member, key witness and in the lead for drafting, Keynes had a profound influence on the Report. A single sentence sums up the underlying perspective:

> [In] the case of our financial, as in the case of our political and social, institutions we may well have reached the stage when an era of conscious and deliberate management must succeed the era of undirected natural evolution. (Cmd 3897, p 5, para 9)

The rate of interest, however, was not afforded a central role, as Keynes recognised in deliberations while preparing the Report for publication:[6]

> This memorandum brings home to me what I was beginning to forget, namely that I have nowhere introduced into my draft chapters in any clear or emphatic form what I believe to be the fundamental explanation of the present position. My fundamental explanation is, of course, that the rate of interest is too high, – meaning by the 'rate of interest' the complex of interest rates for all kinds of borrowing, long and short, safe and risky. A good many of Brand's factors I should accept as part of the explanation why interest rates are high, eg effects of the War, post-war instability, reparations, return to gold, mal-distribution of gold, want of confidence in debtor countries etc, etc.
>
> Next comes the question of how far central banks can remedy this. In ordinary times the equilibrium rate of interest does not change quickly, so long as slump and boom conditions can be prevented from developing; and I see no insuperable difficulty in central banks controlling the position ... The drastic reduction of the whole complex of market-rates of interest presents central banks with a problem which I do not expect them to solve unless they are prepared to employ drastic and even direct methods of influencing long-term investments which, I agree with Brand, they had better leave alone in more normal times. ...
>
> But I should not be surprised if five years were to pass by before hard experience teaches us to get hold of the right end of the stick. (*CW* XX, pp 272–3)[7]

Only a few weeks after the publication of the Report, the financial crisis that had begun in continental Europe hit the financial markets in London. The subsequent political and economic chaos led to the replacing of the Labour-led coalition Government with the

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6 In correspondence dated 7 April 1931 to fellow committee member Robert Brand, at the time a managing director of Lazards merchant bank and a leading figure in economic debate over the 1930s and long into the post-war period.

7 He made almost exactly the same points two months later at the Harris Foundation Lectures (*CW* XIII, pp 343–5). In December 1931, an *Economic Journa*l article by H Somerville hailed the Treatise as "a vindication of the Canonist attitude to interest and usury!", and asserted that "interest is the villain of the economic piece" (Somerville, 1931, p 647). The paper prompted a symposium on "Savings and Usury" in the following issue (March 1932). Keynes's own contribution concluded: "Personally I have come to believe that interest – or, rather, too high a rate of interest – is the 'villain of the piece' in a more far-reaching sense than appears from the above. But to justify this belief would lead me into a longer story than would be appropriate in this place" (*CW* XXIX, p 16).

"National Government", and on 21 September 1931 Britain suspended membership of the gold standard.

The suspension was the starting point for an era of monetary reform that reached across the globe. Only a few weeks later, in the Preface to his *Essays in Persuasion* (dated October 1931), Keynes wrote:

> We are standing at a point of transition. It is called a national crisis. But that is not correct – for Great Britain the main crisis is over. There is a lull in our affairs. We are, in the autumn of 1931, resting ourselves in a quiet pool between two waterfalls. (*CW* IX, p xix)

While the initial reaction of the authorities was to raise the discount rate, Keynes argued that sterling's strength would come from a strong economy. And a strong economy depended on a *low* rate of interest. On 18 February 1932, a cut of Bank rate to 5 from 6 per cent marked the start of what would be called the cheap-money policy. Then, in the April 1932 Budget, the Government instigated the Exchange Equalisation Account (EEA) which put into effect currency management. A "supplementary fund" of £150 million (4 per cent of 1931 GDP; £60 billion today) was put at the disposal of the Bank of England for intervention in the foreign exchange market. This permitted further Bank rate cuts, which rapidly followed.

Keynes had also supported operations on the long-term rate of interest. On 30 June 1932, the great conversion of the war debt from 5 to 3½ per cent was announced in the House of Commons. It was accompanied by the final cut of Bank rate to 2 per cent and by the introduction of an embargo on overseas loans, ie by capital control. The operation was a success: the authorities had started to bring the long-term rate of interest under control.

Keynes prepared a commentary,[8] containing ideas that were owed to his emerging theory of liquidity preference. He emphasised the importance of "psychological factors" and looked to changes to debt management policy: "It is important that the market should be supplied with securities of different types and maturities in the proportions in which it prefers them" (*CW* XXI, p 115).

Worldwide monetary reform

Other countries began to follow London's lead, not least the British Empire. But from the global perspective the most significant moment was Roosevelt's taking the US off gold in April 1933. The action was seemingly a shot across the bows of the World Economic Conference scheduled for June 1933, and mainly served to stiffen to resolve of the European "gold bloc" countries. But, over the next three years, the system disintegrated. After Belgium's exit, Keynes spoke at a July 1935 conference in Antwerp:

> Belgian example great impression on world
> Calmness, moderation and skill of Belgian transition
> Not surprising
> Currency changes much easier than usually supposed
> Indian example
> Effect on gold bloc
> Stupid and obstinate old gentlemen at the Banks of Netherlands and France crucifying their countries in a struggle which is certain to prove futile. (*CW* XXI, p 356)

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8 First in July 1932 for the Committee of Economic Information; it was reproduced in the September 1932 issue of the *Economic Journal* (with only minor changes, apart from updated empirical information).

The final chapter of the international gold standard began with the election of Leon Blum's Popular Front government in France. On 26 September 1936 his government announced that it planned to devalue the franc and establish an Exchange Equalisation Fund of 10,000 million francs. The action was supported by an act of international co-operation of great significance, with the US and British governments agreeing to support the exchanges in the meantime. These announcements have become known as the *Tripartite Agreement* and marked a significant step in a move to a new international financial order. The British Statement was as follows:

> His Majesty's Government, after consultation with the United States Government and French Government, join with them in affirming a common desire to foster those conditions which will safeguard peace and will best contribute to the restoration of order in international economic relations, and to pursue a policy which will tend to promote prosperity in the world and to improve the standard of living … His Majesty's Government … declare their intentions to continue to use the appropriate available resources so as to avoid as far as possible any disturbance of the basis of international exchanges resulting from the proposed readjustment … [they] desire and invite the co-operation of other nations to realise the policy laid down in the present declaration. (Reproduced in *The Economist*, 3 October 1936)

With the gold bloc leaderless, its total collapse was then inevitable. On 26 September the Swiss Federal Council declared that a decision had been taken in favour of devaluation. On 28 September, Dr Colijn from the Bank of the Netherlands announced the establishment of a managed currency and an equalisation fund, and devalued the guilder by 15–20 per cent. Similarly, the Greek, Latvian and Turkish Governments announced that they had decided to devalue and link their currencies to sterling. Germany chose not to follow; Schacht, the President of the Reichsbank, announced that he did not intend to devalue the German currency nor join the tripartite arrangement.

Nonetheless, the collapse of the gold standard was complete; Britain and the United States were at the centre of a new managed exchange and monetary policy system that was subservient to government and aimed primarily at domestic employment policy. The *General Theory* was published only half a year before the Tripartite Agreement; already Keynes's insights and analysis were reverberating around the world to a most significant extent.

3. The *General Theory* and the theory of liquidity preference

Preamble

While the *General Theory* was a full statement of a theory of a credit money economy, it is in some ways disconcerting that the central innovation was a theory of interest that followed from an analysis primarily of money as a store of value.[9] Keynes's analysis led him not only to the theoretical treatment of uncertainty and expectation, but also to practical conclusions of the most profound importance. Ultimately, the theory turned classical analysis on its head. The rate of interest was the cause, not the passive consequence, of the level of economic activity. Moreover, as a quantity that depended on expectation, the authorities – if they so desired – had full control of the rate of interest that prevailed in a national economy. Keynes

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[9] Keynes warned in the Preface: "… whilst it is found that money enters into the economic scheme in an essential and peculiar manner, technical monetary detail falls into the background" (CW VII, p xxii).

came to see that this control was dependent on greatly changed monetary, debt management and international financial policies, as indicated by the previous discussion.

The classical theory of interest might be rejected on two – related – grounds. First, there can be no constraint on the availability of money or finance, given that it is created at the will of banks. Second, in such a system, aggregate saving is determined by aggregate investment, and the macroeconomic relation is an identity, not an equilibrium.[10]

> *S* = *I* at all rates of investment. *Y* either definable as *C+S* or as *C+I. S* and *I* were opposite facets of the same phenomenon they did not need a rate of interest to bring them into equilibrium for they were at all times and in all conditions in equilibrium. (*CW* XXVII, pp 388–9)

> [A] relationship is set up between aggregate savings and aggregate investment which can be very easily shown, beyond any possibility of reasonable dispute, to be one of exact and necessary equality. Rightly regarded this is a banale [*sic*] conclusion. But it sets in motion a train of thought from which more substantial matters follow. (Preface to the French Edition, *CW* VII, p xxxiii)

These "substantial matters" included the liquidity preference theory of interest (LPT). For Keynes, the determination of the rate of interest did not concern saving, but matters after the decision to save has been made:

> But this decision having been made, there is a further decision which awaits him, namely, in *what* form he will hold the command over future consumption which he has reserved, whether out of his current income or from previous savings. Does he want to hold it in the form of immediate, liquid command (ie in money or its equivalent)? Or is he prepared to part with immediate command for a specified or indefinite period, leaving it to future market conditions to determine on what terms he can, if necessary, convert deferred command over specific goods into immediate command over goods in general? In other words, what is the degree of his *liquidity-preference* – … (*CW* VII, p 166, italics in original)

Liquidity preference is the decision about the degree of liquidity at which savings should be held. Furthermore, it is a decision concerning the stock of savings – wealth – at any point in time, rather than any new flow of saving alone. The rate of interest is hence not determined by the supply of and demand for (flows of) saving, but by the supply of and demand for assets into which holdings of (stocks of) wealth can be placed. In the theory of money as a store of value, money is one of these assets.

> The current rate of interest depends, as we have seen, not on the strength of the desire to hold wealth, but on the strengths of the desire to hold it in liquid and illiquid forms respectively, coupled with the amount of the supply of wealth in the one form relatively to the supply of it in the other. (*CW* VII, p 213)

It is important to understand liquidity preference in these broad terms, rather than as concerned solely with the demand for money (which follows from Keynes's familiar three motives). The theory of liquidity preference is concerned with the demand for assets of various degrees of liquidity, and the rate of interest depends on both the demand for and supplies of assets across the whole of this spectrum. "Money", however, does have a particularly crucial role; while it is obvious that illiquid assets offer holders a reward in the form of interest, the reward for holding money is the essence of liquidity itself. Furthermore, when Keynes wrote, it was a shortage of "money" that followed from the gold standard that most stood in the way of the interest rate policies that he had in mind.

[10] The relevant theory is detailed in Tily (2010, Chapter 6).

Liquidity preference and uncertainty

With the nature of money understood, the central theoretical innovation of the LPT was the role of uncertainty. In the context of this theory, Keynes introduced uncertainty to resolve a paradox: "… why should anyone prefer to hold his wealth in a form which yields little or no interest to holding it in a form which yields interest …?" (*CW* VII, p 168). He was more emphatic and colourful in his 1937 *Quarterly Journal of Economics* (*QJE*) paper:[11]

> Money, it is well known, serves two principal purposes. By acting as a money of account it facilitates exchanges without its being necessary that it should ever itself come into the picture as a substantive object. In this respect it is a convenience which is devoid of significance or real influence. In the second place, it is a store of wealth. So we are told, without a smile on the face. But in the world of the classical economy, what an insane use to which to put it! For it is a recognised characteristic of money as a store of wealth that it is barren; whereas practically every other form of storing wealth yields some interest or profit. Why should anyone outside a lunatic asylum wish to use money as a store of wealth? (*CW* XIV, pp 115–16)
>
> In the *General Theory*, the paradox was resolved as follows:
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> A full explanation is complex and must wait for chapter 15. There is, however, a necessary condition failing which the existence of a liquidity preference for money as a means of holding wealth could not exist. This necessary condition is the existence of *uncertainty* as to the future rate of interest, ie as to the complex of rates of interest for varying maturities which will rule at future dates. (*CW* VII, p 168, Keynes's emphasis)

Keynes argued that the necessary condition for liquid holdings of savings was the fact that people did not know what the future rate of interest would be: it was *uncertain*.

For post-Keynesians, and increasingly more widely, the definition and treatment of uncertainty is understood as a critical component of Keynes's theoretical scheme. His *QJE* definition is often cited and worth repeating:

> By 'uncertain' knowledge, let me explain, I do not mean merely to distinguish what is known for certain from what is only probable. The game of roulette is not subject, in this sense, to uncertainty; nor is the prospect of a Victory bond being drawn. Or, again, the expectation of life is only slightly uncertain. Even the weather is only moderately uncertain. The sense in which I am using the term is that in which the prospect of a European war is uncertain, or the price of copper and the rate of interest twenty years hence, or the obsolescence of a new invention, or the position of private wealth owners in the social system in 1970. About these matters there is no scientific basis on which to form any calculable probability whatever. We simply do not know. (*CW* XIV, pp 113–14)

Keynes saw that this uncertainty meant that economic activity was at least partly dictated by the expectations – and "animal spirits" – of economic actors. But the idea was not deployed arbitrarily, as is common in recent contributions, but as a feature of very specific components of his theory: the liquidity preference and marginal efficiency of capital schedules, and the production decision in the context of the theory of effective demand.

So much for the preamble, but the subsequent detail of the theory of liquidity preference is not straightforward. The theoretical complexities follow in part from the handling of means of exchange considerations alongside a theory of money as a store of value. Published

[11] From which many post-Keynesians draw their inspiration.

correspondence shows Keynes wrestling with this, and at one point deploying a distinction between "active" and "inactive" balances. The practical complexities arise from Keynes seemingly assuming the reader is familiar with his policy conclusions – fine in 1936, but not now – and their emerging in the book only as examples in the course of the development of the theoretical argument.

In the *General Theory* Keynes comes at the matter from the point of view of motives for holding money instead of assets. But in doing so, the fundamental motive for holding assets instead of money is left only implicit: the desire for a return on wealth. The fundamental motivation for a theory of money as a store of value is that households want to keep safe and earn a return on accumulated income into the future.[12] Moreover Keynes's motives explicitly included means of exchange considerations through the "transactions" and the (later) "finance" motives.[13] While the gold standard was already gone when his book was published, no doubt the idea of a monetary system underpinned by a physical commodity with quantity restrictions on the supply of money, and the flaws of this thinking revealed over the 1930s, must have made a very powerful impression on Keynes's mind. Under this system, the quantity of gold was relevant to both means of exchange and store of value considerations – even if this relevance was indirect and complex, given the role of credit. While with the end of gold, the ultimate nature of the supply of money as a store of value is initially less clear cut, it becomes more so through the policy initiatives that were actually deployed over the course of Keynes's life.

In my view it is most useful to approach the theory of liquidity preference directly as a theory of money as a store of value, a distinction that is hard and fast. This essential distinction allows the separation from a theory of money as a means of exchange, founded on a theory of bank money, with the role of private banks, central banks and the sovereign authority understood. Under such conditions, money is normally supplied endogenously, according to the rate of interest, the wider demands of the various institutional sectors, and any restraints within the system.

The theory of money as a store of value concerns matters that occur *after* the creation of bank money, and belongs sequentially after that theory. This follows from the work of Victoria Chick and Sheila Dow, who argue that for liquidity preference theory the quantity of bank money should be taken as "given".[14] Following this, the quantity of income should be taken as given also.

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[12] "The whole object of the accumulation of wealth is to produce results, or potential results, at a comparatively distant, and sometimes indefinitely distant, date. Thus the fact that our knowledge of the future is fluctuating, vague and uncertain, renders wealth a peculiarly unsuitable subject for the methods of the classical economic theory. This theory might work very well in a world in which economic goods were necessarily consumed within a short interval of their being produced. But it requires, I suggest, considerable amendment if it is to be applied in a world in which the accumulation of wealth for an indefinitely postponed future is an important factor; …" (CW VII, p 113).

[13] Keynes introduced the finance motive during the 1937–8 "alternative theories of the rate of interest" dialogue in the *Economic Journal*: "There has, therefore, to be a technique to bridge the gap between the time when the decision to invest is taken and the time when the correlative investment and saving actually occur ... To avoid confusion with Professor Ohlin's sense of the word, let us call this advance provision of cash the 'finance' required by the current decisions to invest" (CW XIV, p 208).

[14] For example: Chick (1983, p 184; 2001, p 9) and Dow (1997). More recently Dow has connected the confusion between "given" and "exogenous" with closed-system thinking. Note also the distinction can later be relaxed, and liquidity preference deployed to aid understanding of the banking system and means of exchange considerations.

Supply and demand

In most general terms, the theory of liquidity preference is simply an application of supply and demand analysis. The demand for liquidity reflects the desired balance between illiquid and liquid assets; it is set against the supply of liquid assets. The equilibrium determines the rate of interest on illiquid assets.

As with any supply and demand analysis, both movements along and shifts in schedules are of importance.[15] Before these matters are examined, it is necessary to clarify and make some simplifying assumptions about the "liquidity" in practice. The essence of liquidity preference is the balance between liquid and illiquid assets; in terms of Keynes's schemes for debt management policy (see below), this most commonly corresponds to the balance between government bonds and bills. Keynes's discussion was quite abstract, with the key statement limited to a footnote:

> [W]e can draw the line between 'money' and 'debts' at whatever point is most convenient for handling a particular problem. For example, we can treat as *money* any command over general purchasing power which the owner has not parted with for a period in excess of three months, and as *debt* what cannot be recovered for a longer period than this; ... (*CW* VII, p 167, n 1)[16]

In practice, interest is still earned on money/liquid assets held as a store of value, and the reward for illiquidity can alternatively be seen as a premium on liquidity. The supply and demand analysis therefore sets the demand for interest-bearing bills against the supply of bills to determine the rate of interest on bonds. These rates then underpin the wider structure of lending costs throughout the economy.[17] *But the most essential feature of the theory is that the position of the demand schedule depends entirely on expectations of the future rate of interest*.

In Keynes, the demand for liquidity was represented by the liquidity preference schedule. The schedule incorporates his analysis of the "speculative" and "precautionary" motives for holding money. Speculators move between bonds and money according to their expectations about the future rate of interest. Those that expect a rise in the rate of interest and hence a fall in the price of bonds will hold all wealth that they use for speculation as money. Those that expect the rate of interest to fall will hold speculative wealth as bonds. The shape of the liquidity preference schedule follows according to the *distribution* of these opinions.[18]

In the *General Theory*, Keynes first and most usefully describes the precautionary motive in general terms: "[T]he desire for security as to the future cash equivalent of a certain proportion of total resources; ..." (*CW* VII, p 170). These cash holdings are earmarked "to provide for contingencies requiring sudden expenditure and for unforeseen opportunities of advantageous purchases, and also to hold an asset of which the value is fixed in terms of money to meet a subsequent liability fixed in terms of money, ..." (*ibid*, p 196). These go further than the standard notion of reserving money for unexpected expenditure opportunities (eg a bargain home-entertainment system) or necessities (eg repairing a leaking roof). The *general* form of the precautionary motive is then the desire to hold money through fear of capital loss on selling a long-term bond before maturity. Understood in this way, the two

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[15] The greatest defect of "Keynesianism" is that such shifts are not considered, unless mechanically following from a change in output.

[16] However the passage ends: "money is co-extensive with bank deposits"; for me, this is an example of the confusion between the means of exchange and store of value perspectives.

[17] Note also that the choice described is not a choice usually made by individuals; it is made by institutions on their behalf, reflecting revealed preferences according to household demand for shop-front financial products.

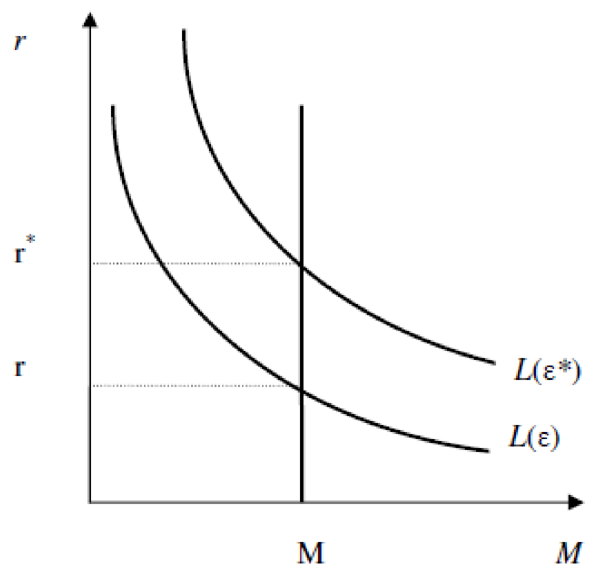
[18] The operation of the speculative motive is examined in detail by Chick (1983, Chapter 10).

motives are closely related: precautionary actions seek to avoid capital loss, while speculative actions aim to make capital gain (and equally to avoid loss from *adverse* changes in the future rate of interest rather than to attempt to profit from expected favourable changes in the future rate of interest). Kahn (1984, p 18) rightly described the distinction between the speculative and precautionary motives as "very blurred".

This blurring leads me to regard liquidity preference in more general terms. Under a given state of expectations, ε, with a quantity of liquid assets, M, a rate of interest, r, prevails. The position is an equilibrium, where the marginal unit of money is exchanged for bonds at r per cent. The schedule shifts according to any change of opinion about the future rate of interest, ie to a change in the state of expectation to ε*.

Figure 1

Liquidity preference in theory



Keynes does not re-state the general determinants of the state of expectation in his chapters on the theory of liquidity preference. Instead, he looks back to the discussion in the context of the theory of investment demand.[19] In Chapter 12, "The State of Long-Term Expectation", he emphasises the role of the "existing situation" as a guide to the future:

> It would be foolish, in forming our expectations, to attach great weight to matters which are very uncertain. It is reasonable, therefore, to be guided to a considerable degree by the facts about which we feel somewhat confident, even though they may be less decisively relevant to the issue than other facts about which our knowledge is vague and scanty. For this reason the facts of the existing situation enter, in a sense disproportionately, into the formation of our long-term expectations; our usual practice being to take the existing situation and to project it into the future, modified only to the extent that we have more or less definite reasons for expecting a change. (*CW* VII, p 148)

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[19] This follows his decision to treat the theory of effective demand before liquidity preference in the *General Theory*.

In the context of liquidity preference he elaborates:

> Just as we found that the marginal efficiency of capital is fixed, not by the 'best' opinion, but by the market valuation as determined by mass psychology, so also expectations as to the future of the rate of interest as fixed by mass psychology have their reactions on liquidity preference. (*CW* VII, p 170)

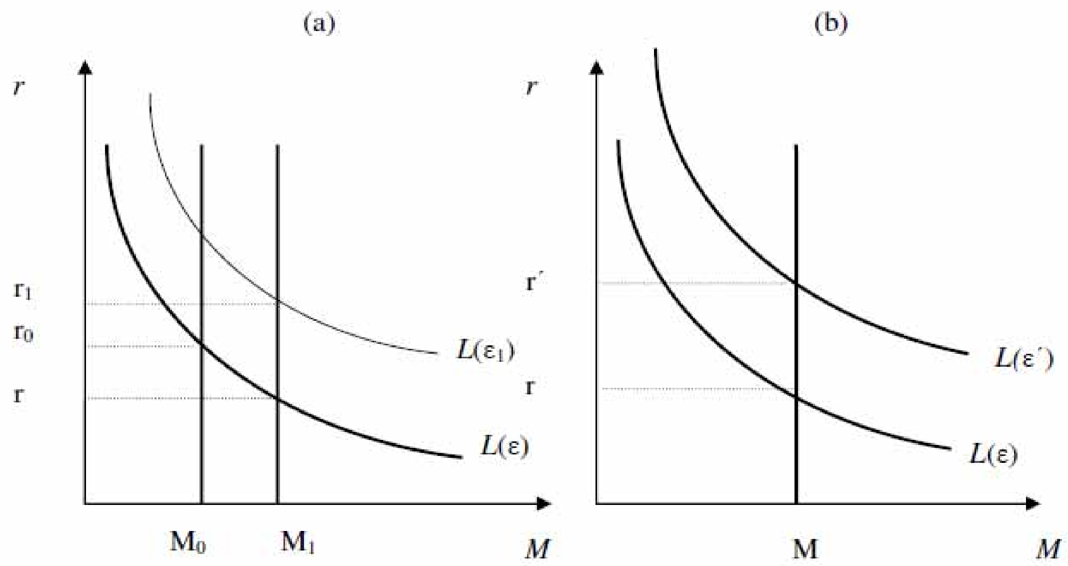
Expectations and policy

Keynes then turns straight to the properties of expectations in the context of policy. His analysis builds to his conclusion that as a "psychological phenomenon", the rate of interest can be brought under control by the management of expectations and a changed debt management policy. The approach is a little oblique, developing theory and policy at the same time, with the specific and yet fundamental policy recommendations given in almost throwaway style.

The central discussion contrasts, within the framework of liquidity preference, the traditional means to reducing the rate of interest through open-market operations (OMOs) with his alternative "expectational" approach. The discussion can usefully be illustrated on the contrasting Figures 2(a) and (b).

Figure 2

Liquidity preference in practice: open-market operation



In the context of OMOs, Keynes first warns "… if we are to control the activity of the economic system by changing the quantity of money, it is important that opinions should differ" (*CW* VII, p 172), amounting to the schedule not being horizontal. Given this, Keynes then turned to the second problem:

> If, however, we are tempted to assert that money is the drink which stimulates the system to activity, we must remind ourselves that there may be several slips between the cup and the lip. For whilst an increase in the quantity of money may be expected, *cet par*, to reduce the rate of interest, this will not happen if the liquidity preferences of the public are increasing more than the quantity of money; ... (*CW* VII, p 173)

So, in Figure 2 (a), a change in the money supply from M_0 to M_1 does not reduce the rate of interest from r_0 to r if expectations change from ε to $ε_1$; instead, the rate of interest increases from r_0 to r_1.[20]

At this point in the *General Theory*, Keynes then left his own theory in order to address the classical theory of interest (Chapter 14). He returns to the contrast between the two approaches in Chapter 15 after detailing the three motives for liquidity, first setting OMOs in the context of the speculative motive:

> But it is by playing on the speculative-motive that monetary management (or, in the absence of management, chance changes in the quantity of money) is brought to bear on the economic system. ...
>
> ... In dealing with the speculative-motive it is, however, important to distinguish between the changes in the rate of interest which are due to changes in the supply of money available to satisfy the speculative motive, without there having been any change in the liquidity function, and those which are primarily due to changes in expectation affecting the liquidity function itself. Open-market operations may, indeed, influence the rate of interest through both channels; since they may not only change the volume of money, but may also give rise to changed expectations concerning the future policy of the central bank or of the government. Changes in the liquidity function itself, due to a change in the news which causes revision of expectations, will often be discontinuous, and will, therefore, give rise to a corresponding discontinuity of change in the rate of interest. (*CW* VII, pp 196–8)

From this point on, Keynes switches attention from OMOs to his "expectational" approach, through his conception of "changes in the news".

> If the change in the news affects the judgement and the requirements of everyone in precisely the same way, the rate of interest (as indicated by prices of bonds and debts) will be adjusted forthwith to the new situation without any market transactions being necessary. Thus, in the simplest case, where everyone is similar and similarly placed, a change in circumstances or expectations will not be capable of causing any displacement of money whatever; ... (*CW* VII, p 198)

So, on Figure 2(b), if a "change in the news" shifts expectations and hence the liquidity preference schedule from L(ε') to L(ε), the rate of interest will fall from r' to r without any movement in the supply of money, M.

This is then the central theoretical representation of Keynes's approach to manipulating the long-term rate of interest. Towards the end of the chapter, he stated his fundamental conclusions about the role of expectations and of the monetary authority in managing those expectations (the italics are Keynes's emphasis):

> It is evident, then, that the rate of interest is a highly psychological phenomenon. … But at a level *above* the rate which corresponds to full employment the long-term market-rate of interest will depend, not only on the current policy of the monetary authority, but also on market expectations concerning its future policy. The short-term rate of interest is easily controlled ... But the long-term rate may be more recalcitrant when once it has fallen to a level which, on the basis of past experience and present expectations of *future* monetary policy, is considered 'unsafe' by representative opinion. …

[20] Note that Keynes assumes the reader is familiar with open-market operations (OMOs). They might involve the central bank exchanging certain assets or creating new deposits (cf quantitative easing) in exchange for bonds and *vice-versa*.

> Thus, a monetary policy which strikes public opinion as being experimental in character or easily liable to change may fail in its objective of greatly reducing the long-term rate of interest, ...
>
> It might be more accurate, perhaps, to say that the rate of interest is a highly conventional, rather than a highly psychological, phenomenon. For its actual value is largely governed by the prevailing view as to what its value is expected to be. *Any* level of interest which is accepted with sufficient conviction as *likely* to be durable *will* be durable; subject, of course, in a changing society to fluctuations for all kinds of reasons round the expected normal. …
>
> … Public opinion can be fairly rapidly accustomed to a modest fall in the rate of interest and the conventional expectation of the future may be modified accordingly; thus preparing the way for a further movement – up to a point. (*CW* VII, pp 202–4)

Keynes then brought practical experience of British policy in the 1930s to bear:

> The fall in the long-term rate of interest in Great Britain after her departure from the gold standard provides an interesting example of this; – the major movements were effected by a series of discontinuous jumps, as the liquidity function of the public, having become accustomed to each successive reduction, became ready to respond to some new incentive in the news or in the policy of the authorities. (*ibid*, p 204)

In the penultimate section of the chapter, Keynes looked beyond the theoretical analysis to a glimpse of the specific debt management policy that his theory pointed to:

> If the monetary authority were prepared to deal both ways on specified terms in debts of all maturities, and even more so if it were prepared to deal in debts of varying degree of risk, the relationship between the complex of rates of interest and the quantity of money would be direct … Perhaps a complex offer by the central bank to buy and sell at stated prices gilt-edged bonds of all maturities, in place of the single bank rate for short-term bills, is the most important practical improvement which can be made in the technique of monetary management. (*ibid*, pp 205–6)

While he bemoaned the authorities' existing policies with regard to dealing with debts across a narrow field, he saw positive signs: "In Great Britain the field of deliberate control appears to be widening" (*ibid*, p 206). The final paragraphs stood back and addressed wider "limitations on the ability of the monetary authority to establish any given complex of rates of interest for debts of different terms and risks" (*ibid*, p 207). While set in the negative, this seems a fairly categorical statement of the policy that Keynes has in mind.

4. Policy after the *General Theory*

Apart from a commentary on international exchange developments, Keynes's key public interventions on domestic monetary policy in the second half of the 1930s were through his annual speeches as Chairman of National Mutual Life Assurance, and then in a 1937 series of articles in *The Times* that then formed the basis of a Committee of Economic Information report.

The necessity for further consolidation of cheap money was the central message of many of Keynes's National Mutual speeches. In February 1934 he had observed:

> There is, surely, overwhelming evidence that even the present reduced rate of 3½ per cent on long-term gilt-edged stocks is far above the equilibrium level – meaning by 'equilibrium' the rate which is compatible with the full employment of

> our resources of men and equipment. It is often forgotten that 3½ per cent is much in excess of the average yield of Consols, which ruled over the 40 years previous to the war – namely, just under 3 per cent – or even the average yield which ruled over the 80 years from 1835 to 1914 – namely, just over 3 per cent.
>
> No one can foretell at what point the rate of interest will reach its equilibrium level until we actually approach it. But it is highly probable that the equilibrium rate is not above 2½ per cent for long-term gilt-edged investment, and may be appreciably less. (*CW* XII, pp 206–7)[21]

He built on his calls in the *General Theory* for the authorities to operate across a wider field. For example, in both 1936 and 1937 he argued that the authorities should issue shorter-term bonds:

> ***Treasury and short-term rates***
>
> Short-term money to-day is extremely cheap. But it is confidence in the future of short-term rates which is required to bring down long-term rates. Now the policy of the Treasury is not calculated to promote such confidence. They seem reluctant to issue bonds of from five to 10 years' maturity and anxious to reduce the short-term debt, in spite of the extraordinary cheapness with which it can be carried. (19 February 1936, *CW* XXI, p 375)

In his *Times* series (published between 12 and 14 January 1937), "How to avoid a slump", Keynes confronted the potential challenge of restraining demand given the scale of the rearmament programme,[22] but doing so in the context of the revised monetary arrangements that he had brought about.[23] He was adamant that any actions should not involve an increase in interest rates:

> Unquestionably in past experience dear money has accompanied recovery; and has also heralded a slump. If we play with dear money on the ground that it is 'healthy' or 'natural', then, I have no doubt, the inevitable slump will ensue. We must avoid it, therefore, as we would hell-fire. ... A low enough long-term rate of interest cannot be achieved if we allow it to be believed that better terms will be obtainable from time to time by those who keep their resources liquid. The long-term rate of interest must be kept continuously as near as possible to what we believe to be the long-term optimum. (*CW* XXI, p 389)

While Keynes looked to fiscal actions to restrain expansion if necessary (see section 6), he celebrated and continued to promote action on the long rate:

> The Bank of England and the Treasury had a great success at the time of the conversion of the War Loan. But it is possible that they still underrate the extent

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[21] Keynes's use of equilibrium is confusing: taken at face value he appears to suggest that the system is only in equilibrium at full employment, and hence unemployment is a disequilibrium phenomenon. But the whole purpose of his theory was to show that the system could be in equilibrium at any position short of full employment.

[22] A five-year programme of about £80 million a year was announced in 1936 after Hitler had occupied the Rhineland.

[23] The piece is noteworthy also for refuting the charge that he was ignorant or neglectful of inflation; as soon as the programme was announced, Keynes was confronting the possible inflationary consequences. The Committee of Economic Information report, below, offers the following definition of a "pressing danger of a serious rise in prices": "This we should define as a state in which it was plain that rises in wages were being demanded, and granted, on the ground that prices had risen, and rises in prices were occurring because wages had risen" (Howson and Winch, 1977, p 352). See also n 33.

> of their powers. With the existing control over the exchanges which has revolutionised the technical position, and with the vast resources at the disposal of the authorities through the Bank of England, the Exchange Equalisation Fund, and other funds under the control of the Treasury, it lies within their power, by the exercise of the moderation, the gradualness, and the discreet handling of the market of which they have shown themselves to be masters, to make the long-term rate of interest what they choose within reason. (*CW* XXI, p 395)

Behind the scenes Keynes had access to the authorities through his membership of the Committee of Economic Information. Moggridge (1992, p 605) notes that the recommendations in his *Times* article then went on to "serve as the basis for the Committee of Economic Information's 22nd report of February 1937, 'Employment policy and the maintenance of trade activity'".

At the end of the Report was a fuller discussion of monetary considerations. The Report tentatively approved the idea that the short-term rate of interest was subservient to wider considerations of cheap money and debt management:

> 24. ... We attach far greater importance to the effect of credit policy on long-term interest rates, as expressed by the yield on Government securities ... (Howson and Winch, 1977, p 352)

Recommendations on the control of credit were also tentative, but still fundamental, looking to "quantitative regulation of the basis of credit":

> 22. ... [I]t may be much more possible and desirable for the financial authorities to exercise adequate control over the supply of credit without recourse to the manipulations of short-term rates which are traditionally associated with this objective ... (*ibid*)

Overall, the report left open the question of manipulation of the short-term rate, limiting the discussion to avoid "determin[ing] the extent to which the short-term rate of interest may be obsolete, or weakened, as an essential means of control – a question upon which, in such an untried area, opinions must certainly differ in degree" (*ibid*).

Sir Richard Hopkins, the Permanent Secretary to the Treasury, added the following handwritten observation to the front of a minute concerning this Report by another Treasury official: "It is interesting to see how profoundly the EAC committee diffused among themselves Mr Keynes's thesis that the Treasury can continue to govern the general state of interest at its will".[24]

Shortly after the completion of this report, in May 1937, Keynes had the first of his heart attacks, and his official and public policy interventions were greatly curtailed (although by no means did they cease). On 23 February 1938, one of his first resumed public appearances was for what would be his final speech as the Chairman of the National Mutual.[25] He focused on the rise in long-term rates that had seemingly occurred while he was indisposed. His philosophy of action that closed the speech is of much importance:

> A great deal is at stake. We are engaged in defending the freedom of economic life in circumstances which are far from favourable. We have to show that a free system can be made to work. To favour what is known as planning and management does not mean a falling away from the moral principles of liberty which could formerly be embodied in a simpler system. On the contrary, we have

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[24] Source: PRO file T 177/38, dated 13/3/1937.

[25] He resigned over disagreements about the firm's retreat from US investments, in the wake of the brief recession. (History shows Keynes was right to expect recovery.)

> learnt that freedom of economic life is more bound up than we previously knew with the deeper freedoms – freedom of person, of thought, and of faith. (*CW* XXI, p 446)

But it took war rather than freedom finally to have Keynes's ideas in the driving seat. Keynes fixed his attention on the financial and economic policies necessary to support the anticipated great increases in public expenditure. In April 1939 he wrote two articles for *The Times* arguing that the Chancellor should not borrow at a rate of interest in excess of 2½ per cent and should be willing to accept a large increase in the share of floating debt. At the end of May 1939, he sent a developed version of the argument to the Chancellor and the Governor of the Bank of England; although at this stage he was advocating 3 per cent (*CW* XXI, pp 533–46). In July 1939, he published two more articles in *The Times* outlining the debt management techniques that would be necessary to effect the setting of rates (*CW* XXI, pp 551–64).

With the end of the "phoney war", Keynes returned to the Treasury for the first time since the Versailles Conference and became directly involved with the policy that he had advocated (the agreed rate was 3 per cent). Over the next years, the authorities developed the specific instruments, arrangements and policies that permitted the full control that Keynes had first championed in 1933.

5. The theory and practice of debt management policy

The conduct of policy in the Second World War set the background to Keynes's most substantial formalisation of his domestic monetary and debt management policies. In April/May 1945 the National Debt Enquiry (NDE) was convened as the Coalition Government began to look to economic policy after the war, but also, more specifically, to contest certain remarks about monetary policy that were included in the famous *Employment White Paper*.

> [The Permanent Secretary] Hopkins was soon persuaded that there was a case for an early inquiry by a committee of officials and economists, which would also consider the future of the cheap money policy. On the last subject, Hopkins noted, 'Lord Keynes has promised to produce ... some far-reaching proposals'. (Howson, 1993, p 45)

At these meetings, Keynes outlined a complete framework of practical debt and money management measures, based on the mechanisms developed in the war. His notes, the Report of the meeting and the associated minutes, constitute a full account of the theory and practice of debt management policy. At this point, a year before his death, he was justified in his statement that "The monetary authorities can have any rate of interest they like" (*CW* XXVII, p 390). The Report of the Enquiry by Sir Richard Hopkins endorsed this conclusion.[26]

It is worth reproducing and discussing the central passage from Keynes's notes as an exercise in the theory of liquidity preference:

> Now the authorities are only fettered in their policy if they themselves have a counter-liquidity preference. If they are indifferent about funding they can make both the short and long-term whatever they like, or rather whatever they feel to be right having regard to possibilities of under and over-employment and other social reasons.

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[26] The Report is reproduced in Tily (2007, Appendix 3.1).

> If, however, they are not indifferent their motivation comes into play.
>
> Historically the authorities have always determined the rate at their own sweet will and have been influenced almost entirely by balance of trade reasons and their own counter-liquidity preference. ...
>
> Authorities make rate what they like by allowing the public to be as liquid as they wish.
>
> Suppose Tr[easury]^y say half the debt must be more than 25 years off *or* floating debt must not exceed £xmn then it is the public which set the rate of interest. If they require a great inducement to become so illiquid, then rates have to be higher. However it is a vicious circle, dear money provokes expectation of dearer money.
>
> It is the technique of the *tap* issue that has done the trick.
>
> Thus, it is only if the Tr^y get rid of the Funding Complex that cheaper money is possible.
>
> The Funding Complex originated in a situation
>
> (a) when there was a fixed fiduciary issue,
>
> (b) Bank rate was the means of preserving the balance of payments,
>
> (c) the rate of interest was used as an instrument of deflation.
>
> With the abandonment of both[27] it becomes completely meaningless. I am not aware of *any* argument in its favour.
>
> On the contrary it is expensive
>
> it is inconsistent with the avowed policy of cheap money
>
> (as Hoppy [Hopkins] pointed out) it means losing control of the rate of interest.
>
> (*CW* XXVII, pp 391–3)

Here Keynes contrasts the desired position with the "funding complex", the conventional debt management policy. Longer-dated debt was known as the "funds"; the authorities' preference for funding, and hence their restricting the supply of shorter-dated debt, constituted a "counter-liquidity preference".

According to the theory of liquidity preference, the problem with funding was that if the public's preference for illiquidity was not as strong as the government's preference for long borrowing then rates on longer-term debt would have to be higher in order to encourage the public to accept the longer-term issues. Under such circumstances "it is the public which sets the rate of interest" – and it was not possible for the authorities to bring the rate of interest under control. His specific example illustrated this point. He also observed that there was a vicious circle whereby increases to the long-term rate of interest to encourage illiquidity would generate further expectations of high rates into the future.

As cheap-money policy meant abandoning the "funding complex", Keynes examined its original justification. The first two of (a), (b) and (c) were explicitly linked to the existence of the gold standard, and therefore were no longer valid. The third consideration was invalidated by Keynes's wider theory. First, the mechanism through which deflationary monetary policy operated was to reduce demand and hence employment. Second, as

[27] (c) was added at a later stage of drafting.

Hopkins observed, the use of Bank rate was inconsistent with cheap money (discussed further below).

Given the rejection of the "funding complex", the practical issue was to devise a debt management technique which facilitated keeping the public as liquid as they would like. Keynes argued that the technique of the "tap issue" provided such a policy: "it is the technique of the *tap* issue that has done the trick".[28] Under the tap system, the Government announced the price and maturity of the bond being issued, but set no limits to the cash amount of that issue. The "tap" of the bond issue was held open so individuals and institutions could purchase when and whatever quantities they desired.[29] The system, therefore, enabled the public to choose the quantity of debt issued at each degree of liquidity, at the price set by the Government.

The second aspect of Keynes's debt management policy was to extend the degrees of liquidity available by issuing a wider range of securities. Before the gradual development of Keynes's techniques, the authorities tended to offer only very long-term securities and a limited amount of Treasury bills. At the NDE, and again following wartime experience, Keynes argued that the Government should offer two fixed maturity bonds of five and ten years, as well as a perpetuity:

(c) ... 5-year Exchequer Bonds at 11/2 per cent and 10-year Bonds at 2 per cent on tap, a new series to be started annually;

(d) 3 per cent Savings Bonds on tap, a new series to be started annually, with an option to the Treasury to repay after 10 years and with, preferably, no final maturity (or, if necessary, a fixed latest date of repayment 35 years hence). (*CW* XXVII, p 399)

The purpose of these arrangements was to cater for medium-term as well as longer-term savings requirements. The offer of extended facilities further relieved pressure arising from the desire for precautionary holdings of wealth as money and served to create a more balanced portfolio of asset holdings.

Keynes argued that for the longer-term debt "the option of early redemption safeguards a future liberty of action" (*CW* XXVII, p 400). This reflected his views on (perhaps very) long-term trends in interest rates. From the macroeconomic perspective, the notion of diminishing returns to capital means that the yield on aggregate capital expenditure will fall over time. With the rate of interest governing the volume of capital expenditure, a monetary policy aimed at stable and high employment would, therefore, have to be managed at not only low but also falling rates of interest. From the debt management perspective, this meant that terms on any long bond issued should not be superseded by terms on a later issue. It was therefore desirable to avoid, to as great an extent as possible, the situation where previous higher-interest bonds remained in the market as new lower-interest bonds were issued. Overall, his minute of recommendations looked to mechanisms that preserved "the maximum degree of flexibility and freedom for future policy" (*CW* XXVIII, p 397).

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[28] Attention should be drawn to the differing meanings of "tap issue" as used by Keynes and later by R S Sayers, the UK banking historian. In the 1967 edition of his Modern Banking, Sayers (p 55) means by "tap issue" a mechanism whereby the authorities issued Treasury bills to Government departments that had funds in hand, and to certain overseas monetary authorities: "the rates of discount at which the bills are issued through the tap is unknown and is irrelevant to the discount market". With the widespread acceptance of Sayers's terminology, it seems that the original notion of the tap – which is of course very different and much more important – has been lost.

[29] An example issue notice stated "subscriptions will be received on Tuesday, 25th June, 1940, and thereafter until further notice ... " (*The Economist*, 29 June 1940, p 1119). The approach was first introduced for the June 1940 wartime issue of 2½ per cent medium-term bonds (known as National War Bonds), and then for the next issue of 3 per cent long-term bonds (known as Savings Bonds).

Last, the notion of diminishing returns to capital also provided a component of the apparatus for cheap-money policy that was likely to be important from the perspective of expectations. With recognition that the long-term rate of interest would move in line with the yield on capital, the public would come to appreciate that movements to the long-term rate of interest would only be in the downward direction. Establishing a shared understanding that terms on present long-term issues would not be superseded by terms on later issues was very fundamental.

On monetary policy, Keynes continued to argue at the NDE that Bank rate was obsolete as an instrument of macroeconomic policy management, and preferred the "quantitative regulation of the basis of credit" (see the 1937 recommendations above). The issue was the most controversial in subsequent debate,[30] and his minute of recommendations left the door (only slightly) ajar:

> Changes in the complex of interest rates, with a view to controlling the trade cycle and to offset inflationary or deflationary trends, should not be precluded, but should affect the shorter-term rather than the longer-term, issues, and should, as a rule be regarded as secondary to the technique of rationing the volume, rather than altering the terms of credit by the machinery of, eg the Capital Issues Committee by influencing the volume of bank advances.

He went on to the following explicit proposal: "(a) Bank rate to be reduced to 1 per cent and to govern the rate payable on overseas money in the hands of the Bank of England, so that this rate would remain unchanged" (*CW* XXVII, p 399).[31]

The most substantial innovation in terms of quantitative control was the Treasury Deposit Receipt, but this was equally important in terms of fiscal policy and provides the point of departure for a brief discussion of these matters.

6. Monetary expansion and fiscal policy

This is not the place for a full discussion of Keynes's approach to fiscal policy. However certain aspects merit emphasis, as the theory and practice bring together monetary and debt management policy on one hand and government (or private) expenditures on the other.

Financial considerations were central to Keynes's case for any expansion of public works expenditures. According to the (full) multiplier theory, government expenditure would increase national income and employment, hence raising taxation revenues and reducing benefit expenditures. He consistently maintained that expenditures would be self-financing:

> … we see that it is a complete mistake to believe that there is a dilemma between schemes for increasing employment and schemes for balancing the Budget, – that we must go slowly and cautiously with the former for fear of injuring the latter. Quite the contrary. There is no possibility of balancing the Budget except by increasing the national income, which is much the same thing as increasing employment. (*CW* IX, p 347)

[30] Notably James Meade and Lionel Robbins contested Keynes's view.

[31] This may have been with an eye to the wartime position: while the official Bank rate remained at 2 per cent, Sayers notes that the discounting procedure of the Bank of England had been formalised as the "open back door", "to which the discount houses could resort ... [and] turn Treasury Bills into cash at the fixed discount rate of 1 per cent" (Sayers, 1956, p 223).

The essential task of policymakers was to bridge the gap between the initial expenditures and the increased future income. His most categorical statement of the required approach was central to his recommendations for the financial conduct of the Second World War that he put to the Chancellor of the Exchequer in May 1939:

> But with modern representative money and a modern banking system, we know that the necessary 'finance' can be created by a series of 'book' or 'paper' transactions. The Treasury can 'pay' in effect by 'book' entries and the book entries can be transformed into a regular loan at a much later date. (*CW* XXI, p 540)[32]

A new instrument – the Treasury deposit receipt (TDR) – was devised to support the creation of these book transactions. The instrument brought together debt management policy, that followed from store of value considerations, and an extension to the system to support means of exchange considerations, in this case government expenditure.

Under the TDR system, retail banks were obliged to lend to government, and hence create credit – alternatively: create a "deposit" for the "Treasury", in exchange for a "receipt" – to finance directly government expenditure. These instruments were added to Treasury bills as part of the floating debt. The new instrument was required because of the traditional role of Treasury bills, which was that they could be discounted at the Bank of England to support an expansion of credit. So an expansion of Treasury bills to support government expenditure could then lead to a further expansion of credit to the private sector. TDRs were therefore not marketable and could not be reserved at the Bank of England against further credit creation. They were issued on a term of six months and, as a less liquid asset, paid a slightly higher interest rate (1 1/8 per cent) than a Treasury bill (1 per cent).[33] At the NDE, Keynes suggested reducing the interest rate on both TDRs and Treasury bills by ½ per cent.

His systems had addressed concerns about "monetising" government debt, and potentially causing inflation, by breaking the direct link between floating debt and credit creation. Outside banking mechanisms, any substantial increases to the floating debt as a result of accommodating liquidity preference for shorter-term instruments were due to savings not spending considerations and therefore were also not inflationary.

> The dangerous character of this type of debt [floating debt] disappears if there are adequate understandings with the financial world (including, it may be, appropriate regulations for continuing into the future the system of Treasury Deposit Receipts) to ensure the continuous holding of a large, and even increasing, floating debt in all circumstances. (NDE Report, paragraph 23)

During the war, the control of credit was also aided by other aspects of economic policy. Most importantly, aggregate demand was dominated by government expenditure, which should have been more easily regulated than other sources of demand. In addition, consumer demand was implicitly controlled by higher and well-thought-out taxation policies,

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32 Jens Warming (1932, p 215) was the first to state clearly this bridging role of credit: "If a bank promises credit for an investment it really disposes of something belonging to the future: the coming saving".

33 Susan Howson (1988, pp 252–3), the economic historian of debt management and monetary policy, describes TDRs as follows: "The introduction in July 1940 of Treasury Deposit Receipts (TDRs), by which the major banks were obliged to lend directly to government, added a new instrument to the floating debt, enabling the authorities to borrow on short term without either increasing the Treasury bill issue or having recourse to Ways and Means Advances. Of longer maturity (six months) than three-month Treasury bills and non-marketable, TDRs were less liquid than Treasury bills and carried a slightly higher interest rate (1/8%). This wartime expedient [This is misleading: the NDE report recommends their continued use into the post-War period.] was, as Sayers put it, 'concocted . . . [so as] not to disturb the customary relationship [between banks, discount houses, and the Bank of England] and customary "ratios" of the peacetime [banking] system', but it was nonetheless seen as a revolution in fiscal policy, at least in Labour Party circles ...".

and (as above) investment was potentially controlled by the Capital Issues Committee's management of the new issues market.

All of these initiatives were indicative of Keynes's preference for the quantitative means for regulating the creation of credit. Moreover they exemplify his anti-inflationary credentials that, in reality, were second to none.[34]

Means of exchange considerations overlapped with store of value considerations – and hence the theory of liquidity preference – in that they were both partly dependent on a supply of liquid assets that was controlled by the authorities. But the former demanded a wider view of quantitative control and of the means to control more directly banks' ability to create credit. The same liquidity constraints are then relevant to a private sector expansion of credit. The central bank is able to set the rate of interest if two conditions are satisfied: first, that banks are supplied with cash according to demand; and second, that there is no shortage of eligible assets to discount at the central bank in exchange for that cash. Both conditions are liquidity preference conditions: there should be an adequate supply of liquidity in the form of both cash and bills to support the supply of bank money. Examining matters in this way abstracts from the transactions and finance demands that Keynes identified and focuses on a broader demand for bank money/active money as a whole.

To reiterate: a supply of bills that is under the control of the authorities is vital to both the practical management of money as a means of exchange and as a store of value. At this point Keynes's simplification through treating inactive and active demands together is seen as justifiable. For me there is no logical reason to see *a priori* reasons why the two theories should be incompatible, according to the ideas of liquidity preference as a theory of money as a store of value and the theory of bank money as a theory of money as a means of exchange. However, the substance of the discussion suggests that Keynes's own treatment was an oversimplification and that it may have been better to elaborate the two processes more fully. This treatment has led to an immense literature, particularly within post-Keynesian economics. I present the above discussion as a provisional attempt at an alternative approach.

7. The international dimension

Finally, from both the theoretical and practical perspectives, is the role of the international financial architecture. As discussed, devising and implementing a system alternative to the gold standard was Keynes's central preoccupation for much of his life. From the most general and fullest perspective, Keynes saw that systems based on international capital should be replaced by systems that utilised domestic banking systems as a bridge to domestically generated savings. Bank money meant that international capital was not necessary for the expansion of domestic activity. But the international system should instead focus on the means to finance international trade and hence the provision of an international means of exchange. Keynes made his fullest contribution to a system in accordance with

[34] Beyond his approach to the rearmament programme, his greatest and most long-standing contributions to any fight against inflation came in the wake of his *How to Pay for the War* (*CW* IX, pp 367–439). He championed a system of deferred taxation, so that private expenditure was restricted during the war and then released after the war, to balance the system as a whole over time. The same contribution utilised extensively and led to further developments of the emerging national accounts information with which he had been closely involved (see Tily, 2009). Through his efforts the accounts were put on a statutory footing for the first time in 1941. Last, but not least, with the accounts in place he devised the macroeconomic approach to annual budget statements that remains in force to this day.

these principles – and perhaps therefore his most profound contribution to the world – in the wartime discussions that led up to the Bretton Woods Agreement.

These discussions first led to a formalisation of the policy on capital control, which had been evolving over the course of his life. At the end of the First World War, an "embargo on overseas loans" was in place in the UK, which was repealed six months after the return to gold. The embargo was then re-imposed to support the 1932 conversion of the War Loan and remained in place from then on. Keynes's perspective is clear: he regarded capital controls as essential to his domestic monetary policies for the post-war world:

> You overlook the most fundamental long-run theoretical reason. Freedom of capital movements is an essential part of the old *laissez-faire* system and assumes that it is right and desirable to have an equalisation of interest rates in all parts of the world. It assumes, that is to say, that if the rate of interest which promotes full employment in Great Britain is lower than the appropriate rate in Australia, there is no reason why this should not be allowed to lead to a situation in which the whole of British savings are invested in Australia, subject only to different estimations of risk, until the equilibrium rate in Australia has been brought down to the British rate. In my view the whole management of the domestic economy depends upon being free to have the appropriate rate of interest without reference to the rates prevailing elsewhere in the world. Capital control is a corollary to this. Both for this reason and for the political reasons given above, my own belief is that the Americans will be wise in their own interest to accept this conception, even though its immediate applicability in their case is not so clear. (*CW* XXV, p 149)

Turning to international exchange policy, on the one hand the Second World War had interrupted the development of the currency management approach. But, on the other, it seemingly offered the opportunity to start from first principles. In 1941, in the course of international summits relating to post-war economic policy, President Roosevelt offered Keynes the opportunity to develop a financial architecture for the world "that excluded nothing in advance".[35] A few weeks later, Keynes described his plans to the head of the British Civil Service, Sir Horace Wilson:

> I have been spending some time since I came back in elaborating a truly international plan … we should do well to start from some such proposal as that which I have prepared or a variant of it, even though we may feel that it is probably too international and too Utopian to take form just in that shape in the real world. (19 September 1941, *CW* XXIII, p 209)

The basic mechanics of his "International Clearing Union" were outlined in a letter to the Governor of the Bank of England:

> The *essence* of the scheme is very simple indeed. It is the extension to the international field of the essential principles of *banking* by which, when one chap wants to leave his resources idle, those resources are not therefore withdrawn from circulation but are made available to another chap who is prepared to use them – and to make this possible without the former losing his liquidity and his right to employ his own resources as soon as he chooses to do so. Just as the domestic situation was transmogrified in the eighteenth and nineteenth centuries by the discovery and adoption of the principles of local banking, so (I believe) it is only by extending these same principles to the international field that we can cure the manifest evils of the international economy as it existed between the two

[35] Roosevelt's words, cited by Moggridge in *CW* XXIII, p 228.

> wars, after London had lost the position which had allowed her before 1914 to do much the same thing off her own bat. (*CW* XXV, pp 98–9)

As he suspected, his proposals were too Utopian for the real world. While the Clearing Union was put forward as the official position of the British Government, the primary "inspiration" for the Bretton Woods Agreement was the rival US Treasury proposals for a "stabilisation fund". Keynes's leading role in the negotiations did mean that the final agreement offered economies a degree of autonomy and flexibility for the post-war era; in particular, Article VI of the Agreement permitted member countries to put into place, or keep in place, capital controls. But Bretton Woods was not the Clearing Union.

The Clearing Union was the culmination of Keynes's work: it applied his *General Theory* and associated practical experience in the widest possible context. These proposals may have been rejected on political grounds; they were *never* rejected or disputed on economic grounds. Indeed the comments on his scheme showed a unanimity of support entirely denied to the *General Theory* – as illustrated by comments from Dennis Robertson (his most truculent and relentless critic) and Lord Catto (later Governor of the Bank of England):

> I sat up late last night reading your revised 'proposals' with great excitement – and a growing hope that the spirit of Burke and Adam Smith is on earth again to prevent the affairs of a Great Empire from being settled by the little minds of a gang of bank-clerks who have tasted blood (yes, I know this is unfair!). (Robertson to Keynes, 27 November 1941, *CW* XXIII, p 67)

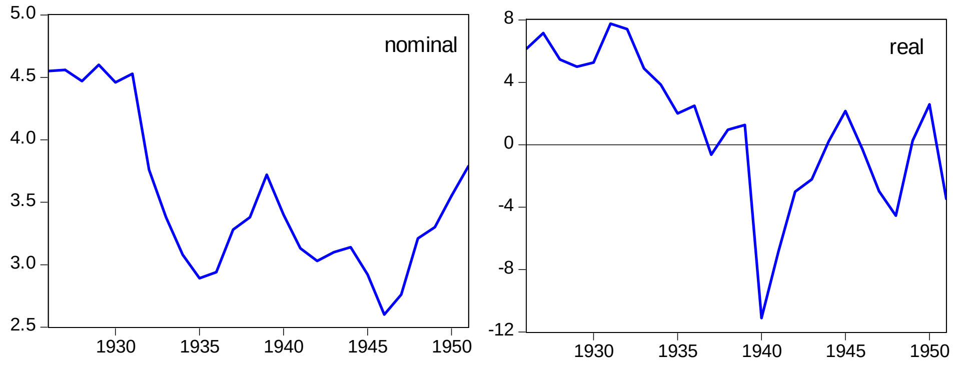
> Now that it has been published, I want to congratulate you on your Clearing Union. I have avoided adding myself to the critics. I felt sure your basic principles were sound and unalterable. I was content to let others, with greater theoretical knowledge than I have, do the criticising. As I expected, the final document does not differ at all in essentials (nor much even in detail) from your very early drafts which I was privileged to see and, if I may say so, to encourage. (Catto to Keynes, 30 April 1943, *CW* XXIII, p 236)

8. Some outcomes

With no recognition of the fundamental policy conclusion of Keynes's theory of liquidity preference, the evidence of its practical application has not been brought to bear to judge its validity. Such evidence is compelling. Liquidity preference theory predicts that deliberate action on the part of the monetary authorities will reduce (or increase) the long-term rate of interest. Mainstream theories of interest either have very little to say on this ability or are underpinned by a natural rate of interest impervious to policy manipulation, except perhaps in a short run. Figure 3 shows that both real and nominal long-term rates declined almost continuously throughout the period when Keynes's monetary prescription was dominant. The main exception was between 1936 and 1939 when Keynes was indisposed. His final address to the National Mutual is indicative of his alarm.

Figure 3

UK Government long rates, 1925–51



Source: Friedman and Schwartz (1982, Table 4.9)

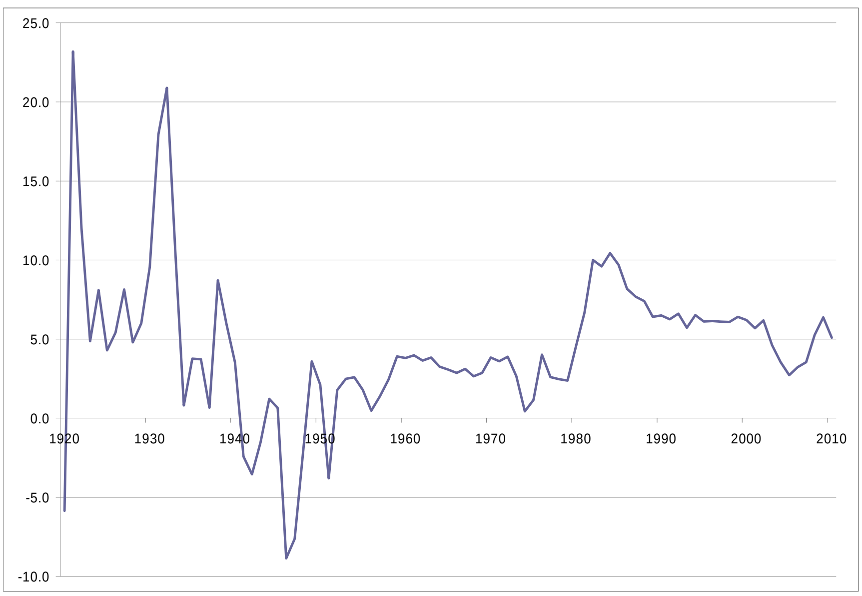
After the war, cheap money was a central goal of the Labour Government. They were successful in driving rates to a historic low (in 1946, the year Keynes died), but were unable to hold them there. Hugh Dalton, the Chancellor and driving force behind the Government's monetary strategy, later reflected:

> The forces against me, in the City and elsewhere, were very powerful and determined, … I felt I could not count on a good chance of victory. I was not well armed. So I retreated. (Dalton, 1954, p 239)

In many ways, events have now run full circle. Figure 4 shows a full history of US interest rates from the 1920s to 2010; importantly, they are adjusted for the effects of inflation. (The US rate is used because it is the only long-run series that is readily available.)

Figure 4

US long-term real interest rates[1]



[1] These are based on US corporate bond yields, adjusted for inflation. UK rates are not available on this basis. It seems reasonable to assume that these rates are a guide to (and set a lower bound to) such rates across the world. The data are based on Moody's BAA ratings; inflation is removed using the US GDP deflator. Sources: websites of the Federal Reserve and the Bureau of Economic Analysis and (for deflators before 1929) Friedman and Schwartz (1982).

The chart shows the high rates of the 1920s on which Keynes's attention was fixed. From the 1930s on, real rates were low for almost 50 years. While the Labour Government had retreated from its most substantial efforts to hold the government bond yield very low, long-term rates were still low across the world for the whole of the golden age.

But from 1980 onwards, rates rose very rapidly and remained at a high level for the rest of the 20th century. This interpretation of the *General Theory* leads to the conclusion that this dear money had its origins in the dismantling of the international and domestic monetary regimes that Keynes had put in place, no matter how imperfect their implementation.

In the UK financial liberalisation began in the late 1960s, with the dismantling of quantitative restrictions on credit control;[36] these actions came in parallel to the rise of the Eurobond market, and were followed soon after by the termination of the Bretton Woods Agreement. Finally, at the turn of the 1980s, all capital and exchange controls were removed and dear money was deployed to fight inflation. Smithin (1996, p 23) concentrates on discount rate policies and identifies three "symbolic harbingers of the political revolution that was to come during the crucial year of 1979".

> One such was the much-publicised change in the operating procedures of the US Fed, after the appointment of a new chair, Paul Volcker, who was very much the candidate of the financial markets … There ensued a three-year effort to bring inflation down via monetary tightness and high real rates of interest. Also in 1979, the most famous adherent of monetarism among politicians, Margaret Thatcher, was elected to her first term as British Prime Minister, and in the next year her government began a similarly draconian disinflation policy, the so-called 'medium term financial strategy' (MTFS). Finally, perhaps less-remarked at the time than the first two events, but of equal significance in hindsight, the year 1979 also saw the inauguration of the European Monetary System (EMS), and the associated exchange rate mechanism (ERM) … In the future, this would ensure that pan-European monetary policy would be determined essentially by the German Bundesbank, which, because of previous history, was an institution traditionally committed to the type of hardline anti-inflationary policy which became very much the order of the day in the 1980s and 1990s. (Smithin, 1996, p 23)

He concludes "… the new regime clearly did succeed in restoring the value of financial capital and in raising the real rate of return earned on that capital" (Smithin, 1996, p 24). The high real rate of interest has endured to the present day.

Paradoxically, however, more attention is paid to a briefer period of lower interest rates in more recent years. In my view these follow in the first instance from the severe extent of financial instability since around the turn of the 21st century: first there were the South East Asian and Russian crises; these were followed shortly afterwards by the collapse of Western stock exchanges as the "new economy" expansion in the corporate sector came to an abrupt halt. The result of these was a retreat to the safety of government debt. As Figure 4 shows, initially, corporate borrowing rates remained at a high level even while the more commonly discussed rates on longer-term government debt began their gradual descent. The second impetus to lower rates followed the steep reduction in discount rates that followed in the wake of the collapse of the corporate expansion. The severely deregulated financial environment that prevailed at that point permitted the parallel creation of a vast array of complex financial products; the combined effect was a vast extension of the money supply and various asset inflations across the world (not least in residential and commercial property). Any lower rates on long-rated instruments were surely primarily a side-effect of this freak monetary expansion: liquidity preference is perfectly clear on this point. Moreover, as

[36] Most importantly with "Competition and Credit Control" in 1971.

we now know, this impact was short-lived (Figure 4 again). This disastrous episode could not be further from Keynes's own approach. Certain rates of interest may have been "cheap", but there was certainly no idea of the quantitative regulation of the basis of credit.

Yet with the advent of the financial crisis, the circle is completed and there has been renewed attention on the policies of the 1930s. Economists are examining again monetary arrangements that have been too long neglected. Most notable is Philip Turner's (2011a) recognition of the importance of the long-term rate of interest to Keynes's theoretical scheme. He has asked: "Is the long-term interest rate a policy victim, a policy variable or a policy lodestar?". The answer seems to me different according to what point in history is being examined.

But in other recent contributions there is an apparent desire to restore this monetary tradition in opposition to any fiscal tradition. Notably Basile *et al* (2009) (rightly) reject the idea that the present situation constitutes a liquidity trap. They argue that Keynes did not think that point had been reached in the 1930s, and, by association, it has not been reached now.

Now it may be that there is a great deal of scope for monetary action to press down on the long-term rate, especially outside of the US and UK (though the authors do not address the role of capital control). However Basile *et al*'s position does not serve to clarify Keynes's perspective. Keynes's theory led to the conclusion that a monetary authority could set whatever long-term rate it chose, given the necessary domestic and international arrangements. The fact that there may be a lower bound to this process should not detract from this fundamental conclusion. The emphasis on the liquidity trap was largely the preoccupation of others, not least Dennis Robertson. The existence or otherwise of the liquidity trap has little bearing on Keynes's initiatives, nor does it have much bearing on the necessity or otherwise of fiscal policy.[37]

Keynes's support for fiscal policy did not follow primarily from any lower bound to this process but from recognition that a low long-term rate of interest might not be sufficient for recovery. A low long-term rate of interest was necessary to prevent recession, but it might not be sufficient to effect recovery from recession, especially given the extent of private indebtedness that was the defining financial characteristic of the 1930s (Fisher, 1933), just as it is today.

This conclusion followed from his wider theory of economic activity, which is outside the scope of the present paper. However, one point must be made. Keynes rejected the classical theory of interest and with it the idea that the rate of interest was somehow an automatic regulator of the economic system. *His monetary theory of interest led to a monetary theory of real activity*. He devised a full statement of the interaction between the long-term rate of interest and the real economy: hence *The General Theory of* ***Employment, Interest and Money***. In this theory the natural rate of interest is an invention that does not exist in the real world (or rather, the monetary world). The system is simply founded on the monetary rate of interest that is permitted to prevail by the financial and/or political authorities.

The essential practical conclusion of his "real" theory was that economic crisis had a root monetary cause. As he saw as early as 1930, the cause of the Great Depression was dear money. He was adamant that society's best interest was served if the policymaker took deliberate charge of the rate of interest and aimed to keep money cheap. I feel sure that the same diagnosis applies today, and that the roots of the present crisis lie in the policies of financial liberalisation that have led to an even more intense and prolonged period of dear

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[37] See Tily (2010, Chapter 4) on Robertson's approach, his relentless hostility to Keynes's analysis and policy prescription, and the relation of this work to "Keynesian" economics. Krugman is true to his "Keynesian" heritage in his rebranded "economics of the zero bound", and the argument is justly attacked by Basile *et al*. But this does not refute Keynes's arguments for fiscal policy.

money than in the 1920s. If a high interest rate could not be earned by corporations in the first quarter of the 20th century, surely it could not be earned in the last? Restoration of the system to health must depend on a wholesale restoration of the monetary initiatives that were finally taken in the 1930s and 1940s.

9. Conclusion

> The higher are a people's intelligence and moral strength, the lower will be the rate of interest.
>
> (Eugene Von Böhm-Bawerk (1851–1914), cited in Homer, 1963, p 200)
>
> We are not condemned to the perpetuation of the high rates of interest which the world economy handed on as a legacy of its past.
>
> (Ciocca and Nardozzi, 1996, p 118)

Philip Turner has argued that the debate on the long-term rate of interest is "an old and controversial issue" (2011b, p 42). This may be true, but the debate has been of little interest to macroeconomists over at least the past fifty years. Moreover, mainstream economists have entirely neglected Keynes's fundamental contribution to this debate. While some of Keynes's true followers protested, especially at the Radcliffe Committee, their words ultimately fell on deaf ears (*ibid*, pp 25–7).

Keynes regarded a low long-term rate of interest as a precondition to economic prosperity and social advance. While the scope of his activities was breathtaking, his greatest contribution to the world was the development of the theoretical means to this conclusion and the associated practical means to its implementation.

Somehow, to our deeply profound peril, we have allowed this to be lost. Many economists continue to confront the greatest crisis of the world economy since the Great Depression with essentially the same theory that Keynes saw as at its root cause. In spite of the revival of his name, it remains my firm belief that the economic profession as a whole is continuing to refuse to re-assess Keynes's theory in a genuine and impartial manner. Given the increasingly obvious high stakes, this cannot be acceptable.

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Thoughts on policies and the policy framework after a financial crisis

Lex Hoogduin[1] and Peter Wierts[2, 3]

Abstract

Attention from policymakers tends to concentrate on the short-term effects of crisis policies on growth and financial stability. This paper investigates side-effects of current crisis policies from the perspective of the classic debate between Keynes and Hayek. It argues that three issues remain largely unaddressed: a lack of confidence, a distorted structure of the economy and policy framework, and too high debt levels. Continuing expansionary and unconventional policies may be counterproductive and it may be better to shift the focus of policies towards real and financial adjustment.

Keywords: Policy framework, financial crisis, unconventional policies, Keynes, Hayek

JEL classification: E12, E58, E61

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[1] Professor at the University of Amsterdam and Duisenberg School of Finance, e-mail: l.h.hoogduin@uva.nl

[2] Financial Stability Division, De Nederlandsche Bank, e-mail: peter.wierts@dnb.nl

[3] The opinions expressed in this article are those of the authors and do not necessarily reflect the views of De Nederlandsche Bank.

1. Introduction

Until recently, the policy framework in advanced economies seemed based on clear and simple principles: market allocation based on the price mechanism; responsibility for sustainable fiscal policy, making fiscal support from other countries or from monetary policy unnecessary; and a clear separation of fiscal and monetary policy from debt management. The validity of those principles is no longer obvious. Important financial market segments – the money market, bond markets and housing finance – have been dysfunctional for considerable periods of time, and have been subject to heavy policy intervention that distorts market-based pricing. Debt is on an unsustainable path in many countries, and has made outside support necessary for several countries. Monetary policy has increasingly come under pressure to intervene for the sake of financial stability and to perform quasi-fiscal roles.

Policymakers' attention has concentrated on the short-term effects of crisis policies on growth and financial stability. But by now macroeconomic policies have been in crisis mode for several years, and a quick exit is not foreseen. Thus, we shift attention here to the side effects of this new policy configuration, and explore the road ahead.

The context is one of high debt and low growth. Full separation in macroeconomic policy no longer holds, and distortive side effects of crisis policies are increasingly visible. Section 2 of this paper focuses on side effects that have already occurred. Section 3 analyses the current policy choices from the perspective of the classic debate between Keynes and Hayek in the 1930s.

Our main message is that policy response to the financial crisis so far has benefited from one lesson of the Great Depression, in that monetary and fiscal policies have been highly expansionary. This has contributed to avoiding another Great Depression and a total collapse of the financial system, but has come at a cost, and has not yet restored sustainable growth. Three other problems remain unsolved and largely unaddressed: lack of confidence, distortion in the structure of the economy and in the policy framework, and excessive debt levels that may ultimately threaten social and political stability. Continuing expansionary and unconventional policies may be counterproductive, and it may be better to shift the policy focus towards real and financial adjustment.

2. Side effects of current policies

Fiscal and monetary response to the credit crisis incorporates the lesson from the Great Depression that monetary and fiscal policies should be expansionary when crisis hits. This worked well, since depression and systemic collapse of the financial system were prevented. Still, growth remains moderate, in line with historical evidence on low growth in the aftermath of financial crises (Reinhart and Rogoff, 2010). The highly expansionary response to the crisis has so far not changed this pattern.

At the same time, it has become clear that these policies have important side effects. Crisis policies are meant to be temporary, as are expected to be their side effects. The continuation of macroeconomic policy in crisis mode, however, implies lasting side effects. We discuss: (i) their emergence during the credit crisis, and (ii) their increasing presence during the debt crisis.

Side effects, phase 1: credit crisis

The side effects of low monetary policy rates and unconventional policies are well recognized (for a full overview, see van den End et al, 2009). In a market environment, banks need to screen each other, and banks with riskier investment strategies pay higher interest rates on the interbank market. Full allotment in combination with low rates, however, distorts the functioning of the price mechanism. All banks – risky or not – pay the same rate. The banks that benefit the most are those that would pay the highest rates in the market, or that would be cut off from market liquidity. Continued unconventional policies will reduce incentives for de-leveraging or de-risking. Distorted pricing decreases efficiency in the channelling of liquidity across the banking system. Moreover, it leads to indirect monetary financing of government debt, insofar as banks pass liquidity on to the government. It provides an incentive for banks to demand short-term government debt, to match the maturity of the full allotment by the central bank.

Insofar as low policy rates spill over to the rest of the yield curve (see below), they favour borrowing over saving. This creates an incentive for banks to delay balance sheet repair, for governments to delay deficit reduction. Decreasing returns also stimulate risk-taking in search for yield.

The side effects of expansionary fiscal policy occur – at least initially – at the long end of the yield curve, that is in the government bond market. Changes in the perception of debt sustainability lead to sovereign risk premiums. Through the benchmark role of government bonds, these increases in risk premiums spill over to the corporate bond markets and other parts of the financial system, and ultimately to the real economy (CGFS, 2011). Countries that are considered safe havens, on the other hand, experience inflows to their bond markets that decrease interest rates because of the safe haven effect (see Nickel and Vansteenkiste, 2011, for a quantification of this effect for the euro area). This may decrease the return on saving to below 'normal' market interest rates. Again, this implies re-pricing in favour of borrowing over saving.

Turner (2010, p. 102) describes how '*very large debt defines the yield curve*'. This phenomenon includes the role of financial regulation in requiring banks to hold government debt, and the effect of public debt management on yields. In a context of dysfunctional markets, central bank operations at the short end of the yield curve do not necessarily spill over to the long end of the curve. As a result, quantitative easing becomes potentially effective in stimulating aggregate demand by reducing long interest rates (see the US and UK experience). Over time, this translates into a risk that persistent credit easing will distort rather than support the markets in which the central bank intervenes. In different countries this applies to markets such as mortgages, covered bonds, equity, corporate bonds and government bonds.

Moreover, public debt management will have macroeconomic implications, since it can affect relative prices along the yield curve. As a result, public debt management should no longer be guided by cost minimisation principles, since the yield curve is not exogenous, but by principles of prudent financing (Hoogduin et al, 2011). The side effect that we are interested in here is the mixture in the macroeconomic policy framework, since the traditional separation of monetary policy and public debt management no longer holds. Views on the consequences of this differ. Some argue in favour of more operational co-operation (CGFS, 2011) while others encourage central banks to revert to their role of managing the national debt (Goodhart, 2010, p. 26).

Side effects, phase 2: debt crisis

The debt crisis starts at the point where bond markets become dysfunctional due to doubts about debt sustainability and a corresponding increase in sovereign risk. This leads to systemic risk due to negative feedback loops from sovereign risk premiums to fiscal positions and to financial institutions that hold government bonds. It puts pressure on the central bank to intervene in the bond markets to prevent a systemic crash. Interest rates of 'riskier' sovereigns are pushed below market rates. This reduces the incentive for fiscal adjustment. It may also further depress long rates in 'safe havens'. To the extent that sovereign risk spills over to the interbank market – due to uncertainty about losses on sovereign exposures – this puts pressure on the central bank to continue or resume unconventional policies, with side effects as discussed above.

From our perspective, the relevant point is that price signals along the entire yield curve get distorted. This means increasing redistribution from savers (wealth) to borrowers (debt) without recourse to the democratic decision-making process – a phenomenon immediately visible for pension funds and insurance companies, which face a decrease in their return on assets, and increases in the value of their liabilities due to low interest rates,

In a context of high debt, fiscal, monetary and financial stability operations become strongly intertwined. We conclude that the side effects during phase 1 – the credit crisis – were characterised by an increasing distortion of financial markets and the end of full separation between macroeconomic policies. Side effects have widened in phase 2 and caused a further interdependence between macroeconomic policies. High debt has triggered an ongoing process in the direction of fiscal dominance over financial stability and monetary considerations.

The key principles of the macroeconomic framework do not hold any more. We are in uncharted territory without a clear, articulated policy framework. This leaves the private sector with less of an anchor on which to base its expectations. Lack of confidence, postponement of investment, and short planning horizons may be a result of this. At the same time there is an incentive to continue and even intensify expansionary and unconventional policies as long as growth remains lacklustre. The question is whether this is the right choice, given the costs of these policies.

Where to go from here? One response is to argue that, since expansionary and unconventional policies work, they should be continued and even intensified. Continue to apply Keynes's lesson from the 1930s, and 'double the dose' as it were. But there is another possible response. Demand management addresses only one element of the impact of a financial crisis. Its impact is limited, and if applied too long it may cause other problems and hamper final resolution of the crisis. Continuing expansionary policies could be a grave mistake. The situation calls for a discussion that revisits the 1930s debate between Keynes and Hayek. Keynes won, but are we not discovering today that Hayek had a point too?

3. The policy debate between Keynes and Hayek, and the resulting policy framework

In the early 1930s the key debate in economics was between Keynes and Hayek (see Cochran and Glahe, 1994). Keynes argued that the economy is not automatically self-adjusting. It can get stuck in equilibrium with less than full employment. The level of production and employment are determined by the principle of effective demand. Demand management can bring the economy back to full employment from an equilibrium that includes unemployment – clearly an improvement in welfare, for everyone benefits and there are no apparent costs. Thus, there seems after all to be a free lunch in economics – known before Keynes as the 'dismal science'.

Hayek's view was fundamentally different. In his theory, the market system provides a mechanism for moving to a unique equilibrium. In this equilibrium there is not only full employment, but also equilibrium of the structure of production and the balance between consumption and saving. However, the optimum is not always attained. Hayek focused on disequilibria between saving and investment and in the production structure. These were brought about by deviations of the market interest rate from the natural interest rate.

The distinction between these interest rates had already been introduced by Wicksell. But in Wicksell's theory a deviation between the natural and market interest rates causes inflation or deflation, since the deviation leads to what we would today call an output gap. Keynes builds on Wicksell in the sense that he too focuses on aggregate demand. New Keynesian theory is even more Wicksellian. There is not only a focus on aggregates, but a revival of the concept of the natural interest rate, which Keynes rejected.

In Hayek's theory the financial sector is at the heart of disequilibria by virtue of setting the market interest rate. If the market interest rate deviates from the natural rate, a cyclical process develops. Let us assume that the market rate is too low. This leads to overinvestment relative to future consumption demand. The capital structure becomes distorted. This will only become clear in the future, when it is revealed that there is more capital available than required for consumption demand. Unemployment develops, and total production falls. Now the economy has to adjust to correct its structure. Hayek assumes that entrepreneurs operating in free markets will succeed in doing this, although the adjustment itself can be painful and will take some time.

In Hayek's view, unemployment is not the result of a lack of aggregate demand, but of disequilibrium in the structure of the economy. An overly expansionary monetary policy does not only, or even primarily, result in an increase in the general price level, but distorts relative prices. In particular, the relation between prices of current consumption and future consumption can become distorted, as reflected in too low an interest rate (or, *mutatis mutandis*, too high an interest rate). Expansions of money and credit are not neutral. They affect the structure and level of production. They thereby also affect a society's distribution of income and wealth and the level and distribution of debt, although Hayek did not pay as much attention to these issues as to the capital and production structure.

Hayek's response to Keynes was in essence that Keynes's policies would ultimately not work, and would make things worse by postponing the inevitable adjustment and increasing the necessary degree of adjustment.

Keynes won the debate and laid the ground for aggregate demand management. Over time, a synthesis with the classical view was established and much of Keynes's original revolutionary view went by the board. The New Keynesian model became the workhorse of monetary policy (NKM). In short, deviations from full employment are now seen as the result of so-called market imperfections, which can be remedied by macroeconomic policy. Money is neutral in the long run. Inflation can be and should be controlled by an independent central bank setting a short-term interest rate. The required separation between monetary and fiscal policies follows directly from this view. Independent public debt management can be added if fiscal policies are fully sustainable – which should be the policy objective – and if the central bank is fully credible in maintaining price stability. In that case government assets are risk free and public debt management does not influence the interest rate on long-term government debt, which is determined by expectations about future monetary policy. Not only is money neutral in the long run in the underlying theoretical framework, but financial variables more generally do not play an important causal role. Finance is ultimately passive. As a result, macroeconomic and financial stability are seen as identical. Keeping output and prices stable should also keep the financial system stable as long as individual institutions are healthy. The latter issue is covered by micro prudential supervision. There is no need for macro prudential policy. Therefore, we end up with three independent macro policies: monetary policy focused on (flexible) inflation targeting; fiscal policy, which can contribute to output stabilisation but should focus on remaining sustainable; and public debt management focused on cost minimisation given a certain level of risk tolerance. Structural policies are seen as important to limit market imperfections as much as possible. Debt levels and income and wealth distribution do not play a role in the NKM.

As argued above, this policy framework has been shaken by the financial and government debt crises. There appears to be consensus on the need for macro prudential policies, but the strategy for such policies and their place in the new policy framework still require a great deal of work. There is also consensus that micro prudential policies have to be strengthened, that the 'too big to fail and/or save' problem must be tackled and that financial institutions have to hold higher capital and liquidity buffers. There is no consensus on whether monetary policy should also have financial stability as an objective.

Otherwise, the implicit idea seems to be to return to the old policy framework where the different policies are clearly separated. The use of the term unconventional policies suggests this. The policies are meant to be temporary. However, before the exit can begin, the general view is that some these policies may have to be intensified until growth has been brought back to the desired level.

In our view, there is every reason to reflect before going forward on this road, drawing lessons from the recent experience with expansionary (unconventional) policies and Hayek's arguments in the 1930s. Experience with the unconventional policies and expansionary monetary and fiscal policies seem to be in line with Hayek's theoretical concerns about them. Yes, Hayek scores some points too.

4. Reflection on Hayek and recent experience

Keynes's lesson about the importance of aggregate demand should be heeded as we move into the future. But recent experiences with respect to the side effects of expansionary policies, as well as Hayek, tell us that there are other matters, which have been neglected at potentially high cost in the current policy environment. Economic developments are more complex than suggested by the NKM. Our ability to control the economy is less than (implicitly) assumed. It may also have to be accepted that adjustments after financial crises are inevitable and painful.

The most important elements that have to be brought back into our macro analysis and policies are: finance; distributional issues; structural issues; political economy considerations; and the role of fundamental uncertainty and confidence. Thus, a very full and exciting research agenda awaits.

These considerations should also lead to reflection on whether the adjusted policy framework as described above is the right one to return to in the long(er) term. If money is not neutral, and financial and real variables cannot really be separated, it is an open question whether the policy assignment and distribution of responsibility in the old (adjusted) policy framework are appropriate. Deciding on the new policy framework and making it explicit is urgent. The well-articulated and definitive policy framework of the pre-crisis era no longer exists. This has created a lot of uncertainty, making it difficult for the private sector to adjust and take long-term decisions. Providing guidance on the new policy framework and the strategy for its implementation should speed up the adjustment process.

The most pressing issue is what the appropriate policies are for reducing debt ratios and for making structural adjustments. Reinhart and Sbrancia (2011) discuss the options for reducing debt ratios:

1. Reviving economic growth
2. Fiscal adjustment/austerity
3. Explicit default or restructuring
4. A sudden unexpected burst in inflation
5. A steady dose of financial repression

The current approach, as described above, is as follows: Try to revive growth as much as possible, using expansionary macro policies in combination with financial repression (since that is what unconventional policies amount to). Make fiscal adjustments if inevitable, but if you can credibly postpone them do so, since that helps to revive growth. Explicit default and restructuring of government debt should be avoided unless inevitable. However, in the EU there is also a view that government debt should be restructured ‘earlier’. This is the debate about so-called private sector involvement. Inflation is not seen as a solution.

Recent experience, as well as Hayek, suggest that the emphasis should be put more on austerity and less on reviving growth by stimulating demand and conducting financial repression. This would mean not extending unconventional policies, but rather leaving them behind while at the same time more rapidly normalising conventional policies.

Such a path would contribute to making markets function properly again, to creating the conditions for the resumption of sustainable growth and to restoring government debt as a safe form of assets. But this would take time. Inflation should remain taboo. However, this would make the distributive consequences of adjustment after a financial crisis even more visible and explicit. It makes it even clearer that adjustment after a financial crisis is not solely, or even primarily, a technical economic problem, but rather a political problem. How can support be mustered for the distributive consequences of adjustment policies, societal cohesion be maintained, and fragmentation and conflict be avoided?

Recent experience and a Hayekian analysis may reinforce the case for making government debt restructuring an *ultimum remedium* rather than part of any government adjustment programme as advocated by those in favour of private sector involvement. The discussion about private sector involvement in the euro area has stimulated contagion and weakened the banking sector, and such a path would make it more difficult for countries with an adjustment programme to return to the financial markets. Adoption of this principle would fundamentally change the functioning of financial markets and the relation between fiscal and monetary policy. The markets would have to function without the anchor of a safe asset in the form of government debt. This would have consequences for investment policy and thereby for the functioning of the economy. It may change the rules of the game between debtors and creditors more generally, also creating uncertainty and unintended consequences. Debt management could no longer be operated separately from monetary policy, and prudential supervision would have to attach risk weights to government debt. This also raises issues about the future policy framework, and in the meantime it would prolong regulatory uncertainty.

A Hayekian approach would put more emphasis on adjusting the structure of the economy. This would, for example, call for more attention to adjustment in Europe’s banking sector and in the housing markets of the United States and Spain. Adjustment has both a real and financial side. It is not only about deleveraging, but also about shrinking the size of some sectors and increasing the size of others, and about the emergence of new sectors and activities.

Adjustment of global and regional imbalances should not be analysed only in a crude Keynesian framework as it often is. It is argued that deficit countries with balance of payments deficits and overly expansionary fiscal policies should consolidate public finances, while countries with balance of payments surpluses should run more expansionary fiscal policies to maintain world aggregate demand at a sufficient level. The first part of this is true, but the second is a logical *non sequitur.* A country with a balance of payments surplus may well have an excessive government deficit. The government has to consolidate, yet the export and import-competing sectors must shrink, and the rest of the economy must grow. The real policy issue for the surplus country is to facilitate this adjustment.

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Comment

Christophe Chamley

These three remarkable papers span a wide set of fascinating issues on the management of government debt and interest rates. Even if we leave aside the volumes that have been written on the subject, one can only add here a few short remarks which should be viewed as complementary. The common ground between the papers is the management of the government debt and its impact on the yield curve and in particular on the long-term interest rate. The papers provide essentially a broad and stimulating historical perspective, from World War I until shortly before the current crisis, that is overwhelmingly rich in the description of the events, the policies and the evolution of policy thoughts.

There is a theoretical problem that is not mentioned by the authors. In the world of the Modigliani-Miller theorem (MM), which does not require complete markets, a change of the composition of the government debt through trading has no impact on the real allocation of resources. Private agents undo the trading of the government.

Of course, the neutrality of MM does not hold when the financial policies entail transfers or when there are liquidity constraints, two issues that will be discussed here. However, MM provides a stylised benchmark that is a useful warning for the analysis of the management of the public debt, either by the government or by monetary policy. One should also emphasise that according to MM, a change of the composition of the debt has a first order effect on the price of assets with different maturities. But that first order effect does not translate into an impact on real allocations, ie aggregate investment. The argument should also serve as a reminder that one may not consider only the relation between investment and the long-term interest rate. For example, the short-term rate has an impact on the opportunity cost of delay, which matters when firms under uncertainty choose the timing of their investment (Chamley and Gale, 1994).

Some changes in the composition of the debt have real effects because they are not restricted to trading and entail transfers. An example, which is considered in the papers of Allen and of Tily, is the conversion in mid-1932 of the third war loan that was issued in 1917 at 5 percent, which had been redeemable since 1929 (Internal War Loans of Belligerent Countries, 1918), into a long-term bond at 3.5 percent. The move was supported by Keynes, as described by Tily. That policy took advantage of the low level of the interest rate and the opportunity to refinance the public debt at a lower interest rate. The practice had been standard in England since the 18th century. If we first neglect the uncertainty on interest rates, the policy entails a transfer from the rentiers (who hold the high interest rate debt) to the tax payers, who benefit from the reduction of the cost of the public debt. That significant change in transfers explains why such a policy is always resisted by a lobby and deemed as risky (Chamley, 2011). Indeed, the pressures on financial institutions to facilitate the conversion (Allen) are just a manifestation of the power game that takes place.

The conversion of a callable war loan to a long-term bond that is not callable for another 20 years also alters the maturity of the government debt and its risk properties. As emphasised by Allen, the old loan has a price that cannot rise much above the par because agents are aware of the redeemability of the loan. The “anchor” of the par provides a stability in the price and the old debt, although it can be extended perpetually, has a price behaviour that is similar to that of a short-term bond (at least if the short-term interest rate is low, as in the 1930s).

As highlighted by the three papers, the management of the government debt through trading is done by the fiscal and by the monetary authorities, with no clear separation. As shown by

Allen, sometimes the two authorities work together, sometimes they pursue different objectives. And the MM critique applies as well to the portfolio theory of monetary policy of Tobin (1969) (Chamley and Polemarchakis, 1984).

As is well known, MM is not valid when agents are trade-constrained. These constraints may arise because of habitat (Vayanos and Vila, 2009), or because of liquidity. Liquidity has more than one definition, especially today. For example, the refinancing of the public debt in long-term bonds makes its price more sensitive to changes in long-term expectations, but that does not affect the neutrality of MM. However when this change of composition affects the reserve requirements of financial institutions, as emphasised by Allen, then there is no neutrality. That issue is especially important today with the evolution of the Basel rules on financial institutions.

In the “real world” with constraints on transactions, the composition of the government debt may have an impact on investment. Ignoring the previous caveat on the determination of investment from both the long-term and the short-term rates, it is then natural to focus on the long-term interest rate. It would be good to have more quantitative evaluations of past experiences, although such evaluations are notoriously difficult. One should not forget that the long-term rate depends also on expectations about real activity in the future, especially without future markets for goods (Chamley, forthcoming). As Keynes was well aware (Tily), low expectations of future activity depress future rates, and future expectations depend very much on current fiscal and monetary policies.

A number of empirical studies have tried to measure the impact of debt management policies on the yield curve. They have been surveyed recently by Krishnamurthy and Vissing-Jorgensen (2012). See also Turner (2010), D’Amico and King (2010), Gürkaynak and Wright (forthcoming).

Tily describes how Keynes emphasised the impact of monetary management on expectations about the long-term interest rate. This effect is documented and analysed in Krishnamurthy and Vissing-Jorgensen (2012). They take five announcements by the Federal Reserve implementing QE1, from 25 November 2008 (intent to purchase $500 billion of MBS and $100 billion of debt) to March 2009. The impact on the forward market of the federal funds rate does show a lowering of the entire yield curve, in the span of 3 to 24 months, which is limited by the existence of the forward markets. The measured effect is small, less than 0.5 percent. Note that this effect is in general equilibrium: bond holders may expect the policy to generate a positive impact on future activity which would dampen the decrease of the rate.

The trading of government assets by a policy maker can be a useful commitment device to a future policy. As discussed by Allen, when the Federal Reserve purchases long-term assets (as in QE1), it constructs a portfolio that would suffer a capital loss if rates were to increase in the future. There are a number of examples to be found in past policies. In the 1980s, Margaret Thatcher advocated inflation indexed bonds as “inflation policemen”. Indeed, the private sector did not believe in the commitment of the government to reduce inflation, and bought these bonds at a high price that generated a handsome profit for the government.

In a similar experience, the private sector bought war bonds during the war of the Austrian succession in 1744-1748 under the expectation that interest rates would be high for a long time. But the war did not last as long as expected and the government earned a profit in the early conversion to a low rate such that ex post its rate during the war was about the same as during the peace, at 3 percent (Chamley, 2011).

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Macroeconomic theory

Sovereign debt management as an instrument of monetary policy: an overview

Fabrizio Zampolli[1]

Abstract

The composition of public debt by maturity is irrelevant in the standard New Keynesian model of monetary policy. Nevertheless, central banks have, since the outset of the crisis, purchased large amounts of government bonds in the attempt to support economic activity and stem deflationary pressures. Such moves have often been justified by appealing to portfolio rebalancing effects, which are not well understood at a conceptual level. Without better theory, assessing their empirical relevance might also prove elusive. This paper reviews what theory has to say about the role of sovereign debt management as a tool of monetary policy.

Keywords: Public debt, portfolio rebalancing effects, money, liquidity, Tobin, Friedman, preferred habitat, term structure of interest rates

JEL classification: E4, E5, E6, H63

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1. Introduction

Before this financial crisis, the conduct of monetary policy was neatly separated from the management of the public debt.[2] This is how the dominant paradigm in monetary economics suggests it should be: in the standard New Keynesian framework, all that matters for aggregate demand determination is the path of current and future expected real interest rates. The rebalancing of private agents' portfolios and changes in the relative supplies of financial assets, including money and government securities, have no role. Empirically these effects were regarded as small enough to be safely assumed away from formal models of monetary policy.

Yet the large purchases of government bonds and other assets by central banks during the latest crisis inevitably lead to major questions about the continued adequacy of this paradigm. In particular, a reassessment of the relevance of portfolio rebalancing effects, to which central banks have appealed to justify their interventions, is essential. In addition, given the increasing borrowing needs of governments and the financial regulation requiring banks to hold minimum liquidity buffers, both the size and distribution of government bond holdings across the private sectors could in the future lead to significant changes in the properties of the monetary transmission mechanism even in response to more conventional changes in short-term policy rates. Hence, sovereign debt management could be not only a substitute for interest rate policy, when the short-term policy rate cannot be lowered further, but could become a second complementary instrument more generally.

The purpose of this paper is to review the theories that could rationalise the use of sovereign debt as an instrument for monetary policy. The recent literature on sovereign debt management normally focuses on its fiscal insurance role: the structure of public debt is chosen to minimise the risk that future events such as the inability to refinance may lead to sharp changes in tax rates or cuts in government programmes. This paper, instead, examines some earlier monetary policy paradigms. The focus is on the effects that changes in the maturity structure of the debt held by the private sector can have on the portfolio and spending decisions of private agents. If these effects are large enough, sovereign debt management could play an active role in macroeconomic stabilisation and in the reduction of financial stability risks.

Unfortunately, portfolio rebalancing effects remain poorly understood at a conceptual level. In spite of a growing number of empirical studies, there are still few theoretical contributions on the macroeconomic role of the maturity structure of the public debt. Without much better and more careful theory, empirical studies may fail to give reliable answers, as these effects may vary with market circumstances as well as with the policy measures that attempt to exploit them.

The remainder of this paper is organised as follows. Section 2 introduces the role of sovereign debt management as a potential instrument of monetary policy. Section 3 moves to discuss the role that earlier thinkers such as Tobin and Friedman assigned to open market operations in government securities. Section 4 discusses the role of these open market operations within the context of modern dynamic macroeconomic theory and in particular the irrelevance of these operations within the New Keynesian framework. Section 5 reviews some recent research that has sought to extend the framework to include a role for unconventional monetary policy measures. In these models, however, the role of government debt still remains elusive. Section 6 reviews recent attempts to formalise some of the key mechanisms of the portfolio rebalancing channel which are still missing from the New Keynesian framework, namely the role that preferred habitat agents and arbitrageurs play in transmitting changes in short-term policy rates and in the maturity structure of public debt

[2] Blommestein and Turner (2012) in this volume summarise the main institutional features of this separation.

issuance on long-term interest rates. Section 7 highlights the liquidity services of short-term debt and the consequent role that sovereign debt management can play in reducing financial risks. Section 8 concludes with some remarks on the future research agenda.

2. Sovereign debt management and monetary policy

Both central banks' open market operations and sovereign debt management can alter the maturity composition of privately held public debt. A central bank, in particular, can expand its balance sheet by buying government securities in exchange for reserves or it could swap Treasury bonds of different maturities (without increasing reserves). If the maturity structure of public debt held by private agents is regarded as having significant macroeconomic effects, then sovereign debt management can in principle be regarded more broadly as one of the instruments available to monetary policymakers. As Allen (2012) and Turner (2011) explain, central bank open market operations have historically been viewed as affecting government debt in the hands of banks or the private sector more generally.

Yet, during the decade of low and stable inflation that preceded the crisis, open market operations in Treasuries were mainly used to support the implementation of the overnight rate in the interbank market. They were normally not regarded as a separate instrument of monetary policy and accordingly were not meant to have – and usually they did not have – a significant impact on the maturity structure of privately held public debt.[3] Furthermore, central banks and debt managers had traditionally been assigned and pursued different objectives: while the central banks were assigned the goal of stabilising inflation, economic activity, and minimising financial stability risks, debt managers were given the mandate to strike a balance between minimising interest expense and minimising refinancing risks or future hikes in taxes.[4]

The prevailing view prior to the crisis was that any change in the relative supplies of government securities were bound to have small effects on financial prices in advanced economies, for sophisticated financial market participants would arbitrage away the most part of any price difference not justified by expectations of future interest rates. This consensus was strengthened by the experience of Japan from the mid-1990s onward in that researchers usually failed to find clear evidence that purchases of government bonds had economically large and reliable effects, over and above the signalling effects of continuing the policy of zero policy rates.[5] A sensible conclusion seemed to be that, were central banks to hit the

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3 Procedures for implementing the overnight interest rate differ in their details across central banks but their main features are very similar. Most central banks impose a reserve requirement on banks, so that banks have to hold excess reserves to reduce the risk that an unexpected decline in deposits will force them to borrow from the central bank. The demand for excess reserves leaves the central bank the scope to alter the overnight interest rate. Generally, central banks use a corridor system, whereby the overnight interest rate is forced to lie between the penalty rate at which banks can borrow and the deposit rate at which banks can deposit their excess funds with the central bank. In between the desired interest rate is implemented by varying the supply of liquidity available to banks mainly through repurchasing agreements (repos) and to a lesser extent through outright purchases of government securities. See eg Keister, Martin and McAndrews (2008) for a survey.

4 Missale (2012) in this volume provides an overview of the literature on "fiscal insurance". Also in this volume, Blommestein and Hubig (2012) discuss whether, in the light of the latest crisis, debt managers should be assigned broader objectives in future than the ones they have pursued until now; and Faraglia, Marcet and Scott (2012) provide a specific application.

5 For example, the analysis of Bernanke, Reinhart and Sack (2004) about the impact of quantitative easing in Japan gave mixed results. Leading academics were generally sceptical about its effects (see eg Eggertsson and Woodford (2003)).

zero bound on their policy rate, their best hope to stimulate aggregate demand would be a promise to keep the policy rate from rising for longer than what future inflation and the output gap would warrant under normal circumstances. If credible, such a promise would have an immediate positive effect on inflation expectations, thereby lowering real interest rates and boosting aggregate spending.

Since the beginning of the crisis this perspective has been increasingly questioned. Central banks have become more sanguine about the quantitative significance of portfolio rebalancing effects. Initial empirical studies indicate that purchases of long-term government bonds have had a significant effect on yields both at their announcement and subsequently.[6] Furthermore, a careful look at history suggests that sovereign debt management might have in the past been an important factor in shaping the health of the financial sector and in helping to stabilise the macroeconomy.[7]

3. The theoretical origins of portfolio rebalancing effects

The justification for central bank intervention in bond markets is generally based on a simple argument: a purchase or sale of assets would cause, at unchanged prices, an undesired change in the portfolio of private agents; hence, the relative prices of assets would have to change to induce private agents to absorb a greater or smaller quantity of the traded asset. The less substitutable the assets, the more their relative prices would change. The changes in financial prices thus induced would then influence aggregate spending in the desired direction.

This argument leads to two fundamental questions: Why are assets imperfect substitutes? And what should policymakers try to achieve with open market operations? Tily (2012) has summarised Keynes' views and theories, formulated in the 1930s. A natural place to continue is to look at the work of prominent economists such as Tobin and Friedman who dominated post-war macroeconomics before the rational expectation revolution. Tobin, in particular, devoted a large part of his work to integrating portfolio choice into macroeconomic theory giving the equity market a major role. Albeit outside the Keynesian tradition and without trying to formulate general equilibrium models, Friedman also shared the conviction that portfolio balancing effects had a place alongside the interest rate channel in the determination of aggregate spending.[8] Below I try to summarise their views.

Tobin

Tobin formulated Keynes' liquidity preference theory in terms of portfolio choice under uncertainty. But Tobin put more stress than Keynes did on the relationship between the

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6 See for example in-house analysis of recent purchases of long-term bonds by central bank economists: Gagnon et al (2010), D'Amico and King (2010), Neeley (2010), Joyce et al (2010), among others. For a comprehensive list of empirical analyses of recent large-scale purchases of bonds by central banks see Annex A in Ehlers (2012) in this volume. See also Swanson (2011) in this volume for an empirical analysis of "Operation Twist" in the United States in the early 1960s. McCauley and Ueda (2009) discuss sovereign debt management at low interest rates, examining the historical experience of the United States in the 1930s and of Japan in the 2000s.

7 See for example Allen (2012) in this volume, and Goodhart (1999).

8 For a discussion of the difference between Keynesians and monetarists see eg Bordo and Schwartz (2004). Unlike Friedman, monetarist authors such as Brunner and Meltzer (1993) attempted to incorporate the role of money and credit using the Keynesian IS-LM framework.

return on capital and the long-term interest rate (eg Tobin (1955, 1961)).[9] Reflecting the lower attention that Keynes paid to the bond-equity yield differential than to the money-bond differential, the simplest textbook version of his theory – the IS-LM model (Hicks (1937)) – takes money and bonds as imperfect substitutes and bonds and capital as perfect substitutes. Moreover, in such a cut-down rendition of the Keynesian theory there is no room for sovereign debt management to influence aggregate demand. Monetary policy controls the long-term interest rate, which, along with the marginal efficiency of the capital schedule, pins down business investment.[10]

Tobin, however, objected that the equity premium was stable enough to justify policymakers' explicit focus on the long-term interest rate. Instead, he thought of the equity market as playing a crucial role in the transmission mechanism. Although not perfectly substitutable, bonds of different duration are more substitutable with each other than with capital assets or equities. The reason is that the two classes of assets are exposed to different types of risks, and these risks are largely independent of each other (Tobin (1963, pp 398–402)). Bonds are exposed to inflation risk regardless of their maturity. As to interest rate risk, the risk of loss increases with the maturity of the bonds, but this risk is positively correlated across the maturity spectrum. By contrast, the long-run value of equities is much more dependent on the relative prices of consumption and capital than on general price inflation. Thus, unlike bonds, equities usually offer a good, albeit imperfect, protection against inflation. In addition, capital is also exposed to the risk of higher-than-expected technological obsolescence, a risk to which government bonds are not vulnerable.

Because of the imperfect substitutability between long-term bonds and capital, Tobin argued that the monetary effect of any increase in the supply of government debt is always expansionary, regardless of whether it takes the form of money, short- or long-term debt. Consider, for example, an increase in long-term debt. Such an increase would expand the net wealth of the private sector but, at given prices, agents would not want to absorb all the new debt. They would instead try to sell part of it in exchange for other assets including capital. By selling government bonds they would push down their price and raise the long-term interest rate; and by buying stocks they would boost equity prices and lower the return on equity. A decline in the differential yield between equity and bonds would therefore be required to achieve a portfolio rebalance.[11] This new equilibrium in the asset market would then spur a gradual increase in investment and output.[12]

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9 Tobin's work on sovereign debt management can be found in Tobin (1963), on which this section is mainly based. The main framework which Tobin used to analyse the impacts of various policies is laid out in Tobin (1969). See also Tobin (1955) for an antecedent cast in dynamic terms.

10 See Tily (2012) in this volume for an exposition of the monetary theory of the interest rate in Keynes and Hoogduin and Wierts (2012) for a comparison of Keynes' ideas with those of Hayek in the context of the latest global financial crisis.

11 Despite the rise in the long-term interest rate the increase in public debt would still be expansionary as the equity premium would fall by more than the increase in the long-term interest rate. The fact that the expansion of debt might lead to an increase in the long-term interest rate is one reason why, according to Tobin (1963), the tightness or looseness of monetary policy should not be judged only by the long-term interest rate. Note that were capital and long-term bonds perfect substitutes, the increase in the supply of long-term bonds would be contractionary, as the rate of return on capital would rise one-to-one with the long-term interest rate.

12 This argument can be formalised in terms of an IS-LM model in which the interest rate is replaced by the rate of return on capital (see eg Tobin (1969)). The demand for money depends on income, the rate of return on capital and all other yields. As incomes rises money demand will also go up, requiring an increase in the return on capital to ensure equilibrium. The LM curve in the space (capital yield–income) is therefore positively sloped. Since investment is negatively related to the return on capital (or positively related to Tobin's q), the IS curve is negatively sloped. An increase in debt would shift the LM curve to the right causing income to rise and the equity yield to fall. Long-run equilibrium would be achieved when the crossing of LM and IS curves corresponds to a market value of capital equal to its reproduction cost (that is, when Tobin's q equals unity).

Not all types of debt, however, are equally expansionary. In particular, demand debt or bank reserves are more expansionary than short-term debt, and the latter is more expansionary than long-term debt (Tobin (1963, p 403)). The reason that short-term debt is more expansionary is that its increase is partly absorbed by banks, which amplifies the impact on the capital yield. In this framework, the non-bank public would try to get rid of the excess short-term debt by purchasing other assets, including long-term bonds and capital. Hence, both the long-term yield and the return on capital should fall, while the short-term interest rate may even rise.

As to banks, they would also try to get rid of the excess supply of short-term bonds by expanding loans. The easiest way to understand this is to assume that short-term debt is a very close substitute for excess reserves. In normal situations, banks will usually try to spend excess free reserves by expanding loans, thereby causing a decline in the loan rate. Such a fall would then prompt private sector actors to reduce their holding of private debt, switching their funds to bank deposits. With greater deposits banks would be able to provide even more loans, thus strengthening the initial effect. In the end, the return on capital would also have to fall (in the face of an initially fixed supply of physical capital) to prevent an increase in the demand for capital stimulated by the decline in the long-term interest rate and the loan rate (Tobin (1963, pp 390–394)).

Given that short-term debt is, in the opinion of Tobin, more expansionary than long-term debt, open market operations that substitute short- for long-term bonds should have, on balance, a positive effect, albeit less than swapping reserves for long-term debt. The success of this operation requires that the public regard short- and long-term bonds as imperfect substitutes (although closer substitutes with one another than with equity).

To sum up, shortening the maturity of public debt should have a positive impact on aggregate demand, provided that the private sector regards short- and long-term bonds as imperfect substitutes. Its success in boosting aggregate demand would be measured, however, not by the reduction in the long-term interest rate but by the decline in the equity premium.

Friedman

In contrast to Tobin, Friedman heavily discounted the role of equity market prices, which he viewed as too erratic and unreliable as a determinant of aggregate demand. Long-term government and corporate bond rates were instead seen as more relevant.[13] Additionally, he was sceptical about the possibility that the central bank could control credit, as the latter depended only in part on the interest rates that were more closely under the influence of the central bank. Credit was also viewed as potentially destabilising: specifically, demand for credit was not stable and lenders tended to go through periods of over-leveraging followed by periods of retrenchment.

Nonetheless, the central bank could control the stock of broad money. By ensuring that the latter did not fall, the central bank was thus able to minimise the damage that a collapse of asset prices and disruptions to credit could inflict on the economy. In particular, the key to understanding Friedman's position, according to Nelson (2011), was that "the relationship between credit and economic activity was much looser than that between money and

[13] Nelson (2011), on which this section heavily draws, provides a systematic analysis of Friedman's written work and argues that many of the actions taken by the Fed during the latest crisis were broadly consistent with his thinking. Sovereign debt management issues are discussed in Friedman (1960). Several observations on the conduct of monetary policy during crisis are contained in Friedman and Schwartz (1962a). Portfolio balance effects are acknowledged explicitly in Friedman and Schwartz (1982) and the fact that open market operations also include long-term government bonds is acknowledged in Friedman and Schwartz (1962b).

economic activity. (…) And although credit market instability did spill over into asset prices that mattered for spending decisions, maintenance of the money stock helped limit the response of these asset prices" (p 8). Moreover, consistent with the essence of the monetarist view, money would become ever more important over time, eventually dominating the influence of credit and other factors in the determination of nominal income and inflation.

Under normal circumstances, Friedman did not see sovereign debt management – or changes in the maturity structure of public debt – as an extra tool for stabilising the economy. Instead, he advocated a predictable debt management policy: at regular intervals and uniform quantities the government should issue only one long maturity – ideally a consol or very long-term securities – and one short maturity. It was then the job of the private sector to transform these maturities and tailor them to the ones that private agents wanted or needed (Friedman (1960)). In this context, the central bank would normally implement monetary policy through open market purchases of short-term bills only, which would affect long-term interest rates through both an expectation effect and a portfolio balance effect.

But he took a quite different view for times of crisis. As he argued in his analysis of the 1930s Depression, the threat of deflation and the danger that uncertainty verging on panic could lead to a cascading collapse of bank deposits and bank loans required decisive government or central bank action in bond markets. As banks and borrowers scramble to liquidate their assets, open market purchases of bonds can be an indispensable weapon for fighting deflation. Their effect would work by raising the money stock as well as by putting downward pressure on long-term interest rates relative to the expected path of future short-term interest rates. As money disseminates through the economy and long-term interest rates fall other private yields would also decline, partly because of arbitrage with government yields and partly because increased money would induce agents to expand their holdings of risky assets. In turn, the indirect positive effects on asset prices could help banks to strengthen their capital positions.

According to Nelson (2011), there were two fundamental reasons why portfolio effects were relevant in Friedman's view. The first is that markets were segmented by the presence of institutional investors such as insurance companies and pension funds with a strong preference for long-term maturities, which they would normally hold to maturity, and commercial banks with a preference for short-term maturities. The second, and perhaps more important, reason is that agents demand money to withstand risks. Most private agents want to hold a relatively stable ratio of liquid to illiquid or risky assets in their portfolio, behaving as if they had a self-imposed reserve ratio. Money, in particular, is the most liquid asset or the best asset to insure against unexpected events. In the case of long-term fixed income securities, these were seen as risky and illiquid, at least by some categories of investors.[14] For this reason, these agents were willing to hold more of them only if they could simultaneously increase their holdings of short-term bonds and money.

The demand for money associated with holdings of riskier assets is also the reason why Friedman did not believe that money demand would become infinite when the short-term (riskless) interest rate hit the zero bound. However, as pointed out by Nelson (2011), Friedman acknowledged that, in the case of a severe downturn, when banks are trying to deleverage or are very uncertain about the future, an expansion in reserves may not be enough to boost depressed aggregate demand. In this case, the purchase of fixed income securities was regarded as a more reliable means of expanding broad money.

To sum up, Friedman was also an advocate of portfolio balance effects like Tobin, but he viewed open market operations in long-term government bonds or sovereign debt management as a means that monetary policy should employ actively only in a time of crisis.

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[14] Banks, for instance, could not count long-term bond holdings to satisfy regulatory liquid asset ratios.

Hence his statement about the need to have a predictable issuance of government debt limited to only one long maturity and his well-known position about the need for monetary policy to be predictable. Another important difference is that Friedman gave more weight to the corporate bond market than the equity market as well as the importance of supporting an adequate level of broad money in the economy.

4. The irrelevance of open market operations

The portfolio effects advocated by Tobin and others were not cast in terms of modern dynamic macroeconomic theory. Macroeconomic models that incorporated such effects were usually versions of the textbook IS-LM models, with a greater amount of details and disaggregation. But the relationships between asset demands and prices were taken as given rather than explained in terms of agents' optimising behaviour. In particular, an increase in government debt amounted to an increase in net wealth for the private sector. By contrast, modern dynamic macroeconomic theory requires the careful specification of the objectives and the intertemporal budget constraints of the various agents of the economy, how these constraints relate to each other, what information is possessed by whom and when, and what transaction costs or other frictions prevent agents from trading with each other. By explicitly modelling the intertemporal nature of decisions and the role of expectations, modern dynamic macroeconomic theory has led to doubts about the relevance and stability of portfolio rebalancing effects.

Indeed, any argument that relies only on the imperfect substitutability of assets is incomplete. It does not take into account the fact that private agents may anticipate that their transfers or taxes will depend on the performance of the government portfolio. On the (strong) assumptions that private agents are forward-looking, have full information about the future and do not face liquidity constraints, agents would anticipate a change in their net tax liability of the same amount as the earnings on the government portfolio. They would accordingly adjust the size and composition of their savings in such a way as to neutralise the changes that the government wants to implement. In other words, the private sector understands that it remains ultimately exposed, through higher taxes or lower transfers, to the very risk that the government is seeking to reduce. If so, the attempt by the government to change the distribution of asset holdings between the public and the private sectors would not alter the allocation of aggregate consumption across time and states of nature; hence, given that asset prices depend on aggregate allocations, prices would not change. It also means that the differences in the risk-return characteristics of assets or imperfect substitutability would be irrelevant given that their distribution across sectors would not lead to changes in aggregate risk.

The irrelevance of open market operations – and hence of changes in maturity structure of public debt – is therefore based on the same ideas as the Modigliani-Miller theorem in corporate finance or the Ricardian equivalence result in public finance.[15] Formally, the irrelevance result has been proven, in different economic settings, by Wallace (1981), Chamley and Polemarchakis (1984), and Sargent and Smith (1987), among others. More recently, Eggertsson and Woodford (2003) have also shown that it holds within the type of representative agent model with nominal rigidities that forms the backbone of the New Keynesian model of monetary policy.

[15] The Ricardian equivalence theorem holds that for a given path of government expenditure the financing of such expenditure – either by issuing debt or raising taxes – has no impact on equilibrium allocations. See Barro (1974).

The irrelevance result is relevant not because it is necessarily realistic, but because it forces clear thinking about the reasons why portfolio balance effects may arise. In particular, the imperfect substitutability of assets is not sufficient for open market operations to alter financial prices. What “frictions” prevent changes in private portfolios from mirroring those in public portfolios, and vice versa? An intertemporal budget constraint also forces analysis of the associated fiscal risks or costs of open market operations. Indeed, even if open market operations were to be initially successful in reducing some targeted yields, the increase in the risk of losses on the central bank or the public sector’s balance sheet might eventually lead to an adverse reaction of the private sector, eliminating or reducing the effectiveness of any similar operations in the future.

The macroeconomic effects of open market operations, therefore, may not be invariant either over time or with respect to changes in policy. Empirical analysis based on reduced forms may lead to misleading conclusions about the effectiveness of policy as the market structure, information, preference and other important factors that influence agents’ decisions may vary over time. They would, in particular, be vulnerable to the Lucas critique according to which attempts by the policymaker to exploit any empirical evidence of these effects could lead to their disappearance. It is therefore crucial to build models that explicitly account for these factors.[16]

While early Tobin-like models gave a prominent role to portfolio rebalancing effects, the move towards intertemporal optimising-agent models has generated a new framework for monetary policy – the New Keynesian model – which assumes them away. Curiously enough, a model without money embeds the monetarist creeds that inflation is always a monetary phenomenon and that a monetary expansion cannot raise economic activity permanently but only produce inflation. But without a modelling of portfolio rebalancing effects, it also assumes away relevant aspects of the monetary transmission mechanism, including the role of money itself.[17] Recent research, spurred in large part by the latest financial crisis, is trying to overcome some of these criticisms. In what follows I review the irrelevance of open market operations within the New Keynesian model and the research aimed at bringing back portfolio balance effects into formal models of monetary policy.

The irrelevance of open market operations in the New Keynesian framework

The irrelevance result of Eggertsson and Woodford (2003) rests on two main assumptions (see also Curdia and Woodford (2011)). The first is that all assets are valued for their pecuniary value only; and not, for example, their convenience (“liquidity”) in the exchange of goods or other financial assets. The second is that agents can purchase any asset in the amount that they desire at a given market-determined price; that is, there should be no barrier to the execution of trades.

As pointed out by Curdia and Woodford (2011) and noted above, the irrelevance proposition can hold even if agents’ preferences are heterogeneous, asset markets are incomplete, or assets are imperfect substitutes in terms of their risk-return profile. It may even hold if the expectation hypothesis of the term structure of interest rates fails: term premia may be

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[16] An intertemporal setting seems essential in assessing the effects that the maturity structure of public debt may have on future inflation if the fiscal authority is not credible in its commitment to balance its intertemporal budget constraint. The fiscal theory of the price level stresses that an increase in the price level could be the inevitable outcome of the inability of governments to balance their budgets or lack of credibility in this regard. In this context, the choice of the maturity structure of public debt may not prevent future inflation, but could still change its timing (Cochrane (2011)).

[17] For a discussion of the role of money in the transmission mechanism and a criticism of the New Keynesian model see Carboni, Hoffman and Zampolli (2010).

time-varying but such variation may have nothing to do with changes in the relative supply of government bonds.

Even if open market operations do not have any direct effect on asset prices, the central bank can still use them to signal its belief or commitment about the path of future short-term interest rates. If the central bank realises that long-term interest rates are higher than what it wants them to be (based for example on its internal forecast of short-term interest rates), it can purchase government bonds to signal market participants that it will implement a given policy. It is, however, not clear why such purchases should necessarily be a powerful tool for signalling future intentions, especially when other means of communication exist. Moreover, if the signal is also seen as a commitment, then such commitment might not be fully credible. Once inflation begins to pick up, the central bank may renege on its earlier promise and lift interest rates as soon as evidence of inflationary pressures emerges.

This difficulty leads to the second argument that purchases of long-term bonds may help make the commitment to keep rates "low for longer" more credible. This requires that the duration of government securities be long enough and their amount large enough to impose significant losses on the central bank's own capital in case of an early sharp rate rise; it also requires that the central bank care about these losses – for example, to safeguard its independence from the government or avoid public criticisms (eg Clouse et al (2000), Jeanne and Svensson (2007)). The argument that inflation expectations should momentarily rise to lower real interest rates has, however, been rejected by most policymakers because of the risk that such moves may permanently dislodge inflation expectations (see eg Bernanke (2010)).

5. The general equilibrium effects of unconventional monetary policy

Recent research has focused on versions of the New Keynesian model that explicitly incorporate financial intermediation and could thus rationalise quantitative measures taken by central banks since the beginning of the crisis. Curdia and Woodford (2011), in particular, assume that the key friction is financial intermediation between patient and impatient households. Intermediation gives rise to a variable spread between the lending and borrowing rates, which depends on the resources used in the intermediation process and the market power of financial agents. The main implications for monetary policy are that the interest rate should be set taking into account not only the natural rate (at which the output gap would be eliminated in a world without nominal rigidities), but also the credit spread. Any shock that causes the credit spread to increase (such as an increase in risk aversion or a disruption to credit) should be offset by a reduction of the policy rate. But if the shock is large enough to push the policy rate to zero, then the central bank can still compress the credit spread by directly lending to the private sector.[18]

This model is an important step forward in terms of realism, but it is still unsatisfactory for at least three reasons. The first is that the type of financial intermediation that matters is not only between impatient and patient households but also between households and firms as well as between households and their government. Output losses during a crisis can be exacerbated by the curtailment of credit to firms. The ability of governments to borrow to intervene in support of aggregate demand is not unlimited, and may also depend on the eventual responses of private agents to prospective changes in taxes or inflation. The

[18] Even when the policy rate is above zero, the existence of the credit spread involves a distortion that monetary policy should in principle eliminate. However, the authors assume that there are costs for the central bank to provide credit to the private sector, which justify the use of such strategies only at times of crisis.

second reason is that, even if household debt were the most important type of debt, the lack of a housing market in this model precludes a discussion of what levels of debt are sustainable and what trade-offs authorities may face in setting monetary policy both before and after the occurrence of a financial crisis. The third reason is that liquidity ("money") still does not play a role in this model, whereas the provision of liquidity by the central bank plays a crucial role in a financial crisis. This may also explain why there is no role for the purchases of government bonds in this extension of the New Keynesian model.[19]

A good starting point for the explicit modelling of liquidity – surely a crucial element – in the context of a dynamic general equilibrium model of the business cycle is Kiyotaki and Moore (2011). Their model does not feature nominal rigidities, unlike the New Keynesian model, but otherwise it shares all the other main features. Its importance consists in showing how a demand for money arises endogenously from the uncertainty about future business investment opportunities.

There are two key aspects of this model. The first is that entrepreneurs face a borrowing constraint: they cannot raise all the funds they need to finance their own capital when an investment opportunity arises. The reason is that the return on the capital investment depends in part on the human capital of the entrepreneur, which is inalienable. The entrepreneur can therefore only pledge a fraction of the future returns. In the absence of an investment opportunity, entrepreneurs will lend the funds to other investing entrepreneurs by buying the latter's equities. When an investment opportunity arrives, they can purchase new capital using their holding of money as well as selling the equities that they previously purchased. A key constraint in this model is that they can sell only a fraction of their total holding of equities in the current period.

This makes equities illiquid. Along with the borrowing constraint, this resaleability constraint gives rise to a demand for money: money is needed because it relaxes the cash flow constraint that investors would otherwise face when the investment opportunity arises; the more money the entrepreneur holds, the less he will be constrained in the good state of the world.[20] In this model, a shock that reduces the liquidity (or the resaleability) of equities raises the liquidity premium and reduces equity prices, investment and output. In this case, the central bank can offset this shock by purchasing equities in exchange for money.[21]

Building on Kiyotaki and Moore (2011), Gertler and Kiyotaki (2010) provide a model in which intermediation is between households and firms. In every period, entrepreneurs differ on whether they face an investment opportunity or not. Those who do have an opportunity obtain the funds they need by borrowing from "local" banks (banks that belong to the same "island" as the entrepreneurs). Banks can fund themselves both through deposits provided by households and through the interbank market. Banks that lend to investing entrepreneurs need to get extra funds by borrowing on the interbank market from banks located in places

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[19] Curdia and Woodford (2011) discuss the possibility that the demand for money at the zero short-term interest rate is not infinitely elastic. If instead a satiation point exists, then supplying more than the initial increase in the demand for reserves may lead banks to expand their loans. The authors, however, are sceptical that such a policy would be as effective as credit easing measures.

[20] The authors show that a demand for money arises endogenously from the borrowing and resaleability constraints, rather than being assumed, provided that both constraints are sufficiently tight.

[21] Note that a simple injection of money funded by lump transfers (a helicopter drop) would be neutral in this framework. It is instead important that money is used to alter the share of liquid assets in entrepreneurs' portfolios. The model can also produce some facts about asset prices that are puzzling from the viewpoint of the standard theory such as the low riskless interest rate puzzle, limited participation in financial markets, and excess sensitivity of asset prices. As stressed by Carboni, Hoffman and Zampolli (2010), the model also goes some way in rationalising the observed empirical association between the price of capital and certain components of broad money over the business cycle.

where firms do not invest. The key friction is that banks face a borrowing constraint both in obtaining funds from deposits and in borrowing in the interbank market.

The authors show that these financial frictions largely amplify and prolong the effects of a negative shock to bank capital on the cost of capital, investment and output. The amplification comes from the fact that banks are leveraged and is accentuated by the fire sales of assets by which banks attempt to regain liquidity. The persistence of such effects is due to the fact that it takes time for banks to rebuild their capital. Within this framework, credit easing policies (ie discount window, direct lending and capital injections) by the central banks are shown to ease the effects of an adverse shock to bank capital.[22]

To recap, recent research efforts to extend the New Keynesian framework have focused on explaining how credit easing measures by central banks could be effective in reducing credit spreads in certain markets that had been seriously hit during the crisis. But central bank intervention in the market for long-term government securities (or what several commentators have dubbed quantitative easing) is still largely missing from these models.[23] There are important differences between the two types of interventions and clarifying them should be an important topic for current research.

Credit easing versus quantitative easing

How far does quantitative easing differ from credit easing, in terms of both the effects and the associated costs and risks? What circumstances justify the use of the one rather than the other?

Credit easing measures may be more effective in preventing a deepening of a crisis, and are perhaps unavoidable in times of emergency. But there are drawbacks. First, while a central bank may be able to bear more risk than financial intermediaries, it does not usually have the same capability of monitoring and screening private sector borrowers as private financial institutions. And even if the central bank avoids direct lending to non-financial companies, lending to banks may reduce the latter's incentives to cut credit to companies that are no longer viable or would not be if interest rates were to be raised.[24] Second, once a central bank enters into allocative decisions exposing the taxpayers to potential future losses, it might become politically difficult for it to withdraw, or not to renew, these measures in the future. By taking on a task which should be part of fiscal policy, the central bank may become the object of lobbying pressures. A fear that losses to the taxpayers will be realised once the credit policy is scaled back or halted may cause the authorities to delay or moderate any rise in interest rates or tightening of lending policies.

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[22] Other efforts to incorporate financial intermediation in the New Keynesian framework include Gertler and Karadi (2011) and Del Negro et al (2011). Adrian and Shin (2011) provide a formal model for explaining the procyclical expansion of financial intermediaries' balance sheets based on their risk-taking behaviour, although not cast into a fully specified business cycle model. Their model highlights the importance of the term premia in affecting banks' profitability (see also Borio and Zhu (2011) for an overview).

[23] One recent exception is Harrison (2012) but his model assumes that (rather than explains why) agents have a preference for holding liquid assets in some proportion of their holdings of risky assets. Canzoneri, Cumby and Diba (2012) in this volume discuss the implications of the monetary services of government bonds for the setting of monetary policy interest rates. They also assume that short-term bonds yield utility to agents. Breedon, Chadha and Waters (2012), also in this volume, examine the effects of unconventional monetary policies within some recent DSGE models.

[24] There is evidence that "ever-greening" and "zombie lending" in Japan depressed market prices and raised wages by more than would be allowed by competitive forces, thereby reducing the profits of and investment by healthy and more productive firms (Hoshi and Kashyap (2004); Caballero, Hoshi and Kashyap (2008)). The experience of Japan is a reminder of the risks that a continuation of credit easing policies could pose to long-term growth.

Some of these objections should be less strong when the central bank's operations consist only or mainly in altering the maturity structure of government debt. Risks of capital losses for the central bank would not depend on the performance of a particular financial market or real sector of the economy.[25] The liquidity created by buying government bonds should indirectly ease credit conditions more generally in the economy without involving allocative (and hence politically sensitive) decisions by the central bank. If so, an important question is: how far could the same effects achieved through credit easing also be achieved by changing the structure of privately held public debt and liquid assets? Given its indirect nature, quantitative easing may take longer to work than credit easing measures. A further question is whether the effects of quantitative easing are more persistent and pervasive than credit easing; or whether the only difference is a trade-off between short-term effectiveness and long-term efficiency.

If actively managing the structure of the public debt can stabilise the economy without creating the fiscal risks and distortions of credit easing measures, then theory should provide a better understanding of how the term structure of interest rates is influenced by the actions of the central bank and the fiscal authority. It should also explain how interest rates at various maturities affect the spending decisions of various agents. Unfortunately, we are far from having a model that can explain either the determination of the term structure of interest rates or the feedback of the term structure on aggregate demand in the New Keynesian model.[26] There are, however, some interesting developments on which future general equilibrium research could build. Recent work is providing a greater clarity on the role that the maturity structure of public debt can play: (a) in determining interest rates and the funding decisions of the private sector; and (b) in the creation of private money. We examine both in turn in the next two sections.

6. Preferred habitat and the term structure of interest rates

The simplest theory of the term structure, the expectation hypothesis, holds that the long-term interest rate should equal the average of the expected future short-term interest rates over the relevant maturity. Given that the yield curve is normally sloping up, the hypothesis is accepted only in its weak form: interest rates are also determined by risk premia, but these are assumed to be constant over time. Such a weaker hypothesis has been found a good approximation in countries or monetary regimes such as the Gold Standard in which inflation expectations had been well anchored (eg Gürkaynak and Wright (2010)). In general, empirical research had found that risk premia tend to vary systematically, but the prevailing pre-crisis view among researchers was that such variations in risk premia were largely unrelated to changes in the relative supplies of bonds (or other assets).[27]

The difficulty in modelling risk premia means that they are normally absent in the macroeconomic models used for forecasting and policy analysis at central banks. In the standard New Keynesian model, in particular, income is a function of the future infinite sequence of expected short-term real interest rates (which can be thought of as the real yield on an infinite-maturity bond). Thus, the canonical version of the New Keynesian model is

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[25] A central bank paying an interest rate on reserves is also exposed to the risk of capital losses, for the coupons on the long-term government securities held on the central bank's balance sheet might turn out to be insufficient to pay interest on reserves if the short-term interest rate were to be raised fast. See eg Goodfriend (2011) for a discussion.

[26] See eg Gürkaynak and Wright (2010) for a survey of the theory and the empirical evidence.

[27] See Bech and Lengwiler (2012) in this volume for an analysis of the yield curve during the latest financial crisis.

consistent with the expectation hypothesis theory of the term structure of interest rates. And the little progress that there has been in modelling time-varying risk premia in the New Keynesian framework has normally led to unrealistically small premia.

The relative supply of different securities is, by contrast, at the heart of the preferred habitat hypothesis of Culbertson (1957) and Modigliani and Sutch (1966, 1967). This approach is now enjoying a revival thanks to the more rigorous formalisation provided by Vayanos and Vila (2009) and Greenwood and Vayanos (2010b).[28]

There are two key aspects of this hypothesis. The first is that some agents, including the government, have strong preferences for specific maturities. For example, insurance companies and pension funds have a preference for long maturities, while commercial banks and corporate treasury managers traditionally have a preference for short maturities. These agents are highly averse to interest rate risk, preferring to match as closely as possible their assets to their future spending or liquidity needs. The government too may have preferences about issuing debt of some specific maturity: it may prefer long maturities in order to reduce the risk of having to raise taxes in the future, or it may have a preference for short maturities to reduce its interest payments. One key assumption is that within their preferred maturity agents demand more of the asset, or the government offers less of it, if its yield rises. That is, the net supply of a given maturity (the difference between the supply of government and the demand of the habitat preference agents) decreases in line with the return for that maturity. For example, the government will issue fewer long-term bonds if the yield is higher (and vice versa); and the private sector will substitute bonds for other private assets as their yield increases (and vice versa).

The second key aspect is the existence of limits to arbitrage, which should eliminate any price differences among bonds of different maturity. The key assumption in Vayanos and Vila (2009) is that arbitrageurs are risk averse. If the interest rate on a bond of a given maturity is too high relative to the average expected future short-term rate, the arbitrageurs can expect to make a profit by purchasing more of the long-term bond and borrowing short-term (and vice versa when interest rates are too low), thereby exerting pressures on interest rates to equalise. But this activity is risky: the longer the mismatch between long- and short-term bonds that they take on their balance sheets, the larger the losses that they would incur if the short-term interest rate were to rise or if a shock to the demand and supply of preferred habitat agents were to move long-term interest rates. Since arbitrageurs are risk averse they will demand a premium for the extra risk and any interest rate differences will not be fully eliminated.

The model shows that arbitrageurs' risk aversion creates room for shocks to the supply of or demand for bonds to affect interest rates. If arbitrageurs are risk neutral, arbitrageurs will absorb any change in net supply for a given maturity until price differences are completely eliminated. In this case the model yields the expectation hypothesis as a special case. In the opposite case of infinite risk aversion, arbitrageurs will not trade in bonds at all. Bond prices at different maturities will be fully determined by their local demand and supply and completely independent from each other. An excess supply of a given maturity will therefore be cleared only if preferred habitat agents increase their demand or reduce their supply, which requires the interest rate for that maturity to fall. For intermediate cases of risk aversion, arbitrageurs will not absorb the entire increase in the net supply of a given maturity. Part of the increase in the net supply will have to be taken up by preferred habitat agents, resulting in a decline in the interest rate in equilibrium. Supply effects will be stronger the greater the risk aversion of arbitrageurs and the larger the uncertainty of interest rates.

[28] See also Greenwood and Vayanos (2010a) for some recent historical episodes in which preferred habitat effects have probably played an important role in shaping the yield curve.

This model provides a rationale for central bank interventions, but their effectiveness depends on the risk aversion or risk-taking capacity of arbitrageurs.[29] If arbitrageurs' risk aversion is sufficiently high, changes in the short-term interest rate will not be fully transmitted to longer maturities. In this case, direct purchases of bonds at longer maturities can reduce the relevant interest rates.[30] Since risk aversion can vary over time, being higher in times of crisis, purchases will be more effective when markets are disrupted or when uncertainty about the short-term interest rate is higher.[31] Alternatively, purchases would have to be very large – relative to past or ordinary behaviour – to produce the same effects on yields for a given level of risk aversion or interest rate uncertainty.

The preferred habitat hypothesis of the term structure is, however, incomplete without explaining how private sector agents react to changes in the mix of public debt. Greenwood, Hanson and Stein (2010a) extend the previous model of preferred habitat agents and arbitrageurs to include a role for corporate issuers of debt. Corporate issuers are able to supply long-term debt elastically in response to differences between the expected returns of short- and long-term debt. For example, when the expected return on long-term government debt falls they can issue new additional long-term debt and vice versa. If the Modigliani-Miller theorem holds, then they are indifferent to the structure of their debt, and they will adjust their debt structure in such a way as to eliminate any discrepancy between the expected cost of short-and long-term debt. In this extreme case, differences in interest rates are fully eliminated and the expectation hypothesis of the term structure of interest rates holds, similarly to the case in which arbitrageurs are risk neutral. In reality, transaction costs, informational asymmetries and tax treatment imply that corporates are not indifferent to the composition of their own debt: they have a preferred or optimal mix of short- to long-term debt from which they find it costly to deviate. Deviation of the long-term rate from the expectation of short-term rates will provide them with an incentive to deviate from their optimal mix, but generally not to the point that they will completely eliminate the term premia.

It follows that changes in the average maturity of public debt or open market operations by the central bank will have an impact on both term premia and the amount of corporate debt issued. The more elastic is the response of corporate issuers, the smaller the price effect and the larger the quantity effect. Moreover, if the elasticity of issuance is large at short horizons, measuring the success of open market operations by looking at the effects on interest rates only could be misleading. Greenwood, Hanson and Stein (2010a) provide evidence that the maturities of corporate and public debt in the United States exhibit a strong negative correlation and that issuance of long-term corporate bonds tends to fill between 30 and 40% of the gap left by changes in the maturity structure of government debt.

The theory has also another couple of interesting implications, which the authors find to be confirmed in the data. The first is that corporate issuance is larger when the government debt is a greater share of total debt. The reason is that when there is relatively more government debt, it takes a larger change in the fraction of corporate debt to absorb a given absolute change in the supply of government debt. The second is that the corporate issuers that respond more elastically to changes in government debt maturity are the ones with stronger balance sheets, for which deviating from an optimal maturity of debt is less costly. When expanding their share of long-term debt they can therefore take more interest risk than firms with weaker balance sheets.

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[29] Risk aversion is a short-cut for the more general ability of arbitrageurs to take risk. For a theory where arbitrage depends on the capital of arbitrageurs, see Gromb and Vayanos (2010a, 2010b).

[30] An interesting result shown by Greenwood and Vayanos (2010b) is that a swap of short-term for long-term bonds (at unchanged size of total debt) causes the interest rate to fall at all maturities.

[31] On this point also see Doh (2011). For a discussion of the reasons why interest rate uncertainty will be higher in the future, see eg Turner (2011).

7. The liquidity benefits of short-term public debt

Short-term public debt may provide significant liquidity services. It is a close substitute for currency and bank deposits and may be sought after by investors who have a strong preference for liquid assets. As the financial system can also provide assets that are close substitutes for the short-term government debt and money, short-term public debt competes with private money. Hence, the composition of public debt may influence the size of the financial system and with it the risks to financial stability. In this sense, sovereign debt management could be seen as one of the macro-prudential tools that authorities have at their disposal to minimise such risks.[32]

The existence of a crowding out effect of public debt on private money creation has been confirmed by empirical evidence in the US by Krishnamurthy and Vissing-Jorgensen (2010) and by Greenwood, Hanson and Stein (2010). The latter authors also provide evidence that, at unchanged size of public debt, tilting the maturity of public debt towards long maturities and away from short ones increases the issuance of short-term private debt (that is, "private money" creation).

The existence of this effect leads Greenwood, Hanson and Stein (2010) to ask what should be the optimal maturity structure of debt. On the one hand, issuing extra short-term debt involves a cost, which is the expected reduced tax smoothing that long-term debt allows. On the other hand, issuing more short-term debt brings two benefits: the direct monetary benefits of the newly issued debt and the indirect benefit of crowding out private sector money. Reducing private money is beneficial because banks do not internalise the social cost of fire sales in bad states of the world and hence create too much of it.

The authorities could attempt to control private money creation directly, but this may not be possible or effective, because more controls on traditional banks would lead them to lose business to other less regulated jurisdictions or to an expansion of the unregulated shadow banking system.[33] In this case the logic of second best suggests that the authorities could also use the issuance of short-term public debt, along with regulatory and other tools, to curb the excessive creation of private money.

8. Final remarks

This paper has reviewed what theory has to say about the monetary effects of the maturity structure of public debt. Research efforts are underway to extend the New Keynesian model to incorporate a banking sector and to explain the quantitative importance of the credit easing policies undertaken by central banks in the financial crisis.

Yet the provision of liquidity through the purchase of long-term government securities or changes in the maturity structure of public debt is still largely missing from models of the business cycles used by central banks. Instead, some significant progress seems to have

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[32] Tily (2012), in this volume, points out that Keynes argued that the government should simply accommodate shifts in the liquidity preferences of the private sector: "the authorities make the [long-term] rate what they like by allowing the public to be as liquid as they wish".

[33] For example, Pozsar (2011) argues that in the years preceding the crisis there was a large shortage of short-term debt instruments relative to the large and rising demand from institutional investors and corporates. Given the limits to deposit insurance, these investors could not spread all their large holdings of short-term assets through all insured banks and hence looked at alternative safe assets, such as repos and asset-backed commercial paper. These were created by a web of institutions – the shadow banking system – ultimately linked to the insured banks. This explanation for the growth of the shadow banking system is complementary to the one that stresses regulatory arbitrage (see eg Pozsar et al (2010)).

occurred outside the realm of the DSGE models used for monetary policy analysis. Such analysis has provided useful insights on the interaction between investors' habitat preferences, the variable ability of speculators to arbitrage away differences in financial prices, and the behaviour of non-financial corporate issuers in response to changes in the supply of government bonds. Future research should focus on at least four main areas.

What explains time-varying risk premia? The first is to provide a better understanding of the determinants of time-varying risk premia and the funding decisions of private agents as well as how they are associated with the maturity of privately held public debt. Money and other forms of short-term public debt provide liquidity services – that is, insurance against the possibility that a household, a firm, or even a government, hits a cash flow constraint. That includes missing profit opportunities but especially defaulting on one's contractual obligations such as providing a good or service or repaying outstanding debt. The probability of this occurring should be inversely related to the holding of money or short-term liquid bonds. Hence, by purchasing long-term government securities central banks can boost private holdings of money and liquid assets, thus indirectly strengthening the balance sheets and the risk-taking capacity of the financial and non-financial private sector. The positive impact on asset prices and spending decisions should in turn further strengthen, in a positive feedback loop, the initial effects on balance sheets. Moreover, the same reason why agents need money gives rise to financial intermediation. As stressed for example by Goodhart and Tsomocos (2011), the crucial element missing in current general equilibrium models is a potential for default. Unfortunately, current general equilibrium models of monetary policy assume the existence of money, financial intermediation, and risk premia in a largely ad-hoc manner as they are unrelated to the risk of default.[34] Given the difficulties involved in modelling default, it is possible that initial progress will only be made if researchers abandon the pursuit of an all-encompassing model and instead attempt to build partial equilibrium or non-fully internally consistent general equilibrium models. This is perhaps better than continuing to work with models that exclude the types of non-linearities that become important during a financial crisis.

What are the limits to open market operations? The second area where more research is needed is on the limits of open market operations. In this context, an important issue concerns the circumstances under which quantitative easing should be preferred to credit easing policies. On the one hand, credit easing may have more direct and rapid effects on asset prices, which would make it more suitable when markets are highly dysfunctional. On the other hand, the effects of quantitative easing measures may play out more slowly and over a longer horizon than credit easing. Quantitative easing, however, appears preferable because it does not involve allocative decisions by the central bank and exposes it to fewer risks of capital losses and political interference.

While both credit and quantitative easing operations appear to have had some significant impact in the short run, a number of questions regarding their long-run consequences – or better, the consequences of large central bank balance sheets – remain largely unanswered. For example, to what extent can various risks faced by the private sector be shifted to the public sector's balance sheet without compromising the efficiency of the productive sectors of the economy or endangering expectations of price stability? What are the limits to the expansion of a central bank's balance sheets? Will further open market operations continue to have the same effects as in previous experience? Will side effects emerge? All these questions are inherently intertemporal and require theoretical models that capture the links

[34] In truth, current financial accelerator versions of the New Keynesian framework (eg Bernanke, Gertler and Gilchrist (1999); Gertler and Kiyotaki (2010)) model default but as an out-of-equilibrium phenomenon and not as a phenomenon that can occur in equilibrium (Goodhart and Tsomocos (2011)).

between intertemporal budget constraints and the impact of agents' expectations of the future on the present.

How should objectives related to the maturity of government debt be formulated? The third area where research could be helpful is to clarify the objectives that should be assigned to the distinct authorities that can affect the maturity structure of public debt. The objective of sovereign debt management has traditionally been viewed as striking a balance between the interest cost of the debt and the risk of future hikes in taxes or bank-type runs on the public debt. An interesting question arises when these objectives conflict with the cyclical stabilisation of the economy, the reduction of financial risks, or the maintenance of low and stable inflation that is assigned to central banks. If such a conflict exists, then how should the coordination between the fiscal agency of the government and the central bank be achieved?

Constraints, expectations and non-linearities. Last but not least, research on all the previously mentioned issues may have to make better use of available research methods to account explicitly for non-linearities in economics. In particular, agents face constraints that may not be binding currently but that might bind in future. These constraints may, nevertheless, influence their current behaviour in an important way. Indeed, as noted above, the need for money and financial intermediation usually arises in the real world from the possibility of hitting some constraints in the future. And policies may exert an influence by relaxing or tightening these constraints or creating expectations about their future relaxation. When the constraints finally bind, the response of agents to given shocks may not be extrapolated from recent experience. Moreover, agents differ in the types of constraints they face and the likelihood of being constrained. A better understanding of the money, credit, portfolio decisions and risk premia is therefore likely to involve the explicit modelling of temporarily binding constraints as well as a richer modelling of agents' heterogeneity than in some recent extensions of the New Keynesian models. While recent extensions of these models are proving very useful, they seem to be still too stylised and hence rule out, for analytical tractability, features that are essential during a crisis. It is hoped that a greater diversification of the research effort, which makes full use of the existing model-solving techniques, will provide new insights not only on the role of sovereign debt management but to macroeconomics more generally.

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Monetary policy and the natural rate of interest

Matthew Canzoneri,[1] Robert Cumby[2] and Behzad Diba[3]

Abstract

We identify the economic environments in which it is most important for monetary policy to be able to track the natural rate of interest. To do this, we study two models: one is a standard New Keynesian model; in the other, government spending shocks move the natural rate of interest away from its steady state value and for a protracted period of time. Policy rules that cannot make the policy rate track the natural rate precisely perform poorly in both of these environments. These rules are especially bad in the second model, where the natural rate movements are sustained and the policy rate cannot catch up. In this model, households would give up half a per cent of their consumption each period to have a rule that can track the natural rate. Even in the standard model, households would give up a quarter of a per cent of consumption to obtain such a rule. Consistent with earlier literature, first difference rules perform quite well in this situation, and they do not require any information about the natural rate of interest. In the current climate of big spending cuts, our results suggest central banks would do well to maintain unusually high inertia in their interest rate setting.

Keywords: Monetary policy, natural interest rate, government bonds

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[1] Georgetown University, canzonem@georgetown.edu

[2] Georgetown University, cumbyr@georgetown.edu

[3] Georgetown University, dibab@georgetown.edu

1. Introduction

"One can only say that if the bank policy succeeds in stabilizing prices, the bank rate must have been brought in line with the natural rate."

Orphanides and Williams (2002)

Why is the natural rate of interest so important for inflation control?[4] Consider a variant of the Taylor Rule.[5]

$$i_t = i_t^n + 1.5\left(\pi_t - \overline{\pi}\right) \tag{1}$$

where π_t is the rate of inflation, $\overline{\pi}$ is the inflation target, i_t is the policy instrument, and i_t^n is its natural rate – defined as the rate that would prevail if there were no nominal rigidities. Inflation is brought to its target if the policy rate is brought to its natural rate. Intuitively, when an increase in aggregate demand, or a decrease in productivity, pushes inflation above its target, the policy rate should be raised above its natural rate for a period of time, raising the real rate of interest to curb the rise in inflation.[6]

The problem here is of course that the natural rate of interest is not observed directly, and estimating it is known to be difficult. In an early paper on the subject, Laubach and Williams (2003) found considerable movement in their (imprecise) estimates of the natural rate; they concluded that "...this source of uncertainty needs to be taken account of in analysing monetary policies that feature responses to the natural rate of interest".

Nevertheless, Curdia, Ferrero, Ng and Tambalotti (2011) argue that the Federal Reserve has a history of trying to track the natural rate. They quote Alan Greenspan as saying, "... In assessing real rates, the central issue is their relationship to an equilibrium interest rate, specifically, the real rate level that, if maintained, would keep the economy at its production potential over time. Rates persisting above that level, history tells us, tend to be associated with slack, disinflation, and economic stagnation – below that level with eventual resource bottlenecks and rising inflation ...". Moreover, the authors show that the assumption of such a policy helps New Keynesian models fit the data better.

The conventional view is that observing the natural rate (or being able to make the policy rate track it closely) is very important for welfare. We will show that this is indeed the case. Moreover, we will use two New Keynesian models to assess – in terms of household consumption equivalents – which features of the economic environment make this problem important. In one model, which we call the Standard Model, deviations of the policy rate from its natural rate are substantial, but they have short half lives. In the other model, which we call the Liquid Bonds Model, government bonds are liquid and are imperfect substitutes for both money and illiquid bonds. Only when money and bonds are close substitutes are the deviations of the policy rate from its natural rate short lived. If money and government bonds

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[4] In the New Keynesian models we consider here, there is no tradeoff between stabilizing inflation and output. Stabilizing inflation maximizes household utility.

[5] The intercept term in the original Taylor Rule was the long run value of the natural rate; we have replaced it with the current period's value, which of course will fluctuate over time.

The original specification of the Taylor Rule also contained an output gap. We will suppress the gap in this paper. It is well known that (unless the natural rate of output can be measured accurately) smoothing the output gap is harmful in models where productivity shocks play a prominent role. Here, we leave those well studied issues aside so that we can focus on the natural rate of interest.

[6] This analysis assumes that nominal rigidities keep prices from adjusting immediately.

are not close substitutes, the deviations of the policy rate from the natural rate are substantial and have protracted half lives.

In either of the models, the deviations of the policy rate from its natural rate will depend upon the monetary policy that is in place; we will consider four generic rules:

Rule 1: $i_t = \bar{i} + 1.5\left(\pi_t - \bar{\pi}\right)$

Rule 2: $i_t = 0.8 i_{t-1} + \left(1 - 0.8\right)\left[\bar{i} + 1.5\left(\pi_t - \bar{\pi}\right)\right]$

Rule 3: $i_t = i_{t-1} + 1.5\left(\pi_t - \bar{\pi}\right)$

Rule 4: $i_t = \left[r_t^n + E_t\left(\pi_{t+1}\right)\right] + 1.5\left(\pi_t - \bar{\pi}\right)$

r_t^n is the real natural rate of interest and $\bar{i}$ is the steady state value of the policy rate.

Rule 4 is the variant of the Taylor Rule discussed above. Rule 4 implicitly assumes that the natural rate is observed; since it cannot be observed in practice, Rule 4 must be considered a benchmark. Rule 1 is often used in the literature because it only assumes that the steady state value of the natural rate is known. Rule 2 is also used in the literature since interest rate smoothing is found in estimates of the central bank's policy rule; the coefficients – 0.8 and 1.5 – are typical of what is found in those estimates. Rule 3 is called the first difference rule; Rule A in Levin, Wieland and Williams (1999 and 2003) specified an inflation coefficient of 1.3; we simply use 1.5 across all of the models.

In the Standard Model, the difference in household utility between Rule 1 and Rule 4 is worth a quarter of a per cent of consumption each period, which is a substantial number in the New Keynesian literature. In our preferred parameterization of the Liquid Bonds Model, the difference rises to half a per cent of consumption each period. But in another parameterization where money and bonds are close substitutes, the welfare difference is closer to the gain in the Standard Model. In all cases, the first difference rule provides virtually the same utility as Rule 4 (the full information rule), and it does not require any knowledge of the natural rate of interest.

The first difference rule has been much lauded in the past. In all of the papers we are aware of, an ad-hoc welfare criterion is used instead of household utility – the central bank minimizes a weighted average of the variances of inflation, output and the policy rate.[7] The variance of the policy rate was a concern because of instrument instability. Orphanides and Williams (2002) and Laxton and Pesenti (2003) are perhaps the papers that are closest to ours. They discussed central bank misperceptions of a constant long run natural rate of interest, and they found that a first difference rule worked quite well in that context. Levin, Wieland and Williams (1999 and 2003) discussed model uncertainty, and found a first difference rule worked quite well in that context; they made no mention of a fluctuating natural rate. Taylor and Williams (2011) provide a nice review of a number of papers in this vein, and provide an extensive bibliography.

Before proceeding to the analysis, we should address two questions. Do bonds have liquidity value? And if so, are they good substitutes for money? The basic premise should not be controversial. US Treasuries facilitate transactions in a number of ways: they serve as collateral in many financial markets, banks hold them to manage the liquidity of their portfolios, and individuals hold them in money market accounts that offer checking services. However, in what follows we will consider both cases – using the Standard Model and the

[7] In some cases, there is just a limit placed on the variance of the interest rate.

Liquid Bonds Model. If bonds do have liquidity value, are money and bonds substitutes or complements? We believe that substitutability is quite low: cash is not used as collateral, and government bonds are not used to pay the barber. However, in what follows, we will consider both cases.

We are of course not the first to study the transaction services of bonds. Early contributions to the literature include: Patinkin (1965), who put both money and bonds in the household utility function; and Friedman (1969), who discussed the optimum quantity of money and (private) bonds. More recent theoretical contributions include: Bansal and Coleman (1996), who used the approach to study the equity premium puzzle and related issues; Holmström and Tirole (1998), who argued that the private sector cannot satisfy its own liquidity needs; Calvo and Végh (1995), who studied the policy implications of liquid bonds; and Linnemann and Schabert (2010), who used a model similar to ours to study macroeconomic policy. The empirical literature finds a liquidity premium on government debt, and moreover that the premium depends upon the quantity of debt. Empirical contributions to the literature include: Friedman and Kuttner (1998), who studied the imperfect substitutability of commercial paper and US Treasuries; Greenwood and Vayanos (2008), who find “that (i) the supply of long-relative to short-term bonds is positively related to the term spread, (ii) supply predicts positively long-term bonds’ excess returns”; Krishnamurthy and Vissing-Jorgensen (2010), who find that the spread between liquid treasury securities and less liquid AAA debt moves systematically with the quantity of government debt; Bohn (2010), who presents results similar to those of Krishnamurthy and Vissing-Jorgensen; and Pflueger and Viceira (2011), who decompose “excess return predictability in inflation-indexed and nominal government bonds into liquidity, market segmentation, real interest rate risk and inflation risk” and find “a liquidity premium, which appears systematic in nature”.

The rest of the paper proceeds as follows: in Section 2, we outline the two models. In Section 3, we compare the dynamic properties of the two models. In Section 4, we perform the welfare analysis. And in Section 5, we discuss directions for future research, and implications of our results for current policy making.

2. The liquid bonds model with a standard model imbedded in It

The Liquid Bonds Model was developed by Canzoneri, Cumby, Diba and Lopez-Salido (2011). The model extends a standard New Keynesian environment to reflect the fact that government bonds provide liquidity and are imperfect substitutes for money. The model uses Schmitt-Grohé and Uribe’s (2004) specification of transaction costs, but it replaces money with a CES aggregate of money and bonds in their definition of velocity.[8] Imbedded in the Liquid Bonds Model is a Standard Model in which bonds have no liquidity value; it just returns to the original Schmitt-Grohé and Uribe definition of velocity. In the Standard Model, bonds have no liquidity value and are obviously not a substitute for money. The substitutability of money and bonds in the Liquid Bonds Model plays a strong role in the sections that follow. We begin with households and their transaction costs; that is where the action is.

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8 Canzoneri, Cumby, Diba and Lopez-Salido (2011) developed a more structural model in which banks hold money and bonds to manage their deposits. The model we use here makes it easier to build a quantitative model because we can pin down a number of important parameters by matching the sample averages of some key monetary and fiscal variables in US data.

2.1 Households and transaction costs

There is a continuum of households of measure one. Each household supplies labour to every firm; so, in a symmetric equilibrium the households' behaviour will be identical and we can dispense with household indices.

Households maximize

$$E_t \sum_{j=t}^{\infty} \beta^{j-t} \left[\log\left(c_j\right) - \left(1+\chi\right)^{-1} n_j^{1+\chi} \right] \tag{2}$$

subject to a sequence of budget constraints,

$$b_j + m_j + \left(1+\tau_j\right) c_j + \Upsilon_j = w_j n_j + \frac{\left(I_{j-1} b_{j-1} + m_{j-1}\right)}{\Pi_j} + d_j \tag{3}$$

where c is household consumption of a composite final good, n is hours worked, wn is real labour income, and τc are household transaction costs. m and b are real money and bond holdings, I is the gross nominal return on a riskless, one-period government bond, $\Pi_t \left(\equiv \frac{p_t}{p_{t-1}} \right)$ is the gross rate of inflation, Υ represents real lump sum taxes, and d dividends.

We have followed Schmitt-Grohé and Uribe (2004) in assuming that transaction costs are proportional to consumption. The factor of proportionality, τ, is an increasing function of velocity, v. Letting $\hat{v}$ be the satiation level of velocity,

$$\tau_t = \left(A/v_t\right)\left(v_t - \hat{v}\right)^2 \tag{4}$$

where $A > 0$. Schmitt-Grohé and Uribe defined velocity as $v_t = c_t / m_t$, but in the Liquid Bonds Model, we broaden the notion of transaction balances and let

$$v_t = \frac{c_t}{\tilde{m}_t} \tag{5}$$

where $\tilde{m}_t$ is a CES bundle of money and bonds,

$$\tilde{m}_t^p = a^{1-\rho} m_t^\rho + \left(1-a\right)^{1-\rho} b_t^\rho \tag{6}$$

In the Standard Model, we revert to Schmitt-Grohé and Uribe's definition of velocity; that is, $\tilde{m}_t = m_t$.

The elasticity of substitution in the Liquid Bonds Model is $\xi \equiv 1/\left(1-\rho\right)$. When $\xi < 1$, money and bonds are complements; and when $\xi > 1$, they are substitutes. As stated previously, this is an important parameter in the model.

Households' first order conditions include:

$$w_t \lambda_t = n_t^\chi \tag{7}$$

$$1/c_t = \lambda_t \left[1 + 2A\left(v_t - \hat{v}\right)\right] \tag{8}$$

where λ_t is the real marginal utility of wealth. When real resources are depleted in the purchase of consumption goods, the marginal utility of wealth is less than the marginal utility of consumption.

$$\left\{1 - A\left[v_t^2 - (\hat{v})^2\right]\left(\frac{a\tilde{m}_t}{m_t}\right)^{1-\rho}\right\} = \left(I_t^*\right)^{-1} \tag{9}$$

$$\left\{1 - A\left[v_t^2 - (\hat{v})^2\right]\left(\frac{(1-a)\tilde{m}_t}{b_t}\right)^{1-\rho}\right\} = \frac{I_t}{I_t^*} \tag{10}$$

where I_t^* is the gross nominal CCAPM interest rate; that is $\left(I_t^*\right)^{-1} \equiv \beta E_t\left\{\frac{P_t}{P_{t+1}}\frac{\lambda_{t+1}}{\lambda_t}\right\}$. We will think of I_t^* as the rate of return on a bond, b_t^*, that does not provide liquidity services.

Equations (9) and (10) imply

$$\frac{I_t^* - I_t}{I_t^* - 1} = \left(\frac{1-a}{a}\right)^{1-\rho}\left(\frac{m_t}{b_t}\right)^{1-\rho} \tag{11}$$

Since b provides transaction services, it will be held at a lower rate of return than b^*; the spread, $I_t^* - I_t$, will be non-negative in equilibrium. The spread is the pecuniary opportunity cost of holding the bond that does provide transaction services, and $I^* - 1$ is the opportunity cost of holding money. So, equation (11) says that in the optimal portfolio, the relative price of m and b is equated to the marginal rate of substitution between m and b.

When, for example, the central bank conducts an expansionary open market operation, m_t/b_t will rise; the marginal liquidity value of bonds (relative to money) will rise. This will cause the relative price to rise, and the spread, $I_t^* - I_t$, will increase.

Note also that when money and bonds are complements $(\rho < 0)$, a given movement in m_t/b_t will produce a larger change in the relative price, and in the spread, than when money and bonds are substitutes $(\rho > 0)$. This fact will play a role in what follows.

2.2 Intermediate goods and the final consumption good

The modelling of the production side of the economy is quite standard. Our description of it can be brief.

A continuum of monopolistically competitive firms, indexed by j, produce intermediate goods using a common technology,

$$y_{j,t} = z_t k n_{j,t}^{\psi} \tag{12}$$

Where k is the firm's fixed capital stock, $0 < \psi < 1$ and z_t is a common productivity shock that follows an AR(1) process:

$$\ln(z_t) = (1-\rho_z)\ln\bar{z} + \rho_z \ln(z_{t-1}) + \varepsilon_t^z$$

Where $0 \le \rho_z < 1$ and $\bar{z}\,(=1)$ is the steady state value of z_t. Competitive retailers buy the intermediate goods and bundle them into the final good, y_t, using a CES aggregator with elasticity η.

Intermediate good firms engage in Calvo price setting. Each period, with probability $1-\alpha$, a firm j gets to set an optimal new price; if the firm does not get to re-optimize, its price goes up automatically by the steady state rate of inflation, $\bar{\Pi}$. Bars over variables indicate a steady state value.

2.3 Goods market clearing

Households' transaction costs are a drain on resources. The market clearing condition for output is

$$y_t = (1+\tau_t)c_t + g_t \tag{13}$$

where g_t is real government spending on the final good.

2.4 Fiscal policy

Government spending follows an exogenous AR(1) process

$$\ln(g_t) = (1-\rho_g)\ln\bar{g} + \rho_g \ln(g_{t-1}) + \varepsilon_t^g \tag{14}$$

where $0 < \rho_g < 1$ and ε_t^g is a spending shock.

The government uses a lump sum tax, Υ, to stabilize its debt. The tax rule is

$$\Upsilon_t = \bar{\Upsilon} + \phi_d\left(b_{t-1} - \bar{b}\right) \tag{15}$$

When $\phi_d > I/\bar{\Pi} - 1$ fiscal policy is stabilizing since tax increases are more than sufficient to pay the interest on any increase in the debt.[9]

2.5 Steady state and model calibration

Canzoneri, Cumby, Diba and Lopez-Salido (2011) described the steady state of the Liquid Bonds Model and its calibration in some detail. Our discussion here can be brief, and once again, the interested reader is referred to that paper for a more complete description.

The calibration was based on quarterly US data. Sample averages were used to estimate the steady state values of $\bar{\Pi}, \bar{I}, \bar{b}/\bar{c}, \bar{b}/\bar{m}$, and $\bar{g}/\bar{y}$; β was set equal to 0.99 (as is usual in quarterly models) to calibrate $\bar{I}^*$. Using these estimates, we choose values of the parameters, a, $\hat{v}$, A to match $\bar{b}/\bar{c}, \bar{b}/\bar{m}$, and $\bar{I}^* - \bar{I}$. The other parameters in the model were set equal to values that are standard in the literature: $\alpha = 0.75$ implies that the average duration of prices is four quarters; $\eta = 7$ implies that the steady state markup is 1.17; $\chi = 1$ implies that the disutility of work is quadratic; $\psi = 0.66$ implies that capital's share is one third; and $\theta_\pi = 1.5$. Parameters in the stochastic processes for government spending and productivity are: $\rho_g = 0.95$, $SD(\varepsilon^g)$; $\rho_z = 0.93$, $SD(\varepsilon^z) = 0.01$.

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9 This is a passive fiscal policy. Eschewing the Fiscal Theory of the Price Level, we will always assume that fiscal policy is passive.

3. p rate dynamics

Observing the natural rate of interest is presumably more important for policy making when the natural rate is moving a lot and the policy rate cannot keep up with it. Movements in the natural rate will of course depend on the source of the shock, but they will also depend on the economic environment: do bonds have liquidity, and if so, are they good substitutes for money, or are they poor substitutes? In what follows, we will consider three cases for the elasticity of substitution: *complements* $(\xi = 0.75)$, *unit elasticity* $(\xi = 1.00)$, and *substitutes* $(\xi = 1.25)$.

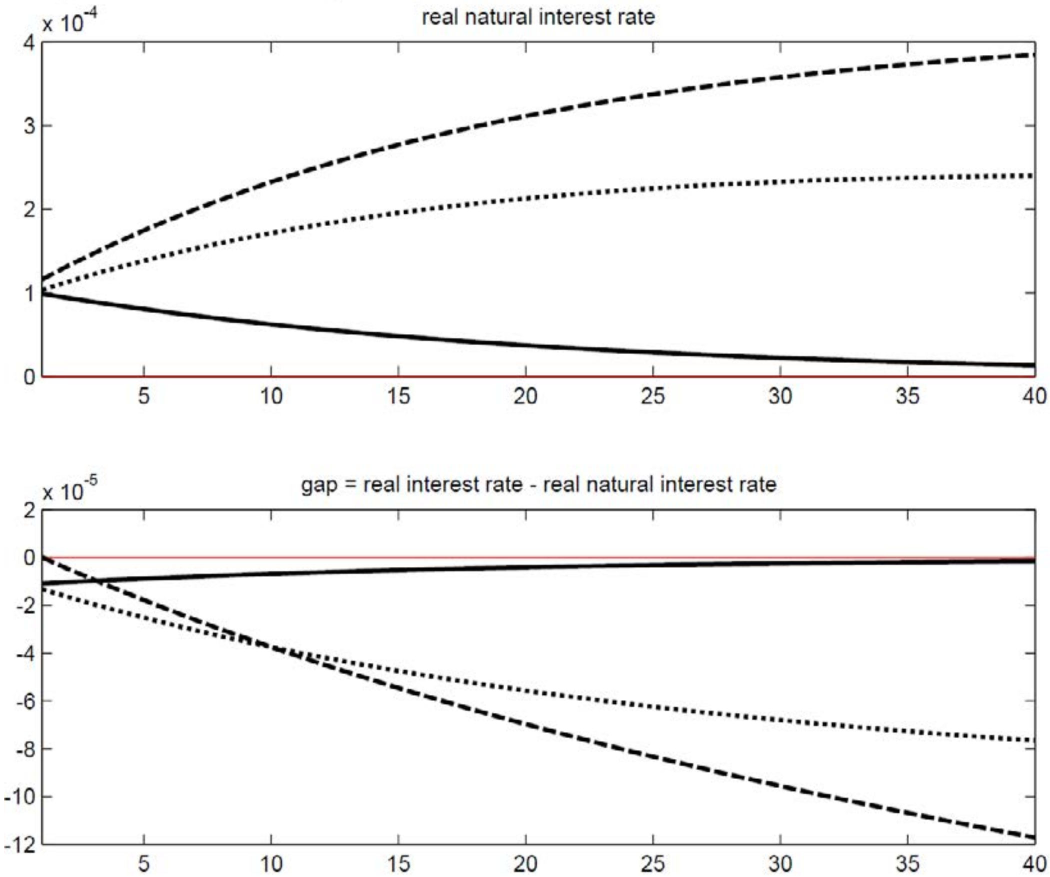
Equally important is presumably whether the policy rate can be made to follow closely the movements in the natural rate. This will of course depend on the policy rule that is in place. We will consider the rules 1 to 4 that were defined in the introduction.

3.1 Importance of the economic environment

First, we look at changes in the natural rate, and the deviation of the policy rate from its natural rate, in response to shocks in government purchases and productivity. And we see how these responses depend on the economic environment. For this exercise we assume that monetary policy is guided by Rule 1.

Figure 1 shows impulse response functions for an increase in government purchases. Rule 1 has a constant intercept term; there is no attempt to follow unobserved fluctuations in the natural rate. The top panel shows responses of the real natural rate of interest, and the bottom panel shows the gap between the policy rate and its natural rate.

Figure 1: Government Spending Shock, Rule 1



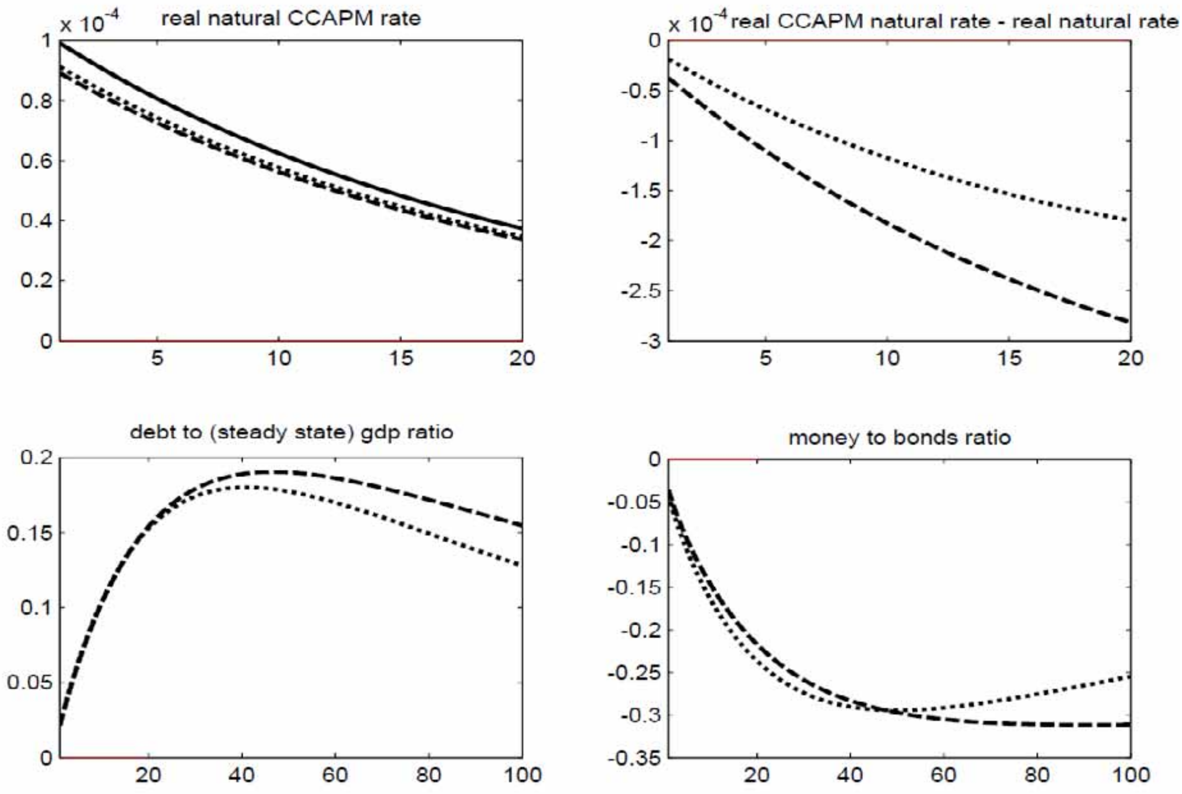
Standard Model: solid line; Liquid Bonds model, compliments: dashed line; substitutes: dotted line

An increase in government purchases crowds out consumer spending, thus raising the natural rate of interest. In the Standard Model, the increase in the natural rate is moderate, and it dies out relatively quickly. The policy rate rises in response to the inflation caused by the spending increase, but by slightly less than the natural rate. A small gap is created but it too closes rather quickly.

There is a very different response in the Liquid Bonds Model, and that response depends upon whether money and bonds are complements $(\xi = 0.75)$ or substitutes $(\xi = 1.25)$. In either case, the initial rise in the natural rate is moderate, not unlike the increase in the Standard Model. But here, the natural rate does not return to its steady state value for a very long time. The gap term shows a similar pattern. And these responses are much more pronounced when money and bonds are complements.

Why is this so? In both the Standard Model and the Liquid Bonds Model, the increase in government spending crowds out consumption and the natural rate rises. But when bonds provide liquidity, there is more: as seen in the bottom left panel of Figure 2, a bond financed increase in government spending increases the supply of bonds and that process continues for a very long time. In response to an innovation in government purchases of one per cent of quarterly GDP, debt continues to rise for more than 11 years, and at its peak, the increase is nearly 20 per cent of quarterly GDP.

Figure 2: Government Spending Shock, Rule 1



Standard Model: solid line; Liquid Bonds model, compliments: dashed line; substitutes: dotted line

As the debt rises and m_t/b_t falls, the marginal liquidity value of bond holdings declines, which raises the natural rate and reduces the spread, $I^* - I$. To see this, let Δx be the difference in the response of variable x between any two of the three models (the Standard Model, the Liquid Bonds Model where money and bonds are complements, and the Liquid Bonds Model where the two are substitutes). We can then decompose the difference in the natural rates into,

$$\Delta I^N = \Delta I^{*,N} - \Delta\left(I^{*,N} - I^N\right) \tag{16}$$

The upper left panel of Figure 2 shows that there is very little difference between the real natural CCAPM rates in the three models. So, the first term on the RHS of equation (16) is close to zero, and the differences in the natural rate of interest are due essentially to differences in the marginal liquidity value of government debt, which is reflected in the smaller spread. Thus, the natural rate rises by more in the Liquid Bond Models than in the Standard Model. And because the supply of bonds grows over time, the difference in the real natural rates of interest rises over time as well.

The next question is, why is the response of the natural rate so much larger when money and bonds are complements? A fiscal expansion makes m/b fall.[10] This leads to a larger decline in the marginal liquidity value of bonds when money and bonds are complements. From equation (11), when money and bonds are complements (and ρ is low), the decrease in m/b results in a larger change in the marginal liquidity value of bonds and a larger change in the spread, $I^* - I$. As seen in Figure 2, the ratio of money to bonds is virtually the same in both cases so that essentially all the difference in the natural rates arises from the greater response in the spread, $I^* - I$, to a given change in m/b when money and bonds are complements.

The increase in the natural rate in the Liquid Bonds Model is relatively moderate: an innovation in government purchases of one per cent of GDP raises the annualized natural rate by about 35-50 basis points after five years (depending on the version of the model) and about 40-60 basis points after 10 years. But the increase in the natural rate is extremely persistent, reflecting debt dynamics. As seen in Figure 2, debt continues to grow, and m/b continues to decline, for more than 10 years following a persistent shock to government purchases. As a result, the marginal liquidity value of debt continues to decline, and the natural rate continues to rise, for more than 10 years before these changes begin to reverse. As we will see in the next section, failing to adjust monetary policy in response to these moderate but extremely persistent changes in the natural rate of interest has significant welfare implications.

These differences across models in the marginal liquidity value of government bonds explain the differences in the behaviour in the gap between the policy rate and the natural rate as well. In all three cases, the policy rate, which follows Rule 1, rises in response to inflation. Initially, the gaps between the policy rates and the natural rates are all similar and small. Over time, however, as the policy rates respond only to inflation, and the natural rates move with the accumulating bond supplies, the gaps in either one of the Liquid Bonds Models grow. And because the rise in the natural rate is greater when money and bonds are complements, the gap between the policy rate and the natural rate is greater as well.[11]

A productivity shock, unlike a shock to government purchases, does not have a direct effect on government liabilities, $m + b$. But, monetary policy changes their composition, and this has real effects through (11). Figure 3 shows that a productivity shock has sizable effects on the natural rate of interest; however, they are not long lasting. A positive productivity shock

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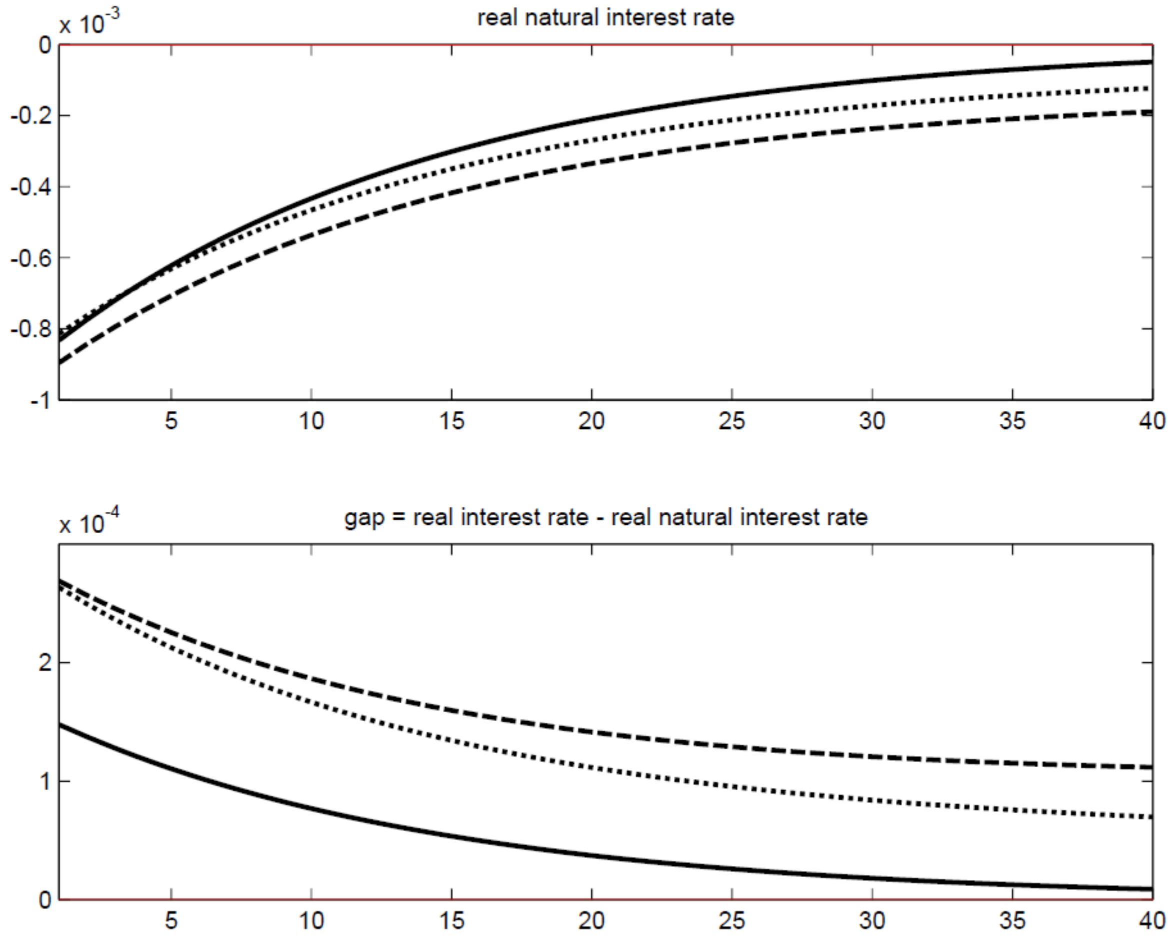
[10] A deficit financed increase in government purchases increases $m + b$. Monetary policy responds to the increasing inflation with an open market sale of bonds. The net effect is a fall in m/b.

[11] The gap between the policy rate and the natural rate is less than the rise in the natural rate. Because the policy rule fails to take into account the rise in the natural rate, the policy rate is set too low. As a result, inflation rises more in the Liquid Bonds Model and is persistent. The policy rule raises the real policy rate when inflation rises, thereby reducing the gap somewhat.

increases supply, and this drives the natural rate down. The effect is more pronounced in the Liquid Bonds Model, but the differences, while long lasting, are not large.

Figure 3: Productivity Shock, Rule 1



Standard Model: solid line; Liquid Bonds model, compliments: dashed line; substitutes: dotted line

Summing up: In the Standard Model, government spending shocks cause the natural rate to rise moderately, and productivity shocks cause the natural rate to fall moderately. But in each case, movements in the natural rate die out relatively quickly. Moreover, the policy rate tracks movements in the natural rate rather closely. When bonds provide liquidity, roughly the same conclusions hold with respect to productivity shocks. However, bond financed government spending shocks induce sustained movements in the natural rate (because of sticky prices); Rule 1 cannot make the policy rate keep up. In this case, observing and tracking the natural rate would seem to be most important. Finally, this last result is more pronounced when money and bonds are complements; when they are substitutes, a given change in the money to bonds ratio does not cause as large a swing in the relative prices of the two assets or the interest rate spread. And simulations show that movements in the spread are closely related to movements in the natural rate.

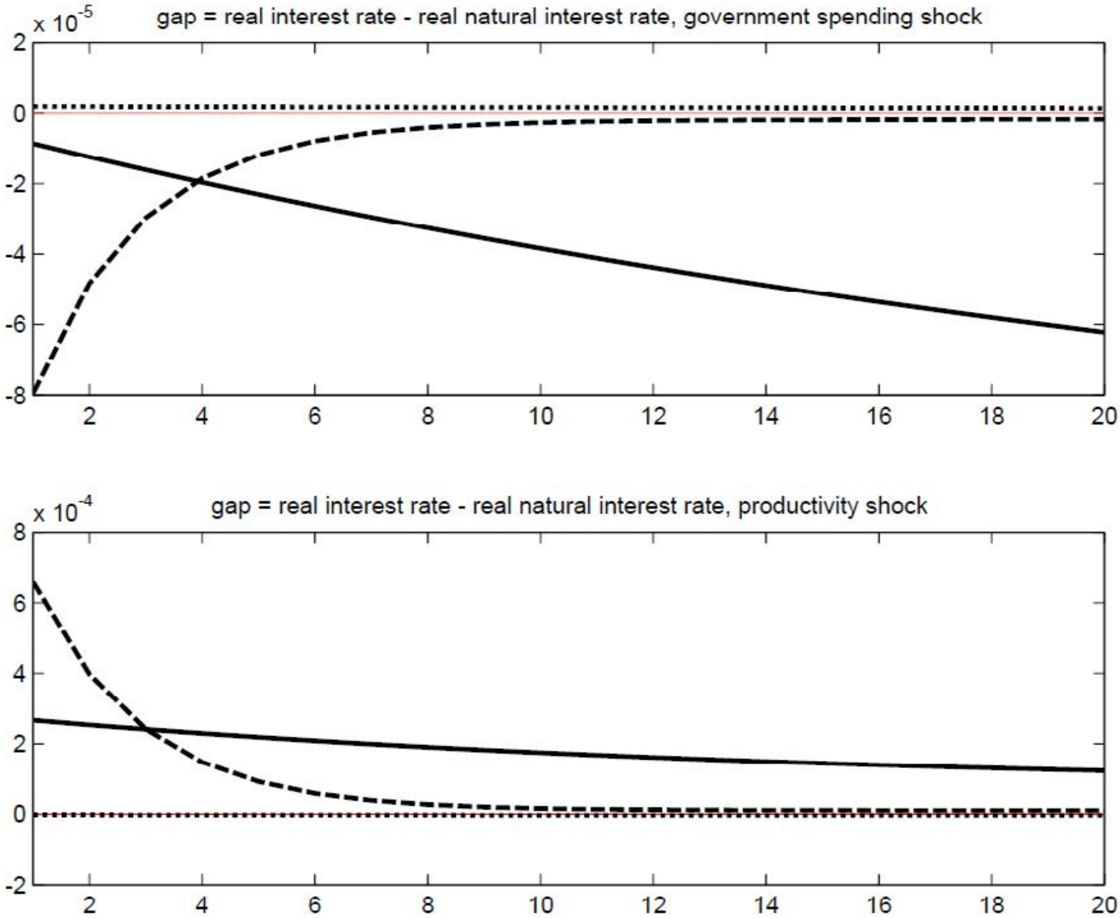
3.2 Importance of the Interest Rate Rule

The real natural rate of interest comes from the flexible price solution, and monetary policy cannot affect that solution. However, some policy rules are better than others in making the policy rate track its natural rate. Rule 1 has a constant intercept term, set at the steady state value of the nominal natural rate of interest; this rule makes no direct attempt to track short run fluctuations in the natural rate. Neither does Rule 3, the first difference rule. But there is no intercept term in it, and it may track the natural rate better than Rule 1. Why? A unit root process may be better at picking up prolonged movements in the natural rate. Rule 4 assumes that the natural rate is actually observed; this rule must be considered a benchmark case, since Rule 4 cannot be implemented in practice.

In this section, we examine the performance of these three rules in the Standard Model and in our Liquid Bonds Model.[12] We begin with the Liquid Bonds Model; for this exercise, we set the elasticity of substitution between money and bonds equal to one $(\xi = 1)$; this case is right in between the complements $(\xi = 0.75)$ case and the substitutes $(\xi = 1.25)$ case.

Figure 4 shows responses in the interest rate gap to government spending and productivity shocks. As might be expected, Rule 1 does a very poor job of tracking the natural rate. For an increase in government purchases, the interest rate gap is still widening after five years. This is, once again, because a bond financed expansion reduces the marginal liquidity of bonds and induces a protracted increase in the natural rate. The rule fares somewhat better for an increase in productivity: the interest rate gap has a half life of four years and a quarter. Rule 3 does a much better job of tracking the natural rate: the half life is just two quarters for either of the shocks. And, not surprisingly, Rule 4 tracks the natural rate perfectly.

Figure 4: Liquid Bonds Model, unit elasticity, Policy Rules

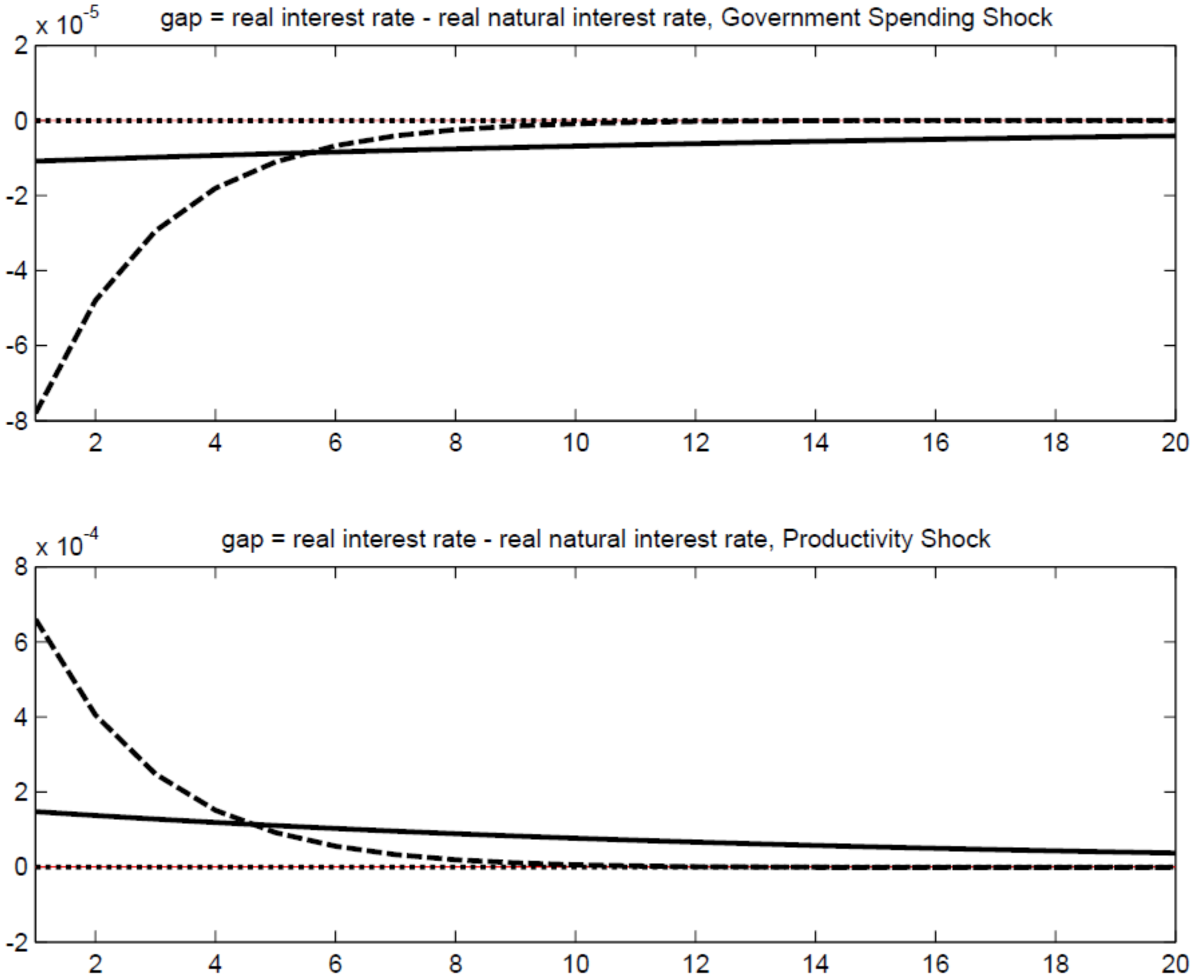


Rule 1: solid line; Rule 3: dashed line; Rule 4: dotted line

12 Rule 2 tracks the natural rate better than Rule 1, and worse than Rule 3. For simplicity of exposition, we do not include it in this section.

Figure 5 gives the analogous results for the Standard Model. Since bond financed fiscal expansions do not directly affect liquidity, Rule 1 fares much better in the case of an increase of government spending: the interest rate gap has a half life of just four years. Rule 1 also does somewhat better in the case of a positive productivity shock: the gap has a half life of less than three years. Rule 3 appears to fare a little better than in the Liquid Bonds Model, though the half life of the gap is still two quarters for either shock. And once again, Rule 4 tracks the natural rate perfectly.

Figure 5: Standard Model, Policy Rules



Rule 1: solid line; Rule 3: dashed line; Rule 4: dotted line

Summing up: Rules that quickly bring the policy rate in line with its natural rate are presumably better policies, a normative question we pursue in Section 4. Rule 1 makes no explicit attempt to track the natural rate, and in fact, it does a bad job of it. This is especially true for bond financed spending increases in the Liquid Bonds Model. Rule 3, the first difference rule, does a much better job, in both models and for both government spending shocks and productivity shocks. This may be because a unit root process is better at picking up prolonged movements in the natural rate. Rule 4 assumes that the natural rate of interest is directly observable, and as a consequence it tracks the natural rate perfectly; however, it is not implementable in practice.

4. Is observing the natural rate of interest important in terms of household utility?

The previous section conducted a positive analysis of three of the policy rules; here we study the normative performance of rules 1 to 4. The notion guiding the positive analysis was that good policy rules make the policy rate track its natural rate closely. If that notion is correct, then Rule 2 is better than Rule 1, Rule 3 is better than Rule 2 and Rule 4 is better than Rule 3. Here, we confirm that notion, and we ask whether the gain from going from one rule to the next is quantitatively important. We also compare different economic environments in this regard; that is, we study the Standard Model and the Liquid Bonds Model. In the latter we consider cases where money and bonds are complements $(\xi = 0.75)$ and cases where they are substitutes $(\xi = 1.25)$.

The metric we use is the expected discounted value of household utility, conditional on the economy starting in its steady state. But since this metric has no clear meaning, we follow the custom of comparing the policy rules in terms of consumption units: what per cent of consumption would households be willing to give up each period – *assuming that the work effort is held constant* – to move from one rule to the next.

Table 1 presents the welfare results. In it, the comparisons are all with respect to Rule 1, the original Taylor Rule (minus the output gap), with a constant intercept term.

Table 1

Welfare comparisons, steady state consumption gained over Rule 1 (in per cent)

	Standard model	LB model: complements	LB Model: substitutes
Rule 1	X	X	X
Rule 2	0.11	0.13	0.06
Rule 3	0.25	0.51	0.29
Rule 4	0.25	0.50	0.29

Rule 2 is the version of the Taylor Rule that is used in much of the New Keynesian literature; it has a constant intercept term and interest rate smoothing. Households would give up a little over a tenth of a per cent of consumption to have interest rate smoothing in either the Standard Model or the Liquid Bonds Model with complements; in the Liquid Bonds Model with substitutes, it is only half as much.

Rule 3, the first difference rule, does much better when compared with Rule 1: a quarter of a per cent in the Standard Model, and half a per cent in the Liquid Bonds Model with complements. These are large numbers by the standards of the New Keynesian literature. And the fact that the first difference rule does particularly well in the Liquid Bonds Model with complements is perhaps not surprising; in that environment, government spending shocks cause sustained movements in the natural rate that are hard for Rule 1 or Rule 2 to track. The gain is not as large in the Liquid Bonds Model with substitutes: about a third of a per cent of consumption.

It is interesting to note that the first difference rule performs virtually as well as Rule 4, the full information rule that assumes the natural rate can be observed. To implement the first difference rule, there is no need to observe the natural rate. It may be somewhat surprising that the first difference rule does so well, but it is consistent with earlier results discussed in the Introduction.

Summing up: In the Standard Model, households would be willing to give up a quarter of a per cent of consumption to replace the original Taylor Rule with a full information rule that requires direct observation of the natural rate of interest. In the Liquid Bonds Model where money and bonds are complements, and government spending shocks cause sustained movements in the natural rate, households would be willing to give up half a per cent of consumption to get the full information rule. Finally, the first difference rule performs virtually as well as the full information rule in all of the cases. Presumably that is because a unit root process can better pick up sustained movements in the natural rate.

5. Conclusion

In Section 3, we showed that – in some economic environments and with some standard monetary policy rules – shocks to the economy can make the natural rate of interest deviate substantially from its steady state value for a very long time. In Section 4, we showed that in this kind of environment, household utility improves significantly when the monetary policy rule can make the policy rate track its natural rate precisely. Moreover, a first difference rule – a rule that does not require any information about the natural rate – performs virtually as well as the full information rule. More detailed results have already been summarized at the ends of the preceding sections. They need not be repeated here.

The actual choices of central banks are not limited to rules with no information or (impractical) rules with full information. It would be interesting to explore rules that use the central bank's perceptions of the natural rate; that is, rules that replace the intercept term in the original Taylor Rule with the central bank's perception of the natural rate. This would be difficult to do, since it would require one to take a stand on how to model the central bank's perceptions.

Finally, there is a timely lesson to be learned from our analysis. As of this writing, many OECD countries are undertaking, or contemplating, large cuts in government spending to stabilize their sovereign debts. If bonds do provide liquidity services, then our results suggest that the natural rate of interest will be moving a lot. Central banks will find it difficult to track the natural rate, and the first difference rule seems to be made for just this situation.

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Comment

Stephen Cecchetti

If we are to understand the role of debt, and especially government debt, in the economy, the starting point has to be macroeconomic models that admit financial frictions. And these frictions must create market imperfections both atemporally and intertemporally. Furthermore, debt has to matter both in the private and in the public sphere. To put it more generally, we need to understand why the Modigliani-Miller theorem fails and why Ricardian equivalence fails. Without models that admit financial frictions and a clear role for both public and private debt, we cannot start to understand why the structure and size of central bank balance sheets matter, nor can we understand why the maturity structure of government finances should have an impact on aggregate activity.

The papers in this workshop help move us towards this understanding. By building models that bring finance explicitly into the New Keynesian macroeconomic framework, they provide us with the first glimpses of the direction we need to go. With these objectives clearly in mind, Fabrizio Zampolli reviews theories in which sovereign debt management plays a role as a monetary policy tool. Jagjit Chadha looks at the effects of quantitative easing in dynamic stochastic general equilibrium (DSGE) models with certain financial frictions. And Robert Cumby considers a DSGE model in which government bonds have liquidity value.

Before proceeding to my main remarks, let me make a general point about modelling. First, without models – by which I mean simple mathematical representations of economic systems – we are lost. At the very least, models give us a structure to organise our thinking and provide a check on the logical consistency of our conclusions. Models are transparent, putting everything out in the open. At their best, models reveal astonishing conclusions driven by the inescapable logic arising from the assumptions they embody. In these critical respects, DSGE models are no different from any other models, so we should not campaign against them. What is critical, however, is that models not be built or used mindlessly. They are a means to an end, and that end is to understand relationships in the economy.

Second, I should reveal my preferences for linear models relative to non-linear ones. This is a practical preference, not a theoretical one. Of course, reality is non-linear. Even the smallest amount of introspection reveals non-linearities in one's own thinking. But our ability to model non-linear systems is, in my view, destined to fail. Recall that several decades ago there was a move to try to distinguish non-linear deterministic systems from linear stochastic ones.[1] This caught many people's fancy, including mine. But after playing around with this for a while, most of us realised that statistical tests had zero power – and I mean *zero* power – to distinguish the non-linear from the linear. The reason is simple: everything is locally linear, so what you need to find non-linearity is a large amount of data in what appears to be the tail of the distribution of the stochastic model. But the tail events that could identify the non-linearity are sparse. So, in the end, the econometrician trying to find convincing evidence of non-linearity is dead in the water.

Turning to my main points, I would like to discuss four challenges to macroeconomic modelling: the introduction of financial intermediation, the assumption of rational behaviour

[1] See, for example, the material that is presented in Brock, Hsieh and LeBaron (1991).

and optimisation, the use of representative agent models, and the use of general equilibrium.[2]

Starting with financial intermediation, recall that banks play no role whatsoever in macroeconomic models of the pre-crisis era. These traditional models are based on the distinction between nominal and real quantities, and there are interest rates. But the only friction is the one associated with nominal price changes, so inflation and inflation control become the focus. (If it is costly to change prices, inflation creates a deadweight loss.) And, since the model is devoid of banks, there is no private debt. As I suggested at the beginning, the macroeconomic models of the future, with their added focus on financial linkages, need to have a rationale for debt as distinct from equity. We need to understand why the predominant financial contract is a loan or a bond rather than equity. In fact, we need a clear understanding of the optimal debt/equity ratio for the economy as a whole. We know that high levels of debt can lead to disaster for a society, but beyond notions from crude empirical work, we don't have any idea what the right level of debt is. A rich enough macro/monetary/financial model will tell us the answer.

Next, I have a few comments about rational behaviour, information structures and optimisation. The adoption of optimal control methods with rational expectations, and the associated information structures, is comfortable. Alternative formulations do not have either unique equilibria or straightforward solution techniques. For a theorist, having a continuum of equilibria is unsettling. For a policymaker, it is a disaster. What central banker, when asking his or her economic adviser to characterise the likely impact of a change in policy, wants to hear: "Well, to tell you the truth, anything can happen"? With uniqueness comes a good night's sleep. But, in the end, the models are wrong and the equilibria are numerous. This means that persistent deviations from fundamentals are the norm, not the exception, and we need to move away from our desperate psychological need for uniqueness.

The third item on my list is representative agent models. For several decades, we have insisted that macroeconomic models be built on solid microeconomic foundations. And, even worse, that the microeconomic foundations be those for a representative agent. This created a lack of any real distinction between macroeconomics and microeconomics, beyond the questions the models were used to address. But the insistence on microeconomic foundations may have blinded us to the fact that the macroeconomic models are not up to the task of addressing the questions we really need to answer. An analogy may help illustrate what I have in mind. Let's say that we are trying to measure tide height at the beach. We know that the sea is filled with fish, and so we exhaustively model fish behaviour, developing complex models of their movements and interactions. Finally, we have a model of the fish that we are able to simulate and compare to the data from monitoring the fish themselves. The model is great. And the model is useless. What we needed was a model of the moon! The behaviour of the fish is irrelevant for the question we are interested in: how high will the seawater go up the beach? I worry that by building microeconomic foundations we are focusing on the fish when we should be studying the moon.

Finally, there is the issue of partial versus general equilibrium. Most macroeconomists, including me, have spent our entire professional careers trying to ensure that we focus on general equilibrium. We have various tricks and rules of thumb for making sure that we don't fall into traps, ascribing partial equilibrium results to general equilibrium systems. But the fact that there may be fallacies of composition doesn't mean that we should always insist on general equilibrium. In those cases where general equilibrium is too hard – and there are many – shouldn't we accept and use the lessons partial equilibrium has to offer?

[2] These remarks are based on Cecchetti, Disyatat and Kohler (2009).

In conclusion, let me say that the work presented in this workshop is of clear value. It moves us forward, helping us to understand many of the key questions that arise in the aftermath of the financial crisis. Integrating financial systems into monetary models helps us to understand how we should be thinking about interactions between the real economy and the financial system. This is essential work if policymakers are to succeed in delivering high, stable growth, low, stable inflation and a stable financial system.

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Sovereign debt management and economic theory

Is the standard micro portfolio approach to sovereign debt management still appropriate?

Hans J Blommestein and Anja Hubig[1]

Abstract

This paper examines the analytical underpinnings of the standard micro portfolio approach to public debt management (PDM) that aims at minimising longer-term cash-flow based borrowing costs at an acceptable level of risk. The study concludes that two technical key assumptions need to hold for the standard micro portfolio approach to yield optimal (ie cost-minimising) results. We argue that these assumptions do not hold in the current borrowing environment characterised by fiscal dominance with complex links between PDM and monetary policy. By using the principles of portfolio theory we demonstrate that in this borrowing environment cost-risk optimality requires the use of a broader cost concept than employed in the standard micro portfolio approach. This new concept incorporates not only the cash flows of the debt portfolio itself, but also those related to primary borrowing requirements. The resulting broader cost measure includes therefore the interactions with the budget. Finally, the paper demonstrates that the standard cost-risk framework of the micro portfolio approach is nested within this new, broader cost concept.

Keywords: Public debt management, micro portfolio approach, portfolio theory, cost-risk optimality, sovereign asset liability management, fiscal dominance

JEL classification: E43, E61, G11, G17, G32, H63

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[1] Hans J Blommestein is Head of the Public Debt Management and Bond Market Unit, OECD. Anja Hubig is the corresponding author: email address: anja.hubig@gmx.de. Anja Hubig is a Doctoral candidate at the School of Business and Economics at the Humboldt University of Berlin (Institute for Banking and Asset Markets).The views expressed are personal ones and do not represent those of the institutions with which the authors are affiliated.

1. Introduction

There is a consensus among OECD debt managers that the primary strategic objectives or functions of government debt management are:[2] (a) securing continuous (and easy) access to markets, while (b) minimising longer-term borrowing costs at an acceptable level of risk. These strategic cost-risk objectives constitute the basis of the so-called standard micro portfolio approach to public debt management (PDM). The recent global financial and economic crises, however, have triggered a growing debate on the need for making possible changes in this standard strategic mandate of PDM. This policy debate is also informed by the (potential) implications of new and complex interactions between PDM, monetary policy and financial instability in the face of serious fiscal vulnerabilities, a perceived increase in sovereign risk and considerable uncertainty about future interest rates – denoted as *fiscal dominance* (Blommestein and Turner (2012). This situation is likely to last for many years.

Although both these interactions and fiscal dominance are the result of (or were revealed during) the global financial crisis and its aftermath, structural changes in (or features of) the new financial (and business) landscape may be additional structural reasons why some of these new complex links are likely to persist. These developments, in turn, have significantly changed the policy environment for debt management offices (DMOs), central banks (CBs) and fiscal authorities. The size of the balance sheets of CBs has been expanded significantly while their composition has been radically changed.[3] The use of unconventional monetary policy has created (potential) conflicts and new interactions between monetary policy, PDM and fiscal policy. Several analysts and policy makers have argued that government debt managers should be more aware of, and/or take explicitly into account, the broader (macro) impact of their policy decisions on the economic policy mix and the financial system as a whole. Several authors have used this perspective as a basis for suggesting a revision of the conventional (micro portfolio) mandate to PDM, including Turner (2011), Hoogduin et al (2010), Surti et al (2010) and Goodhart (2010).

Against this complex, multi-faceted borrowing background, the paper will address the core question as to what extent a conceptual reformulation of the standard micro portfolio approach to PDM is needed. In this context, we will focus on the following specific questions related to the underlying technical assumptions of the micro portfolio approach:

(i) Under which technical conditions or assumptions is the standard micro portfolio approach to PDM an optimal one in the sense that effective borrowing costs[4] are indeed minimised subject to a stated preferred level of risk?

(ii) Do these technical (optimality) conditions remain valid in a situation of sustained fiscal dominance, imperfect asset substitutability, and the (partial) loss of risk-free assets?

Our analysis identifies two key technical assumptions for the standard micro portfolio approach to public liability management to yield optimal (ie cost-minimising) results. In this context we also demonstrate that the standard cost-risk framework of the micro portfolio approach represents a special case of a general framework associated with an alternative (ie broader) cost measure based on portfolio theory. The underlying reasoning demonstrates under which conditions it may be desirable to take a broader view of cost and risk than the

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2 For further details, see Blommestein (2002), Kreiner (2002) and other contributors in OECD (2002).

3 See Ben S Bernanke, The Federal Reserve's Balance Sheet: An Update, Speech at the Federal Reserve Board Conference on Key Developments in Monetary Policy, Washington, DC. 8 October 2009.

4 The concept of the cash-flow measure based on the standard borrowing costs of the sovereign liability portfolio associated with the standard micro portfolio approach differs from a wider measure referred to in this paper as *effective sovereign borrowing costs*. The latter concept is further explained in section 3.

measure implied by the standard micro portfolio approach to sovereign liability management. We shall refer to this broader measure as *effective sovereign borrowing costs*. In essence we show how the use of this broader measure of sovereign borrowing costs (that explicitly encompasses interactions with the budget) may be a potentially effective response to the complications associated with situations of fiscal dominance.[5]

The paper is structured as follows. Section 2 provides a detailed analysis of the analytical underpinning of the standard micro portfolio approach, thereby demonstrating that this approach has important similarities with the behaviour of private financial institutions guided by micro-economic principles. By comparing the micro portfolio approach to well-established asset management practices in section 3, we are in the position to deduce the two key technical assumptions of the cost and risk framework associated with the standard micro portfolio approach. In section 4, we closely examine each of these technical conditions. In doing so, we evaluate the implications of the financial-cum-sovereign debt crisis for the standard micro portfolio approach. To that end, we are making an explicit distinction between normal ("non-crisis") periods and more challenging crisis situations. Our analysis shows that in a situation of fiscal dominance[6] the standard micro portfolio approach does not yield optimal cost-risk results. The final section (section 5) concludes and outlines the next steps in our research programme.

2. The analytical roots of the standard micro portfolio approach

The micro portfolio approach currently pursued by most government debt managers is reflected in the basic functions of PDM (securing market-based financing at lowest cost subject to risk preferences). The organisation of PDM underwent major changes in the 1990s, reflecting the move to a micro portfolio approach to PDM. Debt management operations have been delegated to separate operationally autonomous units (DMOs) sometimes outside the Ministry of Finance (MoF), albeit subject to the policy responsibility of the MoF.[7] A crucial feature of this institutional set-up is the separation between PDM and fiscal policy on the one hand, and monetary policy (for which independent CBs are responsible) on the other.[8] DMOs operate as professional and predictable market players sticking to basic market rules, thereby supporting a liquid and transparent market for government securities.

As a result of this institutional set-up, active support by PDM for broader macroeconomic objectives, such as was common in the 1950s and 1960s and which entailed active use of the debt portfolio structure in the conduct of macroeconomic policies, has lost ground.[9]

5 As noted, this reflects a situation with challenges and tensions in sovereign debt markets, where policy makers are facing serious fiscal vulnerabilities, a rapid increase in sovereign risk and considerable uncertainty about future interest rates.

6 Characterised by critical public debt ratios, perceptions that the risk-free asset condition has been weakened as well as imperfect asset substitutability along the yield curve.

7 A more comprehensive treatment of the transformation process, and also of the role and structure of DMOs, is given by Kalderen and Blommestein (2002, pp 109-133).

8 After all, this was one of the reasons for the change in the institutional set-up in the 1990s. See Kalderen and Blommestein (2002, p 110) with further references.

9 Hain (2004, pp 113-131) provides a historical overview of macroeconomic approaches to PDM (mostly in the 1950s and 1960s), which in particular involved the use of the maturity structure of government debt to influence market interest rates and the level of economic activity. Most notable are the studies of Simons (1944), Musgrave (1959), Rolph (1957) and Tobin (1963). See also Wolswijk and de Haan (2005, pp 7 f) with

Instead, the adoption of a micro portfolio approach entails a narrow focus on cost and risk targets directly linked to the sovereign debt portfolio. This implies that DMOs execute issuance and funding strategies based on a clear set of rules guided by micro-economic principles. These principles are summarised as the strategic objective to "minimise longer-term borrowing costs at an acceptable level of risk".

It should be noted that the objectives "minimising borrowing costs" and "managing the associated risks" cannot be seen in isolation from each other. Maturities are the main components or features to manage the cost and (interest-rate) risk profile of the sovereign debt portfolio.[10] The shorter the average term to maturity of the debt portfolio, the more frequently refinancing at new market conditions will be necessary. Thus, portfolios with a larger share of short-term financing instruments are subject to a higher level of interest-rate risk than those with a larger share of longer-term instruments. On the other hand, considering the commonly observed upward-sloping yield curve, longer-maturity securities provide on average higher yields than shorter-term securities. In other words, the basic PDM strategy entails the need to manage a cost-risk trade-off in structuring the (optimal) debt portfolio.[11]

In this context, we will refer to the underlying conceptual framework as the standard micro portfolio approach to sovereign liability management and argue that there are important analytical similarities with asset management (allocation) concepts.[12] Specifically, both the micro portfolio management of sovereign liabilities and private asset (or investment) management require making decisions under conditions of uncertainty regarding:

(a) the (optimal) structure of a debt (or investment) portfolio, which involves

(b) the optimisation of the micro cost (or return)/risk relationship, by taking into account

(c) the existing portfolio (with liabilities or assets) and nothing else.

Point (c) implies that the primary budget balance is treated as an *exogenous* variable in the standard micro portfolio approach. Hence, the level of debt is largely determined by changes in the primary budget balance. The budgetary balance, reflecting the stance of fiscal policy, therefore constitutes exogenous input for simulations associated with the sovereign debt strategy (*while payments for servicing the debt are endogenous*). Hence, within the context of the analytical framework of the standard micro portfolio strategy, there is a clear functional separation between PDM and fiscal policy, while the PDM strategy is also functionally separated from monetary policy. Consequently, such an institutional set-up implies that PDM is in principle not integrated into the conventional macroeconomic framework. In section 4 we will discuss whether this is an appropriate approach.

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additional remarks on conventional macroeconomic debt management objectives (such as macroeconomic and deficit stabilisation as well as tax smoothing).

[10] In altering the cost-risk profile of debt portfolios, DMOs also make use of interest-rate swaps. These derivative instruments enable the government to optimise the risk structure of the debt portfolio structure, while simultaneously proceeding with a demand-driven issuance strategy focused on lowest possible borrowing costs (see, for example, Daube (2009, p 79)).

[11] See also Risbjerg and Holmlund (2005, p 41) and Bolder (2003, p 4). The UK DMO provides an insightful analysis of the Principles and Trade-Offs When Making Issuance Choices; see OECD (2011).

[12] However, we will also show that there are fundamental *differences* between sovereign liability management and asset management.

3. Technical conditions underlying the micro portfolio strategy

In order to identify the key technical assumptions associated with the current cost and risk framework of PDM, we will take a closer look at the underlying micro portfolio management strategy. In essence, a long-term debt management strategy is *broadly similar* to passive private investment or asset management strategies (based on the principles of portfolio theory for managing the risk/return relationship[13]). Instead of replicating a broad market bond index as in a passive asset management strategy, the approach used in strategic government debt management is to follow a predefined benchmark portfolio[14] (reflecting the long-term cost and risk preference) as closely as possible. The PDM strategy is characterised by risk-aversion and diversification, thereby mirroring the spirit of risk optimisation in passive bond portfolio strategies. This usually also involves the implementation of a buy-and-hold strategy.[15]

There are, however, also substantial differences between strategic government debt management and a private asset or investment management strategy. A PDM strategy:

(a) focuses on medium- to long-term borrowing costs vs short-term market value considerations of private asset or investment management;

(b) cannot maintain a risk-free position (a sovereign debt portfolio is always exposed to changes in interest rates[16] due to the need to undertake refinancing activities);

(c) requires the formulation of expectations about the evolution of interest rates (not implicit in current market prices) over a longer-term horizon.[17]

Consequently, DMOs need to tailor the analytical basis of passive private investment or asset management strategies to their specific situation. In short, DMOs use sophisticated portfolio and risk management techniques, in particular simulations of debt strategies based on a stochastic framework for the development of key risk measures (especially interest rates).[18]

Nevertheless, strategic debt management can to an important degree be considered as the mirror image of an extended or adapted form of passive portfolio management. For this reason, strategic PDM, firmly based on the principles of portfolio theory,[19] is primarily concerned with the micro-optimisation of the portfolio structure based on the cost (return)/risk

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[13] The principles of portfolio theory, introduced by Markowitz (1952, 1959), were further developed by Sharpe (1964), Lintner (1965) and Mossin (1966) in the Capital Asset Pricing Model (CAPM), which became the simplest standard for measuring risk and return.

[14] Most governments with well-developed financial markets establish strategic portfolio benchmarks to guide the long-term management of their debt portfolio (Jensen and Risbjerg (2005, pp 64 f) and IMF and World Bank (2001, p 129)).

[15] A passive investment strategy implies that active trading on market views will *not* take place. The counterpart of a "buy-and-hold" strategy in debt management can be viewed as holding debt to maturity, although these strategies might include (tactical) buy-back operations and the use of swaps (see, for example, Risbjerg and Holmlund (2005, p 50) and Jensen and Risbjerg (2005, p 64)).

[16] The possible implications of a more critical perception of sovereign risk by market participants and its impact on interest rates is excluded here. However, we come back to this particular point in section 4.2.

[17] It is not possible to define or formulate an optimal long-term financing strategy using only information implicit in current market prices, This feature substantially distinguishes debt management from passive investment or asset management strategies because the latter do not require the formulation of market expectations regarding the actual development of interest rates.

[18] For a comprehensive treatment of debt strategy simulations, see Risbjerg and Holmlund (2005). These authors discuss also the standard analytical framework for government debt and risk management.

[19] For a similar view, see Jensen and Risbjerg (2005, p 66).

relationship. We will use this insight to identify the key technical assumptions of the standard micro portfolio approach to PDM.

Portfolio theory is associated with the following core assumptions:[20]

- Core assumption 1: Rational financial decision makers that act as risk-averse expected utility (or wealth) maximisers.
- Core assumption 2: Perfect or efficient capital markets implying perfectly competitive markets[21] that are frictionless.[22]

Clearly, the first assumption can easily be applied to public sector decisions such as those relating to PDM since they are also concerned with the allocation of scarce resources, thereby rationally weighing costs against benefits.[23] However, the second assumption cannot so easily be justified in the public sector. Governments have considerable market power, especially in the market for government securities. This means that the price-taker assumption needs to be further scrutinised. We will return to this particular point in the next section.

In addition to these two core assumptions, there is another, specific feature of the standard micro portfolio approach to PDM. As noted, PDM treats the "primary budget balance" as exogenous since fiscal policy is functionally separated from PDM. This implies that the key optimisation parameters only refer to the outstanding debt portfolio. The OECD Borrowing Outlook[24] makes a policy distinction between *funding strategy and borrowing requirements*. The total central government marketable gross borrowing needs are calculated on the basis of budget deficits (the outcome of fiscal policy decisions that determine the primary borrowing needs) and redemptions. The funding strategy of DMOs entails decisions on how total borrowing needs are going to be financed using different instruments (eg long-term, short-term, nominal, indexed, etc) and distribution channels.

In sum, total borrowing requirements, and the associated funding strategy, are in part independently determined via the fiscal strategy of the government. In other words, they are in part exogenous for DMOs. For example, the funding strategy of DMOs may be informed by the central government's preferences to enhance fiscal resilience by seeking to mitigate refinancing and rollover risk.[25] However, in particular by treating the "primary budget balance" as exogenous, the standard micro portfolio approach to PDM implies that the interactions between the debt portfolio on the one hand, and the *budgetary position*[26] on the other, are irrelevant for the standard micro portfolio optimisation framework.

In conclusion, we have identified the following two (related) key technical assumptions that drive the optimality results of the standard micro portfolio approach to public liability management:

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[20] For a rigorous treatment of these assumptions, see Fama and Miller (1972), especially pp 189-214 (expected utility maximisation) and p 21 (notion of perfect or efficient capital markets).

[21] Where the prices of securities contain all available information while they are taken as given by buyers, sellers and issuers of securities.

[22] This in turn implies infinitely divisible securities, no transaction costs or taxes, while information is costless and available to everybody.

[23] See, for example, Fuguitt and Wilcox (1999, especially pp 35-42), who provide a comprehensive treatment of cost-benefit analysis for public sector decision makers.

[24] See OECD Sovereign Borrowing Outlook 2012.

[25] See Annex A of OECD Sovereign Borrowing Outlook 2012.

[26] The budgetary position encompasses all public expenditures and revenues minus the debt servicing payments, as measured by the primary budget balance (or *primary* borrowing requirements).

Technical assumption 1: the actions of the government (in particular planning and executing the funding strategy) have no impact on the market prices of government securities and the term structure of interest rates derived from them (price-taker assumption).

Technical assumption 2: the budgetary position and the debt portfolio are statistically independent from each other (zero dependency or correlation).

These two assumptions or conditions are related to each other and need to be satisfied in order for the micro portfolio approach to PDM to yield optimal cost-risk choices, as explained in detail in the annex of Blommestein and Hubig (2012). If they do not hold, decisions based on the associated cash-flow cost measures do *not* lead to the same result as decisions taken on the basis of present value (or market value) considerations derived from portfolio theory.

More specifically, our analysis implies that cost-risk optimality (in the portfolio theoretical sense) can only be achieved if we broaden the cost-risk perspective of the standard micro portfolio approach by including not only the cash flows associated with the debt portfolio itself, *but also those related to primary borrowing requirements*. In this way, a direct link is established between the debt portfolio (with its composition determined by the underlying funding strategy) and the government's capacity to service it via future budget surpluses. The main objective can then be formulated as *"to minimise the net burden of the debt portfolio"* (as measured by the present value of the net fiscal position[27]) given a desired level of risk, via the choice of the funding strategy of DMOs. This adjusted funding perspective corresponds to the "*minimisation of the effective interest costs*" associated with the government's net fiscal position.[28] Clearly, this total effective sovereign borrowing cost measure is broader than the standard borrowing cost measure[29] because, as explained, it also captures the (potential) impact of the DMO funding strategy on the primary borrowing requirements of the budgetary position over the planning horizon. This in turn implies that the standard micro portfolio approach represents a special case of a more general framework based on the total effective borrowing costs associated with the inter-temporal fiscal position.

4. Empirical validity of technical assumptions of the standard micro portfolio approach

After having identified the two key technical conditions supporting the standard micro portfolio approach, we will analyse in this section their empirical validity. To that end, two general situations will be explored. In *world situation one* (***World 1*** for short) we have in mind the "normal"[30] circumstances such as those that existed in the two decades or so prior to the

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[27] The *net fiscal position of the government* equals the net present value (NPV) of all cash flows. This means that we take into account the cash flows of both the existing and the planned or expected future sovereign debt portfolio and those associated with the primary borrowing requirements. Note that the portfolio of government liabilities does not only include the stock with already issued securities, but also those that will be issued in the future (ie over the "life time" of this portfolio). See for further details the annex in Blommestein and Hubig (2012).

[28] The mathematical derivation of this and also the standard cost measure is given in the annex of Blommestein and Hubig (2012).

[29] As noted, this is the measure associated with the standard micro portfolio approach (based on the cash flows of the debt portfolio itself).

[30] This statement is not as straightforward as it seems. It has been argued that these circumstances were "not normal" (therefore the use of expressions such as the Great Moderation) and that, indeed, they laid the basis for asset bubbles and macroeconomic imbalances that ultimately triggered the Great Crash (see Blommestein, Hoogduin and Peeters (2010); Blommestein (2010)). We will ignore this complication and simply assume that the two decades or so prior to the crisis represent the normal conditions for PDM.

2008-2009 crisis: low volatility and strong liquidity in financial markets (including government securities markets), primary dealers with strong balance sheets and excellent capacity to make markets, relatively low borrowing costs, moderate government borrowing requirements, low sovereign risk,[31] perfect or high asset substitutability across maturities, and low or moderate government debt levels. The first key question can then be formulated as follows: does the standard portfolio approach, with its criterion of "minimising the long-term borrowing costs subject to risk" (using the cash flows associated with the portfolio of existing and planned government liabilities), constitute an adequate basis for the sovereign debt and funding strategy in World 1? Special attention will be paid in this context to the practical implications for DMOs of the assumption of exogenous primary borrowing requirements.

World situation two (***World 2*** for short) represents crisis conditions, in particular serious fiscal vulnerabilities, a perceived increase in sovereign risk and considerable uncertainty about future interest rates. Another feature of the current crisis situation is the (potential) implications (for the underpinning of the standard micro portfolio approach) of new and complex interactions between PDM, fiscal policy, monetary policy and financial instability with (ultra-)high borrowing costs.

4.1 Evaluation of assumptions under normal (non-crisis) conditions (World 1)

The normal conditions of World 1 are characterised by low or moderate government deficits and debt levels (implying sustainable debt levels and perceptions of low sovereign risk) and well-functioning liquid debt markets with efficient access by DMOs to borrow funds at "normal" ("risk-free") costs. Under World 1 conditions public debt managers – although they (and central bankers) have potentially substantial market power – can be treated as price-takers. However, this presupposes a specific institutional set-up of DMOs and CBs. In many countries, the core of this institutional arrangement consists of institutionally independent CBs with strong anti-inflation mandates and operationally autonomous DMOs.

It was further assumed that potential policy conflicts between monetary policy and sovereign debt management could be avoided by following two "separability principles":[32]

CBs should not operate in the markets for long-dated government debt, but should limit their operations to the bills market.

Government debt managers should be guided by a micro portfolio approach based on cost minimisation mandates, while keeping the issuance of short-dated debt to a prudent level.

In World 1, these institutional arrangements and principles conveniently simplified the lives of policy makers in CBs and DMOs. More importantly, CBs and DMOs were judged as being fairly successful in executing their respective mandates. Moreover, they allowed each institution to be held accountable for their distinct mandates. And they provided considerable insulation from short-term political pressures. In such an environment, government debt managers do not (need to) mobilise their power to move markets. Instead, DMOs act as professional and fair market players (largely by following the market rules of private financial

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[31] We refer here to perceptions of low (or high) sovereign risk without going into the complications associated with the fact that there are quite different views on what exactly sovereign risk is (see Blommestein, Guzzo, Holland and Mu (2010)).

[32] See Blommestein and Turner (2012) for a comprehensive discussion.

institutions). In addition, the direct interactions between DMOs and CBs (setting monetary policy conditions and controlling interest rates[33]) are minimal.

Hence, in the non-crisis conditions of World 1, PDM activities can be expected to have a minimal impact on market prices (and, hence, on the yield curve derived from them). Moreover, given exogenous primary budget balances (known with certainty), the first technical precondition, that actions of the government have no impact on the yield curve, is certainly met in the standard micro portfolio approach. The dependence between technical conditions 1 and 2 implies that the second condition of zero correlation between the budgetary and the debt position is also valid.[34] Hence, in World 1, the standard portfolio approach minimises longer-term borrowing costs (being equivalent to minimising the net present value of the debt portfolio) and therefore provides in principle an appropriate basis for the sovereign funding strategy.

4.2 Evaluation of technical assumptions under crisis conditions (World 2)

The previous section shows that in normal circumstances the interactions between the budgetary and the debt positions are assumed to be negligible. This assumption is clearly not valid in crisis periods with highly volatile government securities markets with fiscal dominance periods and sovereign balance sheets very vulnerable to shocks. In that case, a sovereign asset-liability management approach becomes more important. Put differently, the more likely that the structure of the government debt portfolio may help in providing an effective protection of the sovereign balance sheet against possible shocks, the more important an integrated management of sovereign assets and liabilities becomes. Moreover, this approach[35] is closely related to (the macroeconomic objectives of) tax smoothing and budget stabilisation.[36] But even outside the framework of an integrated management of the balance sheet it has to be acknowledged that both the budget and sovereign debt position are basically driven by the same macroeconomic variables (inflation, GDP and economic growth). This perspective puts pressure on maintaining the zero-correlation assumption even in periods that cannot be classified as extreme crisis periods.[37]

World 2 conditions are associated with a structurally reshaped monetary, financial and fiscal environment, notably fiscal dominance characterised by high debt levels, a more critical perception of the underlying sovereign risk (leading to a weakening/loss of the risk-free rate assumption) and, associated with these features, greater uncertainty about the (future)

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[33] In World 1, short-dated and long-dated instruments are close substitutes and control of the overnight interest rate is sufficient for CBs to affect the near end of the yield curve (Blommestein and Turner (2012)).

[34] This feature follows directly from treating the primary borrowing requirements as an exogenous variable in the strategic framework for funding and debt management.

[35] Sovereign asset-liability management is concerned with the management of the overall risk exposure of the entire sovereign balance sheet, comprising financial assets (mainly tax-paying capacities) and financial liabilities (government debt portfolio). See also Risbjerg and Holmlund (2005, pp 42 f) and Blommestein and Koc (2008).

[36] These theories are focused on lowering the variability of the budget balance, thereby avoiding fluctuations in tax rates in response to economic developments. Such a policy framework is welfare-improving because changes in tax rates may create economic distortions. See the early contributions by Barro (1979) and Missale (1997). More recent contributions include Missale (2011), Faraglia et al (2008, 2010), Lustig et al (2008), Nosbusch (2008), Bacchiocchi and Missale (2005), Buera and Nicolini (2004), Barro (2003), Angeletos (2002).

[37] Nevertheless, treating the primary budget balance as an exogenous variable known with certainty may be a good starting point for debt strategy simulations under fairly normal market conditions. As noted by Risbjerg und Holmlund (2005, p 48), a general lesson from building simulation models is to start out simple and gradually expand the model (eg allowing for the stochastic modelling of the budget balance). Such an approach, however, is certainly not appropriate in World 2.

development of interest rates. In World 2, the actions of government debt managers may become a critical element in the overall conduct of macroeconomic policy.[38] For these reasons we will take a closer look at how World 2 conditions might affect the key technical assumptions underlying the standard micro portfolio approach.

First, the price-taker assumption is unlikely to hold in World 2, although price-making may not be the intention of debt managers. However, under less liquid and highly volatile market conditions, market operations by the DMO (a very large player vis-à-vis the market) may lead to *de facto* shifts in markets.[39] Moreover, strategic decisions (in particular about the portion of short-term vs long-term borrowing amounts) may also have a significant impact on relative market prices of government securities and, as a result, influence the shape of the yield curve. This also applies to debt levels having reached a critical limit (eg 90% of GDP and above[40]), which could put upward pressure on interest rates (due to increased supply and crowding-out effects) and downward pressure on economic growth.

In such an environment – and in spite of the separation of mandates – PDM and monetary policy may start to have a direct influence on each other.[41] The main reasons are decreased substitutability along the yield curve and the existence of illiquid and dysfunctional market segments, which may hamper the monetary transmission process. As a consequence, the CB's use of the overnight rate to control the shape of the yield curve in order to influence economic activity becomes less effective.[42] At the same time, purchases and sales of government bonds by CBs become more effective. However, by shifting their emphasis from the short end to the longer-term segment of the yield curve, the monetary authorities inevitably interact directly with government debt management decisions. These operations also change the maturity of government bonds in the hands of the public.[43] DMOs (and the fiscal authorities) therefore need to have greater awareness that their operations may also affect economic activity through new and at times complex interdependencies with monetary policy measures.[44]

Finally, the perception that sovereign risk has increased and the associated weakening of the "safe (or risk-free) asset" assumption has resulted at times in a significant credit risk premium implicit in the yield curve for government securities. Through this new channel, actual and expected changes in sovereign liabilities (or changes in fiscal policy) can directly affect the term structure of interest rates. This may also entail contagion to third countries, in particular

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[38] This is the reason why several authors suggest a revision of the conventional or standard micro portfolio approach, including Hoogduin et al (2010), Surti et al (2010), Goodhart (2010) and Blommestein and Turner (2012).

[39] Also the accumulated (borrowing) effects of DMOs are likely to contribute to at times significant market moves.

[40] Based on an empirical study, incorporating data on 44 countries and covering the time period 1946 to 2009, Reinhart and Rogoff (2010, p 577) demonstrate that across both advanced countries and emerging markets, high debt/GDP levels (90% and above) are associated with considerably lower growth. See also the more recent BIS study by Cecchetti et al (2011).

[41] See section 3 of Blommestein and Turner (2012) and also Hoogduin et al (2010, pp 15-17) for additional detail.

[42] For the same reasons, PDM operations become more effective. In this context, the increasing use of short-term borrowing by government debt managers to secure additional funding during the global financial crisis is viewed critically. See, for example, section 8 of Blommestein and Turner (2012) and Hoogduin et al (2010, p 2). Short-term issuance has the same effect as monetary expansion, and therefore might complicate the control of the policy rate by the monetary authorities.

[43] As argued by Turner (2011, pp 5 f).

[44] See section 9 of Blommestein and Turner (2012).

among countries within a monetary union.[45] Furthermore, changes in perceptions about sovereign risk may be transferred to the holders of the government debt within and across borders (in particular by affecting the balance sheets of financial institutions[46]).

This implies that the interactions between the debt portfolio and the budgetary position need to be incorporated in the analytical framework of PDM. Put differently, the second technical assumption needs to be dropped. The previously described link between fiscal policy (reflected in the primary budget balance) and the development of interest rates needs to be taken into consideration within the simulation framework of the debt strategy (for example, via specific macroeconomic/fiscal scenarios). Moreover, high debt levels (eg above the critical level of 90%) directly feed back into the government's fiscal position due to increasing debt servicing costs. In extreme cases, this chain of events may lead to a negative debt-deficit spiral. To prevent these negative feedback situations, the government needs to maintain control over the risks associated with the entire balance sheet. This can be accomplished by using a sovereign asset-liability management approach, because, as noted, in this way policies can be identified to insulate the fiscal position in part or fully against supply and demand shocks.

In sum, the two key technical assumptions underpinning the standard micro portfolio approach to PDM do not hold in World 2. Micro-optimisation of cost and risk using the standard approach would result in funding decisions that are suboptimal. We believe that the following World 2 conditions will remain in force for a considerable period of time: (a) high debt ratios, (b) perceptions of elevated sovereign risk levels, and related to this, (c) greater uncertainty about future interest rates, accompanied by critical interactions between PDM and monetary policy.

5. Concluding remarks

Although the standard micro portfolio approach to PDM has worked well for a long time, rapidly changing conditions associated with the current period of fiscal dominance has prompted a major re-think of the underlying framework. Our paper draws the following main conclusions:

(a) The widespread use of the standard micro portfolio approach is associated with government debt management having become a distinct discipline, operationally independent, and guided by transparent micro-economic principles and rules, which seeks to ensure that the government is able to secure the required funding at the lowest possible costs subject to a preferred or acceptable level of risk. The standard approach is well-anchored in the principles of portfolio theory.

(b) The underlying core objective to "minimise longer-term (cash-flow based) borrowing costs at an acceptable level of risk" leads to optimal financing decisions, provided the following two key technical assumptions hold:

1. Actions by the government (including the execution of its borrowing and funding programme) have no impact on market prices of government securities and the term structure of interest rates derived from them (price-taker assumption); and

[45] For example, rating changes in country X may have a systemic impact on other countries, even when the latter countries are not formally downgraded; for example, in the form of higher funding rates.

[46] See also Hoogduin et al (2010, pp 14 f).

2. The budgetary and debt positions are statistically independent from each other (zero dependence or correlation).

(c) The identification of these two key technical assumptions allows us to make a distinction between:

World 1: Normal (non-crisis) period. Minimising standard cost measures (ie cash flows based on the borrowing costs of the sovereign liability portfolio as in the standard micro portfolio approach) yields optimal results.

World 2: Crisis period (fiscal dominance). Minimising standard cost measures leads to suboptimal results. More specifically, violations of assumptions 1 and 2 are caused by critical public debt ratios, perceptions that the risk-free asset condition has been weakened as well as imperfect substitutability along the yield curve. Especially the weakening and (partial) loss of the risk-free asset condition has profound implications. In response, our suggestion is to minimise a broader cost measure so as to achieve optimal results during crisis periods.

What are the practical implications of these conclusions for PDM? The answer is less straightforward than one would perhaps think. On the one hand, it can be noted that the standard borrowing cost measure can be directly influenced by the debt manager through the choice of the funding strategy. On the other hand, we have shown that when World 2 conditions determine the borrowing environment, then we may need a broader cost objective for ensuring optimal funding decisions.[47] However, the adoption of a broader borrowing framework may also have implications for the current institutional set-up. Clearly, the pros and cons of any institutional change need to be carefully examined so as to avoid implementation decisions that may carry too much risk. We will assess these institutional issues in follow-up research.

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[47] It was also shown that the cost-risk objective of the standard micro portfolio approach is nested within this broader borrowing framework that uses a cost concept that ensures optimal funding decisions in World 2.

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Sovereign debt management and fiscal vulnerabilities

Alessandro Missale[1]

Abstract

A wide consensus has emerged on the role of debt management in reducing fiscal vulnerability by providing insurance against macroeconomic shocks to the government budget. Whether this goal is better accomplished by nominal or inflation-indexed debt, by a short or a long maturity structure, remains however controversial. In this paper we review the issues of indexation and debt maturity, discussing in particular the role of the maturity structure in light of integrated financial markets and the risk of default. We argue that the role of inflation-indexed debt as a hedge against demand and inflation shocks is less important when price stability is ensured by a Ricardian fiscal policy and an independent central bank. A strong case can instead be made for a long maturity structure to reduce interest-rate risk and, more importantly, the risk of default. The maturity of the debt is a key variable to assess the vulnerability of the government fiscal position and should deserve greater attention in debt sustainability analysis. Finally, we compare the theory of fiscal insurance to the debt managers' practice of minimizing the cost and risk of the interest expenditure. A concern for the cost of debt service is justified only if expected return differentials between debt instruments are determined by mispricing, market imperfections or liquidity, but not if higher risk premia reflect a fair price for insurance. Our analysis points to the danger of minimizing the interest expenditure over a short horizon as may happen in times of crisis, when the government strives to achieve budget balance. More generally, fiscal insurance cannot be evaluated using national accounts figures, such as the interest expenditure and the book value of the debt. The lack of a more theory-based accounting framework is indeed a major obstacle to optimal debt management.

Keywords: Debt management, default risk, inflation-indexed debt, maturity structure, interest-rate risk, optimal taxation

JEL classification: E61, G12, H63

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[1] Alessandro Missale, DEAS, Università degli Studi di Milano, Via Conservatorio 7, 20122 Milano, Italy. Tel. +39250321512, Fax +39250321505. E-mail: alessandro.missale@unimi.it

1. Introduction

How should the debt be managed? Twenty years ago, the literature on debt management was small, made of few, important but unrelated contributions.[2] Certainly, there was no unique answer to what the objectives of debt management should be.

A wide consensus has now emerged on the role of debt management in reducing fiscal vulnerability by providing insurance against macroeconomic shocks to the government budget. The debt should be managed to make the fiscal position resilient to shocks and thus avoid the risk of having to adjust tax rates or cut government programmes (Bohn 1988, 1990, Missale 1997, 1999).

Faraglia, Marcet and Scott (2008) have named this approach "the fiscal insurance theory" of debt management. While this approach is not new, as it is rooted in the optimal taxation theory, fiscal insurance is a better term to encompass the potential goals of debt management. Indeed, as called for by optimal taxation, a debt structure that provides a hedge against shocks to the budget allows policy makers to minimize variations in tax rates and thus the welfare losses of tax distortions. But, the insurance that the debt structure can offer is not only valuable for tax smoothing; it helps achieve other important objectives of fiscal policy. For instance, by stabilizing the debt-to-GDP ratio, fiscal insurance enhances debt sustainability (Lloyd-Ellis and Zhu 2001, Borenzstein and Mauro 2004, Giavazzi and Missale 2005). The immunizing debt structure also works as an automatic stabilizer: it avoids higher tax rates in bad times, thus preventing taxation from being pro-cyclical, consistent with the Keynesian view of fiscal policy. Finally, as insurance is provided by debt holders to taxpayers, the debt-tax scheme implements an allocation of risk that appears desirable in that debt holders are in a better position to withstand risk, if anything because taxes are compulsory while debt holdings are voluntary (Missale 1999).

It is then clear that debt management is crucial for fiscal policy to attain important macroeconomic objectives and thus cannot be confined to portfolio optimization, which is often the focus of Debt Management Offices. Indeed, according to the theory of fiscal insurance, debt management is inseparable from fiscal policy in that the debt structure affects the distribution of tax rates over time and across states of nature.

Although the optimal taxation literature has increasingly focused on the role of debt maturity in real economies where governments are able to commit to a sustainable path of future taxes, earlier studies dealing with the time inconsistency of taxation also addressed the interaction between debt management and monetary policy. In a closed economy without capital, Lucas and Stokey (1983) showed that – without a proper maturity structure – intertemporal tax changes, by altering the equilibrium allocation of consumption, could affect real interest rates and thus the value of the debt. They also showed that, in a monetary economy, the inability to commit to a future tax plan even prevents the government from issuing nominal debt because of the incentive to wipe out its real value with a price level jump so as to dispose of distortionary taxation. The sustainability of fiscal policy, ie the government's ability to commit to a credible path of future surpluses, is indeed crucial for monetary policy to control inflation and nominal interest rates. As emphasized by the "fiscal theory of the price level", if fiscal policy is Non-Ricardian, the price level and nominal interest rates are determined by the expected primary surpluses, the level of nominal debt (Leeper 1991, Woodford 1994, 1995) and its maturity structure (Cochrane 2001).

The denomination and maturity of public debt may also alter the incentives faced by the monetary authority. Because of inflationary temptations, domestic currency -nominal- debt

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[2] Earlier contributions include Tobin (1963), Fischer (1983), Lucas and Stokey (1983), Bohn (1988) and are surveyed in Missale (1997).

may lead to inflationary expectations and thus higher nominal interest rates as first shown by Calvo (1988). Then, foreign currency debt or short maturities are needed to restore the credibility of the anti-inflationary policy (Missale and Blanchard 1994).

The time-consistency literature has provided the theoretical underpinning for the decision to delegate monetary policy to independent central banks with a clear mandate for price stability since the mid-1980s in advanced economies and, more recently, in emerging countries. The effective independence of monetary policy was then supported by pledges of fiscal responsibility, as witnessed by the adoption of fiscal rules in many countries. In turn, central bank independence was instrumental in shifting the debt composition to domestic currency fixed-rate debt and lengthening its maturity structure as shown by Falcetti and Missale (2002).

The separation of debt management from monetary policy was also favoured by the removal of capital controls and financial liberalization. As interest rates had been determined in internationally integrated financial markets with no role, if any before, for changes in the relative supply of domestic securities, the coordination of debt management and monetary policy was considered not an issue anymore.

The separation of debt management from monetary policy worked well and remained undisputed until the global financial crisis, when we entered a new era of fiscal dominance as argued by Turner (2011) and Blommestein and Turner (2012).

Research on debt management over the last decade has been influenced by monetary policy independence (and its ability to control inflation) in that the optimal debt composition for fiscal insurance has been investigated within real economies (with no distinction between real and nominal bonds) under sustainable debt paths guaranteed by the assumption of debt limits or expected primary surpluses satisfying the No-Ponzi game condition. On the other hand, financial integration and the increasing importance of global factors in determining long-term interest rates have not been accounted for by models that remained focused on closed economies. Another serious obstacle for the implementation of fiscal insurance is that economic theory and practical policy refer to different concepts. Indeed, theory and policy speak different languages: while the former focuses on the market value of the debt and rates of return, policy makers are concerned with national accounting figures; the book value of the debt and the interest payments (Hall and Sargent 2011).

It is then not surprising that the fiscal insurance approach still offers a limited guidance to policy makers. Based on sound economic principles, fiscal insurance provides general prescriptions but offers no precise indication regarding the type of bonds to be issued and their maturity. While the benefits of fiscal insurance are undisputed, whether this goal is better accomplished by nominal or inflation-indexed debt, by a short or a long maturity structure, remains controversial.

In the first part of this paper we review the issues of price indexation and debt maturity, discussing in particular the choice of the maturity structure in light of integrated financial markets and the risk of default. We argue that the role of inflation-indexed debt as a hedge against demand shocks or inflation shocks loses much of its importance if price stability is ensured by a Ricardian fiscal policy and an independent central bank. A strong case for long maturity debt can instead be made to reduce interest-rate risk and, more importantly, the risk of default when a Non-Ricardian policy regime is entered into due to a sudden shift in expectations driven by market sentiment.

In the second part of the paper, we relate the fiscal insurance theory to policy practice, discuss their different objectives and examine whether they can be reconciled. In particular, we compare the policy implications from fiscal insurance with the debt managers' practice of minimizing the cost and risk of the interest expenditure. We find that a trade-off between cost and risk emerges only if expected return differentials are determined by mispricing, market imperfections and liquidity, but not when higher risk premia reflect a fair price for insurance. Our analysis points to the danger of minimizing the costs and risks of the interest expenditure over a short time horizon. The excessive role played by current deficits in the evaluation of fiscal performance and in fiscal rules may lead to suboptimal debt strategies in times of crisis, when the government strives to achieve budget balance. Fiscal insurance cannot be evaluated on the basis of national accounts figures, such as the interest expenditure and the book value of the debt. The lack of a more theory-based accounting framework is indeed a major obstacle to optimal debt management.

The paper is organized as follows. After this Introduction, Section 2 deals with the absence of explicitly contingent debt. Section 3 reviews the main arguments for and against inflation-indexed debt. Section 4 investigates the role of debt maturity in providing insurance against macroeconomic shocks and the risk of default. Section 5 examines how the debt is managed in practice and whether it is managed in a way consistent with fiscal insurance. Section 6 concludes.

2. The fiscal insurance theory of debt management

A wide consensus has emerged on the role of debt management in reducing fiscal vulnerability by providing insurance against macroeconomic shocks affecting the government budget. The idea of fiscal insurance is innate in the theory of optimal taxation, in that a debt structure that provides a hedge against macroeconomic shocks to the budget can support a relatively constant tax rate over time and across states of nature. "Tax smoothing" is desirable because it allows policy makers to reduce the welfare losses from tax distortions under realistic assumptions about the elasticity of labour supply and other tax bases (Chari, Christiano and Kehoe 1994).

To reduce fiscal vulnerability, and thus the risk of having to adjust tax rates or cut spending programmes, the government should issue debt instruments with returns that covary negatively with government consumption and positively with the tax base, say, output and aggregate consumption. As first shown by Lucas and Stokey (1983), with complete markets this can be accomplished by issuing debt instruments that are explicitly contingent on the shocks affecting the government budget, for instance by issuing debt negatively indexed to expenditure shocks and/or positively indexed to output (Shiller 1993, Barro 1995, Borenzstein and Mauro 2004).

2.1 Explicitly contingent debt: why does it not exist?

Economic recessions and government spending shocks due, for example, to natural disasters are main sources of fiscal vulnerability. The lack of insurance against such events is, at first glance, puzzling. Why do governments not issue bonds explicitly contingent on their spending or GDP? Moral hazard is the obvious answer for the absence of spending indexation (Bohn 1990, Calvo and Guidotti 1990). The lack of GDP-indexed bonds cannot instead be explained by adverse incentive effects, and deserves further discussion.[3]

Issuance of GDP-indexed bonds runs into various difficulties. A first problem is the delay with which estimates of GDP become available and their later, sometimes substantial, revisions. A second problem regards the complexity of the instrument that makes its pricing a difficult business. When liquidity is added to the list, it becomes immediately evident why governments have not even considered the introduction of such bonds. In fact, the cost of innovating might be substantial. Among the few experiments with GDP indexation it is worth

[3] GDP-indexed bonds have been advocated, among others, by Shiller (1993), Borenzstein and Mauro (2004), Griffith-Jones and Sharma (2006), Kamstra and Shiller (2010).

recalling the offer of GDP warrants on the restructured Argentine debt in 2005. Since the warrant was barely valued at the time of issuance, while GDP growth turned out strong in the following years, sizeable losses were experienced by the Argentine government. However, illiquidity and unconventionality (on which pricing problems depend) could just be an equilibrium phenomenon that a strong move toward real indexation could possibly overcome. This suggests that GDP indexation should attract more attention from researchers and debt managers.

3. Fiscal insurance: nominal versus inflation-indexed debt

A main result in the literature on debt management is that explicitly contingent securities are not needed for fiscal insurance (Bohn 1988, 1990). When markets are incomplete and the government has only conventional debt at its disposal, tax adjustments can be averted by issuing securities that offer low returns in bad states of nature, when output is lower and government consumption higher than expected.

Nominal bonds, being implicitly contingent on the realization of the price level, can provide insurance against shocks that lead to a negative correlation between unexpected inflation and output or to a positive correlation between unexpected inflation and government consumption; that is, when inflation covaries positively with government financing needs.

Whether inflation-indexed or conventional debt provides the best hedge against budget risk thus depends on the types of shocks hitting the economy, in particular on whether supply or demand shocks are expected to prevail. For instance, inflation-indexed bonds provide insurance against negative demand shocks but amplify the budget costs of negative supply shocks.[4] Unfortunately, empirical research may offer limited guidance as to the choice of nominal versus inflation-indexed debt as the optimal mix appears to depend on the countries and time periods considered.[5] More important, nothing guarantees that the same shocks that occurred in the past will repeat in the future.

The lack of knowledge about the type of shocks affecting the economy suggests portfolio diversification as an argument for issuing “some” inflation-indexed debt. On the other hand, cost considerations may favour conventional debt. In fact, the positive differential between expected and “break-even inflation” that is often observed especially at the start of indexation programmes suggests that indexed bonds pay a sizeable premium over nominal bonds.[6] Sack and Elsasser (2004) find that the US Treasury paid interest on TIPs of about 20 basis points higher than on conventional bonds.[7] According to TBAC (2008), the estimated cumulative losses on inflation-indexed debt reached 30 billion dollars over the first ten years of the programme.

If a premium is required to compensate investors for the lower liquidity of indexed bonds (and illiquidity is not just a temporary phenomenon due to the low volume of bonds outstanding),

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4 Furthermore, inflation-indexed debt immunizes the government budget from inflation shocks unrelated to fiscal variables (Barro 2003), whereas nominal debt provides insurance against government consumption shocks that lead to higher inflation (Siu 2004, Lustig, Sleet and Yeltekin 2008).

5 See eg Bohn (1990), Missale (1997b, 1999), Bacchiocchi and Missale (2005), Giavazzi and Missale (2005), Berndt, Lustig and Yeltekin (2010).

6 See eg Shen and Corning (2001), Sack and Elsasser (2004), Sagnes and Coeuré (2005), Campbell, Shiller and Viceira (2009).

7 On the opposite side, Garcia and van Rixtel (2007) estimate that interest savings in the UK and France on inflation-indexed bonds were about 45 basis points in the period 2004–06.

then expected cost minimization can play a role as relevant as fiscal insurance for the choice of indexation (see Section 5.1). It is however clear that the case for conventional debt cannot be made by simply looking at the ex-post interest costs of indexation programmes because ex-post gains and losses could be temporary and, when taken alone, have little to say about insurance effects (Dudley, Roush and Steinberg 2009). For instance, higher payments on inflation-indexed bonds would be perfectly consistent with fiscal insurance if they occurred at times of sustained output growth. In fact, in the wake of the global financial crisis and the ensuing deflation, indexed bonds have proved to be a valuable hedge against output contraction (TBAC 2009). Figure 1 shows the gains obtained by the US Treasury on the 5-year TIP note issued in April 2007. Not only realized inflation over the period turned out to be lower than break-even inflation, but price indexation also provided a useful hedge against output fluctuations, as made clear by the positive correlation between inflation and real GDP growth.

Figure 1

US 5-year TIP maturing Apr 2012

Whether governments should issue nominal or inflation-indexed bonds remains controversial. While there are no compelling arguments against indexed bonds, there are no strong arguments for issuing them either. No doubt, the advent of independent central banks able to control inflation has reduced the importance of inflation-indexed bonds as a hedge against unexpected inflation and demand shocks. In particular, the classical argument for inflation-indexed bonds as an instrument for protecting the real value of the debt against inflation shocks unrelated to other variables (Barro 2003) has lost much of its appeal in stable inflation environments where fiscal policy is Ricardian and price stability is ensured by the central bank.

Then, one may wonder why inflation-indexed bonds have been issued in countries like France, Greece, Germany and Italy only after they delegated their monetary policy to the ECB, and, less recently, in countries with inflation targeting regimes like Canada, the UK and Sweden. Among possible explanations, two are worth considering. The first is that governments care about the risk of inflation; they want to avoid the additional burden of indexation at times of high inflation and may issue nominal debt to build a constituency against inflation and prevent indexation from spreading to wages, pensions, etc. (Pecchi and Piga 1999). Then, an independent central bank solves these problems. The second explanation is that nominal debt offers an implicit insurance against the realization of extremely bad events: it can be inflated away in emergencies like wars (Fischer 1983) or its real value may adjust as the price level rises to equilibrate the intertemporal budget constraint (Cochrane 2001 and references therein). When fiscal policy is Ricardian and the central bank controls inflation this option is lost and so is the benefit of nominal debt.

4. Fiscal insurance: the role of debt maturity

When markets are incomplete and the government has only conventional debt at its disposal, it can choose the maturity of the debt to make its value contingent on the term structure of interest rates. Angeletos (2002) and Buera and Nicolini (2004) show that, in a real economy without capital where government consumption is uncertain, a sufficiently rich maturity structure of real bonds can support the same distribution of tax rates as that obtained in a complete market economy. Although, as shown by Faraglia, Marcet and Scott (2010), these results cannot be generalized to more complex stochastic structures, they are nevertheless suggestive of the insurance that conventional debt can provide.

The idea is that the value of a bond (and thus its return), being implicitly contingent on the realization of the interest rate of the corresponding maturity, can provide insurance against budget risk. In particular, shocks that adversely affect the budget and raise long-term interest rates can be hedged by a fall in the market value of long maturity debt. If instead the same shocks led to a fall in long-term rates, they could be hedged by a long position in long-term debt funded with short-term debt.

To gain further insight into the fiscal insurance role of the maturity structure it is useful to look at the government's intertemporal budget constraint. Let us restrict our attention to the case where the government issues only inflation-indexed bonds with different maturities; that is, claims on future consumption. Then, defining with $B_{t-1}(t+j)$ the obligations (principal redemptions and coupons) implied by the bonds outstanding at the end of time $t-1$ to be paid at maturity time $t+j$ (with $j=0,...,M-1$), the intertemporal budget constraint (in real terms) can be written as:

$$B_{t-1}(t)+\sum_{j=1}^{M-1} q_t(t+j)B_{t-1}(t+j)=S_t+\sum_{j=1}^{\infty} E_t\left[m_t(t+j)S_{t+j}\right] \tag{1}$$

where E_t denotes expectations conditional on information at time t, S_t is the primary surplus and $m_t(t+j)\equiv \beta^j u'(c_{t+j})/u'(c_t)$ is the marginal rate of substitution between consumption in period t and $t+j$.[8] Finally, $q_t(t+j)$ are the prices, at time t, of real zero-coupon bonds maturing in period $t+j$; ie they are the prices associated with the term structure of real spot interest rates.

Using the Euler equation $q_t(t+j)=E_t m_t(t+j)$, from consumer maximization, the intertemporal budget constraint can be written as:

[8] See Angeletos (2002) for a derivation. To save on notation the dependence of primary surpluses and consumption on the history of events is not made explicit.

$$B_{t-1}(t)+\sum_{j=1}^{M-1} q_t(t+j)B_{t-1}(t+j)=S_t+\sum_{j=1}^{\infty} q_t(t+j)E_tS_{t+j}+\sum_{s=1}^{\infty} Cov_t\left[m_t(t+j);S_{t+j}\right] \quad (2)$$

where Cov_t denotes the covariance conditional on information at time t.

Equation (2) shows that a long maturity structure makes the market value of the debt sensitive to interest-rate changes. If negative shocks to current and future primary surpluses lead to higher interest rates, the value of long maturity debt falls and this reduces the need for fiscal adjustment.

4.1 Government consumption shocks

A long maturity debt structure provides fiscal insurance against macroeconomic shocks that induce a positive covariance between interest rates and government financing needs. For instance, government consumption shocks that lead to an upward shift in the term structure of interest rates can be hedged by a fall in the market value of long-term debt (Angeletos 2002, Barro 2003, Buera and Nicolini 2004, Lustig, Sleet and Yeltekin 2008).

This does not mean that the increase in interest rates is beneficial. Higher rates do worsen the fiscal position, as they reduce the present value of future surpluses above the direct effect of government consumption, but a long maturity structure minimizes their impact; the longer the maturity, the lower the deterioration in the fiscal position and thus the necessary correction. The government's holding of a short maturity asset, ie $B_{t-1}(t)<0$, can further improve the hedging performance of the government portfolio, as in the example of Angeletos (2002). Furthermore, insurance is enhanced by long-term nominal debt to the extent that fiscal shocks lead to contemporaneous or expected future inflation (and thus higher long-term interest rates) as in Lustig, Sleet and Yeltekin (2008).

How relevant is this argument for long maturity debt? Empirical evidence on the impact of government spending, and more generally of budget deficits, on interest rates casts serious doubts on the importance of this channel. Indeed, the evidence is mixed and, even when the effect of spending on interest rates appears significant, such effect is estimated to be small, around a few basis points (Ardagna, Caselli and Lane 2007, Laubach 2009). As suggested by their strong international comovements, long-term interest rates appear to be mainly driven by international risk factors (Codogno, Favero and Missale 2003) and/or global fiscal trends (Dell'Erba and Sola 2011).

4.2 Output shocks

The maturity structure can also provide insurance against shocks that affect output and tax revenues to the extent that such shocks lead to changes in interest rates. Finding the maturity structure that provides the best hedge against such shocks is however a difficult task because the covariance between output and interest rates may vary with the source of output fluctuations.

For instance, productivity shocks are best hedged by short maturity debt because negative shocks that reduce output and revenues also decrease interest rates and thus lead to higher returns on long-term debt (Faraglia, Marcet and Scott 2010).[9] The same is true for prolonged recessions that are accompanied by an easing of monetary policy. On the other hand, supply shocks due to rising wages or energy prices are best hedged by long maturity debt especially

[9] Put another way, when productivity and output are lower than expected, a short maturity structure allows policy makers to roll over the debt at low interest rates thus reducing the need for tax adjustments.

if the resulting inflation is countered by higher real interest rates. In fact, the impact of monetary policy rates on output is another argument for a long maturity structure. Bacchiocchi and Missale (2005) show that long maturity debt is optimal in a model where the central bank is able to fully stabilize demand shocks but has to induce an output contraction to counter inflation from supply shocks.

As the covariance between output and interest rates depends on the source of variations, on whether supply or demand shocks prevail, and on the monetary policy reaction to such shocks, little can be said on whether a long or a short maturity debt structure should be in place.

4.3 Interest-rate shocks

As the relation between interest rates and fiscal variables is either weak or depends on the types of shocks hitting the economy, characterizing the optimal maturity structure seems a frustrating exercise. However, to the extent that interest rates are mainly driven by international factors, say, global fiscal trends and "risk appetite" or risk awareness (and are thus unrelated to domestic fiscal variables), long maturity debt is optimal. A long maturity structure immunizes the government budget from pure interest-rate risk, ie from interest-rate shocks that are independent of domestic fiscal variables and thus primary surpluses.

If we assume that the covariance term in equation (2) is, to a first approximation, negligible (and debt obligations are honoured with certainty), then it is easy to see that the budget can be insured against interest-rate risk, ie against shocks to the term structure $q_t\left(t+j\right)$, by structuring the debt so that maturing liabilities match current and future primary surpluses (Barro 1995, 2003). If perfect matching were possible, no new debt would be expected to be issued, and the government budget would be immune from interest-rate shocks. However, since in the real world the maturity of the debt is typically shorter than the maturity of primary surpluses – ie $B_{t-1}\left(t\right)>S_t$ – the government budget is exposed to interest-rate (or refinancing) risk. Any unanticipated increase in interest rates would require an increase in taxes (or a reduction of government spending) to satisfy the intertemporal budget constraint. The necessary revision in tax rates is however lower the longer the maturity of the debt. This is because the fall in the present value of future surpluses due to an increase in interest rates is partially hedged by a fall in the market value of the debt and such insurance effect increases with debt duration. Therefore, a long maturity structure is needed to hedge against interest-rate risk and maintain a stable tax rate.[10]

4.4 The risk of default

A strong case for long maturity debt also emerges when a Non-Ricardian policy regime is entered into either because fiscal policy becomes unsustainable or is perceived as such due to a sudden shift in market sentiment. The consideration of debt crises triggered by a revision in economic growth, fiscal fundamentals or a sudden change in investors' confidence suggests that the risk of default should be a main concern of debt management. Debt crises also provide a clear instance in which the maturity structure of the debt affects expectations and interest rates thus interacting with monetary policy, adding to the cases considered in Turner (2011) and Blommestein and Turner (2012).

[10] A relatively shorter maturity structure would be consistent with budget insurance only if interest-rate shocks led to opposite movements in short- and long-term interest rates producing an inversion of the term structure.

A long maturity structure is the best insurance against the risk of default because debt crisis episodes are characterized by a fall in expected primary surpluses and a sharp increase in interest rates driven by the emergence of sizeable default-risk premia. Long-term debt is then a natural hedge against a sudden change in expectations because its market value falls when default-risk premia rise as a result of weak fiscal fundamentals or a shift in market sentiment.

This is not a new result; it has long been known that a long maturity structure enhances debt sustainability as it minimizes the risk of having to roll over a large share of debt when interest rates are too high or market access is denied (Calvo 1988, Alesina, Prati and Tabellini 1990). However, looking at the intertemporal budget constraint offers new insight into the role of debt maturity.

The maturity structure that reduces the risk of default can be characterized by looking at the government's intertemporal budget constraint (1) modified to consider the possibility that debt obligations may not be repaid:

$$B_{t-1}(t)+\sum_{j=1}^{M-1} q_t^*(t+j)B_{t-1}(t+j)=S_t+\sum_{j=1}^{\infty} E_t\left[m_t(t+j)S_{t+j}\right] \tag{3}$$

where a "star" on bond prices emphasizes that $q_t^*(t+j)$ are lower than the prices of "safe" claims on future consumption, $q_t(t+j)$, as the former discount the possibility that debt commitments will not be honoured in full.

Equation (3) shows that a downward revision in the expected path of future surpluses leads to a fall in the market value of the debt as bond prices, $q_t^*(t+j)$, decline due to the emergence of a default-risk component in interest rates. Since the unconditional probability of a default occurring at any future date increases with the horizon considered, the price of bonds falls more the longer their maturity, j. As the impact of the probability of default on the value of the debt increases with its duration, the longer the maturity of the debt the lower the default-risk premium that is needed to match the fall in the expected value of future primary surpluses.[11] Therefore, a long (and balanced) maturity structure minimizes the risk of default that the market prices in interest rates. As debt maturity is critical for debt sustainability, it should be considered as important as other fiscal fundamentals.

4.5 Nominal versus inflation-indexed debt

The policy implications of fiscal insurance for the maturity structure are usually derived from models where all variables are in real terms and government bonds are claims to future consumption, ie they are indexed to the price level. This raises the issue of whether, and under what conditions, these results extend to the case that the government issues fixed-rate nominal bonds.[12] In fact, nominal bonds are still the predominant financing instrument despite the rapidly increasing market in inflation-indexed bonds and thus the relevant case to consider.

Lustig, Sleet and Yeltekin (2008) show that when the government only issues non-contingent nominal debt, long-term nominal debt provides insurance against fiscal shocks that induce costly contemporaneous or expected future inflation and thus higher long-term interest rates.

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[11] The discussion is purposely informal. See Cochrane (2001) for a similar role of nominal-debt maturity in stabilizing expected inflation in a model where expected inflation plays the same role as the default-risk premium in devaluing long maturity debt following shocks to the present value of primary surpluses.

[12] Cochrane (2001) examines the case of nominal bonds but assumes constant real interest rates.

More generally, Bernaschi, Missale and Vergni (2009) find that a long maturity structure of nominal debt is optimal when the nominal term structure moves in the same direction as the term structure of real rates, as is the case in a stable inflation environment.

Consider the intertemporal budget constraint with nominal debt. While the market value of nominal debt varies with nominal interest rates, the present discounted value of primary surpluses (being naturally indexed to the price level)[13] depends on the marginal rates of substitution between consumption at different dates and thus, to a first approximation, on real interest rates (see equation (2)).[14] Hence, whether long-term nominal debt provides a hedge against variations in the present value of primary surpluses induced by shocks to real interest rates depends on the relation between the term structure of real and nominal interest rates. To the extent that nominal rates covary positively with real interest rates, that is, if the nominal term structure moves in the same direction as the term structure of real rates, then previous results apply, with qualifications, to the maturity structure of nominal debt.[15] In particular, if nominal interest rates change more than one-to-one with shocks to real rates, then the greater market-value sensitivity of nominal debt can provide a substitute for duration in hedging against variations in the present value of primary surpluses. However, the optimal duration of nominal debt should still be very long, as this effect is unlikely to compensate for the observed much longer duration of primary surpluses. More realistically, if nominal interest rates change less than one-to-one with real interest rates, then the argument for a long maturity structure is strengthened because the duration of the nominal debt must be longer than that of primary surpluses to compensate for the lower variations in nominal interest rates.

The argument for long nominal debt is also valid for shocks to expected inflation to the extent that such shocks induce a positive reaction of real interest rates. This is the case in inflation targeting regimes where, following the Taylor principle, the central bank controls expected inflation by raising the nominal interest rate more than the increase in expected inflation. To conclude, if shocks to nominal interest rates have a real component, the argument in favour of a long maturity structure derived for inflation-indexed debt extends to nominal debt.

5. Debt management in practice

How do policy implications from fiscal insurance compare with practical debt management? Most debt managers focus on aims broadly based around the notion of "minimizing cost subject to an acceptable level of risk". In practice, they often choose debt portfolio strategies looking at the trade-off between cost and risk minimization of the interest expenditure obtained from stochastic simulations of macro-dynamic models.

The cost-risk management of the interest expenditure apparently shares with the fiscal insurance theory the objective of minimizing budget risk and thus tax adjustments. However, the management of expenditure risk is mainly motivated by the objective of minimizing the cost of debt service. Debt managers worry about expenditure risk because a greater risk may lead, ex-post, to higher interest costs for any given expected expenditure. This raises the issue of whether the objective of cost minimization is economically justified, and especially so

[13] As tax revenues and government consumption increase with inflation, primary surpluses are, to a first approximation, unaffected by inflation.

[14] The real value of the debt also depends on the current price level that we assume to be stable.

[15] See Appendix 1 in Bernaschi, Missale and Vergni (2009) for a formal analysis.

since governments have to pay a risk premium on their debts to reduce fiscal vulnerability to macroeconomic shocks.

5.1 The cost of fiscal insurance

While debt managers aim to minimize the expected cost of debt service independently of its source, the fiscal insurance theory holds that governments should be ready to pay a premium to avoid risk. To the extent that risk premia reflect a fair price for insurance, there should be no trade-off between risk and cost minimization: to avoid risk, the government should incur higher expected costs (Bohn 1995, 1999, Nosbusch 2008). Cost considerations matter only if expected return differentials, ie risk premia, between alternative debt instruments arise because of credibility problems, mispricing, market imperfections and liquidity (Bohn 1999, Missale 1997).

The reason why the government should issue bonds with higher risk premia to hedge against macroeconomic shocks is that it has a comparative disadvantage in providing insurance to the private sector, as explained in Bohn (1995). This is because bonds that have a higher return in bad states of nature (that is when output is lower and the fiscal position weaker than expected) imply higher tax rates on private-sector income. These tax changes undo the insurance offered by high debt returns. Hence, a strategy that relies on debt instruments to insure the private sector is self-defeating.

Optimal taxation models may, however, underestimate the magnitude of risk premia for, at least, three reasons. First, higher risk premia may result from market imperfections, illiquidity, and perhaps mispricing. In fact, as shown by Mehra and Prescott (1985), once we account for the low variance of consumption growth, observed risk premia appear too high to be generated by standard consumption asset-pricing models such as those considered in the optimal taxation literature. If actual risk premia are too high because of high risk aversion, then governments should refrain from policies which minimize the cost of debt service, as the latter impose significant risks on taxpayers. Cost minimization is instead warranted if high risk premia reflect private intermediation costs due, for example, to illiquidity. In this case, Bohn (1999) shows that a government's issuance of a safe asset at low cost is welfare improving. The increasing demand for safe and liquid assets in the wake of the global financial crisis suggests that the argument has some relevance.

The second reason why optimal taxation models may underestimate risk premia is that bond pricing depends on the equilibrium allocation of aggregate consumption because of the assumptions of rational expectations and a representative household. As bond holders differ from taxpayers, say, because taxes fall on future generations, the welfare maximizing distribution of taxes and aggregate consumption may not be relevant for debt holders' decisions and thus for bond pricing.[16] Perhaps more important, by assuming rational expectations, models of optimal taxation give households the ability to correctly perceive the distribution of tax rates and thus the equilibrium allocation of consumption associated with alternative debt-tax schemes.

The third reason is that the optimal debt structure is usually derived from non-monetary models or under the assumption of full commitment. When time-consistency problems are considered, implications for debt management change, as first shown by Lucas and Stokey (1983) in a model of optimal taxation where the government issues (explicitly contingent) real debt. Credibility problems may lead to substantial expected return differentials among alternative debt instruments and imply a trade-off between fiscal insurance and cost

[16] This may however strengthen the argument for risk minimization.

minimization (Calvo and Guidotti 1990). If this were the case, the government would have to buy less insurance to minimize interest costs and tax distortions.

These considerations suggest that our knowledge on the determinants of the cost of insurance is too limited to easily dismiss cost minimization; certainly more research efforts should be devoted to understanding the determinants of risk premia.[17]

5.2 The risk-cost management of the interest expenditure

A second fundamental difference between theory and practice is that fiscal insurance focuses on the intertemporal budget constraint; that is, on the market value of government liabilities *vis-à-vis* the present value of future primary surpluses, whereas debt managers are just concerned with the stochastic sequence of interest-expenditure flows or budget deficits. Hence, the fiscal insurance theory implicitly assumes an asset-liability management framework for the evaluation of debt financing strategies whereas the simulation approach is, at best, an optimal management of expenditure flows.

The debt managers' focus on interest expenditure, as opposed to the market value of the debt, is forced by accounting standards and by the excessive role that budget deficits play in fiscal policy evaluation. How far does this concern take us away from the policy recommendations of the fiscal insurance approach?

Consider first the following simple example. Suppose that the short-term interest rate is expected to increase so that the term structure is upward sloping consistent with the expectations theory. Then, as the long-term interest rate is fully determined by the perfectly foreseen path of the short-term interest rate, the maturity of *new* bond issues is irrelevant for expected cost minimization. Indeed, economic theory holds that – in the absence of a term premium – the type of debt that the government issues does not matter. However, over a short time horizon, the expected interest expenditure is minimized by short maturity debt.

Bernaschi, Missale and Vergni (2009) show that interest-expenditure minimization may lead to suboptimal debt strategies when carried out over a short time horizon. They evaluate the cost-risk performance of debt portfolios of different maturities by examining the time path of the stochastic distribution of their interest expenditures.[18] They find that a very long, possibly infinite, horizon should be taken as the reference period to obtain implications that are consistent with the fiscal insurance theory of debt management.[19] Intuitively, portfolio strategies can be compared in terms of interest expenditure only if the horizon extends up to the redemption date of the longest maturity bond issued during the simulation period.

The analysis points to the danger of a cost-risk management of the interest expenditure and raises concerns over debt strategies derived from medium-term simulation models such as that provided by the World Bank and IMF (2009).[20] In the example above, by issuing short-term debt a government would move away from the (long maturity) portfolio that minimizes interest-rate risk and expose the budget to the costs of future interest-rate shocks. The risks of short-termism are further investigated in the next section.

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[17] For an analysis of risk premia on inflation-indexed bonds see Campbell, Shiller and Viceira (2009).

[18] The stochastic distribution of the interest expenditure over time is simulated using simple stochastic models of the evolution of the term structure of interest rates.

[19] We also find that the ranking of debt portfolios by expenditure risk may depend on the length of the simulation period.

[20] Although most governments run simulations over a ten-year period, they often focus on cost-risk indicators computed on much shorter horizons (see Risbjerg and Holmlund 2005).

5.3 Fiscal rules and the risk of impatience

Fiscal rules, such as the Stability and Growth Pact or a Budget Balance rule, make the interest expenditure the key variable to be controlled by debt management. Then, the excessive role played by current deficits in the evaluation of fiscal performance together with governments' myopic views may distort debt managers' choices and favour suboptimal debt strategies.

To make a simple example, consider the implications of a Budget Balance rule. In order to ensure a balanced budget the nominal primary surplus, S_t^N, has to match the nominal interest expenditure, I_t, ie the sum of coupons, capital uplifts and the per-year difference between the face values and the issue prices of the outstanding bonds.[21]

Defining the ex-post payment rate on the outstanding debt as $i_t = I_t / B_{t-1}$, the Budget Balance rule, $S_t^N = I_t$, can be written in terms of the surplus-to-GDP ratio, s_t, and the debt-to-GDP ratio, b_{t-1}, as:[22]

$$s_t = \frac{i_t}{1+y_t} b_{t-1} \tag{4}$$

where y_t is the growth rate of nominal GDP.

If the primary surplus is affected by output shocks so that its ratio to GDP increases with unanticipated output growth, $y_t - E_{t-1}y_t$, then a balanced budget requires that the government offset such shocks by controlling the policy component of the primary surplus, for example, the average tax rate. Defining the policy controlled component of the surplus as fiscal adjustment, A_t, the Budget Balance rule implies:

$$A_t = \frac{i_t}{1+y_t} b_{t-1} - \eta\left(y_t - E_{t-1}y_t\right) \tag{5}$$

where η is the elasticity of the surplus ratio to nominal GDP growth; ie we assume, for simplicity, that real growth and inflation elasticities are the same (which is generally not the case).

Equation (5) shows that a decline of GDP growth below its natural rate implies an additional burden to fiscal adjustment on top of interest payments. It also makes clear that GDP-indexed bonds and, to a lesser extent, inflation-indexed bonds help to stabilize the policy component of the surplus by providing an insurance against shocks to nominal growth.

In fact, a sensible objective function for the debt manager would be to minimize the expected quadratic loss of the fiscal adjustment in the current and future periods. Assuming two periods, the present and the future, we have:

$$Min\ L = E_{t-1}A_t^2 + \beta E_{t-1}A_{t+1}^2 \tag{6}$$

Substituting equation (5) for A_t yields:

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[21] According to ESA95 accounting rules, the difference between the face value and the issue price of a bond divided by its life (from issuance to maturity) is considered an interest payment as well as its coupon.

[22] Dividing both the surplus and the interest payments by nominal GDP is justified by the fact that the variable that the government controls is the surplus-to-GDP ratio, for example, by choosing the average tax rate.

$$
\begin{aligned}
Min\ L = &\left(E_{t-1} \frac{i_t}{1+y_t} b_{t-1} \right)^2 + Var_{t-1}\left[\frac{i_t}{1+y_t} b_{t-1} \right] - 2\eta b_{t-1} Cov_{t-1}\left[y_t ; \frac{i_t}{1+y_t} \right] + k + \\
&+\beta \left(E_{t-1} \frac{i_{t+1}}{1+y_{t+1}} b_t \right)^2 + \beta Var_{t-1}\left[\frac{i_{t+1}}{1+y_{t+1}} b_t \right] - \beta 2\eta Cov_{t-1}\left[y_{t+1} ; \frac{i_{t+1} b_t}{1+y_{t+1}} \right]
\end{aligned} \tag{7}
$$

where Var_{t-1} and Cov_{t-1} denote, respectively, the variance and covariance conditional on the information at time $t-1$ when the debt manager chooses the type of debt to be issued, and k is an unimportant constant.

Equation (7) shows that bonds indexed to nominal GDP would provide a valuable hedge against cyclical variations in the primary surplus that are not controlled by the government. Inflation-indexed bonds could also provide insurance to the extent that inflation and real output growth were not negatively correlated, that is, if supply shocks did not prevail. However, if issuing GDP-indexed bonds is “too costly” because investors require a premium for illiquidity and complexity (see Section 2.1), then the choice is between conventional long maturity bonds and short maturity bonds, say, bonds with a 10-year and 1-year maturity.

A distinctive feature of both types of bonds is that their interest payments at period t are known at the time of issuance, $t-1$, which implies that the conditional variance and covariance terms in the loss function for period t are zero. However, while the interest payments on 10-year bonds will remain fixed for 10 years ahead, 1-year bonds, being rolled over in period t, expose the fiscal adjustment to interest-payment uncertainty. Indeed, short maturity debt implies greater interest-payment variability at $t+1$ (see the variance term in the loss for period $t+1$) and may lead to higher future payments when the interest rate is expected to rise (see the expected term in the loss for period $t+1$). Moreover, short maturity debt may lead to additional losses if interest rates covary negatively with nominal GDP growth. Although we argued in Section 4 that a systematic relation between interest rates and output growth is hard to find, there may be instances when high rates are associated with output contraction, say, as in the case of monetary policy tightening to fight inflation.

It is worth saying that debt managers are aware of the risks and potentially higher future costs of short maturity debt and opt for fairly long maturities as shown by the actual maturity structures of sovereign debts in OECD countries. However, in a time of crisis, when the government strives to achieve budget balance and the deficit becomes the focal point of the economic policy debate, the debt manager’s horizon may shorten dramatically. Suppose that the 1-year yield to maturity is lower than the 10-year yield either because the yield curve is upward sloping or, more generally, because of the presence of a term premium. Then, an impatient debt manager who discounts the future heavily, ie when $\beta \to 0$, will only issue 1-year bonds to minimize next-period interest payments (and ease fiscal adjustment) as this is the only variable that enters the loss function (7) when $\beta = 0$.

Therefore, in times of crisis, when surviving the present is what matters most, focusing on interest payments, a concept of dubious economic relevance but crucial for fiscal rules binding the overall deficit, may bias the choice of debt managers in favour of short maturity debt. While a forward looking debt manager may try to resist the urge to cut the interest expenditure, she may be forced to deliver a “nice” budget under the pressure of a government striving to meet its commitments. The use of “unconventional” swaps contracts by fiscally weak Member States to satisfy the 3% deficit limit in the run up to EMU is a real-world example of how accounting conventions may set the wrong incentives and distort debt managers’ choices.

No doubt, these examples are extreme but still point to the danger of evaluating fiscal sustainability on the basis of national accounts figures that are vaguely related to debt sustainability, such as the current deficit, the interest expenditure, and the book value of the debt. Hall and Sargent (2011) show how different debt returns are from interest payments and thus how different are the dynamics of the market value of the debt (relative to GDP) compared to official figures. In fact, while economic theory and fiscal insurance evaluate debt strategies for their impact on the intertemporal budget constraint, and thus look at the market value of the debt, real returns, debt maturity, etc., in most countries, data on the market value of the debt do not even exist!

We may feel comfortable with the simple concepts of current deficits, interest expenditure, and debt-to-GDP ratios, but we just abide by conventions: the use of national accounts as the only standard to evaluate fiscal policy is a major obstacle to optimal debt management.

6. Concluding remarks

Debt management should aim at minimizing fiscal vulnerability by providing insurance against macroeconomic shocks affecting the government budget. Indeed, a wide consensus has emerged in the literature on the benefits of fiscal insurance and debt managers have paid greater and greater attention to reducing the exposure of their debts to interest-rate risk and exchange-rate risk. The reliance on domestic currency bonds and the lengthening of the maturity structures that has taken place over the last two decades is clear evidence of the increased awareness of such risks.

However, the fiscal insurance approach does not offer simple policy recommendations for the specific debt instruments to be issued. Whether insurance is better provided by nominal or inflation-indexed bonds, by a short or a long maturity structure depends on the type of shocks hitting the economy. What type of debt should then be issued? In this paper we have re-examined this issue looking at the fiscal insurance that inflation indexation and debt maturity can offer in light of the different shocks affecting the government budget and their relevance.

Whether governments should issue nominal or inflation-indexed bonds is controversial. The lack of knowledge about the type of shocks hitting the economy suggests portfolio diversification as an argument for “some” inflation-indexed debt. On the other hand, the role of inflation-indexed bonds as a hedge against demand shocks or inflation shocks (unrelated to other variables) is less important in a stable inflation environment when fiscal policy is Ricardian and price stability is ensured by the central bank.

By contrast, there is no doubt that indexation to nominal GDP would be ideal to hedge against output fluctuations. Issuing GDP-indexed bonds can be costly because of the premium required for illiquidity and complexity but the time has come to take this opportunity into greater consideration.

We have made a strong case for long maturity debt, either nominal or indexed. Our argument is not based on the relation between interest rates and fiscal variables, which is either weak or conditional on particular shocks, but on the fact that a long maturity structure avoids interest-rate risk and, more importantly, reduces the risk of default if expected future primary surpluses fall as a result of policy or a shift in market sentiment. The euro debt crisis does provide a clear indication for the management of sovereign debt: a long maturity structure is the best insurance against the risk of default. The maturity of the debt is a key variable to assess the vulnerability of the government fiscal position and should thus deserve greater attention in debt sustainability analysis. An excessive focus on the level of debt, on the debt-to-GDP ratio, as well as on current deficits, is misleading in the presence of substantial differences in debt duration. Moreover, as the original duration of the debt is modified by swaps contracts, a correct assessment of fiscal vulnerability calls for a greater transparency of such operations.

Finally, we have compared the policy implications from fiscal insurance with the debt managers’ practice of minimizing the cost and risk of the interest expenditure obtained from stochastic simulations of macro-dynamic models. The management of expenditure risk is mainly motivated by the objective of minimizing the cost of debt service, taking risk into account. Debt managers worry about expenditure risk because a greater risk may lead, ex-post, to higher interest costs, for any given expected expenditure.

A concern for the cost of debt service is justified if expected return differentials between debt instruments are determined by mispricing, market imperfections and liquidity, but it is not when higher risk premia reflect a fair price for insurance. In the latter case, there is no trade-off between cost and risk minimization. This suggests that more research efforts should be devoted to understanding the determinants of risk premia.

A second fundamental difference is that the fiscal insurance theory focuses on the intertemporal budget constraint, that is, on the market value of government liabilities *vis-à-vis* the present value of future primary surpluses, whereas debt managers are just concerned with the stochastic sequence of interest-expenditure flows. Interest-expenditure minimization may lead to suboptimal debt strategies when carried out over a short horizon. To obtain implications that are consistent with the fiscal insurance theory of debt management, portfolio strategies should be compared over a time horizon that extends up to the redemption date of the longest maturity bond issued during the simulation period.

The debt managers' focus on interest expenditure, as opposed to the market value of the debt, is forced by accounting standards and by the excessive role that budget deficits play in fiscal policy evaluation. Fiscal rules, such as the Stability and Growth Pact or the Budget Balance rule, make the interest expenditure the key variable to be controlled by debt management. In times of crisis, when surviving the present is what matters most, focusing on interest payments, a concept of dubious economic relevance but crucial for fiscal rules binding the overall deficit, may bias debt managers' choices and favour suboptimal debt strategies. Our analysis points to the danger of evaluating debt management on the basis of national accounts figures that are vaguely related to debt sustainability, such as the current deficit, the interest expenditure and the book value of the debt. The lack of a more theory-based accounting framework is a major obstacle to optimal debt management.

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Debt management and optimal fiscal policy with long bonds[1]

Elisa Faraglia,[2] Albert Marcet[3] and Andrew Scott[4]

Abstract

We study Ramsey optimal fiscal policy under incomplete markets in the case where the government issues only long bonds of maturity $N > 1$. We find that many features of optimal policy are sensitive to the introduction of long bonds, in particular tax variability and the long-run behaviour of debt. When government is indebted, it is optimal to respond to an adverse shock by promising to reduce taxes in the distant future as this achieves a cut in the cost of debt. Hence, debt management concerns override typical fiscal policy concerns such as tax-smoothing. In the case where the government leaves bonds in the market until maturity, we find two additional reasons why taxes are volatile due to debt management concerns: debt has to be brought to zero in the long run and there are N-period cycles. We formulate our equilibrium recursively applying the Lagrangean approach for recursive contracts. However even with this approach the dimension of the state vector is very large. To overcome this issue we propose a flexible numerical method, the "condensed PEA", which substantially reduces the required state space. This technique has a wide range of applications. To explore issues of policy coordination and commitment we propose an alternative model where monetary and fiscal authorities are independent.

Keywords: Computational methods, debt management, fiscal policy, government debt, maturity structure, tax-smoothing, yield curve

JEL classification: C63, E43, E62, H63

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[2] University of Cambridge and CEPR.

[3] Institut d'Anàlisi Econòmica CSIC, ICREA, UAB, BGSE and CEPR.

[4] London Business School and CEPR.

1. Introduction

Table 1 shows the average maturity of outstanding government debt for a variety of countries and displays clear differences across nations. Any theory of debt management needs to explain the costs and benefits for fiscal policy of varying the average maturity in this manner. As the current European sovereign debt crisis emphasises, the maturity structure of government debt is a key variable. Deciding fiscal policy independently of funding conditions in the market is a doomed concept: taxes, public spending and fiscal deficits should all take into account the funding conditions in the market for bonds. Therefore debt management should not be subservient to fiscal policy and should not focus simply on "minimising costs". Rather, fiscal policy and debt management should be studied jointly.

Table 1

Average maturity government debt 2010

Country	Average maturity (years)
United Kingdom	13.7
Denmark	7.9
Greece	7.7
Italy	7.2
Austria	7
France	6.9
Ireland	6.8
Spain	6.7
Switzerland	6.7
Portugal	6.5
Czech Republic	6.4
Sweden	6.4
Germany	5.8
Belgium	5.6
Japan	5.4
Netherlands	5.4
Canada	5.2
Poland	5.2
Australia	5
Norway	4.9
United States	4.8
Finland	4.3
Hungary	3.3

Sources: OECD; The Economist.

A number of recent contributions have studied this interaction between debt management and taxation policy in a Ramsey equilibrium setting. Angeletos (2002), Barro (2003), Buera and Nicolini (2004) use models of complete markets. Nosbusch (2008) explores a simplified model of incomplete markets and Lustig, Sleet and Yeltekin (2009) examine an incomplete market model with multiple maturities and nominal bonds. In this paper we build on our recommendations in Faraglia, Marcet and Scott (2010) and extend the setup of Aiyagari, Marcet, Sargent and Seppälä (2002), who studied optimal fiscal policy with incomplete markets and short bonds, to the case when bonds mature N periods after having been issued. We describe the behaviour of optimal policy with long bonds and we show how to navigate computational problems. The equilibrium in our model shows some well known features of optimal fiscal policy under incomplete markets: the government tries to smooth taxes, taxes follow a near-martingale behaviour and debt is used as a buffer stock to spread tax increases over all periods after an unexpected adverse shock. We also find that if the government is indebted and an adverse shock occurs the government should promise to cut taxes in future periods, when the newly issued long bonds generate a payoff. These future tax cuts "twist" current long interest rates so as to reduce the burden of past debt. This means that a typical debt management concern, ie reducing the costs of debt, overrides a typical concern of fiscal policy, namely tax-smoothing. This promise to cut taxes is the reason that optimal policy is time-inconsistent: if the government could, it would renege on the promise to cut taxes.

A further problem that arises only when dealing with long bonds is what decision to make about outstanding debt at the end of each period. Most of the literature assumes that the government buys back each period all previously issued debt and then reissues new bonds. This assumption is innocuous in models of complete markets, but matters under incomplete markets. Furthermore, as shown in Marchesi (2004), governments rarely buy back outstanding debt before redemption. To quote the UK Debt Management Office (2003), "the UK's debt management approach is that debt once issued will not be redeemed before maturity". For this reason we also study optimal policy when the government leaves long bonds in circulation until the time of maturity. We call this the "hold to redemption" case. In this case, at any moment in time the government has a full spectrum of outstanding debt with maturity until redemption of N, $N-1$ through to one year even though the government only ever issues N period debt. The maturity profile of government debt is therefore much more complex with long bonds and hold to redemption and this will potentially impact debt management and fiscal policy. We find that optimal tax policy is even more volatile in this case: the government promises to cut taxes permanently and there are N-period cycles in tax policy.

Obtaining numerical simulations is not straightforward. A first difficulty lies in obtaining a recursive formulation of the model. To do so we extend the recursive contracts treatment of Aiyagari et al (2002). A second difficulty arises because the vector of state variables is typically of dimension $2N+1$. Hence it grows rapidly with maturity: many OECD countries issue 30-year bonds, and both France and the UK issue 50-year bonds. Solving a non-linear dynamic model with these many state variables is not feasible.[5]

To reduce this computational complexity, we propose a new method, the "condensed PEA", that reduces the dimensionality of the state vector while allowing, in principle, for arbitrary precision. We show how in the case of a 20-year bond the state space is effectively only four variables. We believe this computational method has wide applicability to other cases.

The fact that the fiscal authority finds it optimal to twist interest rates to minimise funding costs raises issues of commitment and policy coordination. To assess this, we introduce a model where the fiscal authority is separate from the monetary authority setting interest rates. In this

[5] Linearisation of the policy function is undesirable. First, because it turns out that non-linear terms in the policy function play a crucial role even near the steady state mean. Second, because of the presence of debt limits.

way the "twisting" of interest rates is not possible, since the fiscal authority takes interest rates as given. This setup provides a framework to understand the role of commitment in the Ramsey policy, and in the case with buyback it reduces the dimensionality of the state vector, as the usual co-state variables of optimal Ramsey policy are no longer present. We find that the second moments of the model are not highly dependent on maturity. In a calibrated example, allocations, interest rates and persistence of debt are similar across maturities and across the three models of policy considered. The main difference is the long-run level of debt, as longer maturities are associated with more debt.

The structure of the paper is as follows. Section 2 outlines our main model, a Ramsey model with incomplete markets and long bonds when the government buys back all outstanding debt each period. Section 2 shows some properties of the model using analytic results. Section 3 studies numerical issues, introducing the condensed PEA and describing the behaviour of the model numerically. Section 4 studies the model of independent powers, whilst Section 5 considers the case of hold to redemption. A final section concludes.

2. The model: analytic results

Our benchmark model is of a Ramsey policy equilibrium, with perfect commitment and coordination of policy authorities, in which the government buys back all existing debt each period. In Sections 4 and 5 we relax these assumptions.

The economy produces a single non-storable good with a technology

$$c_t + g_t \leq 1 - x_t, \tag{1}$$

for all t, where x_t, c_t and g_t represent leisure, private consumption and government expenditure respectively. The exogenous stochastic process g_t is the only source of uncertainty. The representative consumer has utility function:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left\{ u(c_t) + v(x_t) \right\} \tag{2}$$

and is endowed with one unit of time that it allocates between leisure and labour and faces a proportional tax rate τ_t on labour income. The representative firm maximises profits, both consumers and firms act competitively by taking prices and taxes as given. Consumers, firms and government have full information, ie they observe all shocks up to the current period, and all variables dated t are chosen contingent on histories $g^t = (g_t, ..., g_0)$. All agents have rational expectations.

Agents can only borrow and lend in the form of a zero-coupon, risk-free, N-period bond so that the government budget constraint is:

$$g_t + p_{N-1,t} b_{N,t-1} = \tau_t (1 - x_t) + p_{N,t} b_{N,t} \tag{3}$$

where $b_{N,t}$ denotes the number of bonds the government issues at time t, each bond pays one unit of consumption good in N-periods of time with complete certainty. The price of an i-period bond at time t is p_{it}. In this section, we assume that at the end of each period the government buys back the existing stock of debt and then reissues new debt of maturity N; these repurchases are reflected in the left side of the budget constraint (3). In addition, government debt has to remain within upper and lower limits $\underline{M}$ and $\bar{M}$ so ruling out Ponzi schemes eg

$$\underline{M} \leq \beta^N b_{N,t-1} \leq \bar{M} \tag{4}$$

The term β^N in this constraint reflects the value of the long bond at steady state, so that the limits $\underline{M}, \overline{M}$ appropriately refer to the value of debt and they are comparable across maturities.[6]

We assume that, after purchasing a long bond, the household has only two options: one is to resell the government bond in the secondary market in the period immediately after having purchased it, the other possibility is to hold the bond until maturity.[7] Letting $s_{N,t}$ be the sales in the secondary market, the household's problem is to choose stochastic processes $\{c_t, x_t, s_{N,t}, b_{N,t}\}_{t=0}^{\infty}$ to maximise (2) subject to the sequence of budget constraints:

$$c_t + p_{N,t} b_{N,t} = (1-\tau_t)(1-x_t) + p_{N-1,t} s_{N,t} + b_{N,t-N} - s_{N,t-N+1}$$

with prices and taxes $\{p_{N,t}, p_{N-1,t}, \tau_t\}$ taken as given. The household also faces debt limits analogous to (4). We assume for simplicity that these limits are less stringent than those faced by the government so that, in equilibrium, the household's problem always has an interior solution.

The consumer's first-order conditions of optimality are given by

$$\frac{v_{x,t}}{u_{c,t}} = 1 - \tau_t \tag{5}$$

$$p_{N,t} = \frac{\beta^N E_t\left(u_{c,t+N}\right)}{u_{c,t}} \tag{6}$$

$$p_{N-1,t} = \frac{\beta^N E_t\left(u_{c,t+N-1}\right)}{u_{c,t}} \tag{7}$$

2.1 The Ramsey problem

We assume the government has full commitment to implementing the best sequence of (possibly time-inconsistent) taxes and government debt knowing equilibrium relationships between prices and allocations. Using (5), (6) and (7) to substitute for taxes and consumption, the Ramsey equilibrium can be found by solving

$$\begin{aligned} &\max_{\{c_t, b_{N,t}\}} E_0 \sum_{t=0}^{\infty} \beta^t \left\{ u(c_t) + v(x_t) \right\} \\ &\text{s.t.} \quad \beta^{N-1} E_t\left(u_{c,t+N-1}\right) b_{N,t-1} = S_t + \beta^N E_t\left(u_{c,t+N}\right) b_{N,t} \end{aligned} \tag{8}$$

and (4), and x_t implicitly defined by (1).

To simplify the algebra we define $S_t = (u_{c,t} - v_{x,t})(c_t + g_t) - u_{c,t} g_t$ as the "discounted" surplus of the government and set up the Lagrangian

[6] Obviously the actual value of debt is $p_{N,t} b_{N,t}$, we substitute $p_{N,t}$ by its steady state value β^N for simplicity, nothing much changes if the limits are in terms of $p_{N,t} b_{N,t}$.

[7] We need to introduce secondary market sales $s_{N,t}$ in order to price the repurchase price of the bond.

$$L = E_0 \sum_{t=0}^{\infty} \beta^t \left\{ u\left(c_t\right) + v\left(x_t\right) + \lambda_t \left[S_t + \beta^N u_{c,t+N} b_{N,t} - \beta^{N-1} u_{c,t+N} b_{N,t-1} \right] \right.$$
$$\left. + \nu_{1,t} \left(\bar{M} - \beta^N b_{n,t} \right) + \nu_{2,t} \left(\beta^N b_{N,t} - \underline{M} \right) \right\}$$

where λ_t is the Lagrange multiplier associated with the government budget constraint and $\nu_{1,t}$ and $\nu_{2,t}$ are the multipliers associated with the debt limits.

The first-order conditions for the planner's problem with respect to c_t and $b_{N,t}$ are

$$\begin{aligned} & u_{c,t} - v_{x,t} + \lambda_t \left(u_{cc,t} c_t + u_{c,t} + v_{xx,t} \left(c_t + g_t \right) - v_{x,t} \right) \\ & \qquad + u_{cc,t} \left(\lambda_{t-N} - \lambda_{t-N+1} \right) b_{N,t-N} = 0 \end{aligned} \tag{9}$$

$$E_t \left(u_{c,t+N} \lambda_{t+1} \right) = \lambda_t E_t \left(u_{c,t+N} \right) + \nu_{2,t} - \nu_{1,t} \tag{10}$$

with $\lambda_{-1} = ... = \lambda_{-N} = 0$.

These FOC help characterise some features of optimal fiscal policy with long bonds. Following the discussion in Aiyagari et al (2002), we see that in the case where debt limits are non-binding (10) says that λ_t is a risk-adjusted martingale with risk-adjustment measure $\frac{u_{c,t+N}}{E_t\left(u_{c,t+N}\right)}$, indicating that in this model the presence of the state variable λ in the policy function imparts persistence in the variables of the model. The term $D_t = \left(\lambda_{t-N} - \lambda_{t-N+1} \right) b_{N,t-N}$ in (9) indicates that a feature of optimal fiscal policy will be that what happened in period $t-N$ has a special impact on today's taxes. Since we have $u_{c,t} - v_{x,t} = 0$ and zero taxes in the first best, a high D_t pulls the model away from the first best and zero taxes. If $D_t > 0$ it can be thought of as introducing a higher distortion in a given period. In periods when g_{t-N+1} is very high, we have that the cost of the budget constraint is high, so λ_{t-N+1} is high, and if the government is in debt $D_t < 0$ so that taxes should go down at t. Of course this is not a tight argument, as λ_t also responds to the shocks that have happened between t and $t-N$ and λ_t also plays a role in (9), but this argument is at the core of the interest rate twisting policy we identify below. In order to build up intuition for the role of commitment and to provide a tighter argument, we now show two examples that can be solved analytically.

2.2 A model without uncertainty

Assume now that government spending is constant, $g_t = \bar{g}$. The only budget constraint of the government is then

$$\begin{aligned} & \sum_{t=0}^{\infty} \beta^t \frac{u_{c,t}}{u_{c,0}} \tilde{S}_t = b_{N,-1} p_0^{N-1}, \text{or} \\ & \sum_{t=0}^{\infty} \beta^t S_t = b_{N,-1} \beta^{N-1} u_{c,N-1} \end{aligned} \tag{11}$$

where $\tilde{S}_t = \frac{S_t}{u_{c,t}}$ is the "non-discounted" surplus of the government. This shows that, for a given set of surpluses, the funding costs of initial debt $b_{-1}^N > 0$ can be reduced by manipulating consumption such that $c_t < c_{N-1}$ for all $t \neq N$. As long as the elasticity of consumption with respect to wages is positive, as occurs with most utility functions, this can be achieved by setting

$$\begin{aligned} &\tau_t = \overline{\tau} \text{ for all } t \neq N-1 \\ &\overline{\tau} > \tau_{N-1} \end{aligned} \tag{12}$$

This achieves a reduction of $u_{c,N-1}$, reducing the cost of outstanding debt. In other words, the long end of the yield curve needs to be twisted up.[8] Interestingly, even though there are no fluctuations in the economy, (12) shows that optimal policy implies that the government desires to introduce variability in taxes. In other words, optimal policy violates tax-smoothing. This policy is clearly time-inconsistent: if the government is able to reoptimise by surprise at some period $t' > 0$, $t' < N-1$ it will then promise instead a cut in taxes in period $t' + N - 1$.

2.3 A model with uncertainty at $t = 1$

The previous subsection abstracted from uncertainty. We now introduce uncertainty into our model. In the interest of obtaining analytic results we assume uncertainty occurs only in the first period, ie g is given by:[9]

$$\begin{cases} g_t = \overline{g} \text{ for } t = 0 \text{ and } t \geq 2 \\ g_1 \sim F_g \end{cases}$$

for some non-degenerate distribution F_g. Since future consumption and λ's are known, the martingale condition implies $u_{c,t+N}\lambda_{t+1} = \lambda_t u_{c,t+N}$ and

$$\lambda_t = \lambda_1 \quad t > 1$$

It is clear that in the case of short bonds $(N = 1)$ equilibrium implies c_t and τ_t constant for $t \geq 2$, reflecting the fact that, even though markets are incomplete, the government smooths taxes after the shock is realised.

For the case of long bonds when $N > 1$, the FOC with respect to consumption (9) is satisfied for $D_t = (\lambda_{t-N} - \lambda_{t-N+1}) b_{N,t-N}$

$$D_t = 0 \text{ for } t \geq 0 \text{ and } t \neq N-1, N \tag{13}$$

$$D_{N-1} = \lambda_0 b_{N,-1},\ D_N = (\lambda_0 - \lambda_1) b_{N,0} \tag{14}$$

Hence equilibrium satisfies

$$c_t = c^*(g_1) \text{ for } t \geq 2 \text{ and } t \neq N, N-1 \tag{15}$$

for a certain function c^*. ie consumption is the same in all periods $t \geq 2$ and $t \neq N, N-1$, although this level of constant consumption depends on the realisation of the shock g_1. Clearly, c_{N-1}, c_N also depend on the realisation of g_1.

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8 This is, of course, a manifestation of the standard interest rate manipulation already noted by Lucas and Stokey (1983), except that in our case the twisting occurs in N periods.

9 Formally, this economy is very similar to that of Nosbusch (2008).

Therefore, there is more tax volatility than in the case of short bonds: taxes vary in periods $N-1$ and N, even though by the time the economy arrives at these periods no more shocks have occurred for a long time.

2.3.1 An analytic example

To make this argument precise consider the utility function

$$\frac{c_t^{1-\gamma_c}}{1-\gamma_c}-B\frac{\left(1-x_t\right)^{1+\gamma_\iota}}{1+\gamma_\iota} \tag{16}$$

for $\gamma_c,\gamma_\iota,B>0$.

Result 1 *Assume utility (16) and* $b_{N,-1}>0$*.*

For a sufficiently high realisation of g_1 *we have*

$\tau_1=\tau_t$ for all $t\geq 1, t\neq N-1, N$

$\tau_1>\tau_{N-1},\tau_N$

The inequalities are reversed if $b_{N,-1}<0$ *or if the realisation of* g_1 *is sufficiently low.*

Proof

Since $\lambda_t=\lambda_1$ $t>1$ the FOC of optimality yield

$$\frac{u_{c,t}}{v_{x,t}}-\frac{B+\left(\gamma_\iota+1\right)\lambda_1}{\left(1+\left(-\gamma_c+1\right)\lambda_1\right)B}+\left(\lambda_{t-N}-\lambda_{t-N+1}\right)F_t=0 \quad \text{for } t\geq 1$$

where $F_t\equiv\dfrac{u_{cc,t}b_{N,t-N}}{\left(1+\left(-\gamma_c+1\right)\lambda_1\right)B}$.

Consider $t=1$. For any long maturity $N>1$ we have that $\lambda_{t-N}=\lambda_{t-N+1}=0$ when $t=1$ so that

$$\frac{u_{c,1}}{v_{x,1}}=\frac{B+\left(\gamma_\iota+1\right)\lambda_1}{\left(1+\left(-\gamma_c+1\right)\lambda_1\right)B} \tag{17}$$

Therefore we can write

$$\frac{u_{c,t}}{v_{x,t}}-\frac{u_{c,1}}{v_{x,1}}=\left(\lambda_{t-N}-\lambda_{t-N+1}\right)F_t=0 \quad \text{for } t\geq 1 \tag{18}$$

That $\tau_t=\tau_1$ for all $t>1$ and $t\neq N-1,N$ follows from (15).

Now we show that $F_t<0$ for $t=N-1,N$. Since $\lambda_1,B,\gamma_\iota>0$ we have that $B+\left(\gamma_\iota+1\right)\lambda_1>0$.

Since $u_{c,1},v_{x,1}>0$ clearly (17) implies that $\left(1+\left(\gamma_c+1\right)\lambda_1\right)B>0$. Since we consider the case of initial government debt $b_{N,-1}>0$ this leads to $b_{N,0}>0$ and since $u_{cc,1}<0$ we have $F_t<0$ for $t=N-1,N$.

Since for $t=N-1$ we have $\lambda_{t-N}-\lambda_{t-N+1}=-\lambda_0<0$ it follows

$$\frac{u_{c,N-1}}{v_{x,N-1}}<\frac{u_{c,1}}{v_{x,1}}\Rightarrow\tau_{N-1}<\tau_t \text{ for all } t>1, t\neq N-1,N.$$

Also, it is clear from (17) that high g_1 implies a high λ_1. Since the martingale condition implies $E_t\left(u_{c,N}\lambda_1\right)=\lambda_0 E_0\left(u_{c,N}\right)$ for slightly high g_1 we have $\lambda_1>\lambda_0$. Therefore, for $t=N$ and if g_1 was high enough we have $\lambda_{t-N}-\lambda_{t-N+1}=\lambda_0-\lambda_1<0$ so that (18) implies

$$\frac{u_{c,N}}{v_{x,N}},\frac{u_{c,N-1}}{v_{x,N-1}}<\frac{u_{c,1}}{v_{x,1}}\Rightarrow\tau_N,\tau_{N-1}<\tau_1 \qquad \blacksquare$$

Intuitively, in period $t=N-1$ there is a tax cut for the same reasons as in Section 2.2. New in this section is the tax cut (for high g_1) at $t=N$. The intuition for this is clear: when an adverse shock to spending occurs at $t=1$ the government uses debt as a buffer stock so that $b_{N,1}>b_{N,0}$, as this allows tax-smoothing by financing part of the adverse shock with higher future taxes. But since future surpluses are higher than expected, as the higher interest has to be serviced, the government can lower the cost of existing debt by announcing a tax cut in period N, since this will reduce the price $p_{N-1,0}$ of period $t=1$ outstanding bonds $b_{N,0}$. The tax cut at $t=N$ is a stochastic analog of the tax cut described in Section 2.2.

2.3.2 *Contradicting tax-smoothing*

The above result shows that in this model tax policy is subordinate to debt management. In models of optimal policy, the government usually desires to smooth taxes. Taxes would be constant in the above model if the government had access to complete markets. But we find that the government increases tax volatility in period N, long after the economy has received any shock. Therefore, government forfeits tax-smoothing in order to enhance a typical debt management concern, namely reducing the average cost of debt.

Obviously this policy is time-inconsistent: if the government could unexpectedly reoptimise in period $t=2$ given its debt $b_{N,1}$ it would renege on the promise to cut taxes in period N. Instead it would promise to lower taxes in period $N+1$.

It is clear from this discussion that what will matter for the policy function is the term $D_N=\left(\lambda_0-\lambda_1\right)b_{N,0}$. Therefore it is the interaction between past λs and past bs that determines the size and the sign of today's tax cut. A linear approximation to the policy function would fail to capture this feature of the model and it would be quite inaccurate.

To summarise, we have proved that in the presence of an adverse shock to spending the government has to take three actions: (i) increase taxes permanently, (ii) increase debt, and (iii) announce a tax cut when the outstanding debt matures. Effects (i) and (ii) are well known in the literature of optimal taxation under incomplete markets, effect (iii) is clearly seen in this model with long bonds since the promise is made N periods ahead. Obviously in the case of short maturity $N=1$ of Aiyagari et al, the effect of D_1 would be felt in deciding optimally τ_1, but this effect would be confounded with the fact that g_1 is stochastic, so effect (iii) is harder to see in a model with short bonds.

3. Optimal policy: simulation results

We now turn to the case where g_t is stochastic in all periods. As is well known, analytic solutions for this type of model are infeasible, so we utilise numerical results. The objective is to compute a stochastic process $\left\{c_t,\lambda_t,b_{N,t}\right\}$ that solves the FOC of the Ramsey planner, namely (8), (9) and (10). First we obtain a recursive formulation that makes computation possible, then we describe a method for reducing the dimensionality of the state space and finally we discuss the behaviour of the economy.

3.1 Recursive formulation

Using the recursive contract approach of Marcet and Marimon (2011), the Lagrangean can be rewritten as:

$$L = E_0 \sum_{t=0}^{\infty} \beta^t \left\{ u(c_t) + v(x_t) + \lambda_t S_t + u_{c,t} \left(\lambda_{t-N} - \lambda_{t-N+1} \right) b_{N,t-N} \right. \\ \left. + \nu_{1,t} \left(\bar{M} - \beta^N b_{N,t} \right) + \nu_{2,t} \left(\beta^N b_{N,t} - \underline{M} \right) \right\} \tag{19}$$

for $\lambda_{-1} = ... = \lambda_{-N} = 0$.

Assuming g_t is a Markov process, as suggested by the form of this Lagrangean, Corollary 3.1 in Marcet and Marimon (2011) implies the solution satisfies the recursive structure[10]

$$\begin{bmatrix} b_{N,t} \\ \lambda_t \\ c_t \end{bmatrix} = F\left(g_t, \lambda_{t-1}, ..., \lambda_{t-N}, b_{N,t-1}, ..., b_{N,t-N} \right)$$
$$\lambda_{-1} = ... = \lambda_{-N} = 0, \quad \text{given } b_{N,-1}$$

for a time-invariant policy function F. This allows for a simpler recursive formulation than the promised utility approach, as the co-state variables λ do not have to be restricted to belong to the set of feasible continuation variables.

The state vector in this recursive formulation has dimension $2N+1$. It is unlikely that further reductions in this dimension can be achieved purely by theoretical results. In order to overcome the problem of dimensionality, some authors model long bonds as perpetuities with decaying coupon payments where the rates of decay mimic differences in maturity (Woodford (2001), Broner, Lorenzoni and Schmulker (2007), Arellano and Ramanarayanan (2008)). One justification for assuming a decaying payoff is that it mimics a bond portfolio with fixed shares that decay with maturity. However, since our goal is to build a model of debt management where the object is precisely to study the appropriate portfolio weights, the assumption of fixed portfolio weights would be inappropriate. Further, although modelling bond payoffs in this way would yield smaller state space vectors, it is contrary to the structure of most government portfolios, where most of the payoff occurs at the time of maturity, as in this model.

3.2 The condensed PEA

We wish to find non-linear solutions, first, because the debt limits are likely to be occasionally binding if we want to keep debt at levels similar to those observed in the real world, second, because per our discussion at the end of Section 2.3, a linear approximation of the policy function F will miss key aspects of optimal policy. Since bonds of maturity $N = 10, 30$ or 50 years are not uncommon a non-linear approach rapidly becomes intractable for a state

[10] In this model it is possible to reduce the state space even further by recognising that the only relevant state variables are N lags of $s_t = b_{N,t}\left(\lambda_t - \lambda_{t-1}\right)$. We do not exploit this feature of the model as it is very specific to this version of the model. For example, the no buyback case of Section 5 needs all state variables.

vector of dimension $2N+1$. To overcome this difficulty, we introduce a solution method based on the parameterised expectation algorithm of den Haan and Marcet (1990). This allows us to reduce the dimensionality of the policy function actually solved for while keeping an accurate solution. Using PEA is useful because it does capture the relevant non-linearities described in Section 2.3 even if the expectations are parameterised as linear functions and because it allows for a natural space reduction method that we call “condensed PEA”.

This method goes as follows. Denote the state vector as $X_t = \left(g_t, \lambda_{t-1}, \ldots, \lambda_{t-N}, b_{N,t-1}, \ldots, b_{N,t-N}\right)$. The idea is that, even though theoretically all elements of X_t are necessary in determining decision variables at t, it is unlikely that in the steady state distribution each and every one of these variables plays a substantial role in determining the solution. For us, most likely some function of these lags will be sufficient to summarise the features from the past that need to be remembered by the government in order to take an optimal decision. In the context of PEA this can be expressed in the following way.

One of the expectations requiring approximation is

$$\mathrm{E}_t\left\{\mathrm{u}_{\mathrm{c,t+N}}\right\} \tag{20}$$

appearing in (10). This expectation is a function, in principle, of all elements in X_t, but it is likely that in practice a few linear combinations of X_t may be sufficient to predict $u_{c,t+N}$. There are two reasons for this. First, the very structure of the model suggests that elements of X_t are very highly correlated with each other, suggesting that a few linear combinations of X_t have as much predictive power as the whole vector. Another way of saying this is that it is enough to project any variable on the principal components of X_t. Other methods available for reducing the dimensionality of state vectors have emphasised this aspect. The second reason is that some principal components of X_t may be irrelevant in predicting $u_{c,t+N}$ in equilibrium and, therefore, they can be left out of the approximated conditional expectation. So the goal is to include only linear combinations of X_t that have some predictive power for $u_{c,t+N}$, the remaining linear combinations can be understood as appearing in the conditional expectation with a coefficient of zero.

More precisely, we partition the state vector into two parts: a subset of n state variables $\left\{X_t^{core}\right\} \subset \left\{X_t\right\}$, where $n < 2N - n$ is small and an omitted subset of state variables $\left\{X_t^{out}\right\} = \left\{X_t\right\} - \left\{X_t^{core}\right\}$ of dimension $1 + 2N - n$. We first solve the model including only X_t^{core} in the parameterised expectations. If the error $\phi_{t+N} \equiv u_{c,t+N} - E_t\left\{u_{c,t+N}\right\}$ found using just these core variables is unpredictable with X_t^{out} we would claim the solution with core variables is the correct one. If X_t^{out} can predict this error, we then find the linear combination of X_t^{out} that has the highest predictive power for ϕ_{t+N}. We add this linear combination to the set of state variables, solve the model again with this sole additional state variable, check if X^{out} can predict ϕ_{t+N} and so on.

Formally, given the set of core variables we define the condensed PEA as follows.[11,12]

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[11] This definition assumes we are interested in the steady state distribution. Of course, it could be modified in the usual way to take transitions into account.

Step 1 Parameterise the expectation as

$$E_t\left\{u_{c,t+N}\right\}=\left(1,X_t^{core}\right)\cdot\beta^1 \tag{21}$$

Find values for $\beta^1\in R^{n+1}$, denoted $\beta^{1,f}$, that satisfy the usual PEA fixed point ie where the series generated by $\left(1,X_t^{core}\right)\cdot\beta^{1,f}$ causes this to be the best parameterised expectation. This solution is of course based on a restricted set of state variables. It is therefore necessary to check if the omission of X^{out} affects the approximate solution. The next step orthogonalises the information in X_t^{out}, which will be helpful in arriving at a well conditioned fixed point problem in Step 4.

Step 2 Using a long-run simulation, run a regression of each element of X_t^{out} on the core variables.

Letting $X_{i,t}^{out}$ be the i −th element, we run the regression

$$X_{i,t}^{out}=\left(1,X_t^{core}\right)\cdot b_i^1+u_{i,t}^1$$

$b_i^1\in R^{2N+2-n}$ and calculate the residuals

$$X_{i,t}^{res,1}=X_{i,t}^{out}-\left(1,X_t^{core}\right)\cdot b_i^1. \tag{22}$$

It is clear that $X^{res,1}$ adds the same information to X^{core} as X^{out}, but $X^{res,1}$ has the advantage that it is orthogonal to X^{core}.

Step 3 Using a long-run simulation find $\alpha^1\in R^{n+1}$ such that

$$\alpha^1=\arg\min_{\alpha}\sum_{t=1}^{T}\left(u_{c,t+N}-X_t^{core}\cdot\beta^1-X_t^{res,1}\cdot\alpha\right)^2 \tag{23}$$

If α^1 is close to zero the solution with only X^{core} is sufficiently accurate and we can stop here. Otherwise go to

Step 4 Apply PEA adding $X_t^{res,1}\cdot\alpha^1$ as a state variable, ie parameterising the conditional expectation as

$$E_t\left\{u_{c,t+N}\right\}=\left(X_t^{core},X_t^{res,1}\alpha^1\right)\cdot\beta^2$$

where $\beta^2\in R^{n+2}$. Find a fixed point $\beta^{2,f}$ for this parameterised expectation. Since $\beta^{1,f}$ is a fixed point, since X_t^{core} and $X_t^{res,1}$ are orthogonal and since the linear combination α^1 has high predictive power, it makes sense to use as initial condition for the iterations of the fixed point

$$\underset{(n+2)\times 1}{\beta^{2,f}}=\begin{pmatrix}\beta^{1,f}\\ 1\end{pmatrix}$$

[12] For convenience we describe these steps with reference only to the expectation $E_t\left\{u_{c,t+N}\right\}$. In practice the expectations $E_t\left\{u_{c,t+N}\lambda_{t+1}\right\}$ and $E_t\left\{u_{c,t+N-1}\right\}$ appearing in the FOC also need to be parameterised concurrently and the steps need to be applied jointly to all conditional expectations.

Go to Step 2 with $\left(X_t^{core}, \alpha^1 X_t^{res,1}\right)$ in the role of X_t^{core}, find a new linear combination etc.

Two remarks end this subsection. In the presence of many state variables, it has been customary in dynamic economic models to try each state variable in order. The idea is to add state variables one by one until the next variable does not much change the solution found. For example, if many lags are needed, we add the first lag, then the second lag, and so on. If, at some step, the solution changes very little, it is claimed that the solution is sufficiently accurate. But it is easy to find reasons why this argument may fail. For instance, perhaps the variables further down the list are more relevant.[13] This is the case, by the way, in our model, where state variable λ_{t-N} and $b_{N,t-N}$ play a key role in determining the solution at t. Or it can be that all the remaining variables together make a difference but they do not make a difference one by one. Our method gives a chance to all these variables to make a difference in the solution. It is therefore more efficient in finding relevant state variables, as Step 3 indicates automatically if they are needed and which of them are to be introduced.

The whole argument in this section is made for linear conditional expectations, as in (21). Of course the same idea works for higher-order terms. In order to check the accuracy for higher-order terms, one can use the condensed PEA with the higher-order polynomial terms, ie one can check if linear combinations of, say, quadratic and cubic terms of X_t have predictive power in Step 2, include these in X_t^{out} and go through Steps 2 to 4 above.

The variables included in X_t^{core} are not the only ones influencing the solution. Due to the nature of PEA, past variables can have an effect even if they are excluded from the parameterised expectation. For example, even if we find a solution $X_t^{core} = \left(\lambda_{t-1}, b_{N,t-1}, g_t\right)$ that excludes λ_{t-N} and $b_{N,t-N}$ from the parameterised expectation these state variables will influence the solution at t through their presence in (9).

3.3 Solving the model with condensed PEA

The utility function (16) was convenient for obtaining the analytic results of Section 2.3. In this section we use a utility function more commonly used in DSGE models:

$$\frac{c_t^{1-\gamma_1}}{1-\gamma_1} + \eta \frac{x_t^{1-\gamma_2}}{1-\gamma_2}$$

We choose $\beta = 0.98$, $\gamma_1 = 1$ and $\gamma_2 = 2$. The choice of discount factor implies that we think of a period as one year. We set η such that if the government's deficit equals zero in the non-stochastic steady state, agents work a fraction of leisure of 30% of the time endowment. For the stochastic shock g, we assume the following truncated AR(1) process:

$$g_t = \begin{cases} \overline{g} & \text{if } (1-\rho)g^* + \rho g_{t-1} + \varepsilon_t > \overline{g} \\ \underline{g} & \text{if } (1-\rho)g^* + \rho g_{t-1} + \varepsilon_t < \underline{g} \\ (1-\rho)g^* + \rho g_{t-1} + \varepsilon_t & \text{otherwise} \end{cases}$$

13 For another example, incomplete market models with a large number of agents need as state variable all the moments of the distribution of agents, which is an infinite number of state variables. Usually these models are solved first by using the first moment as a state variable, and checking that, if the second moment is added, nothing much changes. But it could be, of course, that the third or fourth moment are the relevant ones, especially since the actual distribution of wealth is so skewed.

We assume $\varepsilon_t \sim N(0,1.44)^2, g^* = 25$, with an upper bound $\bar{g}$ equal to 35% and a lower bound $\underline{g} = 15\%$ of average GDP and $\rho = 0.95$. $\bar{M}$ is set equal to 90% of average GDP and $\underline{M} = -\bar{M}$.

We choose $X_t^{core} = (\lambda_{t-1}, b_{N,t-1}, g_t)$ hence $X_t^{out} = (b_{N,t-2},..., b_{N,t-N}, \lambda_{t-2},..., \lambda_{t-N})$. To test if sufficient variables are included for an accurate solution in Step 3 we use as our tolerance statistic:

$$dist = \frac{R_{aug}^2 - R^2}{R^2}$$

where R^2 and R_{aug}^2 denote the goodness of fit of the original regression based on the condensed PEA and augmented with the linear combination of residuals respectively. We use for tolerance criterion $dist \le 0.0001$. Table 2 summarises the number of linear combinations needed for each maturity whilst Table 3 gives details and shows the number of linear combinations needed for each approximations and the R^2 and $dist$.

Table 2

Holding-to-redemption model:
linear combinations introduced with condensed PEA

N	$2N+1$	Number of linear combinations		
		Φ_λ	Φ_{uc_N}	$\Phi_{uc_{N-1}}$
1	3	–	–	–
2	5	0	1	0
5	11	0	1	0
10	21	0	1	0
15	31	1	1	0
20	41	1	1	1

Note: recall that N denotes maturity and $2N+1$ is the dimension of the state vector. In all cases X^{core} has three variables. "# of linear comb" refers to how many linear combinations of X^{out} had to be added to satisfy the accuracy criterion. We denote each expectation to be approximated by $\Phi_\lambda = E_t\left(u_{c,t+N}\lambda_{t+1}\right)$, $\Phi_{uc_N} = E_t\left(u_{c,t+N}\right)$ and $\Phi_{uc_{N-1}} = E_t\left(u_{c,t+N-1}\right)$.

The advantages of the condensed PEA are readily apparent. In nearly half the cases the core variables are sufficient to solve the model and, at most, only one linear combination of omitted variables is required to improve accuracy. Clearly the condensed PEA can be used to solve models with large state spaces with relatively small computational cost, since the state vector is in principle of dimension 41 but utilising a dimension of 4 is sufficient. Whilst we have focused on a case of optimal fiscal policy and debt management, this methodology clearly has much broader applicability.

Table 3

Benchmark model: accuracy measures in condensed PEA

N		Adding 1 linear comb			Adding 1 linear comb		
		Φ_{λ}	Φ_{uc_N}	$\Phi_{uc_{N-1}}$	Φ_{λ}	Φ_{uc_N}	$\Phi_{uc_{N-1}}$
2	# lin comb in	0	0	0	0	1	0
	R^2_{aug}	0.9208	0.7533	0.8669	0.9209	0.7535	0.8669
	dist	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000
5	# lin comb in	0	0	0	0	1	0
	R^2_{aug}	0.9069	0.5022	0.5751	0.9070	0.5026	0.5754
	dist	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000
10	# lin comb in	0	0	0	0	1	0
	R^2_{aug}	0.8911	0.2630	0.2991	0.8909	0.2632	0.2993
	dist	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000
15	# lin comb in	0	0	0	1	1	0
	R^2_{aug}	0.8814	0.1422	0.1609	0.8831	0.1446	0.1635
	dist	0.0001	0.0002	0.0000	0.0000	0.0000	0.0000
20	# lin comb in	0	0	0	1	1	1
	R^2_{aug}	0.8751	0.0788	0.0886	0.8771	0.0807	0.0907
	dist	0.0002	0.0003	0.0002	0.0000	0.0000	0.0000

Note: see Note of previous Table. R^2_{aug} and *dist* are defined in Section 3.3.

3.4 Optimal policy: the impact of maturity

3.4.1 Interest rate twisting

We compute the policy functions[14] and display the implied response functions of key variables to an unexpected shock in g_t in Figures 1 and 2. The vertical axis is in units of each of the variables and expresses deviations from the value that would occur for the given initial condition if $g_t = g^{ss}$.

Figure 1 is for the case when the government has zero debt on impact. It shows minor differences between long and short bonds. As usual in models of incomplete markets, it is optimal to use debt as a buffer stock so that debt displays considerable persistence.

[14] Since debt is very persistent, to ensure we visit all possible realisations in the long-run simulations of PEA we initialise the model at nine different initial conditions, simulate it for 5,000 periods for each initial condition, doing this 1,000 times per initial condition, and compute conditional expectations discarding the first 500 observations for each simulation.

Figure1

Responses to a shock in g_t ,

benchmark model maturities 1 and 10: $b_{N,-1} = 0$

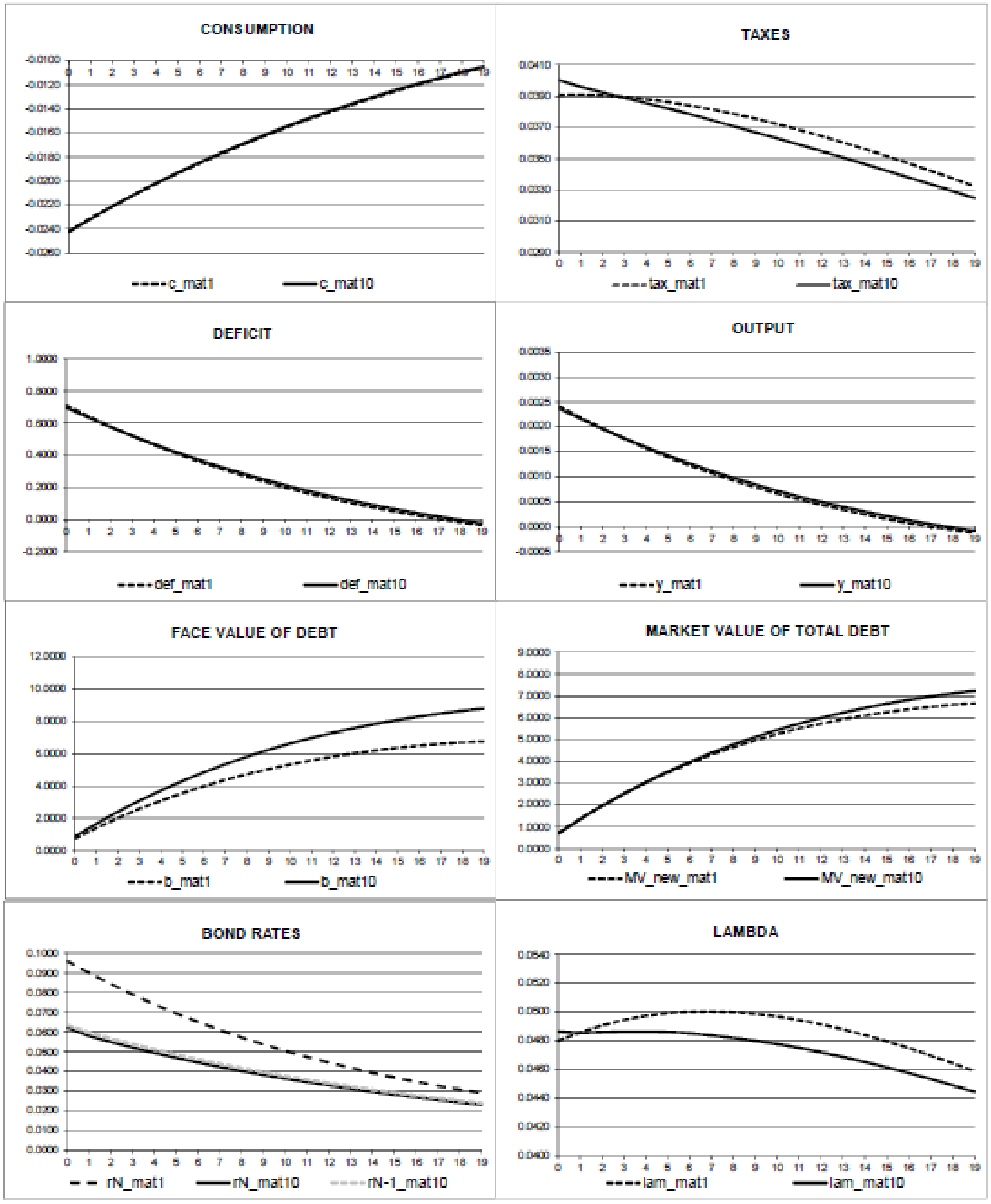
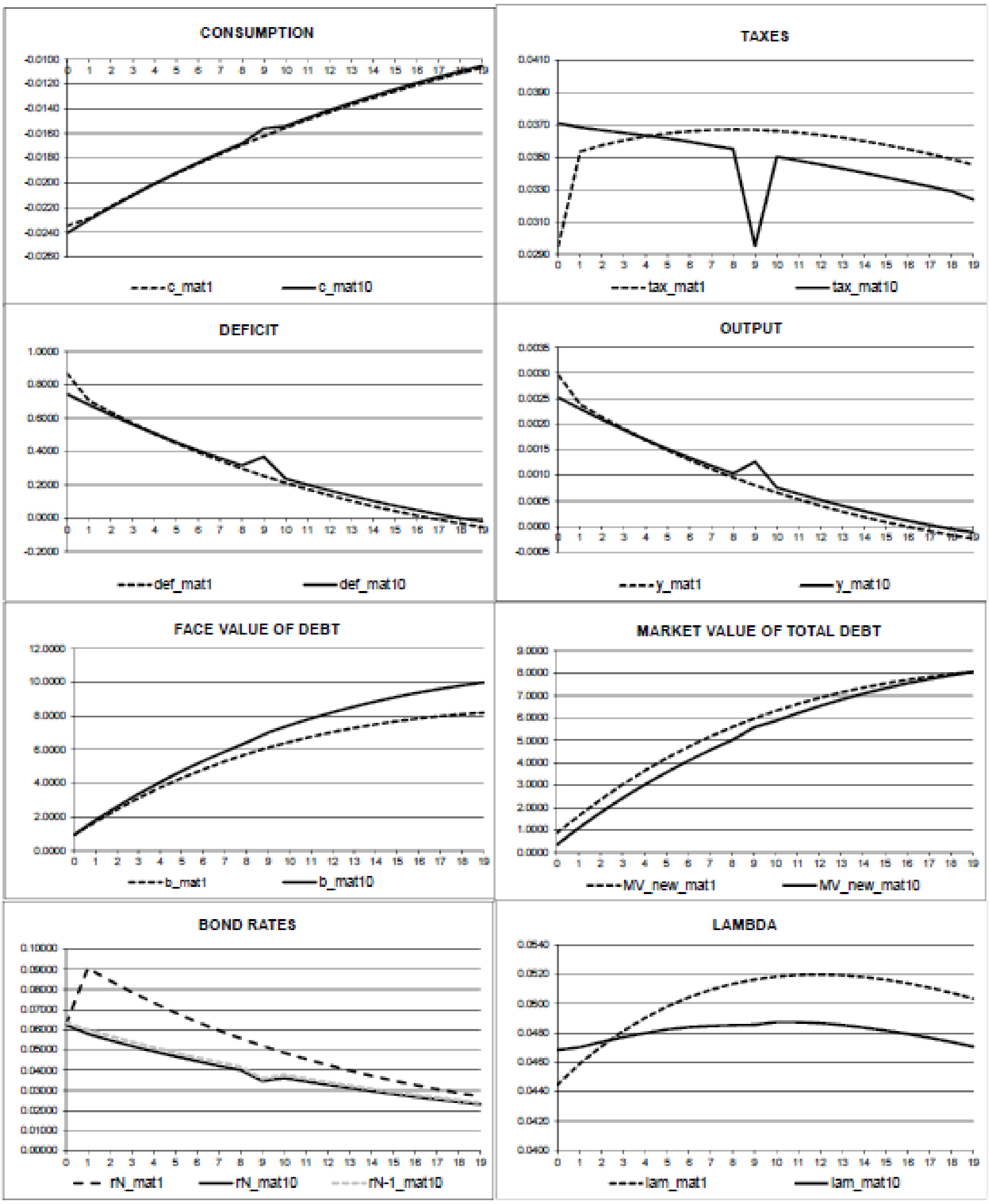


Figure 2 shows the same impulse response functions when we assume the government is indebted on impact, more precisely $b_{N,t-1} = 0.5\, y^{*} / \beta^{N}$ where y^{*} is steady state output.

Figure 2

Responses to a positive shock in g_t,

benchmark model maturities 1 and 10: $b_{N,-1} = \dfrac{0.5y^*}{\beta^N}$



We see that with long bonds of maturity $N = 10$ there is a blip in taxes at the time of maturity of the outstanding bonds. This is a reflection of the promise to cut taxes with the aim to twist interest rates as discussed in Section 2.3, only now the interest rate twisting occurs each period there is an adverse shock.

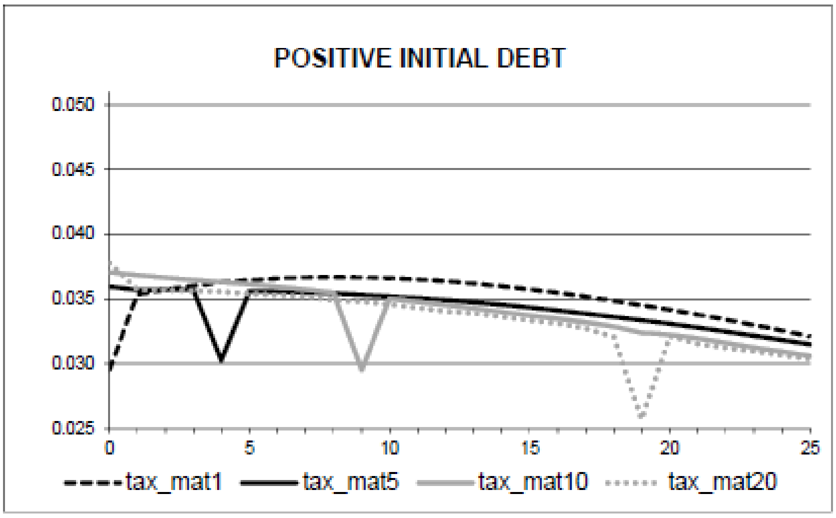
3.4.2 *Optimal policy with short bonds*

This discussion helps to elucidate the role of commitment in the model of short-term bonds as in Aiyagari et al (2002). Consider the case where the government is indebted when an adverse shock occurs, as in Figure 2. As we explained in Section 2.3, optimal policy is to increase current taxes but promise a tax cut in $N-1$ periods. In the case of long bonds, the promised tax cut is clearly distinct from the current increase in taxes. But in the case of short bonds $N=1$ the two effects are confounded as they happen in the same period.

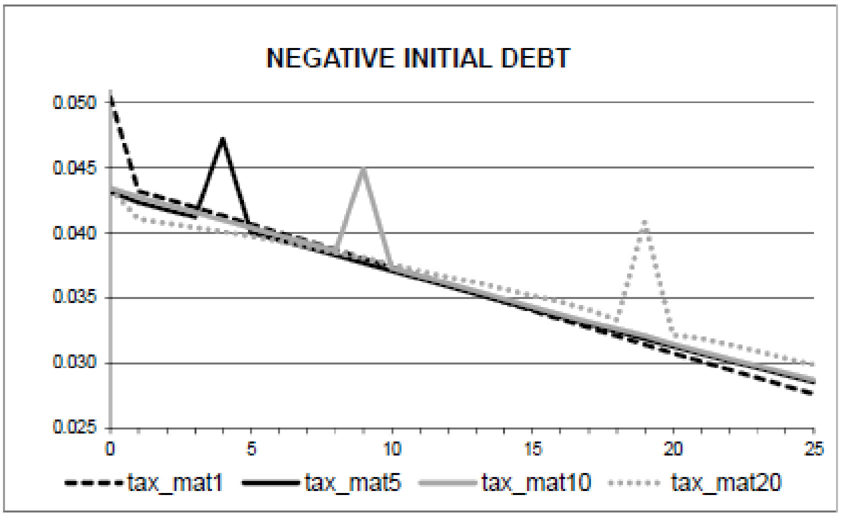
Figure 3

Responses to a positive shock in g_t,
benchmark model maturities 1, 5, 10 and 20:

Taxes: $b_{N,-1} = \dfrac{0.5y^*}{\beta^N}$



Taxes: $b_{N,-1} = -\dfrac{0.5y^*}{\beta^N}$



This is clearly seen in the response of taxes depicted in Figure 3 for maturities $N=1,5,10,20$. Given our previous discussion, it is clear why the blip in taxes keeps moving to the left as we decrease the maturity until the blip simply reduces the reaction of taxes on impact at $N=1$.

Therefore optimal policy for short bonds is to increase taxes on impact but less than would be done if considerations of interest rate twisting were absent.

In the case where the government has assets, the blip in taxes goes upwards, as the government desires to increase the value of assets. This is shown in the response of taxes for the case of assets shown in Figure 3. So, comparing the dashed lines in the response of taxes in Figures 3, it is clear that, for short bonds, the increase in taxes on impact if the government initially has assets is much larger than if the government is indebted.

3.4.3 The level of debt, persistence

Table 4 shows second moments for the economy at steady state distribution for different maturities. Most of the moments differ only to the second or third decimal place across maturities. The main exceptions are the levels of debt and deficit: the government on average holds assets but less under longer maturity. The value of assets when bonds are of 20 years halves the average debt for short bonds.

Table 4

Second moments, steady state

Model: Benchmark model

	N	c	y	τ	Deficit	R_N	$MV = p_N b_N$	λ
mean	**1**	52.60	70.11	0.243	0.42	2.02	–24.68	0.057
	5	52.58	70.08	0.245	0.32	2.02	–19.21	0.058
	10	52.56	70.06	0.246	0.25	2.03	–16.28	0.058
	20	52.54	70.05	0.247	0.17	2.03	–12.46	0.059
std	**1**	3.49	0.35	0.044	1.46	0.5	27.26	0.013
	5	3.48	0.37	0.043	1.57	0.4	30.96	0.013
	10	3.48	0.38	0.044	1.59	0.3	31.97	0.013
	20	3.48	0.39	0.044	1.66	0.2	32.84	0.014

Note: to provide a more interpretable quantity we report annualised interest rates instead of bond prices, namely $R_N = \left(\left(p_N \right)^{-\frac{1}{N}} - 1 \right) 100$.

The intuition for the lower level of assets as maturity grows is as follows. It is well known that in models of optimal policy with incomplete markets, if the government has the same discount factor as agents, the government accumulates assets in the long run. More precisely, it is easy to extend the results in Aiyagari et (2002) Section III for the case of a linear utility of consumption $u(c) = c$ to prove that government assets go to a very high level.

Therefore it is not surprising that all steady states for debt have a negative mean. On the other hand it is also well known that, with long bonds, fiscal insurance recommends that the government issues long bonds. As argued in Angeletos (2002) and Buera and Nicolini (2004), governments should issue long bonds in a model without capital accumulation because long interest rates are higher when the government runs deficits, so that issuing long bonds provides fiscal insurance. Nosbusch (2008) argues that the same tendency for issuing long debt is present in an incomplete markets model. For the same reason, if a government accumulates debt in long bonds, the implied volatility of taxes will be higher. It is therefore not surprising that long-run debt is lower for longer maturities, as holding long bonds causes taxes to be more volatile. In other words, accumulating assets of long maturity is detrimental to fiscal insurance. This is not the case with short bonds, as they provide fiscal insurance when issued. Therefore the level of assets is lower for longer maturities.

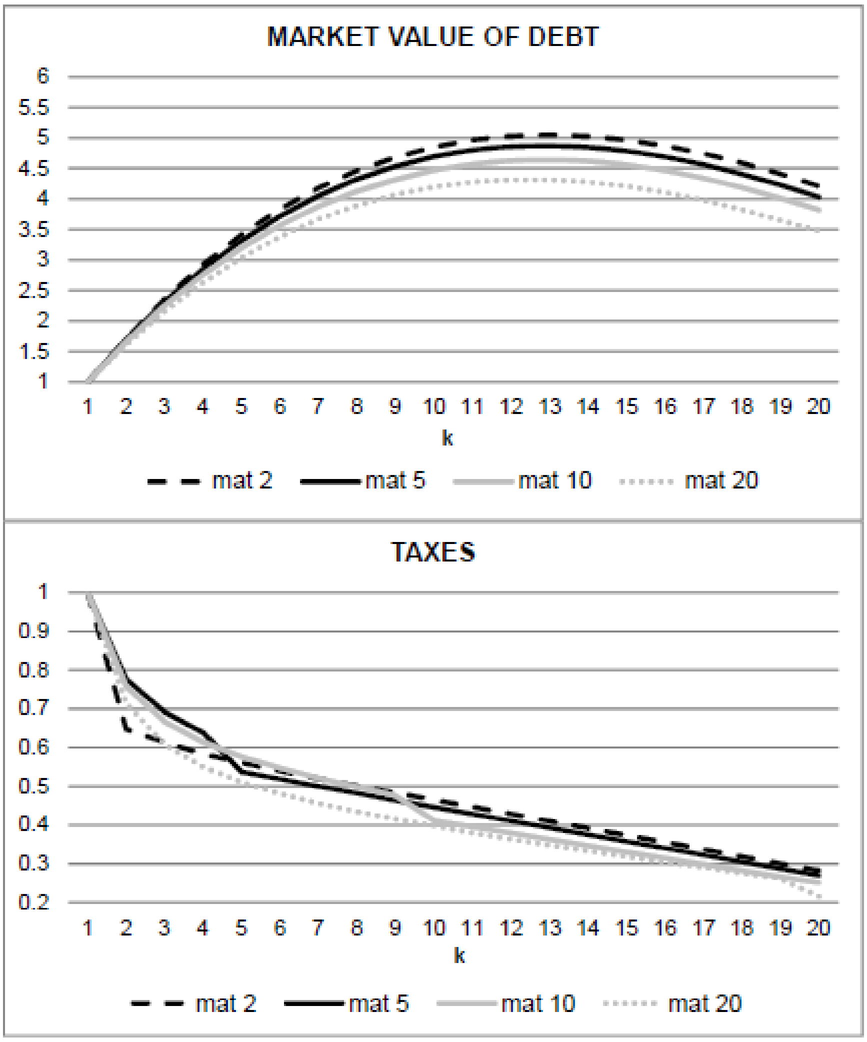
Given that average asset holdings are lower, it is natural that average primary deficits are lower for higher N, since the value of assets is equal to the expected present value of primary deficits also under incomplete markets. For this reason, also, taxes are higher in steady state for higher N.

Another way of examining the impact of varying the average maturity of debt is to see whether this influences how close to the complete market outcome these incomplete market models can get. Marcet and Scott (2009) show that measures of relative persistence are a good way of assessing the extent of market incompleteness and so Figure 4 shows for various variables the measure:

$$P_y^k = \frac{Var\left(y_t - y_{t-k}\right)}{kVar\left(y_t - y_{t-1}\right)}.$$

Figure 4

k-variances, benchmark model maturities 2, 5, 10 and 20:



The closer to 0 this measure, the less persistence the variable shows, whereas the closer to 1 the measure, the more the variable shows unit root persistence. Although the long bond model shows less persistence, suggesting that, in the case of persistent government expenditure shocks, the issuance of longer bonds helps provide more fiscal insurance, the difference between the two cases are minor. Given that taxes are distortionary, we are not in a Modigliani-Miller world and how the government finances its expenditure can affect the real economy. However, the fact that the differences across maturities are so small is perhaps not surprising. With the government only issuing one type of bond in each case and the yield curve showing broadly similar behaviour at different maturities, the tax-smoothing properties of debt issuance are achieved mainly through the role of debt as a buffer rather than through fiscal insurance. Further, we are at this point following the rest of the literature in assuming that every period the government buys back all existing debt and then reissues. So, although the government is issuing 10-period bonds, it always buys them back after a year. Thus, it is effectively always borrowing through one-period debt, reducing the distinction between one-period and 10-period bonds. We shall return to this issue in a later section.

4. Independent powers

In Sections 2 and 3, we found that full commitment implied a tight connection between interest rate policy, debt management and tax policy: when government is in debt and spending is high the government promises a tax cut in $N-1$ periods, knowing that this will increase future consumption and thus increase long interest rates in the current period. The reader may think that this optimal policy is not relevant for the "real world" for at least two reasons. First, as different authorities influence interest rates and fiscal policy, it is unlikely that they will coordinate in the way described above and, second, it is unlikely that governments can commit to a tax cut in the distant future and actually carry through with the promise. Some papers in the literature react to this type of criticism by writing down models where government policy is discretionary. But the assumption that the government has no possibility of committing is also problematic, as governments frequently do things for the very reason they have previously committed to do so.

For these reasons, we change the way policy is decided in this model. We relax the assumption of perfect coordination and assume the presence of a third agent, a monetary authority that fixes interest rates in every period. The fiscal authority now takes interest rates as given and implements optimal policy given these interest rates. We examine an equilibrium where the two policy powers play a dynamic Markov Nash equilibrium with respect to the strategy of the other policy power and they both play Stackelberg leaders with respect to the consumer. More precisely, the fiscal authority chooses taxes and debt given a sequence for interest rates, while the monetary authority simply chooses interest rates that clear the market and the fiscal authority maximises the utility of agents. This assumption sidesteps the issues of commitment, because there is now no room for interest rate twisting on the part of the fiscal authority. It is easy to think of models where, even if the monetary authority is independent, it can not deviate too much from the equilibrium interest rates of the flexible price model. Therefore we take a limit case and assume that the monetary authority simply sets in equilibrium interest rates as:

$$p_{N,t} = \frac{\beta^N E_t\left(u_{c,t+N}\right)}{u_{c,t}} \tag{24}$$

$$p_{N-1,t} = \frac{\beta^{N-1} E_t\left(u_{c,t+N-1}\right)}{u_{c,t}}.$$

given agents' consumption. Now the fiscal authority will not be able to manipulate interest rates, so it will lose any interest in making promises to cut future taxes. To solve this model we are looking for an interest rate policy function $\Re : R^2 \to R^2$ such that if long interest rates at t are given by

$$\left(p_{N,t}^{-1}, p_{N,t-1}^{-1}\right) = \Re\left(g_t, b_{N,t-1}\right) \tag{25}$$

then (24) holds and with the fiscal authority maximising consumer utility in the knowledge of all market equilibrium conditions but, taking the stochastic process for interest rates as given, it chooses a bond policy such that (25) holds. For the fiscal authority, the problem now is a standard dynamic programming one and as a result the state space now only consists of the variables $b_{N,t-1}$ and g_t. An advantage of this model is that there is no reason now for longer lags to enter this state vector, as past Lagrange multipliers do not play a role. Therefore, this separation of powers approach is an alternative way to reducing the state space and simplifying the model's solution.

In this case of independent powers, the Lagrangian of the Ramsey planner becomes

$$\begin{aligned} L = E_0 \sum_{t=0}^{\infty} \beta^t \Big\{ & u(c_t) + v(x_t) + \lambda_t \left[S_t + p_{N,t} b_{N,t} - p_{N,t-1} b_{N,t-1} \right] \\ & + \nu_{1,t} \left(\bar{M} - \beta^N b_{N,t} \right) + \nu_{2,t} \left(\beta^N b_{N,t} - \underline{M} \right) \Big\} \end{aligned} \tag{26}$$

The first-order condition with respect to consumption is

$$\mathrm{u}_{c,t} - \mathrm{v}_{x,t} + \lambda_t (\mathrm{u}_{cc,t} \mathrm{c}_t + \mathrm{u}_{c,t} + \mathrm{v}_{xx,t} (\mathrm{c}_t + \mathrm{g}_t) - \mathrm{v}_{x,t}) + \mathrm{u}_{cc,t} \lambda_t (\mathrm{p}_{N,t} \mathrm{b}_{N,t} - \mathrm{p}_{N-1,t} \mathrm{b}_{N,t-1}) = 0$$

and using the government's budget constraint gives

$$u_{c,t} - v_{x,t} + \lambda_t \left(u_{cc,t} c_t + u_{c,t} + v_{xx,t} (c_t + g_t) - v_{x,t} \right) + u_{cc,t} \lambda_t \left(g_t - \left(1 - \frac{v_{x,t}}{u_{c,t}} \right) (1 - x_t) \right) = 0 \tag{27}$$

To see the impact of independent powers, we calibrate the model as in Section 3 and consider the case $N = 10$. Figure 5 compares the impulse responses to a one standard deviation shock to the innovation in the level of government spending when the government has debt between independent powers and the benchmark model of Section 3. As can be seen, the model of independent powers does not show the blip in taxes at maturity. In this case, debt management is subservient to tax-smoothing and is aimed at lowering the variance of deficits.

To better understand the magnitude of the interest twisting channel, we can compare our independent powers model with our earlier benchmark model. We simulated the model at different time horizons $T = 40$, $T = 200$ and $T = 5000$ discarding the first 500 periods. We calculated the standard deviation of taxes for each realisation and we averaged it across simulations. We repeat the same exercise for $\mathrm{N} = 2, 5, 10, 15, 20$. Figure 6 shows the results.

In shorter sample periods, the effect of twisting interest rates in connection with initial period debt is significant and provides a higher level of tax volatility in the benchmark model. Naturally, as we increase the sample size the initial period effect diminishes.

The second moments of the model in this section are shown in Table 5. They are extremely similar to those of the benchmark model in Table 4. We have essentially a very similar amount of bond issuance, debt persistence, tax-smoothing etc, the only difference being that the interest rate twisting adds some tax volatility, but this volatility shows up only in second moments with short samples as shown in Figure 6. We conclude that the model of independent powers may be a good model to have in the toolkit as it retains many of the interesting features of the Ramsey models, it has the same steady state moments, it avoids the technicalities arising from the very large state vector and it avoids discussion on the role to commitment at very long horizons. There are, however, issues of tax volatility showing up in small samples where the two models differ.

Figure 5

Responses to a positive shock in g_t,
benchmark and independent power model

Maturity 10: $b_{N,-1} = \dfrac{0.5y^*}{\beta^N}$

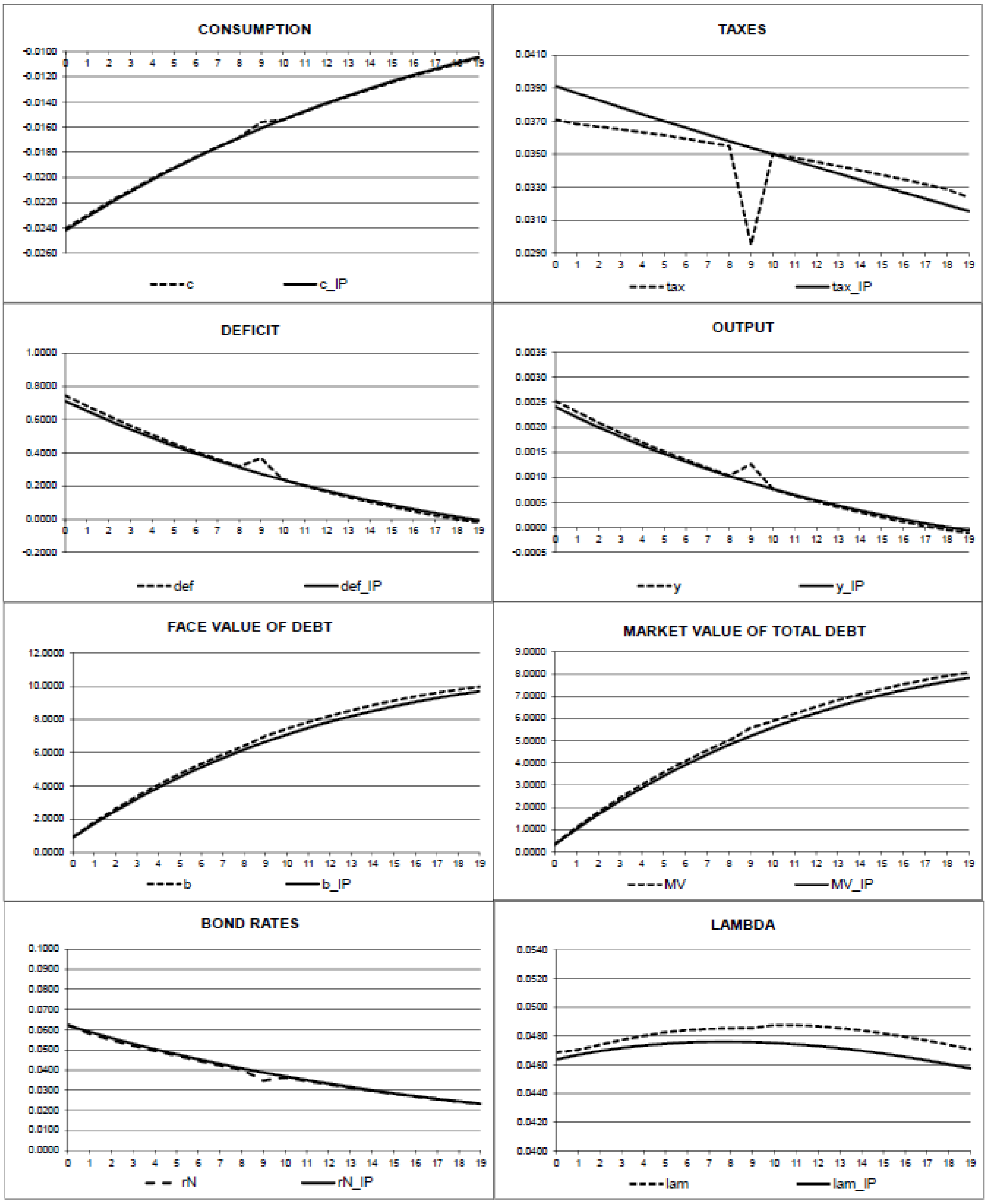


Figure 6

Tax volatility at different horizons: benchmark and independent powers model

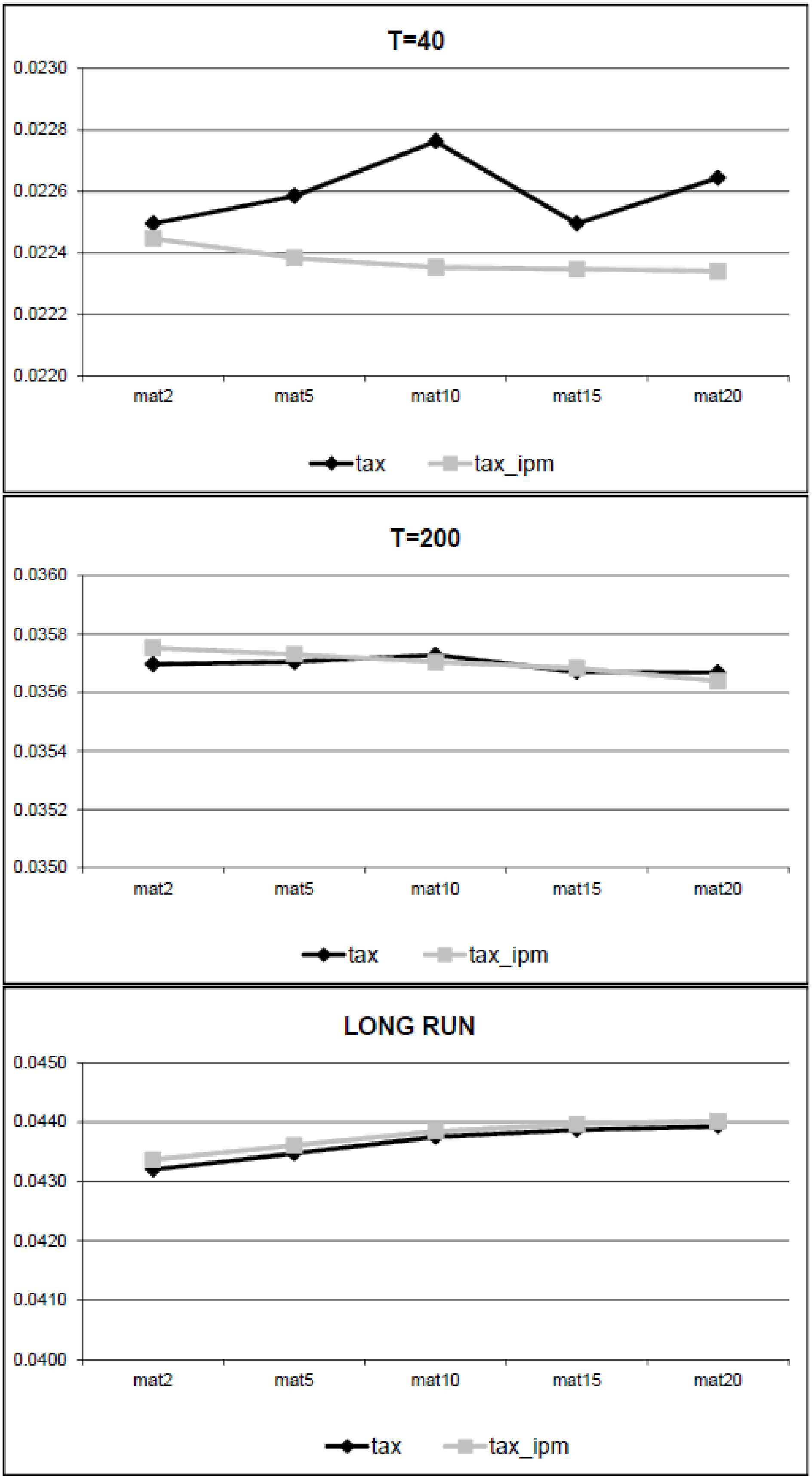


Table 5

Second moments, steady state

Model: Independent powers

	N	c	y	τ	deficit	R_N	$MV = p_N b_N$	λ
mean	**1**	52.60	70.10	0.244	0.41	2.02	–23.54	0.057
	5	52.58	70.08	0.245	0.32	2.02	–19.49	0.058
	10	52.56	70.07	0.246	0.26	2.03	–16.40	0.058
	20	52.54	70.05	0.247	0.17	2.03	–12.31	0.059
std	**1**	3.49	0.34	0.044	1.43	0.5	27.88	0.013
	5	3.48	0.36	0.044	1.51	0.4	31.11	0.013
	10	3.48	0.37	0.044	1.54	0.3	32.20	0.013
	20	3.49	0.37	0.044	1.56	0.2	33.20	0.014

5. Hold to redemption

With long bonds, the government has a choice to make at the end of every period. It can buy back the N period bonds issued last period, as assumed in Sections 2 and 3. Alternatively it can leave some or all of the outstanding bonds in circulation until they mature at their specified redemption date. In models of complete markets, whether or not there is buyback in each period is immaterial: all prices and allocations remain unchanged. But in this paper there are two reasons why the outcome is different. The first reason is that the stream of payoffs generated by each policy is quite different from the point of view of the government: with buyback the bond pays the random payoff $p_{N-1,t+1}$ next period; if the bond is left in circulation until maturity the bond pays 1 with certainty at $t+N$. As is well known, under incomplete markets not only the present value of payoffs of an asset are relevant; the timing of payoffs also matters. A second reason for the differences is that the possibilities for governments to twist interest rates are different.

In Section 2 we made the extreme assumption that the government each period buys back the whole stock of outstanding bonds issued last period. As shown in Marchesi (2004), it is normal practice for governments not to buy back debt – debt is issued and it is paid off at maturity. In this section, we assume that bonds are left to mature to their redemption date. In the case of buyback there are only N-period bonds outstanding. In the case of holding to redemption, there exist bonds at all maturities between 1 and N even though the government only issues N period bonds. Although we model the implications of holding to redemption, an explanation for why no buyback is standard practice[15] is considered beyond the scope of this paper.

In this section, we set up a model where debt managers do not buy back debt at the end of each period, show how full commitment gives rise to a different kind of interest rate twisting,

[15] Conversations with debt managers suggest some combination of transaction costs, a desire to create liquid secondary markets at most maturities or worries over refinancing risk. For simplicity we rule out a third possibility – that governments choose to buy back only a certain proportion of outstanding debt.

outline how to use condensed PEA to solve for optimal fiscal policy and we show the behaviour of the model. Since we follow closely the analysis of Sections 2 and 3 we omit some details and focus on the differences.

The economy is as before except that the government budget constraint is now

$$b_{N,t-N}^{HTR} = \tau_t \left(1 - x_t\right) - g_t + p_{N,t} b_{N,t}^{HTR} \tag{28}$$

so that the payment obligations of the government at t are the amount of bonds issued at $t - N$.

We include the debt limits

$$\underline{M} \leq b_{N,t}^{HTR} \sum_{i=1}^{N} \beta^i \leq \bar{M} \tag{29}$$

Again, this limit mimics the value of the newly issued debt at steady state prices: if the government issued b_N bonds at all periods it would have b_N units of bonds of maturities $1,2,...,N$ outstanding so the total value of debt at steady state would be $\sum_{i=1}^{N} \beta^i b_N^{HTR}$. The budget constraint of the household's problem changes in a parallel way.

5.1 Optimal policy with maturing debt

Substituting in equilibrium bond prices and wages net of taxes (28) becomes

$$s.t. \qquad b_{N,t.N}^{HTR} u_{c,t} = s_t + \beta^N E_t \left(u_{c,t+N}\right) b_{N,t}^{HTR} \tag{30}$$

The Ramsey problem is now to maximise utility (2) over choices of $\left\{c_t, b_{N,t}^{HTR}\right\}$ subject to this constraint and the debt limits (29) for all t. The Lagrangian becomes

$$L = E_0 \sum_{t=0}^{\infty} \beta^t \Big\{ u\left(c_t\right) + v\left(x_t\right) + \lambda_t \left[S_t + \beta^N u_{c,t+N} b_{N,t}^{HTR} u_{c,t}\right]$$
$$+ \nu_{1,t} \left(\underline{M}^{HTR} - b_{N,t}^{HTR}\right) + \nu_{2,t} \left(b_{N,t}^{HTR} - \bar{M}^{HTR}\right) \Big\}$$

where λ_t is the Lagrange multiplier associated with (30), $\nu_{1,t}$ and $\nu_{2,t}$ are the ones associated with the debt limits and $\underline{M}^{HTR} \equiv \underline{M} \left(\sum_{i=1}^{N} \beta^i\right)^{-1}$, $\bar{M}^{HTR} \equiv \bar{M} \left(\sum_{i=1}^{N} \beta^i\right)^{-1}$.

The first-order conditions with respect to c_t and $b_{N,t}^{HTR}$ are

$$u_{c,t} - v_{x,t} + \lambda_t \left(u_{cc,t} c_t + u_{c,t} + v_{xx,t} \left(c_t + g_t\right) - v_{x,t}\right) + u_{cc,t} \left(\lambda_{t-N} - \lambda_t\right) b_{N,t-N}^{HTR} = 0 \tag{31}$$

$$E_t \left(u_{c,t+N} \lambda_{t+N}\right) = \lambda_t E_t \left(u_{c,t+N}\right) + \nu_{2,t} - \nu_{1,t} \tag{32}$$

With $\lambda_{-1} = ... = \lambda_{-M} = 0$.

In short, these FOC have two differences relative to the buyback case: in equation (31) we now have $(\lambda_{t-N} - \lambda_t)$ instead of $(\lambda_{t-N} - \lambda_{t-N+1})$ and we now have λ_{t+N} instead of λ_{t+1} in the martingale condition (32)[16].

5.2 No uncertainty and hold to redemption

Let us now consider the no uncertainty case when $g_t = \bar{g}$. Proceeding in an analogous way to the case of Section 2.2 we could write the implementability constraint as

$$\sum_{t=0}^{\infty} \beta^t \frac{u_{c,t}}{u_{c,0}} \tilde{S}_t = \sum_{i=1}^{N} b_{N,-i}^{HTR} p_{N-i,0}\text{, or} \tag{33}$$

$$\sum_{t=0}^{\infty} \beta^t S_t = \sum_{i=1}^{N} b_{N,-i}^{HTR} \beta^{N-i} u_{c,N-i} \tag{34}$$

for $p_{0,t} \equiv 1$. Bonds issued in periods $i = -1, -2, ..., . -N$ appropriately appear in the right side of the above constraint, as what matters now is the total value of debt initially.

Let us consider the problem of maximising utility when (34) is the sole implementability constraint. If the government is in debt with $b_{N,-i}^{HTR} > 0$ for all $i = 1, ..., N$ it is clear that in this case interest rate twisting will involve changing interest rates in the first $N-1$ periods hence the government will promise to cut taxes in all periods between $t = 0, ..., N-1$. The FOC for consumption indicates that the tax cut will be larger for periods $t = 0, ..., N-1$ where the maturing debt $b_{N,t-N}^{HTR}$ is larger. Therefore tax cuts now last N periods. For $t \geq N$ consumption and taxes are constant.

But assuming that (34) is the sole implementability constraint as we did in the previous paragraph is not correct for our model. It would be correct in a slightly different model, where the debt limits would be in terms of the total value of debt, for example, if debt limits would be

$$\underline{M}^{MV} \leq \sum_{i=1}^{N} b_{N,t-i}^{HTR} p_{N-i,t} \leq \bar{M}^{MV} \tag{35}$$

Take for simplicity the case $N = 2$. It is clear that the optimal allocation described in the previous paragraph can be implemented for bond issuances satisfying $b_{N,t-2}^{HTR} + \beta \frac{u_{c,t+1}}{u_{c,t}} b_{N,t-1}^{HTR} = \sum_{j=0}^{\infty} \beta^j S_{t+j}$ for all $t = 0, 1, ...$ Given initial conditions this provides a difference equation on b_N that satisfies the period-t budget constraint (30) and the value of debt limits if $\underline{M}^{HTM}$ and $\bar{M}^{HTM}$ were sufficiently large in absolute value.

But, for our model, (34) is not sufficient for an equilibrium. This is perhaps surprising, as we think that without uncertainty and one asset one can always complete the markets for sufficiently high debt limits. To see this point, notice that for the optimal allocation described above the surplus is constant, equal to a level, say $\tilde{S}$, for all $t \geq N$. The bonds that would satisfy the period t budget constraint satisfy $b_{N,t-2}^{HTR} + \beta b_{N,t-1}^{HTR} = \frac{\tilde{S}}{1-\beta}$ for all $t = N, N+1, ...$ This path for bonds would satisfy the difference equation

[16] In the case of hold to redemption, the assumption of independent powers would not simplify the analysis in terms of reducing the state space. One would still need N lags of b_N as state variables.

$$b_{N,t}^{HTR}=\frac{\tilde{S}}{(1-\beta)\beta}-\beta^{-1}b_{N,t-1}^{HTR}\ t=N,N+1,... \quad (36)$$

which in general is an unstable difference equation in $b_{N,t}^{HTR}$. Normally the values of $b_{N,t}^{HTR}$ satisfying this equation will explode geometrically to plus and minus infinity, alternating sign. The sequence that is compatible with the non-explosive wealth of the government implies that the debt limits (29) are violated. Therefore, (34) is not sufficient for an equilibrium.

The intuition that one asset completes the markets for no uncertainty if the debt limits are sufficiently loose is only correct if the debt limits are in terms of the value of debt, but not in terms of the actual asset issued. Bond issuance each period in absolute value goes to infinity, constant wealth is only achieved because of the alternation in signs of b_t^{HTR} each period. Of course, one modelling solution would be to assume that debt limits are in terms of the value of debt as in (35), but we believe limits on bonds as in (29) are the more relevant constraint. After all the bond markets are extremely concerned with gross issuance of bonds each period.

This argument shows that, with long bonds, we can not use (34) as the only implementability condition; we need to keep the budget constraint (30) in all periods in the analysis. The following result shows the actual behaviour of optimal policy. Essentially, we show that optimal policy induces higher tax volatility for two reasons: (i) there are cycles of length N, (ii) interest rate twisting is permanent, and the reduction in taxes lasts N periods.

Result 2. *Assume $b_{N,-i}^{HTR}>0$ for all $i=1,...,N$. Optimal policy for the model in this section is that there are cycles of order N in taxes and in bonds. More precisely*

$$\tau_i=\tau_{tN+i} \qquad i=N,...,2N-1 \text{ for all } t=1,2,...$$

and

$$b_{N,i}^{HTR}=b_{N,tN+i}^{HTR} \quad i=0,...,N-1, \text{ for all } t=1,2,...$$

Assume further the standard utility function where higher λ (in a complete markets case) would imply lower taxes, as for example happens with the utility (16), then

$$\tau_{i+N}>\tau_i \quad i=0,...,N-1$$

Furthermore, if $b_{2,-2}^{HTR}>b_{2,-1}^{HTR}$ then $\tau_0<\tau_1$

Proof

Consider the case $N=2$. It is clear from the martingale condition (32) that

$$\lambda_t=\lambda_0 \text{ for all } t>0, t \text{ even}$$

$$\lambda_t=\lambda_1 \text{ for all } t>1, t \text{ odd}$$

Therefore

$$\begin{aligned}&u_{c,t}-v_{x,t}+\lambda_0\left(u_{cc,t}c_t+u_{c,t}+v_{xx,t}\left(c_t+\bar{g}\right)-v_{x,t}\right)=0 \text{ for all } t\geq 2, t \text{ even}\\&u_{c,t}-v_{x,t}+\lambda_1\left(u_{cc,t}c_t+u_{c,t}+v_{xx,t}\left(c_t+\bar{g}\right)-v_{x,t}\right)=0 \text{ for all } t\geq 3, t \text{ odd}\end{aligned} \quad (37)$$

notice the only difference between even and odd is in the Lagrange multiplier λ. This proves

$$\begin{aligned}&c_t=c_2, \tau_t=\tau_2 \text{ for all } t>2, t \text{ even}\\&c_t=c_3, \tau_t=\tau_3 \text{ for all } t>3, t \text{ odd}\end{aligned} \quad (38)$$

The budget constraint (30) can be rolled forward as follows

$$b_{2,t-1}^{HTR} = S_t + \beta^2 \frac{u_{c,t+2}}{u_{c,t}} b_{2,t}^{HTR} = S_t + \beta^2 \frac{u_{c,t+2}}{u_{c,t}} S_{t+2} + \beta^4 \frac{u_{c,t+4}}{u_{c,t}} b_{N,t}^{HTR} = ...$$

Using debt limits we conclude

$$b_{2,t-2}^{HTR} = \sum_{j=0}^{\infty} \beta^{2j} \frac{u_{c,t+2j}}{u_{c,t}} S_{t+2j} \quad \text{for all } t = 0,1,...$$

This combined with (38) implies

$$b_t^{HTR} = b_0^{HTR} = \frac{S_2}{1-\beta^2} \text{ for all } t \geq 0, t \text{ even}$$

$$b_t^{HTR} = b_1^{HTR} = \frac{S_3}{1-\beta^2} \text{ for all } t \geq 1, t \text{ odd}$$

The only statement left to prove are the tax cuts in periods $t = 0,1$. For periods $t = 0,1$ we have

$$u_{c,0} + v_{x,0} + \lambda_0 \left(u_{cc,0} c_0 + u_{c,0} + v_{xx,0} \left(c_0 + \bar{g} \right) - v_{x,0} \right) - u_{cc,0} \lambda_0 b_{2,-2}^{HTR} = 0$$
$$u_{c,1} + v_{x,1} + \lambda_1 \left(u_{cc,1} c_1 + u_{c,1} + v_{xx,1} \left(c_1 + \bar{g} \right) - v_{x,1} \right) - u_{cc,1} \lambda_1 b_{2,-1}^{HTR} = 0$$

Notice that the difference with (37) for $t > 1$ is the presence of the terms $u_{cc,0} \lambda_0 b_{2,-2}^{HTR}$ and $u_{cc,1} \lambda_1 b_{2,-1}^{HTR}$. These are clearly negative, implying that for the considered utility functions we have

$$\tau_2 > \tau_0$$
$$\tau_3 > \tau_1$$

The statement in the last line follows immediately from the last FOC written. ■

These results could be easily extended to the case of uncertainty only in period $t = 1$ as in Section 2.3.1, to show that if an adverse shock to g occurs taxes are lowered for the next $N - 1$ periods and there is a cycle of order N.

5.3 Numerical solutions

To write the model recursively, we observe that the Lagrangean can be rewritten as

$$\begin{aligned} L = E_0 \sum_{t=0}^{\infty} \beta^t \Big\{ & u(c_t) + v(x_t) + \lambda_t S_t + u_{c,t} \left(\lambda_{t-N} - \lambda_t \right) b_{N,t-N}^{HTR} \\ & + \nu_{1,t} \left(\underline{M}^{HTR} - b_{N,t}^{HTR} \right) + \nu_{2,t} \left(b_{N,t}^{HTR} - \bar{M}^{HTR} \right) \Big\} \end{aligned} \tag{39}$$

for $\lambda_{-1} = ... = \lambda_{-N} = 0$. In a recursive formulation we would have the $2N + 1$ states $\left[\lambda_{t-1}, ..., \lambda_{t-N}, b_{N,t-1}^{HTR}, ..., b_{N,t-N}^{HTR}, g_t \right]$ just as before. We use condensed PEA again. The FOC show that this problem is easier to solve as there are only two expectations to approximate, $E_t \left(u_{c,t+N} \lambda_{t+N} \right)$, and $E_t \left(u_{c,t+N} \right)$. We choose the core $X_t^{core} = \left(\lambda_{t-N}, b_{N,t-N}^{HTR}, g_t \right)$. We keep the same tolerance level as in the model with buyback. Table 6 summarises the number of linear combinations we needed to approximate our expectations. Relative to Section 3.3, the required state space is larger – in some cases two linear combinations of residuals are needed. Effectively this just means a total of five state variables is enough. The condensed PEA still dramatically reduces the state space and it makes feasible the computation of a non-linear solution.

Table 6

Holding-to-redemption model

N	$2N+1$	# lin. comb. in	
		Φ_{λ}	Φ_{uc_N}
1	3	–	–
2	5	0	0
5	11	0	0
10	21	2	2
15	31	2	2
20	41	2	2

Note: same as in Table 2 except we denote expectations to be approximated by $\Phi_{\lambda} = E_t\left(u_{c,t+N}\lambda_{t+N}\right)$, $\Phi_{uc_N} = E_t\left(u_{c,t+N}\right)$.

Figure 7 shows the impulse response functions for a 10-period bond under hold to redemption with the same calibration as in the previous sections. We compare the policy with the case of a one- and 10-period bond and buyback. The figure is for the case when the government initially has no debt, so it is comparable to Figure 1. We see from the impulse response functions for tax rates that varying the maturity of the bond does affect optimal policy, even for initial zero debt.

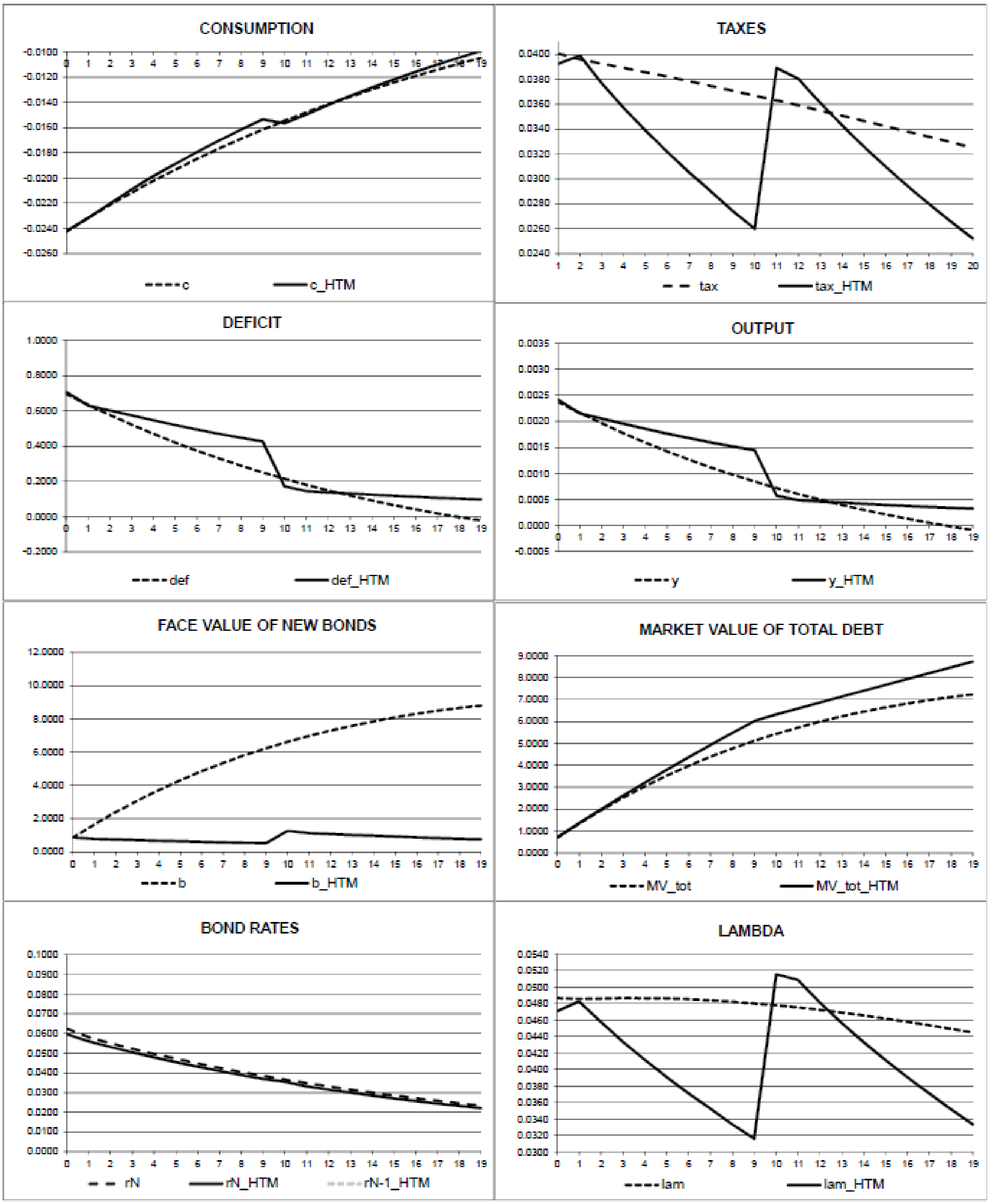
In the buyback case of Sections 2 and 3, when initial debt is zero, $b_{N,-1} = 0$, Figure 1 showed that the government does not promise a cut in taxes. Only when the government is in debt $b_{N,-1} > 0$ (or has assets), as in Figures 2 or 3, did we observe the promise to cut (increase) taxes in $N-1$ periods. Figure 7, however, shows that, even in the case of zero initial debt, taxes show fluctuations. Taxes increase on impact: the response is decreasing for $N-1$ periods, then it jumps at the time of maturity to start going back down after that and so on. The positive but decreasing response for the first $N-1$ periods is standard in optimal taxation models with serially correlated shocks. It would also occur under complete markets: the higher g_t on impact indicates that g_t will also be higher in the next periods, and this generates higher taxes for the next few periods for the utility function considered. The jump in the response function at lag N is a reflection of the fact that there are cycles of order N, as suggested by Result 2 and as can be seen directly from the martingale condition (32). Strictly speaking λ is not a risk-adjusted martingale but one can say that it is a risk-adjusted martingale of cycle N[17]. The initial high and decreasing response echoes N periods later. This is because a high g_t bumps up λ_t so it is optimal to set higher λ_{t+N} and so on. Even if g_{t+N} may be close to its mean, the effect of today's shock on λ_{t+N} drives taxes back up at N lags and the cycle starts again.

[17] Formally, we could say that letting $\xi_t^i = \lambda_{i+tN}$ for $i = 0,1,...,N-1$, each ξ_t^i is a risk-adjusted martingale.

Figure 7

Responses to a positive shock in g_t,
benchmark and holding-to-redemption model

Maturity 10: $b_{N,-1}^{HTR} = ... = b_{N,-1}^{HTR} = 0$



The intuitive reason that there are cycles of order N is the following. One could think of writing the budget constraints under incomplete markets in discounted form as

$$\sum_{j=0}^{\infty} \beta^j \frac{u_{c,t+j}}{u_{c,t}} \tilde{S}_{t+j} = \sum_{i=1}^{N} b_{N,t-i}^{HTR} p_{N-i,t} \text{ for all } t \tag{40}$$

These discounted constraints hold in all periods if and only if the period$-t$ budget constraints (30) hold. But, as should be clear from the proof of Result 2, this is not a very relevant condition: even if (40) holds we would easily violate the debt limits (29), since solutions of this equation for b_N given a sequence of surpluses usually generates an unstable solution for issued bonds.

We could instead write the budget constraints as follows:

$$\sum_{j=0}^{\infty} \beta^{jN} \frac{u_{c,t+Nj}}{u_{c,t}} \tilde{S}_{t+Nj} = b_{N,t-N}^{HTR}, \text{ for all } t$$

These are also necessary and sufficient for (30), with the advantage that they guarantee that if we use these conditions to solve for the b_N 's given surpluses, bonds do not go to infinity. These conditions show that what is relevant is the link between today's issued bonds and the surpluses in $N, 2N, 3N, ...$ periods from now. If today we have a bad shock and we issue N period bonds, when these bonds mature N periods from now there will be a need for higher taxes and a higher deficit, so $b_{N.t+N}$ will increase. Hence there will be a need for higher taxes and higher deficits in $2N$ periods and so on. Therefore it is reasonable that there is a cycle of period N and that optimal policy has the shape displayed in Figure 7. The optimal response to an unexpected shock is to promise future taxes that in part accommodate the additional debt servicing in the periods when today's debt will have to be repaid.

Result 2 suggests that taxes in the first $N-1$ periods should be lower if the government is in debt. This suggests that optimal policy will be to lower taxes during the first cycle of N periods relative to later cycles. An additional role of commitment is indeed to promise a cut in taxes during the first cycle relative to the cycles later down the line. This is why, in Figure 9, which looks at the case of initial debt, the main difference to Figure 7 is that the second peak in taxes is lower than the first peak, while the opposite is true in Figure 7.

Table 7

Holding-to-redemption model with different maturities

	Maturity	c	y	τ	deficit	R_N	MV	λ
average	**1**	52.60	70.11	0.243	0.43	2.02	–24.69	0.057
	5	52.57	70.07	0.246	0.28	2.02	–17.43	0.058
	10	52.55	70.05	0.247	0.22	2.03	–14.53	0.058
	20	52.54	70.05	0.247	0.19	2.03	–12.77	0.059
std	**1**	3.49	0.35	0.044	1.46	0.5	27.26	0.013
	5	3.47	0.40	0.044	1.67	0.4	32.26	0.014
	10	3.48	0.41	0.044	1.72	0.3	33.98	0.014
	20	3.50	0.41	0.046	1.71	0.2	33.81	0.015

Table 7 shows summary statistics for the model with no buyback and bonds of varying maturities. The results are exceptionally similar to the case of buyback. Because debt is held to maturity each period, the government now issues fewer bonds per period. As in the no buyback case the short sample second moments do show more volatility of tax rates, as shown in Figure 8.

Figure 8

Tax volatility at different horizons benchmark and holding-to-redemption model

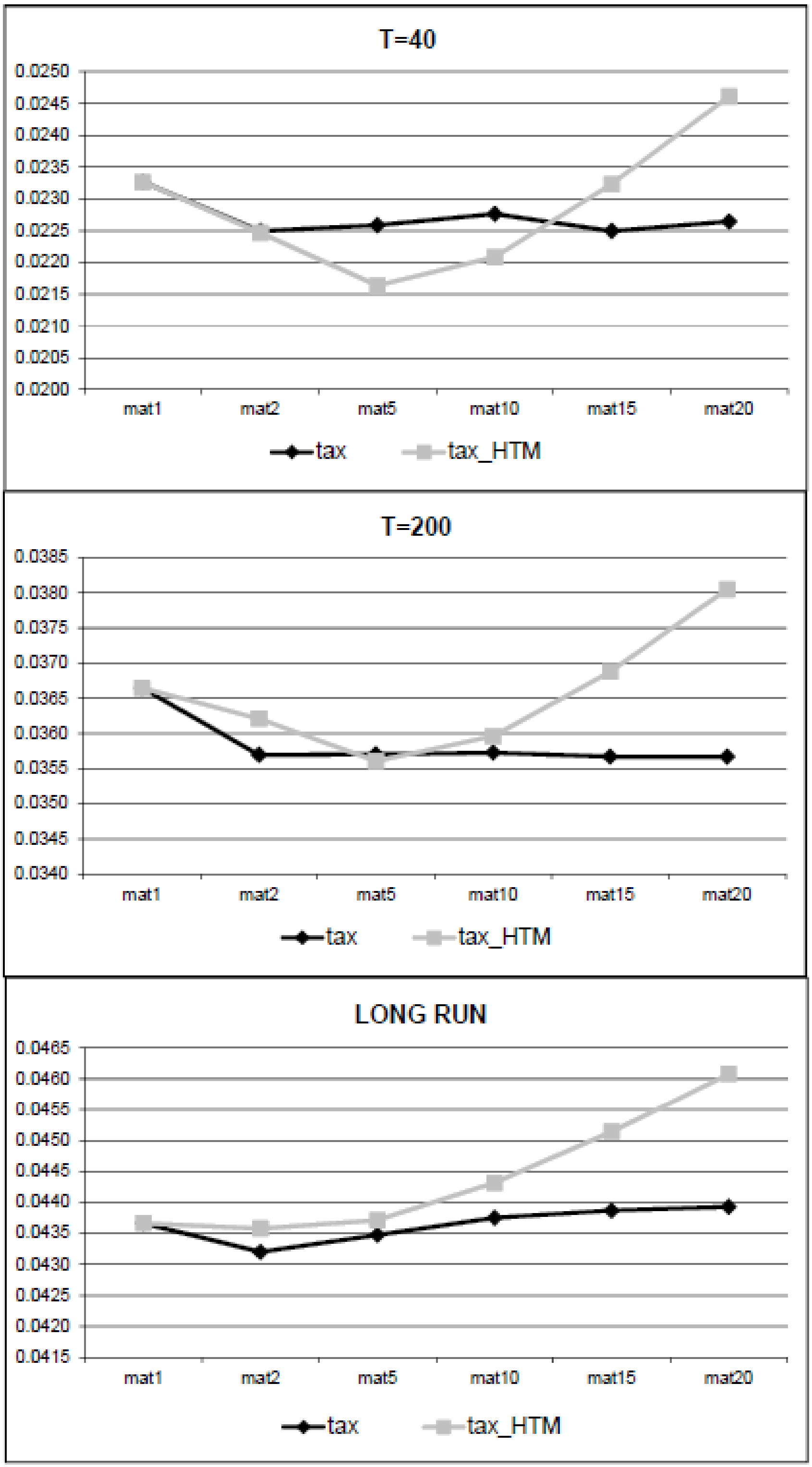
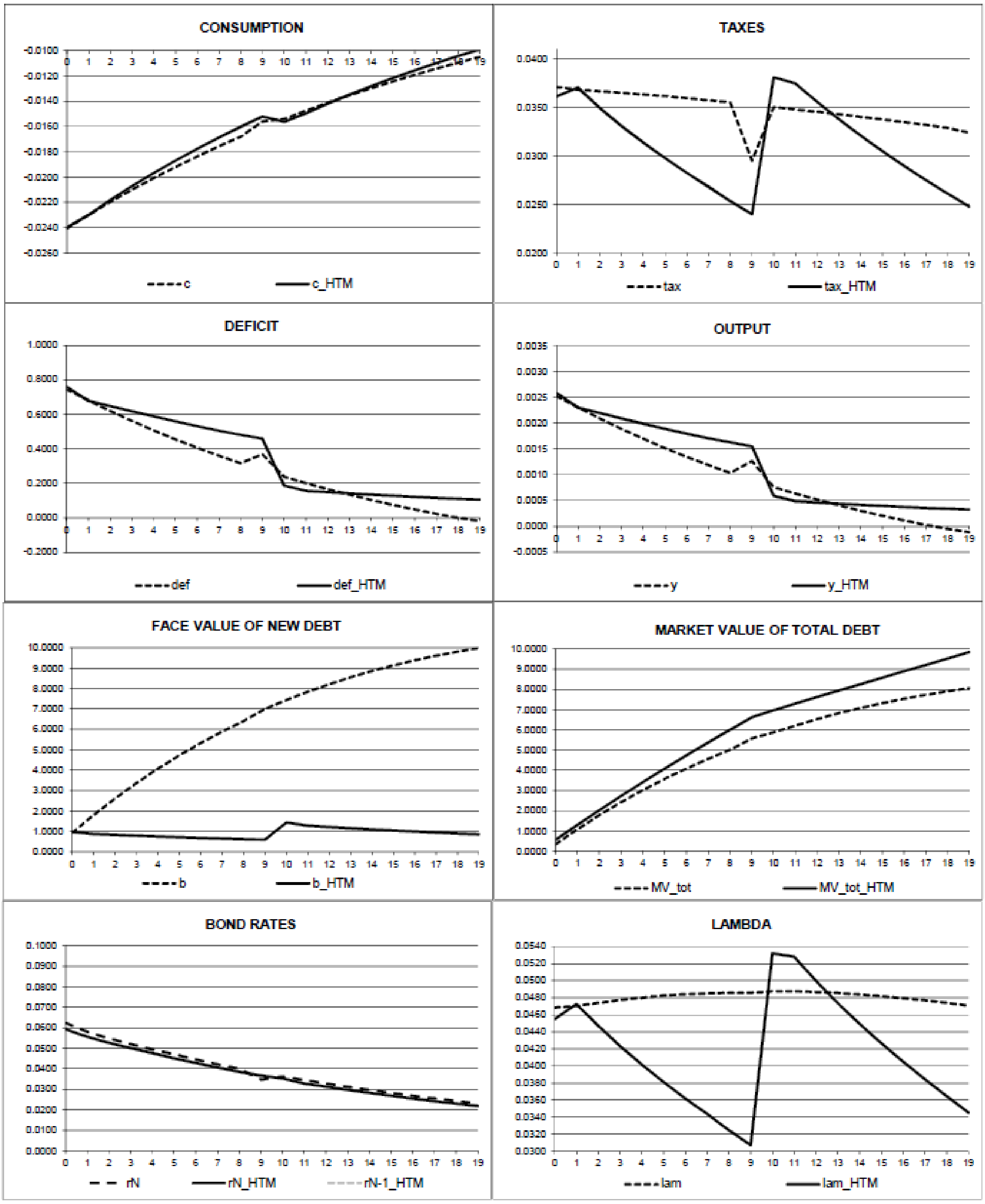


Figure 9

Responses to a positive shock in g_t,
benchmark and holding-to-redemption model

Maturity 10: $b_{N,-1}^{HTR} = \ldots = b_{N,-1}^{HTR} = \dfrac{0.5 y_{ss}}{\sum_{i=0}^{N-1} \beta^i}$



6. Conclusions

This paper has had two interrelated aims. The first has been to study optimal fiscal policy when governments issue bonds of long maturity. The second has been to propose a general method for solving models with a large state space – the condensed PEA.

A number of additional considerations arise when governments issue long-term bonds. If the government inherits debt, it has an incentive to twist interest rates to minimise costs of funding debt. This is achieved by violating tax-smoothing and promising a tax cut in $N-1$ periods, when existing bonds mature. A typical debt management concern, namely lowering the cost of debt, therefore shapes the path of fiscal policy. This suggests that it is important to consider debt management and fiscal policy jointly.

The model with long bonds helps to clarify the role of commitment in models of fiscal policy and incomplete markets. In the case of short bonds, the change in taxes needed to adjust to a shock and the promise to cut taxes at time of maturity are conjoined; what is observed is that taxes increase on impact much less if the government is in debt.

In the case of long bonds these two effects are separated. The commitment to cut future taxes is time-inconsistent and also leads to a potentially very large state space of dimension $2N+1$. Using the condensed PEA enables us to solve this model accurately with a much reduced state space allowing for the computation of non-linear numerical solutions.

We also propose an alternative model of government policy, where a central bank determines interest rates and a fiscal authority separately decides on debt and taxes. This model of independent powers is of interest per se, as policy authorities may not be able to coordinate as much as is required to implement the full commitment solution. Also, it does not display policies where promises that will be implemented very far in the future matter for today's solution. As such it serves to highlight the role of commitment and to look at a solution in which the state space is not enormous.

We started with the case usually considered in the literature where government buys back the existing stock of debt each period. To get closer to actual practice we study the case where government bonds are left in circulation until maturity. This model gives rise to even more tax volatility due to debt management concerns: promises to cut taxes for interest twisting purposes are now permanent and policy creates $N-$period cycles, giving rise to even more tax volatility.

There is little quantitative difference in fiscal policy or economic allocations at steady state second moments as the maturity of debt is varied, justifying the observation in Table 1 that similar countries may have very different average maturity of debt. The main difference is in the steady state level of debt: longer maturities imply lower asset accumulation because long bonds provide a volatile deficit if the government holds assets. However, for second moments computed with short-run moments we do find more tax volatility with long bonds.

A number of further issues remain. We have throughout this paper assumed the government can issue only one bond and has varied its maturity. In order to fully understand debt management, we need to consider the case when the government can issue several bonds of different maturity and choose the optimal portfolio. Another important issue is to consider why governments do not buy back debt – presumably because of concerns over transaction costs. We have abstracted from crucial elements of actual debt management practice such as refinancing risk, rollover risk, transaction costs, default etc. We hope the methodologies of this paper will enable us to provide a detailed study of optimal debt management and to introduce some of these features in the analysis.

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Interactions between sovereign debt management and monetary policy under fiscal dominance and financial instability

Hans J Blommestein and Philip Turner[1]

Abstract

Serious fiscal vulnerabilities arising from many years of high government/GDP ratios have created new and complex interactions between public debt management and monetary policy. Although their formal mandates have not changed, recent balance sheet policies of many central banks have tended to blur the separation of their policies from fiscal policy. The mandates of debt management offices have usually had a microeconomic focus (viz, minimising longer-term borrowing costs, while limiting refunding risks). Such mandates have usually avoided any explicit macroeconomic policy dimension but some major policy overlaps are latent. What is needed is a policy framework for all official actions that affect the maturity structure of government debt in the hands of the public. This requires more analysis of the macroeconomics of government debt management. A full debate about the allocation of functional responsibilities would have to take account not only of the economics, but also of political and institutional constraints. There are operational advantages in having in place appropriate governance arrangements that serve to forestall short-sighted policies and hold specific institutions accountable for their mandates.

Keywords: Monetary policy, central banks, policy design and consistency, policy coordination, debt management, sovereign debt

JEL classification: E52, E58, E61, H63

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1. Introduction

This paper provides an overview of the growing debate on new and complex interactions between public debt management (PDM), monetary policy and financial instability in conditions of serious fiscal vulnerabilities, higher sovereign risk and considerable uncertainty about future interest rates. As Turner (2011) argues, this creates the spectre of fiscal dominance. These conditions are likely to last for a long time. Although both these interactions and the threat of fiscal dominance were accentuated by the global financial crisis and its aftermath, structural changes in the new financial (and business) landscape may be among the deeper reasons why some of these new complex links are likely to persist.

Unfortunately, our inquiry is hampered by a lack of consensus about the macroeconomics of government debt management, reflected in a very considerable diversity of views on this subject. But the economics profession need to re-focus on this subject and in particular go beyond theoretical frameworks based on debt management neutrality. Until this issue has been more satisfactorily dealt with in the literature and, more generally, better understood by both policymakers and academics, considerable caution needs to be exercised about the policy implications of conditions under which the conventional, microeconomic-focused PDM approach may conflict with wider, macroeconomic considerations. Against this backdrop, the paper raises – in a very tentative way – three issues:

- Whether a broader mandate for PDM is desirable;
- How such a broader mandate might affect potential conflicts with central banks (CBs) that are using their balance sheets on a large scale;
- Whether new functional arrangements between debt managers, central banks and fiscal authorities need to be contemplated, either temporarily or permanently. This involves a review of whether this new complex situation requires a change in what Blommestein and Hubig (2012) term the micro portfolio mandate for debt management. Do new functional arrangements between not only debt managers and central banks, but also fiscal authorities need to be contemplated?

To that end, three (related) principal policy questions will be examined in this paper:

1. Is the current separation between mandates for PDM and monetary policy sufficiently robust to deal effectively with financial stability challenges (including banking crises), deep recessions and risks of fiscal dominance?
2. More specifically, are current institutional arrangements for PDM robust enough to deal effectively with major shifts in policies and/or policy outcomes (possibly leading to conflicts or coordination problems) such as: (a) unconventional monetary policies (quantitative easing (QE); prolonged ultra-low policy rates); (b) large or rapidly increasing budget deficits; and (c) a strong increase in borrowing needs, public debt and sovereign risk?
3. Or should the micro portfolio-based debt management strategy, which aims at maintaining orderly conditions in government debt markets and minimising refunding risks, be supplemented by macroeconomic perspectives on fiscal policy, monetary control and financial stability? For example, should debt managers take explicit account of monetary policy and/or financial stability objectives when designing and implementing debt management strategies? What would be the practical consequences of a macro-based mandate for the (direct) debt management objective of ensuring smooth access to markets, while minimising borrowing cost (subject to an acceptable or desirable level of market risk)? For example, is it necessary that the minimisation of borrowing costs should be subordinate to financial stability considerations during times of extreme market stress? If this is so, would it perhaps be necessary or useful to change the institutional set-up and mandate for debt management offices (DMOs)? Are there (other) macroeconomic

considerations that affect the maturity structure or other dimensions of government debt (eg types of instruments such as inflation-linked versus nominal paper) and that would require some re-thinking about the micro portfolio mandate of DMOs?

The remainder of the paper is organised as follows. A historical perspective on today's policy debate is given in section 2. The separation between PDM and monetary policy is assessed in section 3. Section 4 discusses fiscal dominance and the long-term interest rate. Imperfect asset substitutability across maturities is analysed in section 5. The relationship between the long-term interest rate and financial stability is investigated in section 6. A macroeconomic view of CB operations in government debt markets is given in section 7 and of sovereign debt management in section 8. Section 9 studies the potential for policy conflicts between PDM and monetary policy. The need for a broader (macro) mandate for PDM is discussed in section 10. The final section concludes.

2. An historical perspective on mandates and policy coordination

There is ample evidence that the arrangements for PDM and monetary policy in place before the 2007–08 global crisis were very successful in achieving their stated objectives. In the OECD area (and in an increasing number of emerging markets), there was a consensus view that institutional arrangements for PDM should be based on the following core objectives and functions (Blommestein (2002)):

1. to maintain stable access to financial markets for undertaking the necessary government funding operations;
2. to minimise (over the medium term) government borrowing costs subject to a clearly articulated, preferred level of risk; and
3. to develop liquid government bond markets.

The financial crisis has led to some radical re-thinking about central banking: whilst the pre-eminence of price stability has remained, financial stability objectives (notably those with a systemic dimension) have gained ground.[2] Actual CB operations in many segments of financial markets beyond short-term money markets have become more prominent. As Goodhart (2010) argues, CBs have in some sense returned to their very roots.

This re-thinking of the role of the CB makes necessary a similar re-think about government debt management. The recent crisis has brought to the surface the fact that the *macroeconomic* dimension of government debt management has not had the attention it deserves. This is a difficult and contentious subject. Careful analysis and debate is therefore needed before changing policy frameworks that have worked well. Imprudent changes – or even smaller wrong-headed modifications – would be very risky. It is the quality of the debate among relevant policymakers and the weight of the evidence that should in the end determine whether or not changes in existing arrangements should be contemplated. After all, it is the long-term track record and high quality of the current institutional set-up that created policy credibility in financial markets over many years.

Hard-won policy credibility, in turn, is an important determinant of economic development. More specifically, the quality of PDM and a strong, credible (independent) CB are both most important for economic development. Take the following example from economic history as an illustration. Why did Britain surpass France, a country which had significantly larger

[2] Some analysts argue that financial stability objectives should include the (potential) spillover effects of CB policies on other countries (Eichengreen and Rajan (2011)).

economic resources in the 18th century? In his famous book *The Cash Nexus* (Ferguson (2001)), Niall Ferguson credits the founding of the Bank of England and the notion that British government debt management was better than that of the French:

> *"… after the Glorious Revolution, Britain had representative government, which … reduced the likelihood of default, since the bondholders who had invested in the National Debt were among the interests best represented in Parliament. The National Debt itself was largely funded (long-term) and transparently managed (especially after the advent of the consol). And the Bank of England – which again had no French analogue – also guaranteed the convertibility of the currency into gold (save in an extreme emergency), reducing if not eliminating the risk of default through inflation. It was these institutions which enabled Britain to sustain a much larger debt/GDP ratio than France because they ensured that the interest Britain paid on her debt was substantially less than France paid on hers. If one seeks a fiscal explanation for Britain's ultimate triumph over France in their global contest, it lies here."*

Against this backdrop, let us now take a closer look at the evolution of the separation and coordination of monetary policy and PDM in the OECD area before the global financial crisis.[3] This historical perspective on how separation and coordination arrangements between monetary policy and PDM evolved before the crisis is very instructive for today's debate on: (a) the adequacy of the micro portfolio approach to PDM; (b) the robustness of the separation between monetary policy (CB) and PDM (DMO); and (c) the possible need for different (including more intense) coordination arrangements.

Almost 15 years ago, the OECD and IMF undertook a comprehensive study on separation and coordination arrangements between PDM and monetary policy as part of the design of technical assistance programmes to formerly centrally planned economies (the so-called countries in transition). To that end, a survey was undertaken for the 1995-1996 OECD/IMF Project on the Coordination of Monetary Policy and Public Debt Management, covering 14 countries from both the OECD area and emerging markets.

The resulting report (see Sundararajan et al (1997)) noted that during the mid-1990s, Ministries of Finance (MoF) were in general responsible for most *executive* debt management functions, carried out by specialised units within the ministry (in many cases they were part of a Treasury directorate that also had other tasks in financial management). The CB was often the agent for highly technical activities such as the selling of securities by auction and the settlement of trades. In some countries, however, the CB had a much bigger role in these years, and was initially charged with carrying out the *entire* debt programme (including strategy and operations) as decided by the MoF and the Parliament. The 1997 report judged this institutional set-up as appropriate for the *earlier stages* of developing the framework for monetary management and the infrastructure of local bond markets. It is of interest that a recent central bank study group chaired by Paul Fisher of the Bank of England[4] makes similar policy observations to those made in the OECD/IMF Report from almost 15 years ago:

> *"How [PDM] should relate to macroeconomic policy functions depends on their respective objectives and on economic and financial system circumstances. Economies with deep financial markets have tended to emphasise the separation of [*PDM*] from other policy functions. In developing systems, where, for example, the central bank might also issue debt for sterilisation purposes or manage*

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[3] See Blommestein (2011).

[4] The Study Group was created to examine the impact of PDM choices on monetary policy and financial stability under the unprecedented circumstances of the global financial crisis.

> *government-related cash balances, policy coordination has been more common, including some cases where the central bank is responsible for some [PDM] functions or involved in [PDM] oversight."*[5]

But at a later stage of development (when the frameworks for monetary control and for PDM have become more sophisticated), a different institutional structure might further more effectively both monetary policy objectives and debt management objectives. When the CB can readily influence the structure of interest rates by acting only in very short-term interbank markets and when the principal goal of PDM becomes long-term market-based funding based on cost minimisation at a chosen level of risk, the separation of responsibilities becomes the preferred solution. Moreover, the CB's role in developing markets for government securities is much smaller once local capital markets have matured, in many cases supported by an active network of primary dealers, and with commercial banks and the postal system taking over retail selling. With reasonably well-developed financial markets (together with a clear monetary policy mandate), and in "normal" circumstances, the CB's capacity to control the structure of interest rates by moving the policy rate is less dependent on how PDM is being executed.

In such circumstances, shifting the execution of the debt programme to a dedicated unit within the MoF itself, or to a separate DMO with operational autonomy (but under the general supervision of the MoF), would create a better institutional structure for achieving monetary and PDM objectives. Even in such a structure, however, the CB could continue to be responsible for technical tasks such as auctions and settlement. Moreover, this type of co-operative arrangement has been made easier by advances in computer and information technology. Such advances permit the creation and management of sophisticated data bases that are simultaneously accessible by the MoF, Treasury, DMO and CB. As a result, a large number of OECD administrations have transferred the responsibility for the execution of the public debt programme to the MoF and DMOs. The trend of separating the functions between the MoF/DMO and the CB continued throughout the second half of the 1990s.[6]

This "divorce" made their respective roles more distinct. The MoF/DMO could concentrate on financing the fiscal deficit (by minimising financing costs at a given level of risk). The CB plays its part by supporting money market liquidity. Its ready acceptance of government bonds as first-class collateral to support lending to banks is also key.[7] The move in the 1990s to take from CBs the operational responsibility for managing government debt was supported by many policymakers on the grounds of reducing conflicts of interest. The argument was that any mandate for keeping yields on government bonds down (or limiting volatility) could conflict with the monetary policy need to adjust interest rates in the light of changing macroeconomic conditions. Even if the CB resists such a temptation, market perceptions of such a conflict might affect inflation expectations. Another conflict of interest is that advanced knowledge of its interest rate decisions could induce a CB to bring forward bond issuance ahead of raising interest rates.[8]

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[5] Committee on the Global Financial System (2011). Bank for International Settlements (2000) and Wheeler (2004) make very similar observations.

[6] Separate roles and mandates for central bankers, debt managers and fiscal agencies are also defined (and further clarified) via *medium-term fiscal frameworks* (together with the associated formal fiscal rules) as well as via the publication of (and adherence to) international (transparency) standards. For example, the Code of Good Practices in Monetary and Financial Policies, the Code on Fiscal Transparency and Guidelines concerning Government Borrowing Operations (Blommestein (2004)).

[7] Some CBs started issuing their own short-term notes and became very active in the repo market. In some jurisdictions, CBs have borrowed foreign exchange (in their own name) for their reserves.

[8] Allen (2012) in this volume recounts such an episode in the Serial Funding operation in the United Kingdom in 1951.

By the early 1990s, many OECD countries had created committees for consultation and coordination between MoF and CBs on public debt policy. Such committees (where ministries of planning and legal experts from the ministry of justice could also be represented) proved very effective as platforms for sharing information and for the joint monitoring of the country's overall debt situation (including private external debt). These committees also proved useful in detailing the role of each agency in the execution of the debt programme, resulting in agency agreements about the relationships between MoF, DMOs and CBs as well as a detailed specification of the various functions of debt management performed by each agency.

In the 1990s, then, the operational responsibility of managing government debt was given in more OECD countries to operationally autonomous DMOs.[9] These were given clear objectives (such as the minimisation of expected costs subject to pre-defined risk tolerance limits). There was the widespread adoption of portfolio benchmarks. This realignment of policy frameworks often went together with the independence of CBs with clear inflation mandates.[10] There is no doubt that these market-based reforms helped to make government debt markets work better, and lower long-term borrowing costs for governments. The global financial crisis and its aftermath, however, has created some awkward coordination problems for this separation of policy mandates.

3. How robust is the separation between sovereign debt management and monetary policy?

Tobin's equivalence

The obvious logical difficulty in separating monetary policy and government debt management is well known. It is that both policies involve the sale of official debt – albeit in different forms – to the private sector. Firms and households react as the composition of their portfolios is altered – and such responses have macroeconomic effects.

CBs in effect issue the shortest-duration official debt in their operations to implement monetary policy. From the perspective of portfolio choice, government issuance of short-term debt is like monetary expansion. Tobin (1963) puts this point well:

> *"There is no neat way to distinguish monetary policy from debt management, [both] the Federal Reserve and the Treasury … are engaged in debt management in the broadest sense, and both have powers to influence the whole spectrum of debt. But monetary policy refers particularly to determination of the supply of demand debt, and debt management to determination of the amounts in the long and nonmarketable categories. In between, the quantity of short debt is determined as a residuum."*

Milton Friedman made exactly the same point in his 1959 *Program for Monetary Stability*.

Tobin went on to argue for the use of debt management (ie shifting between short-dated and long-dated paper) as a countercyclical policy to influence private capital formation, and thus real output. His conclusion was that:

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9 It is important distinguish *institutional* autonomy (such as that for CBs) from *operational* autonomy (Blommestein (2004)).

10 The greater power of CBs, and their independence from MoF, itself fed a desire to remove certain non-monetary-policy responsibilities from CBs.

"The Federal Reserve cannot make rational decisions of monetary policy without knowing what kind of debt the Treasury intends to issue. The Treasury cannot rationally determine the maturity structure of the interest-bearing debt without knowing how much debt the Federal Reserve intends to monetise."[11]

He based his analysis on portfolio choice under uncertainty (which he had used in his famous interpretation of Keynes's liquidity preference theory). Official sector sale of assets alters private portfolios, forcing investors to rebalance. No one nowadays disputes his analysis. But portfolio rebalancing effects can take many, quite different, forms – depending on the specific circumstances of time and countries. And, as Zampolli's (2012) review of the literature in this volume makes clear, there are general equilibrium effects that may weaken the partial equilibrium results. Finally, there is much controversy about the size of effects in practice.

The 2007–08 global financial crisis and its aftermath: the path to fiscal dominance

The recent financial crisis has reinforced these traditional questions about the separation between monetary policy and debt management policies. Major CBs have used their balance sheets to drive down the rate of interest of long-term government bonds. The European Central Bank (ECB) has shown the greatest reluctance to buy government bonds: the ECB does not of course have a single government in front of it, but instead many governments of different credit standings. How, then, should we think of the link between monetary policy and debt management policy in the light of these new policies?

To express simply the fundamental links between PDM, monetary policy and fiscal policy, it is instructive to use the consolidated government budget constraint. Defining terms as follows (time is indicated by the subscript t):

D_t	=	Budget deficit
B_t	=	Stock of government bonds (ie paper with a maturity greater than one year)
TB_t	=	Stock of Treasury bills (with a maturity of less than one year)
M_t	=	Base money

Table 1 is a very simple representation of the financing of the government. Monetary policy refers to the determination of demand debt. The maturity of long-term government bonds is the domain of debt management. But where should we put decisions about Treasury bill issuance? As part of debt management or monetary policy?[12] The shorter the maturity of Treasury bills, the closer they are to "money".

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[11] His suggestion was that full responsibility for Federal government debt management be assigned to the Federal Reserve, not the US Treasury. One aspect Tobin did not address might be noted: a CB of a monetary area of several independent countries faces a special challenge because there is only one CB but many different governments that decide debt management policy. This is clearly relevant for the euro area.

[12] Historically, the monetary authorities have often expressed their concerns about the impact of the sovereign issuance of very short Treasury bills (T-notes) on the stance of monetary policy. Until the mid-1990s, for instance, the Deutsche Bundesbank took the view that the government should finance itself with medium- and long-term securities only. One compromise solution to potential policy conflicts about this is not only to coordinate the timing and to exchange information on new issuance, but in addition to agree on an issuance ceiling for bills.

Table 1

The government budget constraint and links between fiscal policy, debt management and monetary policy

Fiscal policy		Debt management		Debt management or monetary policy?		Monetary policy
D_t	=	$[B_t - B_{t-1}]$	+	$[TB_t - TB_{t-1}]$	+	$[M_t - M_{t-1}]$

While monetary policy is separated from PDM and fiscal policy, it is recognised that the monetary transmission mechanism may be affected through the impact of the structure of debt on market expectations. Circumstances that entail a risk of "fiscal dominance" (that is, high public debt ratios and heightened sovereign risk weakening the local banking system) can increase uncertainty about future interest rates. This may create expectations of time-inconsistent monetary policies (Sargent and Wallace (1981); Sargent (1993)).

Our focus, although related to this insight, will be more specific. It will be on how particular circumstances of macroeconomic or financial system weaknesses could reduce asset substitutability in financial markets. As asset substitutability across the maturity spectrum declines, conventional CB interest rate policy tools (such as the overnight rate) become less effective and direct CB transactions in bond markets become more effective. The boundary between debt management and monetary policy therefore becomes more and more blurred. This creates a greater need for policy coordination and this may, practically speaking, require a broader interpretation of existing monetary policy or PDM mandates. In other words, the neat-and-tidy separation of policy mandates may not always make for good practical policy.[13] This note considers this issue in a world of fiscal dominance. The arguments summarised here are spelt out more fully in Turner (2011), which contains a number of qualifications to the arguments that follow.

4. Fiscal dominance and the long-term interest rate

New fiscal dominance?

In the OECD area, general government debt increased from 69.8% in 2000 to 73.1% of GDP in 2007 and to an estimated 97.6% of GDP at the end of 2010 (while outstanding sovereign debt is projected to further increase to 105.4% of GDP at the end of 2012).[14] According to BIS estimates of global aggregates, government bonds outstanding amounted to around \$44 trillion in 2010, compared with \$14.4 trillion at the beginning of 2000. Sovereign debt managers are therefore facing major challenges in managing a massive increase in the global stock of government debt, including huge uncertainty about the size of future budget deficits and their financing. There has been an increase in sovereign risk.

[13] In drawing lessons of the crisis for macroeconomic policies, Reddy (2011) argues cogently that "*the separation of various functions in the public sector to avoid conflict of interest has, to some extent, resulted in ineffectiveness of public policy, particularly in terms of coordination in management of money and finance*".

[14] For G7 countries, the OECD's Economic Outlook shows an increase in general government debt from 77.4% of GDP in 2000 to 80.5% of GDP in 2007 and to a projected 122.3% of GDP at the end of 2012.

The huge rise in sovereign debt by itself is going to have lasting effects on the size and the composition of private sector balance sheets. In addition, there is considerable debate (among academics and policymakers) about the short-term versus long-term impact of fiscal reform measures. As a result, there are major differences of view on how quickly deficits (and sovereign debts) should be reduced to achieve fiscal sustainability. Some would stress deflation risks and others inflation risks. What choices will governments make and how will these influence future rates of inflation? In any event, it is fairly certain that government debt/GDP ratios in major countries will continue to rise, setting the stage for a new period of fiscal dominance.

(i) Perspectives from economic theory and empirical work but no consensus

There is no (academic) consensus about the impact of large government debt on the long-term interest rate. A key question is: how strong are Ricardian effects? Academic studies yield a wide range of estimates. In a world of full Ricardian Equivalence, households increase their savings by the present value of future taxes needed to repay government debt. Their desired bond holdings rise by the exact increase in government debt issuance. The long-term interest rate therefore remains constant.

Another question is whether fiscal dominance or monetary dominance will prevail. If there is fiscal dominance, near-term interest rates would be kept lower than under monetary dominance. But higher expected inflation would drive up nominal interest rates further out. If there is monetary dominance, on the other hand, it would be the reverse. In any case, the issue is more complex than fiscal versus monetary dominance. Faithful adherence to an anti-inflation monetary rule may not by itself be sufficient to ensure price stability – because government policy frameworks may engender fiscal expectations that are inconsistent with stable prices.[15]

In short, there is great uncertainty about the impact of high government debt on future inflation rates and on real interest rates … and thus on the long-term interest rate.

(ii) Destabilising market dynamics?

What precisely this will mean for future interest rate volatility depends in part on market dynamics. Banks have taken leveraged positions in government bonds. The larger interest rate exposures become, and the more dependent they are on leverage, the greater the probability of destabilising dynamics. When expectations about yields change, households with variable rate mortgages, banks and other leveraged investors may all tend to "herd" in their efforts to cut interest rate exposures. Even a temporary bout of financial market volatility can undermine the value of an asset as collateral.[16] This dimension of "collateral capacity" can be crucial for the prices of bonds of crisis-hit countries during periods of market stress.

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[15] Sargent and Wallace (1981) and Sargent (1993) analyse the unpleasant arithmetic of the government budget constraint in a game of chicken between the monetary and fiscal authorities. This model shows that even when inflation is prima facie a strictly monetary phenomenon, in the longer run inflation is a fiscal phenomenon. Woodford (2000) demonstrated that: "… *even when both fiscal and monetary policy are consistent with … an equilibrium with stable prices (as one possible outcome) … expectations [may] … coordinate upon an equilibrium … in which the price level is determined by expectations regarding the government budget … [even given a] commitment by the central bank to a Taylor rule"*. In a similar spirit, Cochrane (2011) argues that inflation within the new-Keynesian, Taylor rule framework remains indeterminate.

[16] Fostel and Geanakoplos (2008) demonstrate just how important is the impact of collateral practices on demand for non-core financial assets. The "collateral capacity" of an asset depends on its volatility. If this increases (or is expected to increase), the value of an asset as collateral falls much more than its market price because lenders demand larger haircuts of more volatile assets. Leveraged investors will therefore become more inclined to buy assets which they can pledge as collateral with minimum "haircuts" (ie the discount

5. Imperfect asset substitutability across maturities

Uncertainty about future interest rates is important because it determines whether investors regard short-term and long-term paper as close substitutes. In a world of perfect certainty about future short-term rates, debt of different terms would be perfect substitutes for one another. When short-dated and long-dated paper are close substitutes, control of the overnight interest rate is sufficient for CBs to affect the near end of the yield curve.

But uncertainty about the path of future interest rates will make debt of different maturities imperfect substitutes. Because of this, changes in the mix of short-term and long-term bonds offered by the government will change relative prices, and so influence the shape of the yield curve. At the same time, monetary policy based on setting the policy rate becomes less effective as transmission to other interest rates is reduced. Hence CB purchases or sales of bonds become more effective exactly when classic monetary policy – reliant on the overnight rate – works less well.

This perspective is much broader than the special case of the Zero Lower Bound – when the overnight rate cannot be reduced. Even when the policy rate is above zero, imperfect asset substitutability along the yield curve means that monetary policy can be made to work more surely and more rapidly by CB action in longer-dated markets. It therefore applies to policies of monetary restriction as much as to policies of monetary ease. This may become particularly relevant in the years ahead as CBs seek to reduce their bond holdings when government financing needs are still large: the public sector would then be overfunding fiscal deficits.

It may also have been relevant a few years ago. Take the famous “conundrum” of Greenspan. The fall in bond yields in the early phase of Federal Reserve tightening in 2004–05 was seen as weakening the restrictive impact of higher policy rates. But the Fed could have countered this by direct sales of long-term bonds. How effective this would have been in driving yields higher depends on the degree of asset substitutability. It could be argued that a policy of bond sales would have been ineffective given the prevailing sense of interest rate predictability at the time of the “conundrum”. At that time, banks were all-too-willing to take huge maturity exposures. But such an argument is not quite decisive – because this very sense of interest rate predictability was itself deliberately nurtured by the Federal Reserve policy of a “measured pace” in increasing the Federal funds rate. The Fed was anxious to avoid a repeat of the bond market collapse that took place around the early 1994 tightening. This predictability itself probably made banks and others increase their leverage – including in interest rate markets – and so kept long-term rates low.

Analysis of this is very difficult. There is no reason to expect the degree of substitutability between assets of different maturities to be constant over time. In addition to the uncertainty about future interest rates created by large government debt, the ability of financial intermediaries to take maturity exposures will also be an important determinant. Collateral requirements on leveraged investors in financial assets will also affect the relative attractions of different assets. All these determinants are likely to change over the cycle. In a crisis, therefore, asset substitutability will fall. This is not only because uncertainty about future interest rates rises. It is also because banks will impose more demanding collateral requirements and will be less able to undertake interest rate arbitrage operations. Such uncertainty and the impaired intermediation capacity of banks were important justifications for the exceptional balance sheet policies that CBs in the major countries followed in the recent crisis.

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applied to the asset’s current market value) to their bankers – and may have to forego buying some assets regarded as underpriced (because their price has become too volatile).

CBs in EMEs, where financial markets are typically thinner, may need to be more interventionist. The domestic investor base is often quite small and dominated by a few large, local banks. This means that local bonds are less reliable as collateral at times of market stress (Fostel and Geanakoplos (2008)). The authorities in several EMEs did indeed directly support local bond markets when they were disrupted in autumn 2008 after the failure of Lehman Brothers. Take the case of Mexico – a country which had followed for many years a policy of financing its debt in domestic currency in local markets. The collapse of confidence in its bond markets led to the following policy measures:

- A shortening of the maturity of new debt issuance;
- Official purchases of long-term government bonds in the market;
- The creation of a CB facility for interest rate swaps which allowed bond holders to reduce their exposure to the long-term interest rate.

The CB could not just reduce the policy rate but had to take direct action to lower the long-term rate in government debt markets.[17]

Policymakers will not find it easy in real time to identify large but temporary shocks that distort investors' portfolio choices. Nor will they be able to quantify the impact on underlying asset substitutability. What often becomes clear in retrospect (eg incipient rises in bond market volatility related to worries about fiscal deficits, difficulties in finding adequate collateral, leveraged positions in interest rate markets holding down long-term yields, etc) will not be so obvious and measurable at the time. The pressure on CBs to act in bond markets will often be framed in terms of countering market volatility.[18] But at what point this could be tantamount to impeding discovery of the underlying market prices will sometimes be hard to judge.

6. The long-term interest rate and financial stability

Policy choices are made yet more difficult by another complication: the importance of the long-term rate for financial stability. It could be dangerous to manipulate the long-term interest rate just for macroeconomic objectives. The potential side-effects on financial stability could be significant. It is the structure of interest rates that creates incentives for the maturity exposures that households and the financial industry choose to take.

The elements of maturity risks are very simple. Savers want their part of their assets to be liquid but real productive investment is longer-term and illiquid. This gap can be bridged by maturity transformation offered by banks, by other financial firms, by markets or by government. The problem is that economic theory does not provide clear guidance about the optimal degree of maturity transformation or about who is best placed to undertake it.

Keynes touched on this issue in his analysis of PDM. His liquidity preference theory suggests that the private sector's willingness to assume liquidity and maturity risks is not well-anchored in fundamentals. Instead it is dominated by cyclical and subjective factors

[17] In addition, other unorthodox policy measures were also adopted. Several EMEs (eg Indonesia, Malaysia and the Philippines) eased mark-to-market rules on banks and other financial institutions holding bonds – especially after the IASB and the accounting rulemakers in the United States had relaxed mark-to-market rules for illiquid assets. The justification is that relaxing such rules can forestall distress selling which could destabilise the whole system.

[18] Justification of such measures may include safeguarding monetary transmission channels.

(such as emotions and spontaneous actions, referred to by Keynes as "animal spirits"[19]). Hence his policy prescription was that government debt issuance should "accommodate the preferences of the public for different maturities".

The analysis by Jean Tirole (2008) of maturity transformation by financial intermediaries with long-term liabilities (such as pension funds and insurance companies) carries this Keynesian tradition further. In the presence of macroeconomic shocks that affect everybody simultaneously, he argues, what is needed is an external risk-free store of long-term value such as government bonds. Echoing Keynes, he writes, "risk-free securities are held because they deliver cash when firms need it: they are liquid in the macroeconomic sense". In effect, he argues for a prudential floor for the real long-term rate of interest. This controversial issue clearly requires more analysis. In any event, CBs cannot ignore the incentives for maturity exposures created by the structure of interest rates. An additional complication is that in some jurisdictions the increased perception of sovereign risk has raised questions about how far domestic government bonds can be considered as "risk-free assets". This is becoming a major challenge for the borrowing strategies of some sovereign debt managers.

7. Macroeconomics of central bank operations in government debt markets

But the main emphasis of Keynes was on the macroeconomic theory. Tily (2010) provides a lucid summary of Keynes's monetary theories. Open market operations in long-term government debt were central to his analysis in his *Treatise on Money* of how to combat slumps. His focus was on the asset side of the CB's balance sheet – not on the liability side. This is very similar to the Federal Reserve's rationale for QE. CB purchases have the aim of improving the markets for paper held as assets on private sector balance sheets. The impact on commercial bank reserves (ie CB liabilities) was not seen as the main element of the transmission mechanism.[20]

Keynes argued for what he called "open market operations to the point of saturation":

> *"My remedy in the event of the obstinate persistence of a slump would consist, therefore, in the purchase of securities by the central bank until the long-term market rate of interest has been brought down to the limiting point."*[21]

He felt that CBs had "always been too nervous hitherto" about such policies, perhaps because under the "influence of crude versions of the quantity theory [of money]". He repeated this analysis in *The General Theory*:

> *"The monetary authority often tends in practice to concentrate upon short-term debts and to leave the price of long-term debts to be influenced by belated and imperfect reactions from the price of short-term debts – though … there is no reason why they need do so."*

One constraint Keynes saw was that a CB acting alone would simply induce capital outflows: he felt the BIS (established in 1930) could encourage internationally coordinated CB efforts

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[19] Keynes (1936, pp 161–62). See Blommestein (2010) for a discussion of this concept in the context of sovereign risk, borrowing operations and fiscal sustainability.

[20] In the event, excess bank reserves created by QE in the United States just piled up at the Federal Reserve and presumably had a very weak effect, if any, on the demand for goods and services.

[21] Keynes (1930, pp 331–2).

to reduce long-term interest rates. Per Jacobsson, Economic Adviser at the BIS at the time, also strongly supported policies aimed at reducing long-term rates.

Keynes went on to suggest that the "most important practical improvement which can be made in technique of monetary management" would be to replace "the single Bank rate for short-term bills" by "a complex offer by the central bank to buy and sell at stated prices gilt-edged bonds of all maturities".

It was Tobin in the 1960s who developed the theoretical models of how CB operations in long-term debt markets work. This focus was on portfolio rebalancing channels.

- One channel is rebalancing between domestic assets. CB purchases of bonds force lower bond holdings on the private sector. The effect on the yield curve is greater the lower the degree of substitutability between long-dated and short-dated paper.
- Another is the international portfolio rebalancing channel. CB purchases to lower long-term yields should shift portfolio demands from domestic to foreign assets. This should induce currency depreciation, which would reinforce the impact on aggregate demand coming from the domestic rebalancing channel.

Nobody disputes the logic of these portfolio rebalancing effects. The real controversy concerns magnitudes. How large would the macroeconomic impact of more activist debt management policies be in practice? It all depends on the degree of asset substitutability. But this will not be uniform either across countries or over time. The experience of one country will not necessarily be a good guide to what would happen in another country. In a small, open economy the international portfolio rebalancing may dominate the domestic channel. What works in one episode will not necessarily work in another.

Nevertheless, it is not difficult to imagine circumstances in which such policies can be highly effective. In times of crisis, for instance, a large (but temporary) decline in domestic asset substitutability (because of greater macroeconomic uncertainty, banks with weakened balance sheets less able to take interest rate risks, etc) will make activist debt management policies by CBs more effective. When bonds are widely held by foreigners, exchange rate effects may be strong.

History of central bank operations in government debt markets[22]

Keynes was writing in the 1930s. As today, government debt ratios were high – inherited from the First World War. The Bank of England (and other CBs) did cut rates sharply to counter the depression once they had left gold. But the government ignored Keynes's advice to adopt more aggressive CB purchases of debt (or the equivalent change in issuance). Government debt remained long-term: in the mid-1930s, only 3% of bonds had a maturity of less than five years and 86% of bonds had a maturity in excess of 15 years. Susan Howson's 1975 study of British monetary policy in the 1930s found that this limited the effectiveness of the cheap money policy instituted once Britain had left the gold standard. The depression of the 1930s was made worse because debt management policy ran counter to the monetary policy intent of low short-term rates.

In the closing months of World War II, with the UK facing huge government debts, the Treasury set up a *National Debt Enquiry (NDE)*. Keynes, Meade and Robbins were influential members in this Committee. Keynes argued against the "dogma" of financing debt at long maturities. Governments should not "fetter themselves … to a counter-liquidity preference". Instead they should accommodate the preferences of the public for different maturities. He recommended that:

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[22] Allen (2012) describes the UK's history in this area more fully.

> *"Interest rates [at] different maturities should … pay attention primarily to (a) social considerations in a wide sense; (b) the effects of Government policy on the market for borrowing by the private sector and the problem of controlling the desired rate of investment; and (c) to the burden of interest charges on the Exchequer."*

Note that he mentioned the interest burden to the government last of all – quite the opposite of the current policy focus of DMOs. In any event, the upshot of the NDE was that the policy of "cheap money", which began in the 1930s depression, was reinforced in the post-war period.

It was the Permanent Secretary to the Treasury who drafted the memo, dated 15 May 1945, that summarised the Enquiry's conclusions. He made a point of noting that it took as given Keynes's view that the long-term rate of interest could be controlled by determined official action. The proposed "programme of initial procedure" as he put it – the idea was to adapt this policy in the light of experience – was: "the Treasury bill rate to be brought down to ½% and 5-year bonds to be issued at 1½% and 10-year bonds at 2% to be issued on tap, a new series to be started annually". So Keynes won in 1945 the argument he had lost in the 1930s.

During the 1950s, the proportion of long-dated debt fell steadily. The policy objective became one of holding long-term interest rates down even as growth and investment strengthened. Shorter-term issuance increased. This prompted the *Radcliffe Report* to describe the huge supply of short-dated bonds as "a constant source of embarrassment to the authorities". The aim of maintaining stability in the bond market – not macroeconomic control – had become paramount for the CB. HM Treasury, in its evidence to Radcliffe, made it quite clear that it cared much more about maintaining stability in the bond market than about macroeconomic control:

> *"No attempt is made to use official purchases and sales in the market for the specific purpose of raising or lowering the level of medium and long-term interest rates. … such operations would create market uncertainty and so impair the prospects of continuing official sales of securities … Such operations would involve a serious risk of damage to confidence and to the Government's credit."*

Given that government debt was 130% of GDP, this reluctance to risk triggering bond market instability was understandable. But most of the economists who gave evidence to Radcliffe disagreed with the Treasury. Richard Kahn, Frank Paish, Harry Johnson and others said that the influence of "money" on the long-term interest rate was an important channel in the impact on aggregate demand.

Now the Radcliffe Report is a comprehensive but somewhat diffuse document. But it did conclude with only five main points. Among them a clear statement of the importance of the long-term interest rate as an objective of monetary policy.

> *"There is no doubt that … monetary policy … can … influence the structure of interest rates through the management of the National Debt which … is an instrument of singular potency. In our view debt management has become the fundamental domestic task of the central bank. It is not open to the monetary authorities to be neutral in their handling of this task. They must consciously exercise a positive policy about interest rates, long as well as short."*

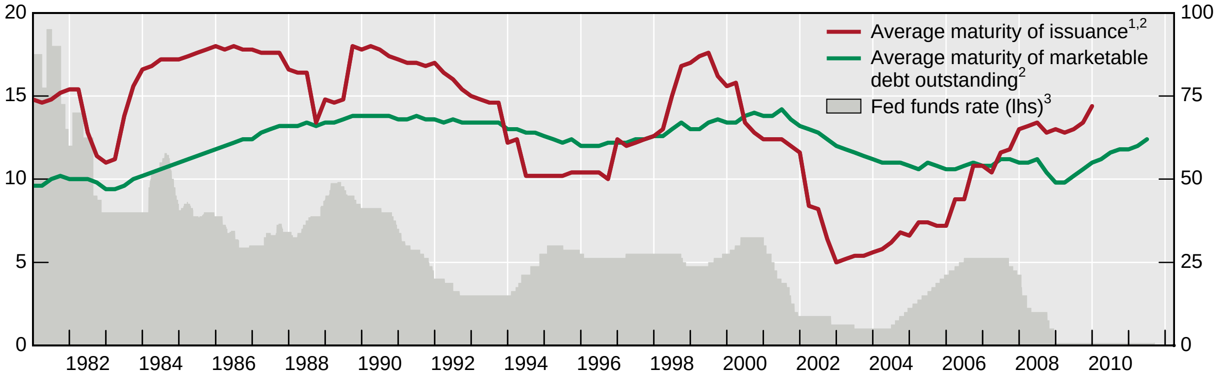
The Report explicitly countered the Treasury view on the need to support by bond market. They argued that greater efforts "to foster greater understanding outside official circles … of the intentions of the authorities would reduce the risk of perverse reactions in the market [from bond sales]".

There have been similar debates in the United States. There was apparently a form of Quantitative Easing in the 1930s,[23] followed by similar efforts to keep long-term rates low during wartime. The United States relied to an increasing extent on shorter-term debt for much of the 1950s and 1960s. A legal ceiling of 4¼% on the rate the Treasury could offer on long-term bonds constrained issuance. As inflation rose, maturities shortened. By January 1976, the average maturity of US government debt reached a low point of only 26 months. But once the 4¼% ceiling had been relaxed, the US Treasury did begin a policy of gradually increasing the average maturity of debt. But by 1980, the average maturity of US government debt was still less than four years (compared with more than 12 years in the United Kingdom[24]).

Graph 1 charts the average maturity of US government debt during the past 30 years – in terms of both the outstanding stock (green line) and issuance (red line). It is striking how large the swings in the average maturity of debt have been.

Graph 1

Maturity of US government bonds



[1] One-year moving average; shown at the end. [2] In months. [3] In per cent.

Sources: Datastream; US Treasury.

This prompts an obvious question: how have these swings been related to macroeconomic policies? To answer this question, a naïve regression was conducted to see how the year-to-year change in the average maturity of bonds outstanding was related to two simple policy variables: the Federal funds rate and the Federal deficit/GDP ratio. The regression was run on annual data over the period 1982 to 2010; it was corrected for first order serial correlation. The Federal deficit as a percentage of GDP, which is not known immediately, is lagged one year. This is shown in equation (a) in Table 2. In a second specification, we replaced the Federal funds rate with the difference between 10-year and federal funds rate to see if average maturity is sensitive to a measure of spread. In a final specification we replaced the deficit/GDP with outstanding debt. Dividing this period into two halves yielded significantly different intercept terms (while the coefficients on the independent variables were not different). This suggests that, irrespective of movements in the independent variables, the average maturity of bonds outstanding tended to fall more rapidly during the first period. To allow for this, a dummy intercept was added (D = 1 for 1982 to 1995 and = 0 for 1996 to 2010).

[23] Anderson (2010).

[24] This relative higher maturity is in part due to a well-developed capitalised pension system where pension funds constitute an important segment of the domestic investor base for government bonds.

All variables in the preferred equation are statistically significant. The simplicity of the regression for equation (a) came as a surprise. This equation provides prima facie evidence that the maturity of outstanding debt is usually shortened when the Federal funds rate is low. This suggests that debt managers deliberately take advantage of unusually low near term market rates to shorten the maturity of issuance when the central bank's policy stance is accommodating. In this sense, debt issuance and monetary policy work in the same direction. The sign on the fiscal variable suggests that a larger fiscal deficit tends to be associated with a lengthening in maturities. Debt managers often say that, following the use of a cost-risk strategy, longer maturities are indeed needed to spread out over longer time periods the higher debt created by fiscal deficits.

The robustness of this finding is confirmed by the results of two other regressions. Using the yield spread, instead of policy rate, does not change the message: the higher the spread the lower is the average debt maturity (equation (b) on Table 4) . The coefficient of spread is about the same size as the Federal funds rate, but, of course, with a negative sign. In addition, the deficit coefficient remained largely unaltered. Using debt instead of deficit produced similar results (the coefficient of the Federal funds rate is only slightly lower than that in equation (a)).

Table 2

Response of average maturity of government debt issuance to macroeconomic variables

	Constant	**Fed funds**	**Deficit/ GDP (–1)**	**10-year yields – Fed funds**	**Debt/ GDP (–1)**	**Adjusted R-squared**	**F-stat**	**DW**
(a)	–6.209	1.134	103.634			0.63	12.3	1.62
	(3.9)	(4.4)	(4.4)					
(b)	–0.250		104.141			0.55	9.3	1.72
	(0.2)		(3.9)	–1.261				
(c)	–27.036	1.054		(3.709)	34.318	0.42	6.0	1.62
	(3.0)	(3.4)			(3.0)			

Notes: Dependent variable: year-to-year changes in average maturity of outstanding public debt in the United States, in months; t-statistics in brackets. The coeffecients of the dummy variable and the first-order autoregressive term are not reported for brevity.

This empirical link between debt management choices and two simple measures of both fiscal policy and monetary policy suggests that debt management choices have in practice been endogenous with respect to macroeconomic policy – even if debt managers usually claim innocence of macroeconomic policy intent.

In short, there has in the past been quite a strong empirical link between actual debt management choices and two simple measures of both fiscal policy and monetary policy. It provides prima facie evidence that debt management choices in the US at least have been endogenous with respect to macroeconomic policy. Hoogduin et al (2010, 2011) also found that, in the euro area, a steepening in the yield curve leads national debt managers to shorten the duration of their issuance. The key point is that debt management choices do not seem *in practice* to have been independent of monetary policy.

8. Government debt management in a macroeconomic spotlight

Such *prima facie endogeneity* means we need to look more closely at the mandate of the government debt manager. In theory, the mandate could be defined in several ways. At one extreme, the Treasury could, once a year, give its debt manager a maturity objective that is consistent with the government's current macroeconomic objectives. At the other extreme, the mandate could be defined in a way that makes it *exogenous* to macroeconomic policy. The debt manager could be told (eg by the fiscal authority after approval by parliament) to ensure that the average maturity of outstanding debt should always be around y years. DMOs would be told to do this irrespective of the current market configuration of interest rates.

In practice, however, the debt manager is usually given a *micro* portfolio mandate to minimise borrowing costs (debt servicing costs) subject to an explicitly articulated, preferred level of risk. The sovereign borrowing strategy therefore becomes (partly) *endogenous* to monetary developments. The macroeconomic consequences of the (micro portfolio) actions of the debt manager depend (among others) on the prevailing degree of asset substitutability.[25] In normal market (and government borrowing) conditions, the macroeconomic consequences of limited changes to debt maturities would be quite small. But the consequences could be significant in difficult market conditions (often associated with fiscal dominance).

In principle, governments have great latitude to effect significant changes in the maturity of their debt. A government that borrows short-term in its own currency does not need to worry about its refinancing risks in the same way as a private borrower does. This is simply because of its power to tax and issue money.[26] Markets treat government debt differently from private sector debt because government debt "is just a promise to deliver more of its own liabilities … [cash being] simply government liabilities that happen to be non-interest-earning". No private firm can do this. Hence, as Keynes put it, a "counter-liquidity preference has more meaning for the private borrower than for the Exchequer".

There are of course major disadvantages to excessive dependence on short-term domestic currency debt. Budget deficits become more sensitive to changes in short-term rates. When household holdings of short-term government debt rise, the sensitivity of household income to short-term rates increases. This will tend to weaken the effectiveness of changes in policy rates as an instrument to stabilise aggregate demand.

But these considerations do not weaken the case for adjusting issuance maturities in response to exceptional cyclical developments. In fact a government with longer-dated debt at the onset of a crisis is better placed to conduct countercyclical maturity shortening than one which enters a recession with short-duration debt. In a similar way as budget surpluses in good times increase the room for fiscal manoeuvre in bad times!

9. Mandates, accountability and the potential for policy conflicts

As noted in section 2, the setting of monetary policy and the management of government debt were increasingly separated from the late 1990s. Governments became more reluctant

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[25] Related research focuses in detail on the conditions and assumptions for the micro approach to PDM to be valid. Blommestein and Hubig (2012) show that the removal or weakening of the *risk-free asset condition* and the high degree of *imperfect substitutability* weaken the applicability of the micro approach.

[26] This obviously does not apply to foreign currency debt – nor to countries in a common currency area.

to give CBs the dual mandate of both setting monetary policy and managing government debt so as to avoid (potential) policy conflicts. Trying to keep debt service costs down (or even limiting the volatility of such costs) can conflict with the monetary policy need to adjust interest rates. In many countries, this realignment of policy frameworks went together with stronger institutionally independent CBs with clear anti-inflation mandates and the creation of operationally autonomous public debt offices.

The underlying philosophy was that predictable policy frameworks (for both monetary policy and PDM) should help to stabilise expectations and minimise risk premia. Furthermore, financial markets were assumed to be efficient and only requiring a "light" regulatory touch. It was also reasoned that potential policy conflicts between monetary policy and sovereign debt management could be avoided by following two "separability principles":

- CBs should not operate in the markets for long-dated government debt, but should limit their operations to the bills market.
- Government debt managers should be guided by a micro portfolio approach based on cost minimisation mandates, while keeping the issuance of short-dated debt to a prudent level.

In *normal times*, these institutional arrangements and principles conveniently simplified the lives of policymakers in CBs and DMOs. More importantly, CBs and DMOs were judged as being fairly successful in executing their respective mandates. Moreover, they allowed each institution to be held accountable for distinct mandates. And they provided some insulation from short-term political pressures.

CB activism in debt markets

But recent CB activism in debt markets as a response to the crisis has inevitably undermined these two "separability" principles. A key problem is that QE operations decided by the CB could easily be contradicted by Treasury financing decisions. Remember that the government's balance sheet is much larger in normal times than that of the CB. The CB's balance sheet is more elastic perhaps. But if its policies just induce the opposite reaction of the debt manager (the endogeneity point argued above), its theoretical elasticity will have less practical effect. Remember too the famous "Operation Twist" in the early 1960s.[27] The Federal Reserve used open market operations (to the equivalent of $225 billion when scaled at today's GDP) to flatten the yield curve by shortening the average maturity of Treasury debt.[28] But the US Treasury at that time ultimately lengthened the maturity of its issuance, undermining the Federal Reserve's policy.

And the US Treasury has been lengthening the average maturity of its outstanding debt during recent years. This is (by itself) difficult to square with the rationale of QE, which aims to shorten the maturity of bonds held by the public. It is therefore essential to examine QE in conjunction with debt management policies. To do this, the first table in Tobin's 1963 paper

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[27] Swanson (2011) argues that earlier studies suggesting that Operation Twist in the 1960s was ineffective do not properly isolate the impact of Operation Twist from countervailing influences. He shows that the programme was successful by lowering longer-term Treasury yields by about 15 basis points. On 21 September 2011, the US Federal Open Market Committee decided on a new Operation Twist involving the purchase, by the end of June 2012, of $400 billion of US Treasury securities with remaining maturities of six years to 30 years and to sell an equal amount of Treasury securities with remaining maturities of three years or less (Federal Reserve press release, 21 September 2011).

[28] Of interest is that Swanson (2011) also shows that Operation Twist and QE2 are similar in magnitude. Therefore it seems reasonable to expect the effects of QE2 to be similar to Operation Twist, with an effect on longer-term Treasury yields of about 15 bps.

was updated – which summarised the structure of Federal government debt in the hands of the public. This provides an illuminating bird's-eye view of the consolidated balance sheet of the Treasury and the CB. This is, of course, a highly stylised characterisation of the monetary impulse of changes in debt maturity … but it is at least a start. This is shown in Table 3.

Table 3

Composition of marketable US Federal government debt held by the public

$ billion

End of fiscal year (Sept)	**Marketable securities**		**Currency & Federal Reserve obligations**	**Total**	**Money, Federal Reserve obligations and short-term debt**
	(<or = 1 year)	**(> 1 year)**			
	(a)	**(b)**	**(c)**	**(d)**	**= (a+c) % d**
1st 2 years of crisis					
2007	955	3474	834	5263	34%
2009	1986	5002	1780	8768	42.9%
	+1031		+946		
3rd year of crisis					
2010[1]	1784	6692	1896	10419	35.5%
	–202		+163		
Latest QE					
2011 June	1529	7785	2659	11973	35%

[1] Using Monthly Statement of the Public Debt of the United States; Federal Reserve Table H.4.1.

Sources: This is an update of that in Tobin (1963) using US Treasury Bulletin; Federal Reserve Flow-of-Funds.

With the adoption of QE after the crisis, reliance on short-term debt and Federal Reserve obligations was increased. Between the end of FY2007 and the end of FY2009, currency and Federal Reserve obligations more than doubled. Short-term marketable securities outstanding also doubled. So an almost $2 trillion expansion in money and short-dated paper. This clearly represented a very significant easing of policy. What might be called "Monetary financing" in the first two years of the crisis went from 34% to 43%. This helped to counter a severe crisis-induced tightening in credit conditions.

But in the third year of the crisis, the maturity of Treasury debt issuance changed in a restrictive direction. Monetary financing actually declined from 43% at end-September 2009 to 36% at end-September 2010. On 3 November 2010, the Federal Reserve announced a special programme to buy around $850 billion in longer-term Treasury securities. This planned purchase took place against a background not only of a substantial expansion in Treasury debt issuance, but also of Treasury policy to lengthen the maturity of its issuance. The need to take account of US Treasury issuance policy is essential to any assessment of

QE. The Treasury had set a policy of lengthening maturity well before QE – a normal response to reduce rollover risks when debt is rising rapidly.

In general, a change to the yield curve induced by CB action may even lead the debt manager to alter its issuance policy to take advantage of what it might view as a temporary interest rate "distortion". Or it may find it can move quickly to attain a maturity-extending objective thanks to favourable market conditions created by the CB. Either way, it could respond *endogenously* to the repricing of debt caused by the CB. This endogeneity is likely to be complex, time-variant and opaque.

The policy tensions between the Treasury and the Federal Reserve have been clear in the recent minutes of the quarterly meeting of the Treasury Borrowing Advisory Committee. On 2 November 2010, for instance, the Committee noted:

> *"Overall, the Committee was comfortable with continuing to extend the average maturity of the debt … The question arose regarding whether the Fed and the Treasury were working at cross purposes … It was pointed out by members of the Committee that the Fed and the Treasury are independent institutions, with two different mandates that might sometimes appear to be in conflict. Members agreed that Treasury should adhere to its mandate of assuring the lowest cost of borrowing over time, regardless of the Fed's monetary policy. A couple of members noted that the Fed was essentially a "large investor" in Treasuries and that the Fed's behaviour was probably transitory. As a result, Treasury should not modify its regular and predictable issuance paradigm to accommodate a single large investor."*

The announcement in September 2011 of a new Operation Twist was significant in that it involved the purchase by the Federal Reserve of longer-maturity debt than under QE2 – and longer than current Treasury issuance. In the absence of Operation Twist, investors would have had to absorb Treasuries with an average maturity of about 7.7 years in the fourth quarter of 2011. With the Fed's purchases, the average maturity of bonds issued to the public falls to about 5.5 years (Ehlers (2012)). One offset, however, will be increased Treasury issuance to replace the shorter-term debt held by the Federal Reserve that will no longer be rolled over.

10. Is a broader (macro) mandate for public debt management needed?

How compelling are then the arguments for revising the conventional (micro portfolio) mandate for PDM? At the OECD Global Debt Forum meeting in January 2011, it was concluded that the global financial and economic crises have led to some blurring of lines between PDM and monetary policy, with DMOs operating extensively at the short end of the yield curve and CBs also at the long end. It was also noted that during these crisis periods, the different mandates appeared sometimes to be in conflict. As noted above, the minutes of the US Treasury Borrowing Advisory Committee have hinted at some tensions.

In addition, it was noted by some debt managers that the mandates of both DMOs and CBs have already become more complex in practice and, as a result, less clear. This raises the question of whether formal (micro portfolio) mandates should perhaps catch up with reality. In any case, there are fundamental or theoretical arguments to question or challenge the micro approach to PDM, including the removal or weakening of the *risk-free asset condition*, and the high degree of *imperfect substitutability* (Blommestein and Hubig, 2011).

Thus far, however, those involved in the policy debate show little appetite for a significantly different *formal* framework for PDM (and/or monetary policy). Clearly, rapidly modifying policy mandates in response to pressures created by an exceptional financial crisis would be a risk.

The debt managers at the OECD Global Debt Forum meeting in January 2011 seem to have supported such policy caution. It was noted, for example, that, despite the deep involvement of DMOs in banking rescue operations during the crisis, there had been no serious deviation from their core (micro) mandate of minimising borrowing costs subject to a preferred risk level.

Yet, in view of the recent financial crisis and danger of fiscal dominance, one can raise the somewhat more practical and specific question of whether debt management should perhaps be an *explicit* part of the macroeconomic triangle: fiscal policy, monetary control (including a financial stability dimension) and debt management strategy (including maintaining orderly government debt markets). This could be done, for example, by making explicit references to monetary policy or financial stability objectives when designing or implementing debt management strategies. An explicit link between PDM and medium-term fiscal policy objectives might be articulated. Or it could be argued that, during times of extreme market stress, the borrowing cost minimisation objective should be (temporarily) subordinate to financial stability considerations. Clear communication channels between debt managers, fiscal authorities, central bankers and financial regulators are important under all circumstances – but they become indispensable during periods of market stress. Against this backdrop, a senior OECD debt manager recently noted that the "neat-and-tidy world of debt management is a thing of the past".

11. Conclusion

The recent financial crisis has stimulated some re-thinking about the monetary policy dimension of PDM. Four conclusions can be briefly stated:

(i) The case for CB transactions in long-term debt markets is stronger whenever there is increased investor uncertainty about the path of future short-term rates. Large government debt increases uncertainty about future inflation. If uncertainty were only about inflation and nominal interest rates, then one answer would be to increase issuance of inflation-linked debt. But the fiscal situation is likely to entail increased uncertainty about real interest rates also. This will reduce the substitutability between short-dated and long-dated paper. In such circumstances, CBs may more efficiently guide markets if they act across the maturity spectrum.

(ii) Very little is known about the empirical magnitudes – either the size of such effects or their stability over time. The recent evidence suggests that CB purchases of government bonds have been effective.[29] But there are grounds for treating the net effects of these operations with considerable caution. Most studies fail to take account of contemporaneous changes to debt management policies which are equivalent to CB transactions in government debt. In addition, there are reasons for thinking that the size of portfolio rebalancing effects – depending as they do on the cyclically sensitive degree of asset substitutability and on the ability of banks to assume interest rate exposures – are likely to vary over time. They will be very hard to predict.

(iii) We need a policy framework for all official actions that affect the maturity structure of government debt for macroeconomic objectives. Without such a framework, even rational policies that economic theory suggests will work may just deepen uncertainty. Markets need to understand what governments or CBs are trying to do.

[29] Table 3 of Turner (2011), page 63, summarises seven recent studies.

They also need to understand the exit strategy. Historically there has been strong official resistance to CBs selling bonds when governments have heavy debts to refinance … particularly when long-term rates are already rising.

(iv) Most DMOs argue that the microeconomic portfolio approach continues to be the most useful policy framework for PDM. Moreover, most (if not all) OECD DMOs speak out in favour of a (continued) functional separation between DMO (PDM) and CB (monetary policy). Sticking to functionally separated mandates is judged, on balance, desirable. DMOs and CBs have different objectives and responsibilities, and each institution is seen as best placed to fulfil their respective functional mandates. A key consideration in this context is that DMOs have a medium-/longer-term operational horizon while that of CBs is often shorter.

Even with well-developed financial markets and a high level of transparency, potential conflicts or tensions between debt managers and monetary policymakers can arise because the government is usually the dominant player in the market. This means that changes in the structure of sovereign borrowing can have a significant impact on interest rates – because DMO operations are large and can have a signalling effect. While sovereign issuers normally act as the biggest player on the supply side, CBs – prompted by the fallout from the global crisis – have been operating as large players on the demand side (as part of quantitative easing operations). For these reasons, consultation and coordination issues assume first order importance.

The jurisdictional sensitivities between different official agencies should not obscure an important but complex issue. The macroeconomic and macro financial context is crucial. The macroeconomics of government debt management (and CB bond purchases) must therefore be better understood. The monetary policy/fiscal policy/debt management linkages were of second order importance when fiscal positions were stronger and fiscal policy frameworks credible. But they cannot be ignored when government debt/GDP ratios will be very high for years. The more complex linkages between PDM, fiscal policy and monetary policy may entail new conflicts of interest and/or of mandates: it is therefore crucial that debt managers, central bankers, and also fiscal policymakers seek a better common understanding of the objectives, functions and institutional arrangements for co-operation and coordination.

This will not be easy. A major stumbling block to policies is simply the lack of a generally accepted theory of the macroeconomics of government debt management. As Missale's (2012) article in this volume makes clear, macroeconomists have been debating this subject for decades.

A common element of the literature on possible macroeconomic objectives is the stabilising or destabilising properties of different debt structures in the face of cyclical movements in GNP or other shocks. In 1998, Barro constructed a model showing that issuing inflation-linked bonds would smooth tax rates in the face of GNP cycles. He also argued that persistent inflation shocks would make long-term nominal bonds more volatile than short-term ones. Hence the government would shift to short-term issues as the volatility of inflation rose. Missale (1999) took a similar perspective. Tax revenues rise with cyclical increases in income (real and inflation). Short-term interest rates are also procyclical. Hence short-term debt ensures tax revenue and interest payments move together. Missale (2012) in this volume summarises the tax-smoothing approach.

Other models have shown how a government can engineer changes in the market value of government debt by market operations to influence the long-term rate. It can do this by altering the maturity of its issuance. In theory, there is no limit to the amount of long-term paper a government can issue in its own currency. At the limit, it could overfund the budget deficit – issue long-dated paper on a massive scale and buy short-term assets from the private sector. One study – cited by Faraglia et al (2010) – found that, given the flatness of the yield curve and its limited volatility, a government following such a strategy would have to hold five or six times GDP in privately issued short bonds and issue similar amounts of long bonds. It is hardly surprising this is not what happens as Faraglia et al (2008) have shown. The reasons are liquidity and credit constraints. The potential private buyers of government debt face liquidity constraints which prevent them from buying an infinite amount of government bonds. The government has a credit constraint in that it would not want to hold an unlimited amount of risky private assets. The assumption of market completeness is therefore not satisfied. The constraints of market incompleteness would be eased in an open economy; but complications arising from currency mismatches would arise.

Much more thinking about these macroeconomic dimensions is therefore needed. We have argued that PDM cannot in current circumstances be regarded as neutral with respect to monetary policy. Policy mandates may at some point require some cautious adaptation.

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Comment

Richhild Moessner[1]

The papers in this session considered the standard sovereign debt management (SDM) framework versus fiscal insurance and macro-based frameworks. They considered the role of debt maturity for fiscal insurance in the presence of default risk, and for optimal fiscal policy in the absence of default, in both cases in the context of imperfect markets. Let me discuss each paper in turn.

Key points of the first paper in this session, by Hans Blommestein and Anja Hubig, on "Is the micro portfolio approach still appropriate? An examination of the analytical framework of public debt management" are that the standard analytical framework of SDM (ie minimising borrowing costs subject to risk) is well anchored in the principles of modern portfolio theory. But the underlying assumptions of the micro portfolio approach to SDM are not valid under fiscal dominance, an absence of risk-free assets, and imperfect asset substitutability. There is therefore a need to formulate a macro approach to SDM.

I think that there is an interesting analogy between the micro versus macro approach to SDM, and the micro versus macro approach to regulation (ie micro supervision versus macroprudential policy). Macroprudential frameworks are currently being developed, and it is very welcome to also have the development of a macro approach to SDM. There is also an analogy between the question of SDM-monetary policy coordination and the question of macroprudential-monetary policy coordination.

An important question is which objectives SDM should be assigned from a macro perspective. In particular, if SDM is to take financial stability concerns into consideration, in addition to macroeconomic ones, how could this best be done? One possibility may be that SDM could make 'safe assets' available in a crisis for private agents to hold or flee into, by providing longer-maturity assets perceived as safe. In addition, SDM could provide long-maturity assets perceived as safe which pension funds and insurance companies can hold. This could be an argument for the government to run a permanent budget deficit, which is small enough to be sustainable. There is a strong demand for safe, long-term government bonds in major economies: witness the very low real yields currently prevailing. Governments could invest the proceeds for example in desired infrastructure projects yielding higher returns than the cost of borrowing.

But a government budget deficit is not a necessary condition for bond issuance. In times of fiscal surplus, the government could still issue long-term government bonds to keep them available as safe assets, and invest the proceeds in other financial assets. Such assets could be local private sector debt securities, equities or foreign assets. This also raises the question of whether there should consequently be four-way coordination between monetary policy, fiscal policy, SDM and macroprudential policy. What would such coordination imply for institutional and governance arrangements?

The second paper in this session, by Alessandro Missale, on "Sovereign debt management and fiscal vulnerabilities" considers the role of long debt maturity as fiscal insurance: long-maturity government debt makes the market value of government debt sensitive to changes in interest rates; negative shocks to current and future primary surpluses lead to

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[1] The views expressed are those of the author and not necessarily the views of the BIS. Email address: richhild.moessner@bis.org.

higher long-term interest rates, so that the value of long-maturity debt falls, thereby reducing the need for fiscal adjustment.

Key findings of the paper are that long-maturity debt reduces default risk (and also interest rate risk), and that the maturity of government debt should receive greater attention in the analysis of government debt sustainability. Moreover, standard SDM in the form of interest-expenditure minimisation over short horizons can lead to suboptimal debt strategies. Furthermore, government debt managers' emphasis on interest expenditure, rather than the market value of debt, is argued to be due to accounting standards and the key role of (current) budget deficits in fiscal policy evaluation, with the absence of a theory-based accounting framework preventing optimal debt management.

I find the emphasis on an analysis of default risk useful, especially in current circumstances where this has become highly relevant. More research to understand the determinants of risk premia as suggested by the author would also be very useful.

The author's call for greater transparency on swap contracts which modify the duration of government debt is very relevant, and mirrors calls for greater transparency about exposures in OTC derivatives markets more generally, in the wake of the financial crisis. But I think a pertinent question is also whether it would be better for SDM not to use swaps (eg in the United States SDM does not use swaps), but instead to buy and sell government bonds at different maturities to modify duration. This would also avoid the counterparty credit risk exposure of the government involved in swap contracts.

As a benchmark, the third paper in the session, by Elisa Faraglia, Albert Marcet and Andrew Scott, on "Debt management and optimal fiscal policy with long bonds" studies optimal fiscal policy assuming full commitment of the government to implement the best sequence of taxes and government debt, with incomplete markets and in the presence of long-maturity government bonds. It also considers optimal policy with an independent monetary authority. The paper considers a nonlinear model, since debt limits are likely to bind occasionally, and since a linear approximation misses important aspects of optimal fiscal policy.

Key findings of the paper are that the presence of long-maturity government bonds affects optimal fiscal policy under commitment of the social planner, compared with having only short-maturity bonds, in the following ways. With long-maturity bonds, debt management concerns make it optimal to have a greater variability in taxes, ie optimal fiscal policy violates tax smoothing (while tax smoothing is optimal if there are only short-maturity bonds). Optimal fiscal policy under commitment in response to adverse government spending shocks is time-inconsistent. In this model an indebted government has an incentive to twist interest rates to minimise the cost of funding debt, by violating tax smoothing. Since debt management concerns affect optimal fiscal policy, it is important to consider debt management and fiscal policy together. But when an independent monetary authority setting interest rates at all maturities in every period is introduced, the fiscal authority cannot manipulate interest rates, and debt management is then subservient to tax smoothing. This highlights the role of commitment under optimal fiscal policy.

The paper makes the following methodological contribution. It provides a recursive formulation of the model, with a numerical solution applicable to a large number of state variables arising in the presence of long-maturity bonds, based on the Parameterized Expectations Algorithm of den Haan and Marcet (1990).

The model assumes rational expectations. It would be interesting to consider departures from rational expectations, eg via learning, and see how sensitive the results are to departures from rational expectations. It would also be useful to consider heterogeneous agents, for example with different preferences for certain maturities, instead of a representative agent assumed in the paper.

It would also be useful to compare results for optimal policy under commitment directly with results for optimal fiscal policy under discretion (ie the time-consistent solution), in addition to comparing with the case of introducing an independent monetary authority considered in the paper, since optimal fiscal policy under commitment is not very realistic.

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Recent balance sheet policies

The effectiveness of the Federal Reserve's Maturity Extension Program – Operation Twist 2: the portfolio rebalancing channel and public debt management

Torsten Ehlers[1]

Abstract

This paper provides a first assessment of the Federal Reserve's recent Maturity Extension Program, dubbed Operation Twist 2. Despite the mere exchange of short-term for long-term Treasury securities, the announcement effect is comparable to the second Large Scale Asset Purchase programme (LSAP2). The portfolio rebalancing channel, however, is countervailed by the issuance of even more Treasury coupon securities, which may explain the temporary nature of the observed interest rate effects. In the extreme, Operation Twist 2 and LSAP2 can be viewed as just offsetting the adverse impact of the pronounced increase in outstanding government securities.

Keywords: Operation Twist, large scale asset purchase programme, portfolio rebalancing effect, fiscal and monetary policy interaction

JEL classification: E43, E52, E58, E63

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I. Introduction

On 21 September 2011, the US Federal Open Market Committee decided to engage in a program to extend the maturity of its Treasury security holdings with the purpose of lowering long-term interest rates to provide additional stimulus to the economy, in an environment with a near-zero policy rate. From 3 October 2011 until June 2012, the Federal Reserve will buy Treasuries with maturities of between six and 30 years. To fund the purchases, an equal amount of securities with remaining maturities of three years or less will be sold, which constitutes almost the entire holdings of the Federal Reserve in short-term Treasuries.

The intended effect on interest rates, and ultimately on the real economy, effectively hinges on manipulating the maturity composition and the relative supply of marketable public debt; a domain traditionally controlled by the US Treasury.[2] While the original Operation Twist[3] in 1961 envisaged a cooperation between the Federal Reserve and the US Treasury, no such plans exist for the current Maturity Extension Program. The essential indivisibility of central bank balance sheet policies and public debt management, however, is not a recent topic and has prominent advocates, such as Tobin (1963) and many others. In fact, the effectiveness of Operation Twist in 1961 seems to have been dampened by a surprise lengthening of newly issued Treasury securities (see Swanson (2011)).

The purpose of this short paper is to examine the effects of Operation Twist 2 on interest rates, but also to analyse the concurrent US Treasury issuance behaviour with the aim of deriving implications for the overall effectiveness of the current operation. In particular, the intended effect of improving refinancing conditions through the so-called portfolio rebalancing channel is likely to be countervailed by the increasing issuances of longer-term debt securities by the US Treasury. While the current Maturity Extension Program differs from LSAP2 in key aspects, the two programmes are still comparable in many ways. Hence, LSAP2 can serve as a reference point in assessing the potential impact of Operation Twist 2.

II. Operation Twist 2 versus LSAP2

In contrast to the two earlier large-scale asset purchase operations (LSAP1 and 2), which involved a significant expansion of the Federal Reserve's asset holdings (Graph 1), Operation Twist 2 is designed to be balance sheet neutral. Despite its solely compositional effect on the Federal Reserve's asset portfolio, Operation Twist 2 is comparable to LSAP2 in terms of its intended economic effect. Various estimates[4] suggest an identical amount of duration risk would be removed from the market under the two programmes ($400 billion in 10-year equivalents), notwithstanding the larger net size of LSAP2. However, purchases under Operation Twist 2 will be concentrated on significantly higher durations, while sales will be restricted to very short maturities, with an average duration of one year (Table 1).

At the time of their respective announcements, both programmes were targeting a substantial share of outstanding marketable securities within certain maturity baskets. As this implies considerable reductions in the expected supply of long-term Treasury securities to the public, the impact on prices is bound to be significant.

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2 The results in this paper do not depend on an argument that the US Treasury changed its issuance policy in response to Federal Reserve policy.

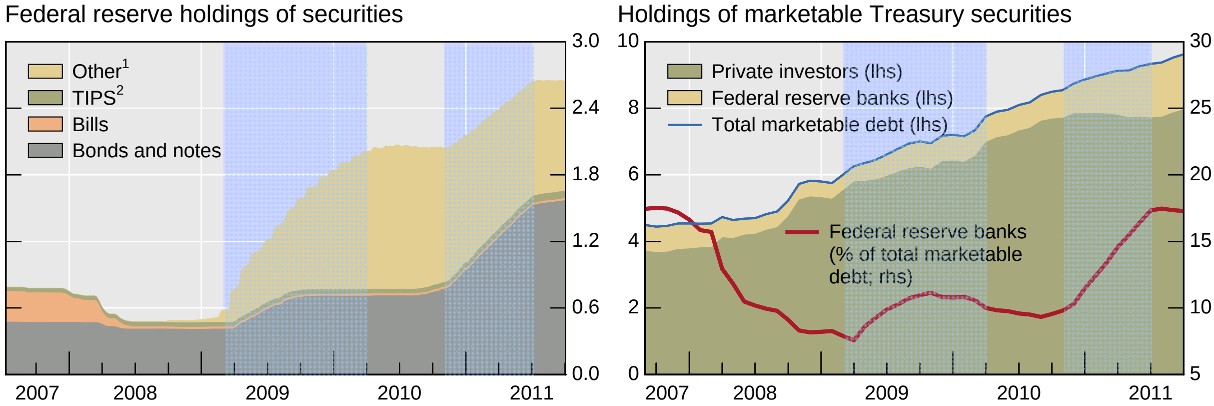
3 The current Operation Twist 2 has a predecessor in the Fed's purchases of $8.8 billion in longer-term Treasury securities and $7.4 billion sales of Treasury bills in 1961. The purchases amounted to 4.5% of total marketable securities outstanding, which is very similar to the current operation (Table 1); see Meulendyke (1998).

4 Federal Reserve Bank of New York (2011).

Graph 1

US outstanding debt holdings

In trillions of US dollars



Note: The blue shaded areas indicate the Federal Reserve's LSAP1 (beginning of March 2009 to end of March 2010) and LSAP2 (beginning of November 2010 to end of June 2011) programmes.

[1] Agency and mortgage-backed securities. [2] Including adjustments for the effect of inflation on the original face value of inflation-linked securities.

Sources: Federal Reserve; US Treasury Bulletin.

Table 1

Relative sizes of LSAP2 and Operation Twist 2

	LSAP2		**Operation Twist 2**	
Remaining maturity at time of purchase	**Purchases[1, 2] (in per cent of total)**	**Relative to the outstanding amount (31 Oct 2010)**	**Announced purchases[2] (in per cent of total)**	**Relative to the outstanding amount (30 Sep 2011)**
>3m – 3y	171.62 (22.1%)	5.40%	–400 (tot sales)	–10.98%
>3y – 6y	205.41 (26.4%)	13.73%	0 (0%)	0%
>6y – 8y	226.3 (29.1%)	33.79%	128 (32%)	15.55%
>8y – 10y	105.48 (13.6%)	17.60%	128 (32%)	21.72%
>10y – 20y	22.37 (2.9%)	7.93%	16 (4%)	5.95%
>20y – 30y	23.35 (3%)	5.68%	116 (29%)	21.01%
TIPS >6y – 10y	19.15 (2.5%)	6.17%	12 (3%)	3.18%
Other	4.76 (0.6%)	0.31%	0 (0%)	0%
Total	778.44	9.16%	0 (400 purchases)	4.16% (purchases)

[1] Federal Reserve Bank of New York Permanent Open Market Operations from 3 November 2010 to 30 June 2011 including reinvestments from maturing MBS securities into Treasuries. [2] In billions of US dollars.

Sources: Federal Reserve Bank of New York; Treasury Direct; BIS calculations.

While the main difference between the two programmes lies in the effect on the supply of short-term securities, the impact at the short end of the yield curve should be limited. In the current environment of very low short-term interest rates, and with the Federal Reserve's commitment to keep the policy rate close to zero until mid-2013, the short-term Treasuries to be sold are fairly close substitutes for central bank reserves. This effectively ties the short-term interest rates to the low levels currently observed, and curbs the price impact of an increased supply of short-term Treasuries. Still, as LSAP2 had an expansionary effect on the total amount of cash in the economy, Operation Twist 2's desired stimulative impact on the real economy may ceteris paribus be smaller than LSAP2's.

III. Transmission mechanisms and announcement effects

While there are various channels through which large-scale asset purchases could ease refinancing conditions on financial markets and ultimately increase economic activity,[5] the prevailing view is that such measures work primarily through the so-called portfolio rebalancing channel.[6]

A reduction in the net supply of longer-dated Treasury securities takes away duration risks from private investors and pushes yields downwards, reducing expected returns. This leads investors to purchase other debt securities of similar maturities, such as long-term corporate bonds. In turn, refinancing conditions are eased, which should ultimately feed into higher credit flows and stronger economic activity. The strength of the portfolio rebalancing channel is hence determined by how much of the outstanding stock of debt is absorbed by the Federal Reserve ("stock effect").

Most of the effect on yields will materialise at the time the purchases, and their size, are announced, as this immediately shifts the expected supply of debt securities in the market. In contrast to a reduction in the policy rate, which may be temporary, both the large-scale asset purchases and the Maturity Extension Program are laid out over a full year. The inherent signal about the persistent stance of future monetary policy strongly contributes to the announcement effect.

Indeed, the announcement effects of Operation Twist 2 on Treasury yields appear to have been sizeable. On 21 September, the 30-year constant maturity Treasury yield dropped around 25 basis points at the time of the publication of the FOMC statement (Graph 2, centre panel). The one- and two-day changes signal drops of 17 bp and 42 bp respectively. A drop in long-term rates of this magnitude is very significant, as it compares to the initial effect of a reduction in the federal funds rate of around 150 basis points.[7] Also, the interest rate effects are statistically significant and quite comparable to LSAP2, even for the shorter five- and 10-year maturities (Table 2). Subsequently, nevertheless, much of the initial effect at the long end of the yield curve appears to have vanished (Graph 2, right-hand panel).

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[5] For a detailed discussion see Krishnamurthy and Vissing-Jorgensen (2011).

[6] See Gagnon, Raskin, Remache and Sack (2010), and Bernanke (2010).

[7] See Gurkaynak, Sack and Swanson (2005).

Table 2

Yield changes of US Treasuries at selected event dates[1]

LSAP2

			Constant maturities				
FOMC statement	**Date**	**Changes**[2]	**3m**	**1y**	**5y**	**10y**	**30y**
Reinvestment of MBS principal into Treasuries; low rates for an extended period likely	10/08/2010	1-day	0	-1	-8	-7	-1
		2-day	0	-1	-10	-14	-8
Maintain reinvestment policy; low rates for an extended period likely	21/09/2010	1-day	0	0	-9	-11*	-8
		2-day	-1	-1	-10	-16*	-13
Purchase of a further $600bn of longer-term Treasuries	03/11/2010	1-day	0	0	-4	4	16**
		2-day	0	-1	-11	-10	11
	Total[2]	1-day	0	-1	-21**	-14	7
		2-day	-1	-3	-31**	-40***	-10
Operation Twist 2							
Prepared to adjust securities holdings as appropriate; low federal funds rate at least until mid-2013	09/08/2011	1-day	-2*	-1	-20***	-20***	-12*
		2-day	-3**	-3	-18**	-23**	-14
Announcement Maturity Extension Program; reinvestment of agency MBS and agency debt principals into agency MBS	21/09/2011	1-day	0	2	3	-7	-17**
		2-day	-1	1	-6	-23**	-42***
	Total[3]	1-day	-2	1	-17**	-27***	-29***
		2-day	-4**	-2	-24**	-46***	-56***
	Std[4]	1-day	1	1.5	6.1	6.6	6.7
		2-day	1.4	1.9	8.4	9.1	9.3

[1] In basis points. Significance levels denoted by: ***=1%, **=5%, *=10%. [2] Two-day changes are from the beginning of the previous day until the end of the event day. [3] Significance level based on the standard deviation of changes calculated over the appropriate number of days. [4] Standard deviation of one-day and two-day changes in basis points based on daily data from 2010 to 2011.

Sources: Federal Reserve Board; BIS calculations.

Clearly, the overall long-term impact of the programme is hard to disentangle from the influence of other factors, such as fluctuations in foreign demand, expectations of US economic growth or changes in inflation expectations. For instance, longer-term rates dropped significantly after the conclusion of LSAP2, clearly due to other factors such as an increased demand for safe haven assets (Graph 2, left-hand panel). Nevertheless, interest rates would certainly have been higher without the Federal Reserve's purchases. Recent research suggests that longer-term yields were 27 to 130 basis points lower as a result of LSAP1 and LSAP2 (see Annex A for a literature overview), with the "stock effect" being responsible for most of the reduction.[8]

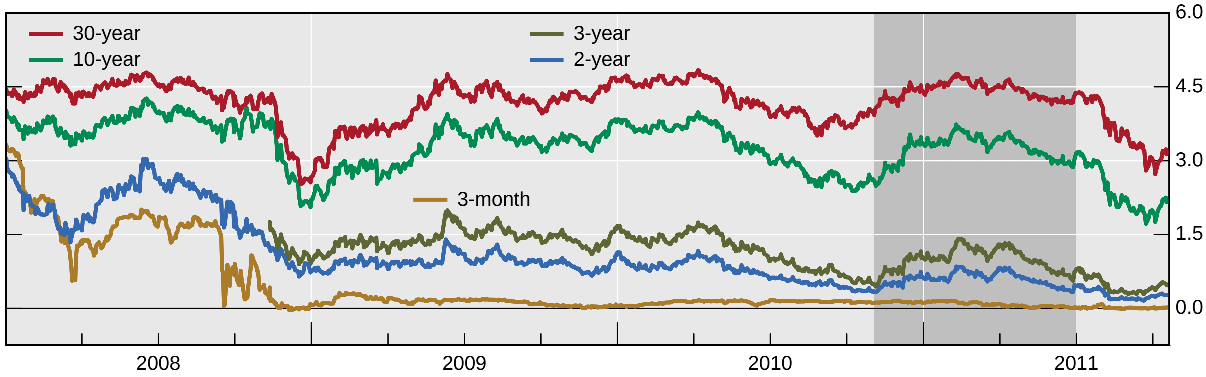
[8] See chapter IV in Swanson (2011), Meaning and Zhu (2011), and D'Amico and King (2010).

Graph 2

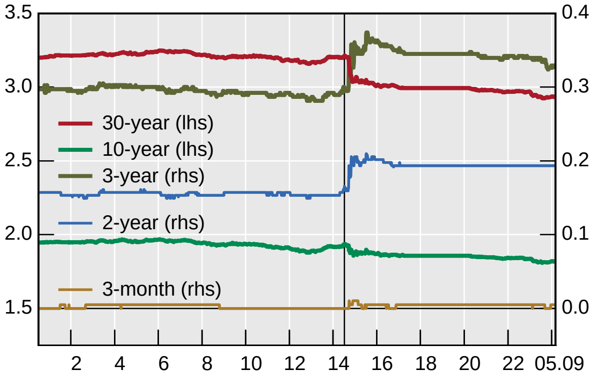
Impact on government bond yields

In per cent

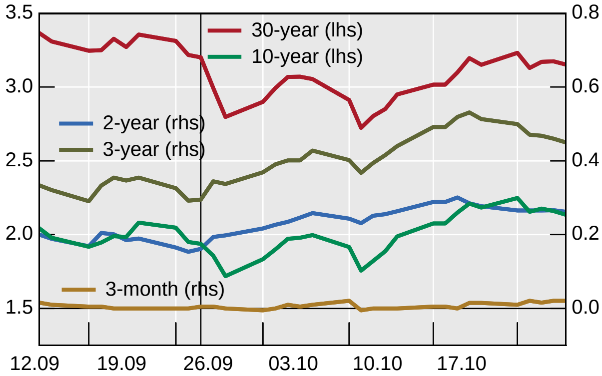
2008–2011[1]



21 September 2011 (Eastern Time)[2]



September–October 2011[2]



[1] The shaded area indicates the Federal Reserve's LSAP2 programme (3 November 2010 to 30 June 2011). [2] The vertical lines mark the Federal Reserve's announcement of "Operation Twist 2" on 21 September 2011.

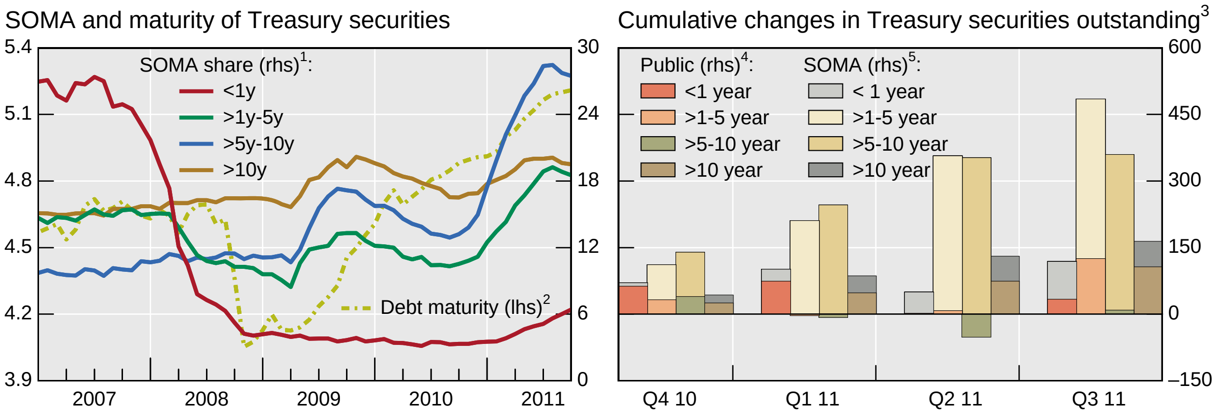
Sources: Bloomberg; BIS calculations.

IV. Public debt management

To judge the effectiveness of both LSAP2 and the recent Maturity Extension Program, in particular in terms of their portfolio rebalancing effects, a comparison with the concurrent issuance behaviour of the US Treasury is indispensable. In fact, the portfolio rebalancing effects of LSAP2 and the recent Maturity Extension Program could be completely offset by an increasing issuance volume of marketable debt securities. Indeed, even though the Federal Reserve purchased a substantial share of outstanding Treasuries at longer maturities under LSAP2 (Graph 3, left-hand panel), the cumulative changes in the supply of US Treasuries exceeded the Fed's absorption after the initiation of LSAP2 at the beginning of November 2010 across all maturities (Graph 3, right-hand panel). At the same time, the average maturity of outstanding debt was persistently lengthening (Graph 3, left-hand panel, green dashed line).

Graph 3

Treasury debt issuance and Federal Reserve purchases



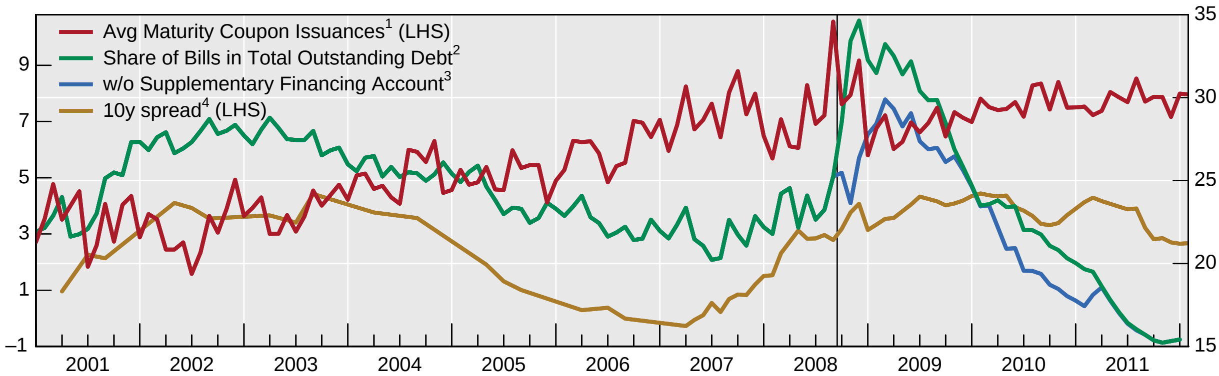
[1] Share of Federal Reserve System Open Market Account (SOMA) in Treasury securities outstanding, in per cent. [2] Average maturity of outstanding marketable Treasury securities in years. [3] Cumulative quarterly changes (end of quarter) since the end of Q3 2010, in billions of US dollars. [4] Marketable Treasury securities not held by the Federal Reserve. [5] SOMA outright holdings of US Treasuries.

Sources: Federal Reserve; Treasury Direct; BIS calculations.

After the collapse of Lehman Brothers, the Federal Reserve requested an additional issuance of bills from the US Treasury with the proceeds to be transferred into the so-called supplementary financing account at the Federal Reserve. This recent example of coordination of central bank policies and debt management was requested by the Federal Reserve in order to better manage the enormous liquidity needs of the financial markets without having to increase the amount of central bank reserves too rapidly. Hence, the share of Treasury bills in total outstanding marketable debt spiked in October 2008 (Graph 4). Reinstated at the beginning of 2010, it effectively reabsorbed some of the central bank reserves created under LSAP1. Subsequently, however, the US Treasury reduced the share of bills to comparatively low levels, while keeping the average maturity of coupon issuances at a level of approximately seven years. As a result, and despite the relatively high yield spreads, the maturity of outstanding debt was lengthened by about one year.

Graph 4

Maturity composition of Treasury issuances



Note: The vertical line marks the collapse of Lehman Brothers on 15 September 2008.

[1] In years. Comprises coupons (maturity > two years) only. Three-month moving average of total monthly issuances. [2] In per cent. Calculated on the basis of marketable debt only. [3] In per cent. Excludes bills in the supplementary financing account of the US Treasury held at the Federal Reserve. [4] In per cent. Difference between the 10-year and three-month Treasury yields at constant maturities.

Sources: Treasury Direct; Federal Reserve Board; BIS calculations.

V. Implications for Operation Twist 2

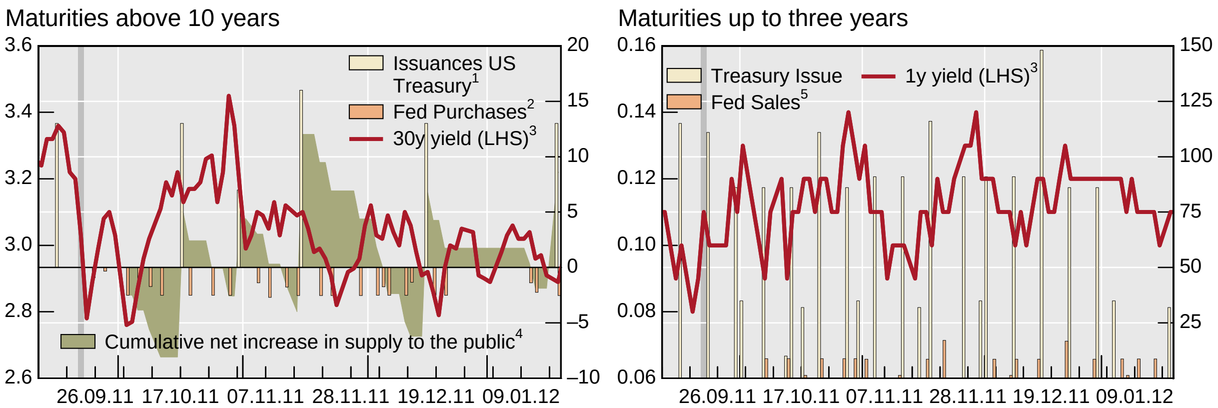
The dampening effects on long-term yields at the announcement of Operation Twist 2 seem to have vanished within a month. Actual purchases by the Federal Reserve, apart from the initial one on 3 October 2011, do not seem to have had additional effects on interest rates (Graph 5, left-hand panel). Even though there seems to be some contemporaneous correlation of security sales and interest rates, the impact on the short end of the yield curve is contained, with the one-year yield remaining within a narrow band at around 10 basis points (Graph 5, right-hand panel).

Given the elevated future refinancing needs of the Treasury, the trend of increasing issuances is likely to continue. The Federal Reserve's purchases at the long end of the yield curve have so far just kept up with the issuances of the US Treasury (Graph 5, left-hand panel). And by the end of Q4 2011, debt issuances had notably exceeded the Federal Reserve's purchases at almost all maturities (Table 3). In light of the roll-over risks of a return to a greater share of bill issuances, and the long-term nature of heightened debt financing of the US government, a shortening of the average maturity of debt issuances seems unlikely. The net supply of longer-term Treasuries will therefore increase further in the coming years.

Hence, any permanent and absolute effect on the yield curve is likely to be small. In the extreme, LSAP2 and Operation Twist 2 can be seen as just offsetting the otherwise adverse impact on government bond prices of the pronounced increase in sovereign debt levels. The effects of LSAP1, LSAP2 and Operation Twist 2 on reducing the maturity of outstanding debt are enormous, which, in itself, may create a stimulative effect on the real economy. For example, in the absence of the Maturity Extension Program, investors would have had to absorb Treasuries with an average maturity of about 7.7 years in Q4 2011, whereas with the purchases, this reduces to only 5.5 years. Nevertheless, a sizeable rebalancing of investor portfolios from government debt to other longer-term private debt securities is inhibited by an even greater increase in the supply of Treasuries.

Graph 5

Operation Twist 2 – sales and purchases of US Treasuries



Note: The shaded areas indicate the announcement of the Maturity Extension Program on 21 September 2011.

[1] In billions of dollars. Total amount of issuances by the US Treasury on a given day not allotted to the Federal Reserve (reinvestment programme). [2] In billions of dollars. Total amount of open market purchases on a given day. [3] In per cent, at constant maturities. [4] Starting from 3 October 2011, when open market operations under Operation Twist 2 commenced. Cumulative sum of issuances by the US Treasury minus Federal Reserve open market purchases. [5] In billions of dollars. Total sales of short-term securities (remaining maturity < three years) conducted on a given day.

Sources: Federal Reserve Bank of New York; Federal Reserve Board; US Treasury; BIS calculations.

Table 3

Issuances and Federal Reserve purchases of Treasury securities for Q4 2011

Remaining maturity at time of purchase	<=3y	>3y–6y	>6y–8y	>8y–10y	>10y–20y	>20y–30y	TIPS <=6y	TIPS >6y
Net issuances of Treasury securities[1, 2]	-46.95	72.92	60.42	68.60	0	43.70	11.10	18.76
Fed purchases[1]	-130.03	0	43.948	41.66	5.224	37.93	-4.03	4.14
Net increase of debt to be held by the public[1]	83.08	72.92	16.47	26.94	-5.22	5.77	16.03	14.63

[1] Marketable securities, in billions of US dollars. [2] Net of securities maturing in Q4 2011, which fall into the category of <=three years of remaining maturity.

Sources: Treasury Direct; Federal Reserve Bank of New York; BIS calculations.

Annex A:
The effects of central bank bond purchase programmes on financial variables

Paper	Country	Focus	Methodology	Variable of interest	Results	Sample period
Gagnon et al (2010)	US	LSAP Treasuries	Event study; changes in yields on the days of announcement	2-yr and 10-yr Treasury yields, 10-yr agency debt yield, 10-yr swap rate, Baa corporate bond index yield	Change in 10-yr Treasury yields in response to LSAP1: –91 bp	Nov 2008–Nov 2009
Yellen (2011)	US	LSAP Treasuries	Event study; changes in yields on the days of announcement	10-yr and 30-yr yields on Treasuries, TIPS, MBS and corporate bond yields	Change in 10-yr Treasury yields in response to LSAP1 and 2: –106 bp	Nov 2008–Mar 2009
Krishnamurthy and Vissing-Jorgensen (2011)	US	LSAP Treasuries	Event study; changes in yields on the days of announcement	Treasury yields at various maturities, agency debt, MBS corporate yields and TIPS	Change in 10-yr Treasury yields: –100 bp (LSAP1); –30 bp (LSAP2)	Nov 2008–Mar 2009; Aug 2010–Nov 2010
Hamilton and Wu (2011)	US	LSAP Treasuries	Times series study	10-yr Treasury yields	Following Fed purchase of $400 billion of long-term Treasury securities and equivalent sale of short-term notes, 10-yr Treasury yields drop by 14 bp	1990–2007
Gagnon et al (2011)	US	LSAP Treasuries	Times series study	Term premium on 10-yr Treasury yields	Impact on 10-yr Treasury yields following a 1% drop in the net supply of long-term government bonds over GDP: between –7 and –10 bp	Jan 1985–Jun 2008
D'Amico and King (2010)	US	LSAP Treasuries	Panel data study	10-yr Treasury yields	Fed purchases $400 billion in long-term Treasuries: –67 bp	Mar 2009–Oct 2009
Greenwood and Vayanos (2010)	US	LSAP Treasuries	Times series study	Treasury spreads: 5-yr over 1-yr and 20-yr over 1-yr	Following Fed purchase of $400 billion of long-term Treasury securities and equivalent sale of short-term notes, 5-yr over 1-yr spread (20-yr over 1-yr spread) drops by 39 (74) bp	1952–2006
Swanson (2011)	US	Operation Twist 1	Event study	10-yr Treasury yields	Change in 10-yr Treasury yields: –16 bp	1961–62
Meaning and Zhu (2011)	US, UK	CB asset purchase programmes (LSAP and APF)	Panel data study	10-yr Treasury yields	Effects similar to D'Amico and King (2010). The effect is largely similar for the LSAP and the APF. MEP should have an effect on longer-term Treasury bond yields similar to LSAP	Nov 2010–Jun 2011 (US); Mar 2009–Jan 2010 (UK)

APF = Asset Purchase Facility; LSAP Treasuries = large-scale asset purchases of Treasuries; MBS = mortgage-backed securities; MEP = Maturity Extension Program.

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The financial crisis and the changing dynamics of the yield curve[1]

Morten L Bech[2] and Yvan Lengwiler[3]

Abstract

We present evidence on the changing dynamics of the yield curve from 1998 to 2011. We identify four different phases. As expected, the financial crisis represents a period of elevated yield volatility, but it can be split into two distinct periods. The split occurs when the Federal Reserve reached the zero lower bound. This bound suppressed volatility in the short end of the yield curve while increasing volatility in the long end – despite lower overall volatility in financial markets. In line with previous studies, we find that announcements with regard to the Federal Reserve's large scale asset purchases reduce longer term yields. We also quantify the effect of widely observed economic news, such as the non-farm payrolls and other items, on the yield curve.

Keywords: Term structure of interest rates, financial crisis, interest rate dynamics, LSAP, unconventional monetary policy

JEL classification: E43, E52

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[2] Bank for International Settlements.

[3] Dept. of Economics, University of Basel, Peter Merian-Weg 6, P.O. Box, CH–4002 Basel, Switzerland.

Corresponding author. Email addresses: morten.bech@bis.org (Morten L. Bech), yvan.lengwiler@unibas.ch (Yvan Lengwiler).

1. Introduction

The yield curve on U.S. Treasury securities is one of the most closely watched data of the global economy. Understanding its dynamics is a preoccupation of many financial market participants as well as academics. In this paper, we investigate how the dynamics of the yield curve were affected by the financial crisis and the subsequent policy responses using the "intelligible factors" framework of Lengwiler and Lenz (2010).

We identify four different phases of yield curve dynamics since 1998 (Section 3). After a "normal" phase ending mid-2004 we observe a period that is characterized by a conspicuous absence of volatility in yields. This "moderation" phase ends with the beginning of the financial crisis in August 2007. The first part of the crisis, which we label "liquidity crisis", was characterized by money market turmoil and liquidity problems. Accordingly, we observe huge volatility in the short and medium maturity spectrum of the yield curve. This pattern abruptly changes in December 2008, after the Federal Reserve reached the zero lower bound. Since then, we observe a lack of perturbations at short maturities, but unusually large volatility in the long maturity spectrum of the yield curve. Reaching the zero lower bound appears in our analysis to be a significant event that has quantitatively changed the dynamics of the yield curve.

Our second result (Section 4) concerns the identification of the most important shocks. We quantify and locate in the maturity spectrum the most significant shocks, e.g. 9/11, the Lehman collapse, the rescue of AIG, or the increase of the large scale asset purchases (LSAPs) in March 2009.

Our third result (Section 5) concerns the measurement of the effect of surprises in key macroeconomic data on the yield curve. In particular, we measure how deviations of published indicators, such as non-farm payrolls, jobless claims, and other items, from expected values affect the yield curve over the whole maturity spectrum. We find that these surprises do indeed correlate with yield curve shocks, but the connection has become weaker in the crisis.

2. Intelligible factors

We use the decomposition of the term structure into "intelligible factors" developed by Lengwiler and Lenz (2010). We have M maturities that we observe on T days. Let $r_t(m)$ denote the interest rate for a zero bond at time t which matures at time $t+m$. The cross section of interest rates is described by three factors,

$$r_t(m) = k_1(m)\phi_{1,t} + k_2(m)\phi_{2,t} + k_3(m)\phi_{3,t} + \varepsilon_t(m), \qquad (1)$$

where $k([M \times 3]\text{matrix})$ are the loadings and $\phi([3 \times T]\text{matrix})$ are time-varying factors. ϕ and k are constructed together so that they have certain desirable properties. Firstly, constraints are imposed on the loadings k, such that they load on different parts of the maturity spectrum, as can be seen from Figure 1. The first factor is the only one that loads on the very long end of the maturity spectrum, so we call ϕ_1 the *long factor*. The second factor is the only one that loads on the very short end of the maturity spectrum, so we call ϕ_2 the *short factor*. The third factor has zero loading at the short and the long end of the maturity spectrum, but it is normalized in such a way that it achieves unit loading somewhere in the middle. We call this the *curvature factor*.[4]

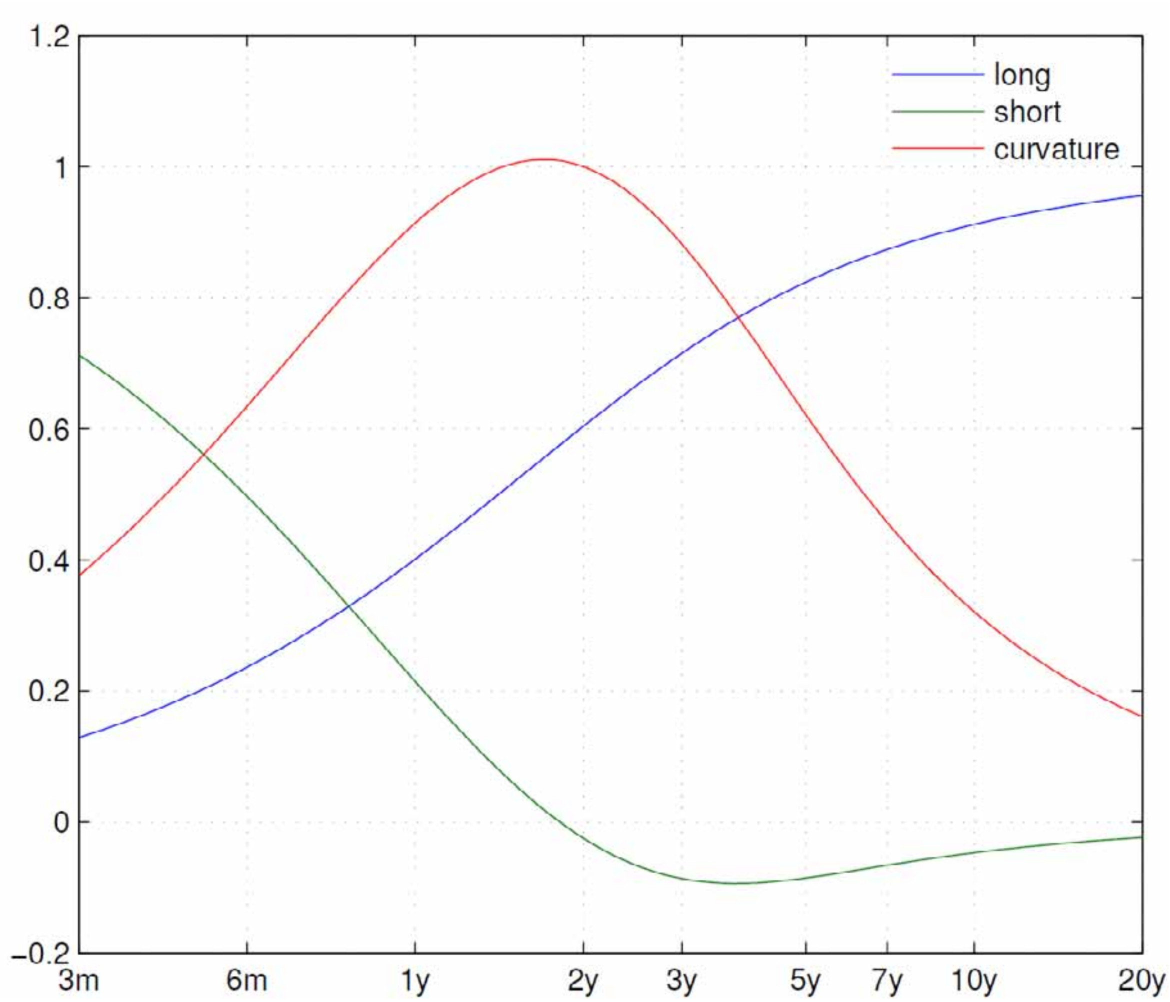
Secondly, the dynamics of the factors Á is described by a vector auto-regression (VAR),

$$\phi_t = D_0 + D_1\phi_{t-1} + \ldots + D_p\phi_{t-p} + u_t \,, \tag{2}$$

where $\phi_t = \left[\phi_{1,t}, \phi_{2,t}, \phi_{3,t}\right]'$ and $D_0,\ldots,D_p$ are the coefficient matrices of the VAR. We set p large enough so that the factor innovations u_t become serially uncorrelated. As described in Lengwiler and Lenz (2010), the shape of the loadings k is adjusted in such a way that the factor innovations u are also uncorrelated with each other. As a result, the covariance matrix of the innovations, $E\left[uu'\right]$, is diagonal, and the VAR is structural in that sense.

Figure 1

Loadings of the three factors



[4] Note that these loadings differ from the more common loadings "level", "slope", and "curvature", which have become custom in applications of principal component analysis (Litterman and Scheinkman, 1991) or in the specification of Nelson and Siegel (1987).

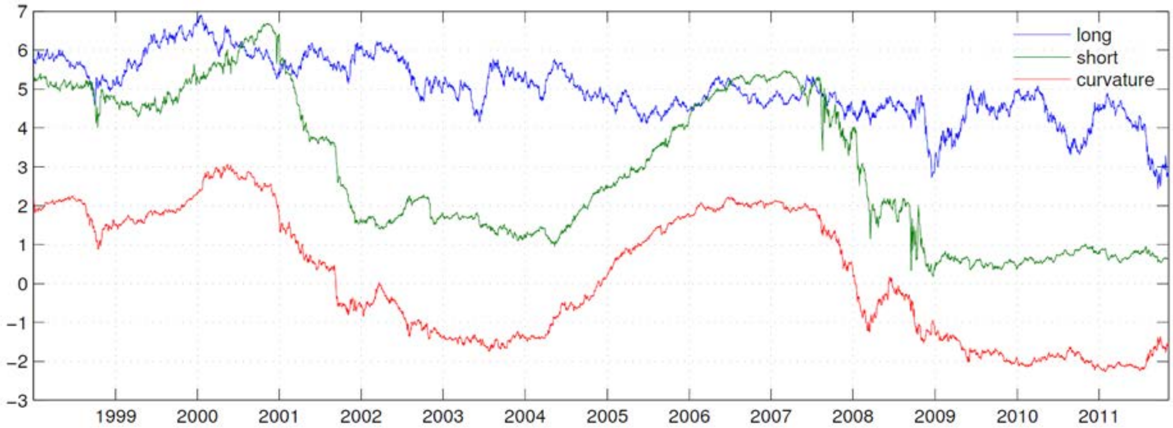
The result of this procedure is a set of loadings that describe the long end, the short end, and the curvature of the yield curve. The dynamics of these factors are described by a structural VAR model.

We use the constant maturity yield curve data produced by the U.S. Treasury. These estimates are generated from secondary market quotes of U.S. Treasury debt, and interpolated with splines to yield estimates at given, constant times to maturity.[5] We use observations at three and six months, and one, two, three, five, seven, ten, and twenty years. We use daily observed data from January 2, 1998 to November 8, 2011 (worth 3468 business days). We repeat the estimation presented in Lengwiler and Lenz (2010) with this expanded data set. We find that we need thirty lags in the VAR to remove serial correlation of the innovations. The estimated factors are shown in Figure 2.

The innovations u are uncorrelated white noise random variables by construction. They drive the dynamics of the factors and thus of the term structure. Through the VAR dynamics, an innovation into one factor has the potential to ultimately affect all the factors as time passes. However, as was already discussed in Lengwiler and Lenz (2010), it is an important stylized fact of the intelligible factors decomposition that innovations into the short and the long factor essentially only affect themselves: there is very little spillover on the other factors. Innovations into the curvature factor, in contrast, are the main drivers of movements of the curvature and the short factor. As a result, curvature innovations are by far the most important source of the overall yield curve dynamics.

Figure 2

Estimated intelligible factors

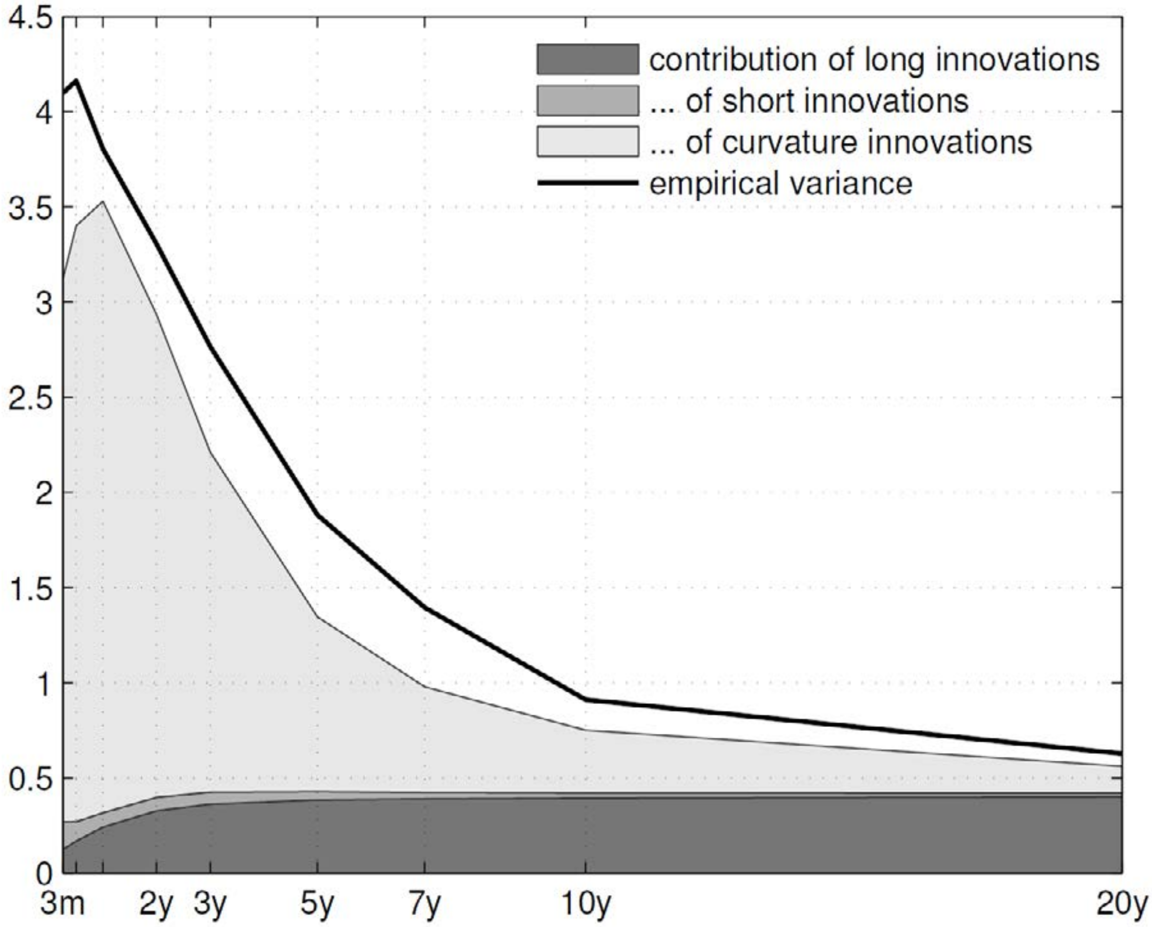


This stylized fact is also true in the extended data sample. Figure 3 depicts the variance decomposition, i.e. the parts of the variance of the interest rates that are due to the innovations into the three factors, u. The variance decomposition firstly reveals that the model captures the second moment of the yields – the term structure of interest rate variance – very well, and secondly confirms that most of the yield curve movements have their source in innovations into the curvature factor.

5 See www.treasury.gov/resource-center/data-chart-center/interest-rates/Pages/yieldmethod.aspx for a description of the methodology.

Figure 3

Variance of yields of different maturities and shares explained by the three types of innovations



3. Four phases of term structure dynamics

Visual inspection of the innovations reveals that their volatility has not been constant throughout the sample. In order to measure this, we compute the "local volatility" of the factor innovations; see Figure 4.[6] The financial crisis is clearly visible in this graph, but we can distinguish two phases. Beginning in August 2007, the volatilities of the short and the curvature innovations explode, and stay high until the end of 2008. After that they go back to pre-crisis levels. The volatility of long factor innovations also increases in 2007, but becomes particularly large at the end of 2008. It remains high until the end of the sample. Today, the long factor innovations appear much more volatile than before the crisis. The same is not true for the short and curvature innovations.

This pattern becomes even clearer if we focus attention only on the largest innovations. To that avail, we compute standardized innovations, i.e. we divide the three factor innovations by their unconditional standard deviations. Figure 5 depicts those standardized innovations

6 "Local volatility" is a non-parametric measure of the second moment. It is essentially a Nadaraya-Watson kernel regression on the squared innovations; details are explained in Appendix A.

that are significantly different from zero at 95% confidence (so greater than 1.96 in absolute terms). We can distinguish four phases.

The first phase begins at the start of our sample and ends roughly at mid-2004 (we chose end of July). In this phase we see approximately what we would expect to see. In fact, the three standardized innovations are independent and serially uncorrelated random variables with unit variance. If they are normally distributed, for each individual series, 5% of the observations should be significantly different from zero. During this first phase, this is more or less what we observe: 3.7% of the long innovations, 2.6% of the short innovations, and 4.7% of the curvature innovations are significantly different from zero. One might label this period the “normal phase”.

The second phase begins August 2004 and ends August 2007. We call this the “moderation phase”. The exact timing between the normal and the moderation phase is difficult to pinpoint. The end of the moderation phase, however, is connected to an important event, namely BNP Paribas’s announcement that it was freezing three funds invested in sub-prime securities, which is commonly taken to mark the beginning of the financial crisis. This second phase is characterized by the marked absence of large innovations. Only 0.7% and 0.5% of the innovations into the long and the short factor are significantly different from zero. For the curvature, the number is 1.3%. Thus, this phase has very low volatility, and thus the standardized innovations turn out to be small and statistically insignificant.

This has dramatically changed with the financial crisis, which we can split into two separate phases. Phase number three, which we call the “liquidity crisis phase”, begins on August 9, 2007 and ends on December 16, 2008. This is the date when the Federal Open Market Committee lowered the target for the effective federal funds rate to a 0 to 25 basis points (bps) range and effectively reached the zero lower bound. This phase was characterized by the freezing of the interbank money market and substantial liquidity interventions by the Federal Reserve; in particular later in the period. Accordingly, we observe 23.4% of the innovations into the short factor that are significantly different from zero. For curvature, the number is also very large, 19.5%. Long factor innovations are also more volatile than before, but to a lesser extent: 8.9% of the days feature a long factor innovation that is significantly different from zero in this phase.

The fourth, the “zero lower bound phase”, begins after the Federal Reserve has reached the zero lower bound and lasts to the end of the sample. With no room downward on the federal funds rate, and traditional instruments of monetary policy exhausted, the volatility in the short and the curvature innovations vanishes. Only 0.3% and 2.5% of the innovations of these factors are significant. In contrast, 12.2% of the long factor innovations are now significantly different from zero.

We ran breakpoint tests (Bai and Perron, 1998, 2003) for the long, short, and curvature innovations, respectively. The tests for the short and the curvature innovations both find a break in early August 2007. All tests find a break in late 2008, but the dates differ. For the long innovations a third break is found in late 2009. For the period before the financial crisis, no consistent breaks are found across the three series.

Figure 4

Innovations and local volatilities

In basis points

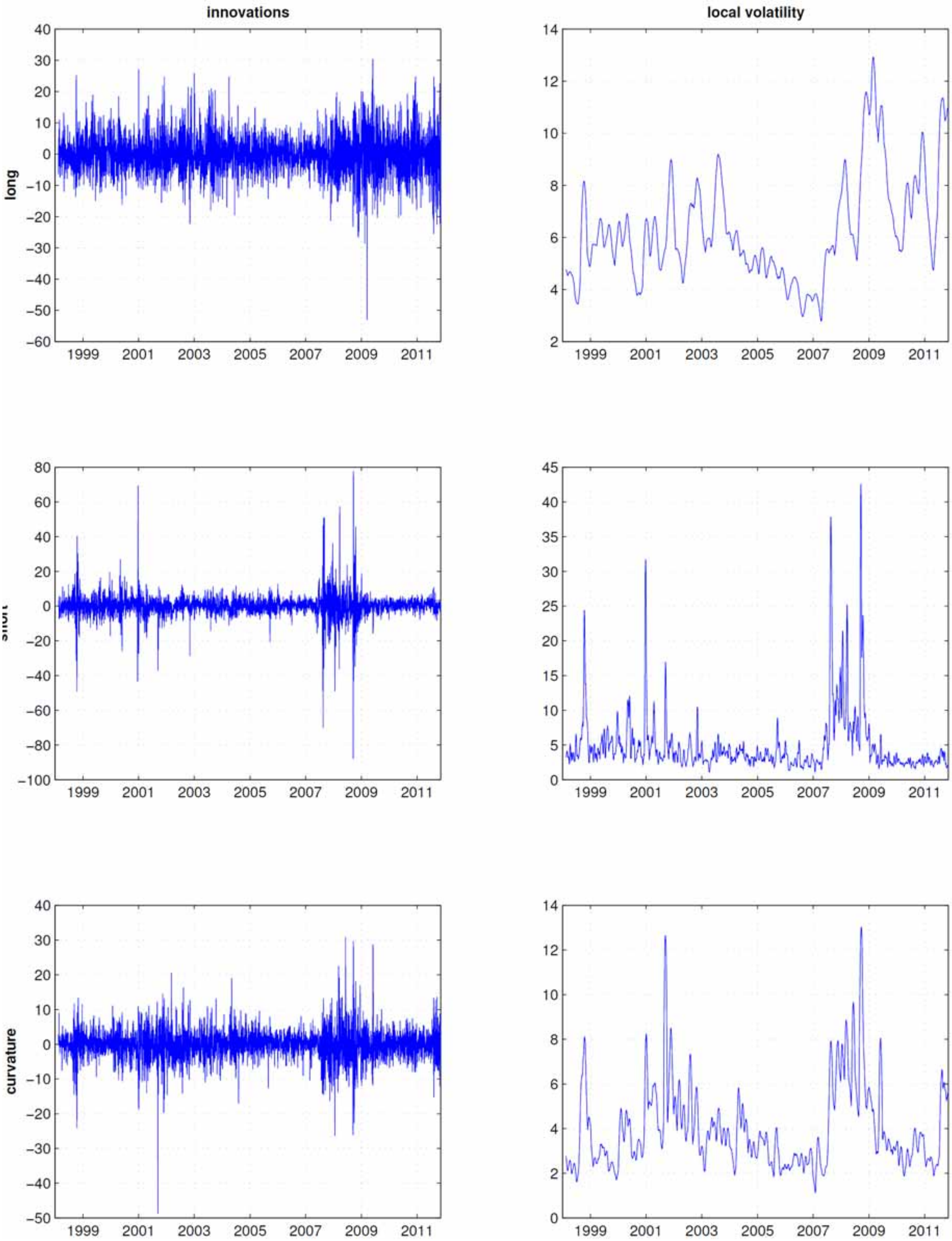


Figure 5

Large innovations into the long, short, and curvature factors, measured in multiples of unconditional standard deviations

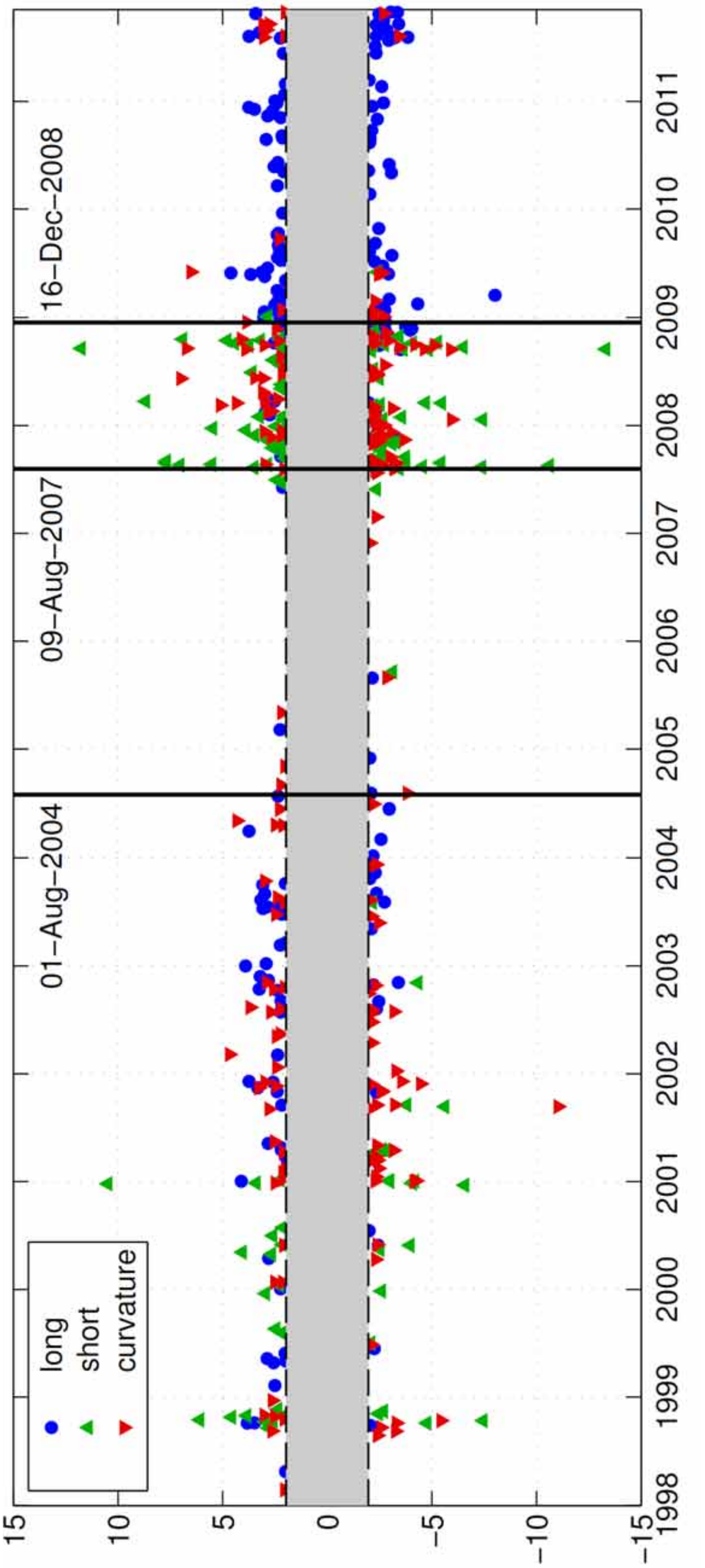


Table 1 reports similar information to Figure 5 but focuses on the joint distribution of the innovations across days. Counting just significant or non-significant innovations, eight combinations are possible on any given day. The most likely possibility is that none of the innovations is significant. Theoretically, that should happen with probability $0.95^3 = 86\%$. The long innovation should be significant while the short and the curvature innovations are not with probability $0.05 \times 0.95^2 = 4.5\%$, etc. The least likely case is that all three innovations are significant on the same day. This event should be observed only in $0.05^3 = 0.01\%$ of the days. The theoretical values for the cases with at least one significant innovation are reported in the first column of Table 1. The remaining columns contrast this with the actual measurement in the four phases. We observe more or less what we should observe if the shocks are independently and normally distributed in the "normal phase". In the "great moderation phase" there are clearly too few significant innovations. In the "liquidity crisis phase" we observe way too many short and curvature innovations. In particular, we also find nineteen days where we observe significant contemporaneous short and curvature innovations. Theory would have predicted zero or one such day. There are even five days where all three innovations are significant. In the "zero lower bound phase", finally, significant short innovations have completely vanished and significant curvature innovations are far below the theoretical expectation. Instead, there is a large density of significant long factor innovations.

Table 1

Significant shocks to the yield curve during the four phases

Theoretical		**normal phase**		**great moderation**		**liquidity crisis**		**zero lower bound**	
		# cases	share	# cases	share	# cases	share	# cases	share
long only	4.51%	49	2.98%	5	0.66%	144	14%	77	10.6%
short only	4.51%	30	1.82%	4	0.53%	50	14.8%	0	0.00%
curv only	4.51%	57	3.46%	10	1.32%	36	10.7%	4	0.55%
long & short only	0.24%	1	0.06%	0	0.00%	5	1.48%	0	0.00%
long & curv only	0.24%	9	0.55%	0	0.00%	6	1.78%	12	1.65%
short & curv only	0.24%	10	0.61%	0	0.00%	19	5.62%	2	0.27%
all three	0.01%	2	0.12%	0	0.00%	5	1.48%	0	0.00%

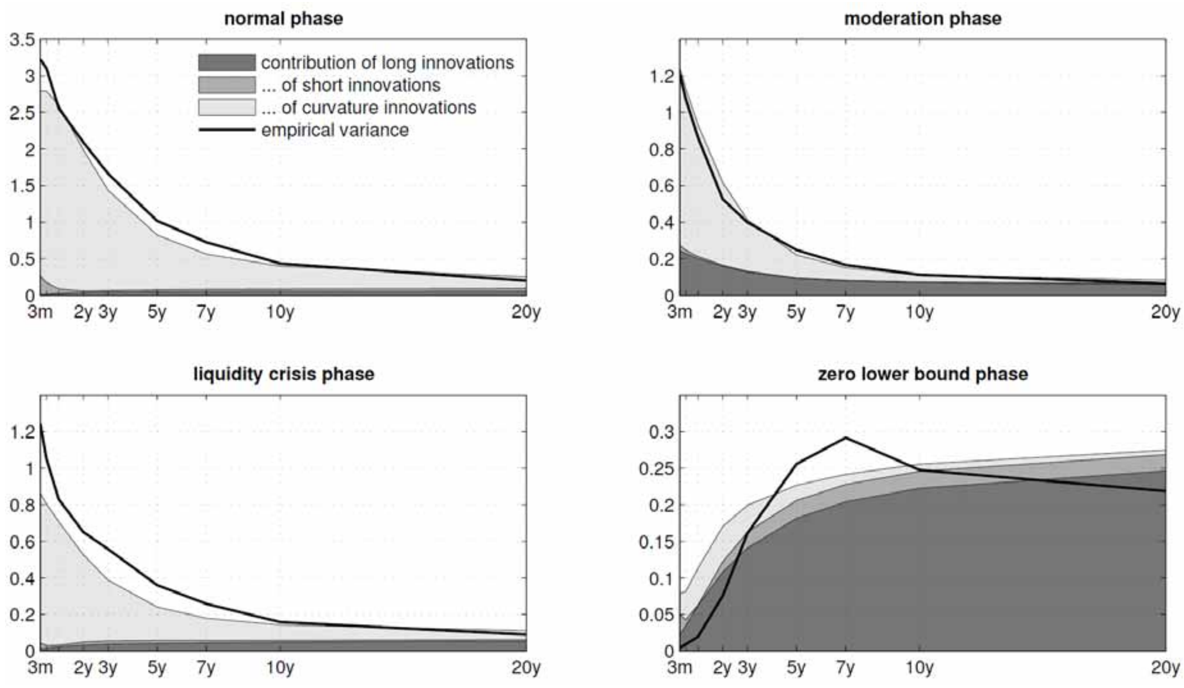
The shift of the location of the innovations during the financial crisis, and in particular to the longer part of the maturity spectrum when the zero lower bound became binding, also manifests itself in the variance attribution. We compute the variance of the yields separately for the four phases; see Figure 6 and compare with Figure 3 for the whole sample. The differences are striking. First of all, the overall variance of the yields has dramatically decreased for shorter maturities in the "zero lower bound phase". This is a direct corollary of the fact that the zero lower bound does not allow rates to decrease further, and the Federal Reserve has not allowed the short rates to increase, hence volatility in this duration spectrum has vanished. As a result, all the volatility that remains is at longer maturities. The volatilities of the ten- and twenty-year yields is more or less unchanged for the two subperiods. Yet, because no further movements at the short end are possible, and the major innovations now occur in the long factor, almost all of the term structure of yield variance can be attributed to long innovations.

4. (Reverse) event study

In this section we relate the largest innovations that we measure to identifiable events. We rely on a variety of sources. For Federal Reserve news we use press release information from the website of the Federal Reserve Board and the Federal Reserve Bank of New York. For market news, in the early years of our sample period we rely on next day summaries of financial market activity from the New York Times – with a particular focus on the Treasury market. After September 2004, we use daily press summaries from Wrightson ICAP. These press summaries are produced towards the end of the business day and are made available for clients before the close of business. They contain so-called "wraps" for different financial markets (including Treasuries) as well as a list of the news stories that are likely to make the headlines the following day. For the part of the sample that covers the height of the financial crisis, we also use the financial crisis time line of the Federal Reserve Bank of St. Louis for robustness.[7] In addition, we also check whether announcements by the Treasury department concerning its funding needs or issuing strategy might be related to our yield curve innovations.[8] We find, however, no evidence that they contain relevant information.

Figure 6

Variance of yields of different maturities and shares explained by the three types of innovations, in the four phases



Tables 2, 3, and 4 collect the twenty-five largest innovations (in absolute terms) for the long, short, and curvature factor, respectively, and also report potentially related economic or financial events. To better gauge the size of these innovations we also divide them, in the seventh column, by the unconditional standard deviation, by the local volatility estimate for

[7] http://timeline.stlouisfed.org.

[8] http://www.treasury.gov/resource-center/data-chart-center/quarterly-refunding/Pages/default.aspx.

that day (the eighth column) and the conditional GARCH volatility estimate (the ninth column). We also report simple first differences of some key interest rates.

Some dates are particularly noteworthy. We measure a –37 bps shock in the short and a –49 bps shock in the curvature factor on the day the markets reopened after the 9/11 attacks. These are 5.6 and 11.0 standard deviation events, respectively. The greatest short factor innovation, however, is measured the day of the AIG bailout (–88 bps).

The Lehman bankruptcy on September 15, 2008 shows up as a large innovation in all three factors simultaneously: we measure innovations into the long factor (–23 bps), the short factor (–32 bps), and the curvature (–26 bps) on that day. This amounts to shocks between 3.5 and 5.9 standard deviations of the respective innovation series.

Notable is also the (perverse) effect of the S&P downgrade of U.S. government debt on August 8, 2011. On that day we measure a large *negative* innovation in the long factor (–25 bps). A possible interpretation might be that the downgrade has produced a flight for safety ("Europe will be next") and thus increased the demand for U.S. debt.

Table 2

Twenty-five most important innovations to the long factor. The second column reports the size of the innovation in basis points (bps), and, in parentheses, relative to the unconditional and the local volatility of that day, respectively. For instance, the largest absolute long innovation is measured on March 18, 2009. We measure a –53 bps shock. This is 8.0 times the unconditional standard deviation of the long innovation series, and it is 12.3 times larger than the local volatility of that day.

date	**innovation**		**event**
2011-10-31	–22	[3.4, 2.0]	Greek PM Papandreou announces referendum on Eurozone debt deal
2011-10-27	+23	[3.4, 2.1]	Euro summit on Greek debt
2011-09-22	–23	[3.4, 2.1]	One day after Operation Twist 2 was announced
2011-08-24	+21	[3.2, 1.9]	French government unveils a EUR 12 billion deficit cutting package
2011-08-11	+25	[3.7, 2.2]	Bad bond auction three days after downgrade and two days after Fed's forward guidance
2011-08-09	–22	[3.3, 1.9]	"Forward guidance": Low federal funds rate through mid-2013
2011-08-08	–25	[3.9, 2.3]	Downgrade of U.S. government debt by S&P
2010-12-14	+25	[3.7, 2.5]	Confirmation of reinvestment policy and purchase of $600 billion of longer term Treasuries; little likelihood of increase of QE 2
2010-12-07	+23	[3.5, 2.3]	(No relevant news)
2009-06-01	+30	[4.6, 2.8]	Surprisingly strong data sapped the safe-haven appeal of government debt
2009-05-27	+24	[3.6, 2.2]	Concerns about the growing supply of bonds
2009-03-18	–53	[8.0, 4.3]	QE 1 enlargement: Additional $750 billion agency MBS and $100 billion agency debt; $300 in longer term Treasuries
2009-02-17	–29	[4.3, 2.3]	Worries about European banks spurred investors to seek safety in U.S. government debt
2008-12-01	–25	[3.7, 2.1]	Bernanke: Fed could purchase Treasuries
2008-11-25	–27	[4.0, 2.3]	QE 1: Initial large scale asset purchase announcement: $500 billion agency MBS and $100 billion agency debt
2008-11-20	–26	[4.0, 2.3]	Jobless claims reach new record
2008-09-15	–23	[3.5, 2.8]	Lehman bankruptcy
2004-04-02	+25	[3.7, 3.9]	(No relevant news)
2003-01-02	+26	[3.9, 3.8]	(No relevant news)
2002-11-07	–22	[3.4, 2.7]	One day after 50 bps cut
2001-12-07	+25	[3.7, 2.8]	(No relevant news)
2001-11-15	+22	[3.3, 2.5]	Dimmed hopes for further rate cuts due to positive news
2001-01-03	+27	[4.1, 4.0]	50 bps cut
1998-10-09	+23	[3.5, 2.8]	(No relevant news)
1998-10-08	+25	[3.8, 3.1]	Rumors of unwinding of a carry trade by a hedge fund

Table 3

Twenty-five most important innovations to the short factor; see Table 2 for explanation.

date	innovation		event
2008-10-20	+46	[6.9, 2.2]	Government measures show signs of reviving the frozen money market, causing an exodus out of ultrasafe short-dated Treasuries
2008-10-16	+32	[4.8, 1.4]	(No relevant news)
2008-10-10	–35	[5.3, 1.6]	Early close ahead of Columbus day. Flight to safe haven
2008-09-23	–43	[6.5, 1.2]	Bernanke supports TARP
2008-09-19	+78	[11.8, 1.8]	Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF) and ABCP MMMF Liquidity Facility
2008-09-17	–88	[13.3, 2.1]	AIG bailout
2008-09-15	–32	[4.8, 0.8]	Lehman bankruptcy
2008-03-24	+57	[8.7, 2.3]	FRBNY announces that it will provide term financing to facilitate JPMorgan Chase's acquisition of Bear Stearns
2008-03-19	–31	[4.7, 1.3]	One day after 75 bps cut. Reduction of required capital for Fannie Mae and Freddie Mac
2008-03-18	–36	[5.5, 1.5]	75 bps cut
2008-01-22	–49	[7.4, 2.4]	75 bps cut
2007-12-24	+36	[5.5, 2.2]	(No relevant news)
2007-09-04	+51	[7.7, 2.1]	Money market turmoil
2007-08-29	–36	[5.4, 1.1]	Money market turmoil
2007-08-27	+51	[7.7, 1.5]	Money market turmoil
2007-08-24	+37	[5.5, 1.0]	Money market turmoil
2007-08-21	+46	[7.0, 1.2]	Money market turmoil
2007-08-20	–70	[10.6, 1.9]	Money market turmoil
2007-08-15	–49	[7.4, 1.5]	Money market turmoil after BNP Paribas writedown
2001-09-13	–37	[5.6, 2.2]	Market reopens after terrorist attacks, Fed will "provide whatever liquidity might be needed"
2000-12-26	+69	[10.5, 2.2]	(No relevant news)
2000-12-21	–43	[6.6, 1.6]	Speculation that Federal Reserve may lower interest rates before scheduled meeting at the end of January
1998-10-19	+40	[6.1, 1.8]	Two days (!) after 50 bps rate cut, reversing move of short factor a day earlier
1998-10-16	–49	[7.4, 2.0]	One day after 50 bps rate cut
1998-10-08	–31	[4.8, 1.9]	Rumors of unwinding of a carry trade by a hedge fund

Table 4

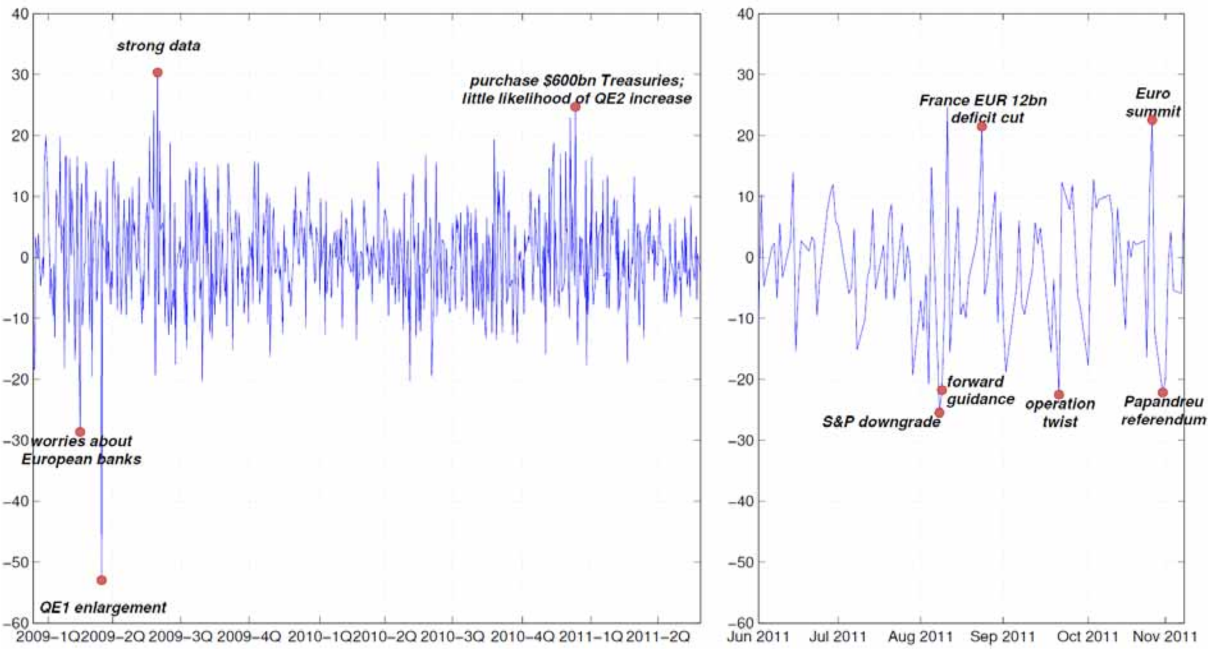
Twenty-five most important innovations to the curvature factor; see Table 2 for explanation.

date	innovation		event
2009-06-05	+29	[6.5, 3.6]	Smaller than expected drop in non-farm payrolls
2008-12-17	+17	[3.8, 3.1]	One day after rate cut to 0–0.25%. FOMC statement mentions the possibility of purchases of longer maturity debt
2008-10-20	+18	[4.1, 2.2]	Government measures show signs of reviving the frozen money market, causing an exodus out of ultrasafe short-dated Treasuries
2008-10-02	–19	[4.2, 1.5]	Rise in jobless claims and worse than expected factory orders
2008-09-29	–23	[5.1, 1.8]	Fed: Expansion of FX Swap lines. The U.S. House of Representatives rejects legislation submitted by the Treasury Department requesting authority to purchase troubled assets from financial institutions
2008-09-19	+30	[6.7, 2.3]	Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF) and ABCP MMMF Liquidity Facility
2008-09-17	–21	[4.7, 1.6]	AIG bailout
2008-09-16	+17	[3.9, 1.4]	Rate unchanged
2008-09-15	–26	[5.9, 2.1]	Lehman bankruptcy
2008-06-12	+15	[3.5, 1.6]	(No relevant news)
2008-06-09	+31	[7.0, 3.2]	Better looking housing data
2008-03-18	+19	[4.3, 2.2]	75 bps cut
2008-03-11	+22	[5.1, 2.5]	Joint statement of central banks of the United States, England, Japan, Canada, Switzerland, and Sweden, and the ECB. Federal Reserve action: Term Securities Lending Facility (TSLF), Fed lends up to $200 billion of Treasury securities against agency debt, agency MBS, and non-agency AAA/Aaa-rated MBS
2008-01-22	–26	[6.0, 3.5]	75 bps cut
2007-11-15	–16	[3.7, 2.1]	Bad job claims report
2004-08-06	–17	[3.8, 3.8]	Bad non-farm payrolls report
2004-05-07	+19	[4.3, 3.4]	Unexpectedly strong employment report
2002-08-14	+16	[3.7, 2.4]	(No relevant news)
2002-03-08	+21	[4.7, 3.4]	Chairman Greenspan provides a positive outlook, saying that an expansion is already “well under way”
2001-12-07	–16	[3.6, 2.1]	(No relevant news)
2001-11-29	–20	[4.5, 2.4]	Correction following Enron and Japan downgrade
2001-09-13	–49	[11.0, 3.9]	Market reopens after terrorist attacks, Fed will “provide whatever liquidity might be needed”
2001-01-05	–19	[4.3, 2.3]	Weaker than expected non-farm payrolls
2001-01-02	–18	[4.1, 2.2]	(No relevant news)
1998-10-16	–24	[5.4, 3.0]	One day after 50 bps rate cut

Overall, we note that the larger volatility of long factor innovations in the “zero lower bound” phase is only partly due to announcements concerning unconventional monetary policy measures. Of the twenty-five events reported in Table 2, thirteen occurred in the “zero lower bound” phase. Only four of these large innovations are related to announcements of the Fed concerning unconventional monetary policy. These are the enlargement of QE 1 (March 18, 2009, –53 bps), the confirmation of the reinvestment policy (December 14, 2010, +25 bps), one day after Operation Twist 2 was announced (September 22, 2011, –23 bps), and finally the “forward guidance” announcement (August 9, 2011, –22 bps). All other major shocks were due to business cycle surprises or are related to the crisis of the European currency union. This point is nicely illustrated in Figure 7.

Figure 7

Major long factor innovations in the zero lower bound phase. The last five months of the sample are depicted separately in the right-hand panel because there is more action there.



5. News

It is well-documented that economic news releases and in particular surprises from market expectations move Treasury yields (see e.g. Fleming and Remolona, 1999). Not surprisingly, a similar relationship holds for our factors. A natural question is whether or not the changing dynamics of the yield curve can (in part) be explained by changing dynamics in terms of economic news surprises. Table 5 shows the results of regressing innovations into our long, short, and curvature factors on day-of-release surprises for a range of economic indicators. The indicators we consider include the Conference Board Consumer Confidence Index®, the Institute for Supply Management (ISM) purchasing managers index (PMI), the advance GDP print, the unemployment rate, industrial production, retail sales, housing starts, one-family houses sold, the personal consumption expenditure price index, capacity utilization, initial jobless claims, the leading economic indicator index, and the federal funds rate target. We measure surprises as the difference between the actual value released and the median value from an "expectations" survey among Wall Street economists conducted by Bloomberg News prior to the release. To put the surprises on a common scale we standardized them by their standard deviation over the sample. Moreover, we switch the sign of some surprise variables, so that a positive surprise is "good news". For instance, non-farm payroll surprises are measured as actual release minus median expectation, whereas jobless claims are defined the other way around. In addition, we control for non-linear effects by including the squared standardized surprises as additional regressors.

Besides the results for the entire sample, we also split our sample in two with a view to investigating whether or not the impact of economic news has changed with the financial crisis. Our "pre-crisis" sample runs from 1998 to August 8, 2007 ("normal" and "great moderation" phases) and the "crisis" sample covers the remainder of our sample ("liquidity crisis" and "zero lower bound" phases). Furthermore, because our left-hand variables exhibit clustered volatility (see Section 3 and Figure 4 in particular), we use the EGARCH specification. In order to capture general market volatility we add the VIX as an exogenous variable to the variance equation. We also add dummies for our phases that we identified in Section 3 to the variance equation.

Consistent with previous literature we find that the non-farm payrolls are among the most informative signals. This was the case before the crisis, and has remained so: non-farm payroll surprises (linear and squared) have highly significant effects on all three yield curve factors. PMI surprises used to be significant predictors of all three innovations before the crisis; since the crisis they contain information only on long innovations. Surprises about retail sales and about capacity utilization used to contain information on long and curvature innovations before the crisis; in the crisis, retail sales surprises seem to no longer affect the curvature, and capacity utilization has lost its connection to the yield curve completely. Surprises about jobless claims used to affect curvature innovations before the crisis, but now affect long innovations instead. Surprises concerning the FOMC's federal funds target rate used to be highly significant with respect to short factor innovations; they have lost their explanatory power during the crisis. Prior to the financial crisis, our economic surprise indicators could account for 4.5%, 1.5%, and 6.6% of the variation in the long, short, and curvature factors (as measured by the R^2-statistic). In our crisis sample, the comparable numbers are 3.2%, 0.3%, and 0.9%.

The phase dummies in the variance equation partially verify our partition of the sample into four phases. Interestingly, the "great moderation" dummy is not significant. The general reduction of the volatility of our innovations between 1998 and the beginning of the financial crisis seems fully captured by the VIX. The two other phase dummies, however, come in as significant, as expected. The "liquidity crisis" dummy measures a higher volatility for short and curvature innovations, but is not significant in the variance equation of the long innovations. The "zero lower bound" dummy, on the other hand, measures a significantly higher volatility of long factor innovations, but significantly lower volatility of the short factor innovations. With respect to curvature innovations, this coefficient is either negative (pointing to a reduced volatility of curvature shocks in this phase) or statistically insignificant.

6. Conclusions

The financial crisis has deeply affected financial markets as well as the economy as a whole. This has also affected the yield curve and its dynamics. We document these changes in this paper. Our main results can be summarized as follows: Firstly, we divide the dynamics of the yield curve into four phases. The first two phases occur prior to the financial crisis. The second phase is characterized by substantially less volatility of the yields compared to the first phase. However, this is well explained by the simultaneous decline of overall financial market volatility during that period as measured by the VIX.

The third and the fourth phase comprise the financial crisis. This means that we can divide the crisis into two distinct subperiods. In the first subperiod, the yield curve experienced very strong shocks in the short and medium maturity spectrum due to the freezing of the money market and subsequent emergency measures taken by the Federal Reserve. The second part of the financial crisis began when the federal funds rate reached the zero lower bound. From that point forward, we find an absence of shocks hitting the yield curve at low and medium maturities. Instead, the longer end of the curve experiences greater disturbances than before.

Secondly, we perform a (reverse) event study in which we match the greatest shocks to the yield curve with headline news. We find that some large shocks are associated with announcements by the Federal Reserve. However, a significant number of shocks in particular in the recent past are due to international developments.

Thirdly, we identify and quantify the informational content of well-known macroeconomic surprise data. We find that that some, but not all of these variables have lost significance in the crisis. The overall information content of these news variables with respect to the yield curve, however, is small.

Table 5

Effects of macroeconomic news on the yield curve

variable	**long innovations**			**short innovations**			**curvature innovations**		
sample	pre-crisis	crisis	all	pre-crisis	crisis	all	pre-crisis	crisis	all
constant	–0.033	–0.090	–0.065	0.235	0.530	0.328	0.206	–0.195	0.122
standardized surprise in:									
Capacity utilization	2.205**	0.813	2.186**	–0.740	–0.457	–0.575	1.233**	–0.224	0.808**
Consumer confidence	1.350**	–0.311	1.135**	–0.358	0.191	–0.135	0.449	0.224	0.360
Initial jobless claims	0.975	2.955**	1.620**	–0.027	–0.160	–0.174	1.005**	–0.553	0.661**
Federal funds target	–2.689	–7.409	–1.334	–12.83***	–1.362	–10.40***	–0.471	3.792	–1.001
Advance GDP	–0.668	–2.094	–0.809	0.018	0.697	–0.038	0.528	–0.654	0.571
One-family houses sold	0.996**	0.711	0.999**	–0.129	–0.076	–0.102	–0.047	0.502	0.010
Housing starts	–0.407	2.167	–0.179	–0.103	–1.067	–0.264	0.055	1.795*	0.126
Industrial production	–0.990	2.364	–0.694	0.439	0.098	0.334	–0.480	0.537	–0.199
ISM PMI	1.597***	3.136**	1.941***	–1.305***	0.348	–0.483*	1.370***	–0.620	0.888***
LEI	0.274	0.175	0.175	–0.833	–0.287	–0.502	–0.708	–0.574	–0.754**
Non-farm payrolls	3.578***	4.786**	3.761***	–2.009***	–2.390***	–2.206***	3.117***	1.938**	2.948***
PCE price index	0.356	–3.064*	–0.482	–1.324*	–0.351	–0.724	–0.141	–0.345	–0.124
Retail sales	1.445**	5.530***	2.110***	–0.570	0.933	–0.143	1.176***	–1.490*	0.581*
Unemployment rate	0.783	1.477	0.961*	–0.542	–0.524	–0.644**	2.065***	0.837*	1.477***

Table 5 (cont)

Effects of macroeconomic news on the yield curve

variable	**long innovations**			**short innovations**			**curvature innovations**		
sample	pre-crisis	crisis	all	pre-crisis	crisis	all	pre-crisis	crisis	all
constant	–0.033	–0.090	–0.065	0.235	0.530	0.328	0.206	–0.195	0.122
squared standardized surprise in:									
Capacity utilization	–0.655	–1.615	–0.968*	0.190	–0.049	0.049	–0.657*	0.809**	–0.052
Consumer confidence	–0.119	–1.337**	–0.286	–0.391	–0.379	–0.390**	–0.085	0.67**	0.133
Initial jobless claims	0.101	0.096	0.184	–0.296	0.018	–0.232*	0.197	0.024	0.149
Federal funds target	–0.331	11.666	1.339	–7.455**	–6.158	–6.005**	4.580	–11.21	3.450*
Advance GDP	0.715	0.118	0.681	–1.056**	0.155	–0.518	0.459	–0.468	0.455
One-family houses sold	–0.090	1.541	–0.063	–0.082	–0.962	–0.137	0.083	0.463	0.047
Housing starts	–0.098	–1.663	–0.143	–0.086	–0.704	–0.142	–0.174	0.323	–0.169
Industrial production	0.220	1.513	0.627	–0.180	–0.008	–0.015	0.740*	–0.315	0.179
ISM PMI	0.809***	–0.025	0.626***	–0.290	–0.377	–0.354**	–0.199	0.213	–0.062
LEI	0.668	0.594	0.580	0.198	0.253	0.314	0.204	–0.066	0.195
Non-farm payrolls	0.782***	1.031	0.821***	–0.622***	–1.396***	–0.774***	0.326**	1.989***	0.296**
PCE price index	–0.826	–0.677	–0.747	1.235*	1.079*	1.086**	0.202	0.276	0.304
Retail sales	0.223	0.078	0.102	0.023	0.135	–0.056	0.023	–0.167	0.180
Unemployment rate	0.066	0.477	0.145	0.000	0.670**	0.490**	–0.456	–0.900***	–0.438**
Variance equation									
constant	0.005	2.658**	0.043	–0.086**	0.284**	–0.001	–0.067**	0.179	–0.046**
$\lvert\varepsilon(-1)\rvert / \sigma(-1)$	0.077***	0.092	0.098***	0.260***	0.271***	0.298***	0.144***	0.251***	0.178***
$\varepsilon(-1) / \sigma(-1)$	0.013	0.034	0.012	–0.061***	–0.112***	–0.072***	–0.024	–0.003	–0.021
$\log\left(\sigma^2(-1)\right)$	0.969***	–0.022	0.952***	0.931***	0.887***	0.907***	0.965***	0.891***	0.956***
great moderation dummy	0.002		–0.006	–0.004		–0.039*	0.000		–0.014
liquidity crisis dummy			0.015*			0.145***			0.051***
zero lower bound dummy		0.415**	0.026**		–0.288***	–0.086***		–0.166**	–0.010
VIX	0.002***	0.043**	0.002***	0.004***	0.001	0.003**	0.002**	0.002	0.001**
R^2	0.045	0.032	0.035	0.015	0.003	0.007	0.066	0.009	0.033

Note: *,**,*** denotes significance at the 10%, 5%, and 1% level, respectively.

Appendix A.: Spot and local volatility

This is a purely technical appendix which is not necessary to understand the economic content of the paper. It explains the concept of "local volatility" that is used in some places in the main part of the article.

We aim at quantifying the changing volatility of the innovations u. Simple visual inspection suggests heteroscedasticity. We fully acknowledge that this feature of the data is not in line with the specification of the model. After all, we assumed normally distributed homoscedastic innovations when estimating the loadings and the VAR with maximum likelihood. Taking the heteroscedasticity fully into account at the estimation stage of the model seems very challenging. Being aware of this inconsistency, here we simply aim to measure the stochastic volatility of the innovations as they present themselves from the model that was estimated assuming homoscedasticity.

Consider a continuous-time diffusion,

$$dX_t = \mu_t dt + \sigma_t dW_t, \tag{A.1}$$

where W_t is a standard Brownian motion. σ_t^2 is the spot variance process, which is not observed. Instead, we observe only X_t at discrete points in time, $t_1 < t_2 < ... < t_n$. Based on work by Bandi and Phillips (2003), Kristensen (2010) establishes that one can estimate σ_τ^2 as

$$\hat{\sigma}_\tau^2 = \frac{\sum_{i=1}^{n} K_h\left(t_{i-1} - \tau\right)\left(X_{ti} - X_{t_{i-1}}\right)^2}{\sum_{i=1}^{T} K_h\left(t_{i-1} - \tau\right)}, \tag{A.2}$$

where K_h is a kernel function with bandwidth h. This is a Nadaraya-Watson kernel regression on the squared first difference of X. Spot volatility is simply the square root of the estimated spot variance. In our application, X is one of the factor innovations in the VAR model, i.e. u_f for $f \in \{1, 2, 3\}$.

In order to estimate spot volatility, two choices need to be made, namely the specification of the kernel function K and the selection of the bandwidth h. To select the bandwidth, we use the cross-validation technique; that is, we minimize the mean squared "leave-one-out" residuals. The kernel function K is symmetric around zero if it weighs observations in the future the same way as observations in the past. Most popular kernel functions have this property. Symmetric kernel functions have, however, the disadvantage that for τ close to the edge of the sample, they assign positive weights to observations outside the available sample, which biases the estimation. This is a well-known problem in non-parametric econometrics.

One way to address this problem is to use a locally adapting kernel function. Such a function was for instance proposed by Brown and Chen (1999) and Chen (2000). Their kernel function, based on the beta-function, automatically adapts to the boundaries of the sample: for τ close to the first observation t_1, the kernel is right-sided, for τ close to the last observation t_n, the kernel is left-sided. We have experimented with this kernel but found it to give unsatisfactory estimates in our application. The volatility measure has significantly more high-frequency variability close to the edge of the sample than in the interior, which suggests that the precision of the estimate deteriorates close to the edge, or that the bandwidth becomes too small.

For this reason, we resort to an older, simpler idea that was proposed by Schuster (1991). It consists of reflecting observations close to the edge of the sample to the other side. So, $\left[\ldots, X_{t_{n-3}}, X_{t_{n-2}}, X_{t_{n-1}}\right]$ are appended in reverse order as $\left[X_{t_{n+1}}, X_{t_{n+2}}, X_{t_{n+3}}, \ldots\right]$, and then the symmetric kernel function is applied to these synthetically expanded observations. We use the popular (symmetric) Epanechnikov specification as the kernel function.

This procedure as described so far is, however, not very successful in our application. The estimated spot volatilities turn out to be much too large on average. Only about 1% of the absolute innovations are greater than 1.96 times the estimated spot volatilities. It is not completely clear why this is the case. It may be due to the fact that equation (A.1) is not the correct model for the innovations u. After all, these are residuals and they have, by construction, no drift, so $\mu_t = 0$.[9]

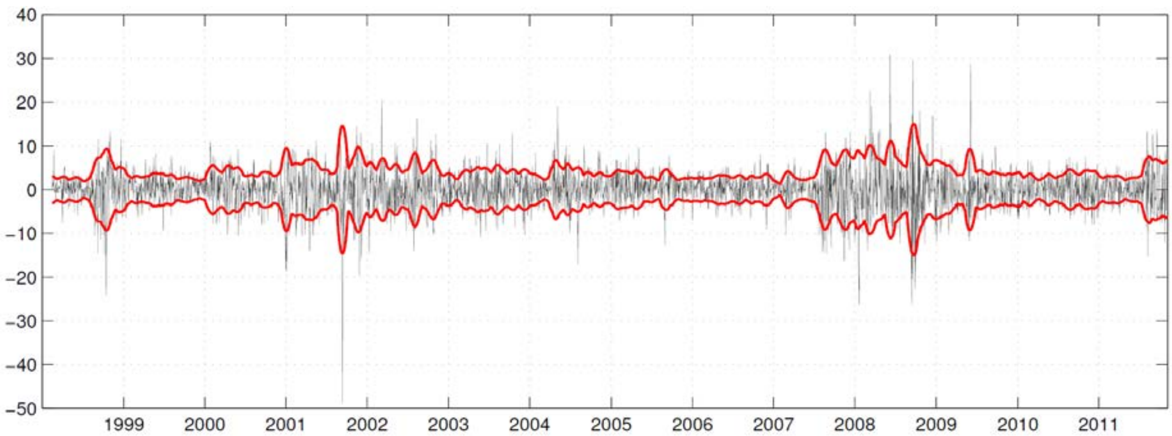
Because the spot volatility does not appear reasonable, we compute a slightly simpler and maybe more transparent measure. We apply the Nadaraya-Watson kernel regression on the squared innovations directly instead of on the squared first differences,

$$\tilde{\sigma}_\tau^2 = \frac{\sum_{i=1}^{n} K_h\left(t_i - \tau\right) X_{t_i}^2}{\sum_{i=1}^{T} K_h\left(t_i - \tau\right)}. \tag{A.3}$$

This is the same as the approach suggested by Carroll (1982) and Hall and Carroll (1989). They consider a model where the mean can be parametrically estimated but the variance cannot. In our case, μ_t is zero by definition, so the setting is simpler.

Figure A.8

Curvature innovations and 50% confidence interval using local volatility estimate



We use the same kernel function and reflection technique as before and perform the cross-validation bandwidth optimization. The result is an estimate of the volatility that seems much more reasonable. We call the square root of $\tilde{\sigma}_\tau^2$ the *local volatility*, in order to distinguish it

[9] Consider $E\left[\left(u_t - u_{t-1}\right)^2\right] = E\left[u_t^2\right] + E\left[u_{t-1}^2\right] - 2E\left[u_t u_{t-1}\right]$. In our case, u is serially uncorrelated by construction, so $E\left[u_t u_{t-1}\right] = 0$. Consequently, the spot variance overestimates the variance of u by a factor of two, $E\left[\left(u_t - u_{t-1}\right)^2\right] = E\left[u_t^2\right] + E\left[u_{t-1}^2\right]$.

from the spot volatility. The size of this volatility measure appears more appropriate: 4.7% of the absolute innovations into the long factor are greater than 1.96 times the estimated local volatility of this factor innovation. For curvature, the corresponding number is 4.8%, reasonably close to the 5% one might expect. Only for the short factor innovations do we find that only 3.3% of the innovations are in absolute terms greater than 1.96 times the estimated local volatility. Still, this is much better than the 1% we get when using spot volatility. The optimized bandwidths are 47.0 days for the long factor innovations, 9.7 days for the short factor innovations, and 23.5 days for the curvature innovations. Figure A.8 depicts, as an example, the innovations into the curvature factor, as well as a 50% confidence band using the local volatility estimate.

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The financial market impact of UK quantitative easing[1]

Francis Breedon,[2] Jagjit S Chadha[3] and Alex Waters[4]

Abstract

We measure the impact of the UK's initial 2009–10 Quantitative Easing (QE) Programme on bonds and other assets. First, we use a macro-finance yield curve both to create a counterfactual path for bond yields and to estimate the impact of QE directly. Second, we analyse the impact of individual QE operations on a range of asset prices. We find that QE significantly lowered government bond yields through the portfolio balance channel – by around 50 to 100 basis points. We also uncover significant effects of individual operations but limited pass through to other assets.

Keywords: Term structure of interest rates, monetary policy, quantitative easing

JEL classifcation: E43, E44, E47, E58

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[2] Queen Mary, University of London. E-mail: f.breedon@qmul.ac.uk.

[3] University of Kent, Canterbury, and Centre for International Macroeconomics and Finance, University of Cambridge. E-mail: jsc@kent.ac.uk.

[4] School of Economics, University of Kent, Canterbury, Kent. E-mail: aw365@kent.ac.uk.

1. Introduction

Following the financial crisis of 2008, Quantitative Easing (QE) – which we define in this paper as large scale purchases of financial assets in return for Central Bank reserves – became a key element of monetary policy for a number of major Central Banks whose interest rates were at, or close to, the zero lower bound. But despite its widespread use, QE remains highly controversial both in terms of its effectiveness and its implementation. Although we now have the benefit of hindsight in the sense that there are a number of QE programmes that can be studied, an empirical assessment of those programmes presents a number of familiar challenges. First, since there is no generally accepted theoretical framework in which to assess QE, empirical studies must either eschew theoretical restrictions that might aid identification or risk having their results dismissed as model-specific. Second, since QE was not entirely unanticipated, in the sense that it was widely discussed by financial market participants before it was implemented, studies that place a large weight on announcement effects may well give misleading results. Third, since QE was implemented in response to an economic crisis, all the standard economic concerns over endogeneity apply in this case. Finally, since the number of QE-policy shocks is still very limited, conventional empirical techniques that rely on a reasonable sample size cannot easily be implemented in this case.

In this paper, which focuses on the impact of the first UK QE programme (March 2009 to February 2010) on asset prices, we aim to bypass most of these problems through two empirical approaches. First we estimate a macro-finance model of the UK government liability curve which allows us to construct a counterfactual estimate of the term structure over the QE period and, under some strong assumptions, to simulate the impact of QE on the yield curve directly. Second, we look in detail at the liquidity effects of the large sample of individual gilt purchase operations and assess the extent to which these liquidity effects extend beyond the gilt market. We also begin with a more qualitative assessment of the impact of QE on UK monetary aggregates. While not a key element of the paper, this assessment serves as useful background and allows us to link our results from financial markets to monetary quantities such as bank lending.

In the remainder of this section we present a brief (not exhaustive) review of the literature on empirical assessment of QE. Section 2 then presents an overview of the observed impact of UK QE on monetary aggregates. Section 3 introduces our macro-financial yield curve model and the counterfactual path it generates. Section 4 examines operation-by-operation liquidity effects of QE, and Section 5 concludes.

1.1 A brief literature review

Early work on the impact of large scale asset purchases as a tool of monetary policy probably began following "Operation Twist" in the United States in 1961. Although not full Quantitative Easing in the sense of being financed by base money creation, this operation involved Federal Reserve purchases of long-term bonds (financed by sales of short-term Treasury Bills) as well as a change in Treasury issuance with the aim of lowering long-term interest rates. Modigliani and Sutch (1966) found that this operation had no significant effect on bond yields, though more recent work by Swanson (2011) has found that this operation had some significant market impact.[5]

More recently, the QE programme implemented by the Bank of Japan from 2001 to 2006 generated new interest in unconventional monetary policy implemented through large scale

[5] Both papers did, however, calculate the point response of medium-term yields at just under 20bp.

asset purchases. In a survey of empirical evidence in the Japanese case, Ugai (2007) found mixed evidence. He concluded that the evidence suggested that QE had some signalling impact on market expectations in the sense of confirming that interest rates would remain low for some time, but that evidence on whether the QE operations had any direct effect on bond yields or risk premia was mixed. However, Bernanke et al (2004), examining the Japanese experience with QE, found little by way of announcement effects but some evidence from a macro-finance yield curve to suggest that Japanese yields were roughly 50bp lower than expected during QE. Unsurprisingly perhaps, the QE programmes implemented in the aftermath of the 2008 financial crisis have led to a dramatic increase in research on this topic. Most notably, the Federal Reserve's QE programme has spawned a large and rapidly growing literature. Important empirical contributions include Doh (2010), D'Amico and King (2010), Gagnon et al (2010), Hamilton and Wu (2010), Neely (2010), Hancock and Passmore (2011), Krishnamurthy and Vissing-Jorgenson (2011) and Wright (2011). In the US case, despite a wide range of methodological approaches, there is near-unanimous agreement that the US programme had significant effects on longer-term bond yields, though estimates of the scale of the effect vary considerably. For example, Gagnon et al (2010) find that the $300bn of US bond purchases, which amount to approximately 2% of GDP, resulted in drops of some 90bp in US 10-year Treasuries, while Krisnamurthy and Vissing-Jorgensen (2010) find that a reduction in public debt outstanding of around 20% of GDP would reduce yields by between 61 and 115 base points. So far, the UK's QE programme has attracted less interest. Recently released empirical estimates of the impact of the initial £125bn of QE and then the full £200bn (14% of GDP) on UK gilt yields by Meier (2009) and then Joyce et al (2010) suggest that yields are some 40–100bp lower than they would have been in the absence of QE. Caglar et al (2011) do, however, suggest that the event study methodology may have overestimated the effects because of the dominant, possibly exaggerated, impact of the first, rather than the subsequent six, announcements. Thus, in this paper we want to make our expectations of the bond price, in the absence of any QE, conditional on the macroeconomic structure, as well as examining the direct impact of actual purchases at each auction.

2. Quantitative easing and the monetary aggregates

Although it is not the main focus of this paper, tracing the impact of QE on the narrow and broad monetary aggregates serves as a convenient way of describing QE in the UK case, and furnishes some useful insights into monetary flows associated with QE.

2.1 QE and the Bank of England's balance sheet

Although a stated policy of quantitative easing was not implemented until March 2009, a number of prior developments paved the way to full easing. Probably the first important step was the dramatic increase in the size of the Bank of England's balance sheet (see Figure 1), which occurred in September 2008 following the collapse of Lehman Brothers under the Special Liquidity Scheme. This expansion effectively involved providing liquidity to the UK banking system (temporarily acquiring bank assets in return for liquidity, predominantly through reverse repo transactions), but since it was financed by issuing Treasury Bills it did not result in an equal expansion of the monetary base.

In effect, the monetary base provided through repo transactions was re-absorbed through issuance of other financial liabilities, leaving the Bank of England holding risky bank assets financed largely by Treasury Bills. However, it is noteworthy that there was some expansion of the monetary base over this period, as banks – which were allowed to set their own targets (within a certain range) for reserve balances held at the Bank of England – chose to set very high targets (close to the limit, ie £1 billion or 2% of their sterling eligible liabilities as set by the Bank of England, whichever was higher) and earn the low but risk-free return that the Bank of England pays on reserves. Thus, in some sense a small measure of quantitative easing occurred over this period, since some of the increase in the Bank of England's assets was financed by an unusually large expansion of the monetary base. The voluntary increase in reserve balances over this period is also important evidence that banks were willing holders of low-yielding but safe reserve money, and so were probably not averse to holding even more reserves when full QE was implemented.

The next step was the policy of 'qualitative' easing that was implemented in January/February 2009 following an exchange of letters between the Treasury and the Bank of England (19 January and 29 January). This involved the creation on 30 January of the Asset Purchase Facility (APF), a legally separate entity run by the Bank of England but with indemnity assurances from the Treasury for any possible losses. Initially, the APF operated by buying unsecured corporate commercial paper financed by issuing Treasury Bills. But following a further exchange of letters between the Bank of England and the Treasury (17 February and 3 March), the Monetary Policy Committee (MPC) meeting of 5 March 2009 decided to move to a policy of quantitative easing (QE), with the Bank of England aiming to purchase £75bn of assets through the APF over the following three months, financed entirely by an expansion of the monetary base. Although the APF continued to purchase corporate debt (expanded to include corporate bonds), the vast majority of purchases were of UK government conventional bonds (gilts) with residual maturity of more than 3 years. In order to facilitate the expansion of the monetary base, the Bank of England suspended both the system of targets and limits on banks' reserve holdings, and pledged to pay the official interest rate of 0.5% on all bank reserve holdings. The target for asset purchases was then increased to £125 billion at the May 7th MPC meeting, to £175 billion at the August 6th meeting and to £200 billion at the November 5th meeting. At the MPC meeting of 4 February 2010, it was decided not to increase the stock of APF assets any further, and thus QE was effectively temporarily suspended as the programme of asset purchases was by then complete until QE was re-introduced in October 2011.[6]

Figure 2 traces the impact of QE by examining gilt holdings by sector. Prior to the fourth quarter of 2008 the main holders of gilts were UK pension funds and insurance companies, the Overseas Sector and other UK-based non-bank institutions. Following the introduction of QE, the APF quickly became a significant holder of gilts, rising to a peak of about 24 per cent of the total stock (over 13 per cent of GDP) by the end of 2009. However, this dramatic increase in APF holdings had remarkably little impact on gilt holdings by other sectors, since it was more than offset by an increase in the total stock of gilts in issue. Thus, apart from other UK non-bank institutions (such as households and hedge funds), gilts holdings by other sectors continued to rise, albeit at a slow rate. Another interesting aspect of the period since late 2008 is the sudden rise in holdings of gilts by banks. This almost certainly reflected increased regulatory pressure on banks to hold more liquid assets.

2.2 QE and the broader monetary aggregates

In the early days of QE, many commentators – arguably including the Bank of England itself (see Financial Times, 2010) – expected the main indicator of QE success to be more rapid growth in the broad monetary aggregates. In this section we look at the qualitative evidence regarding the impact of QE on broad money and lending, as background to a more detailed look at the policy's effect on asset prices.

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[6] Following the MPC meeting in October 2011, it was announced on 6 October that a further £75 billion of asset purchases would occur, implying a total stock of £275 billion of such asset purchases.

Overall, broad money (deposit) growth over the QE period was weak. Figure 3 shows both the level of the Bank of England's favoured measure of broad money, M4x (standard M4 less intermediate other financial corporations, or OFCs) and the year-on-year growth rate. Immediately following the introduction of QE, the growth rate of M4x continued to fall, to just under 1% at the end of 2009, and stayed considerably below the Bank's 6–8% target range through 2010. Although this low rate of growth seems at odds with the idea that QE should boost bank lending, there may be a number of explanations. First, without QE, and given the state of demand, there might easily have been even weaker growth, if not a significant contraction of broad money. Secondly, there was a significant level of new debt and equity issuance by the UK banking sector over this period, as it aimed to recapitalise (see Figure 6). Such issuance will tend to reduce M4x growth for a given level of lending in the banking sector, as it increases non-deposit liabilities (so new lending can be funded without increasing deposits). A measure of the downward pressure on the money supply caused by this recapitalisation of UK banks is captured by net non-deposit liabilities.[7] Over the QE period, the cumulative total creation of these liabilities was approximately £242bn, suggesting a substantial undermining of the impact the monetary boost might have had on the money supply.

If we focus on the lending side of banks balances, however, the picture is similar to M4 deposits. Overall, total M4 lending excluding securitisations and loan transfers (M4Lx) fell over the QE period by £197.5bn.This reflects an increase in bank holdings of other assets such as central bank reserves (see Figure 1) and gilts (see Figure 2). Breaking down lending by sector, Figure 4 shows that there was some recovery in lending to households over the QE period (reaching around 3% growth at the end of 2009, and continuing into 2010), after a contraction in the 12 months following the collapse of Lehman Brothers. However, lending to Private Non-Financial Companies (PNFCs) showed no such recovery. The largest contraction in lending was in May 2010, with a year-on-year contraction of 4.2%, and there was little sign of improvement thereafter.

The low overall rate of money growth is at odds with data from the Bank of England survey on credit conditions. Figure 5 plots the response of corporates to the question "How has the availability of credit provided to the corporate sector overall changed?"[8] In Figure 5, the blue bars show the response over the past three months, and the red line shows the expectations over the next three months. The expected balance is moved forward one quarter so that expectations can be compared to the actual outturn in the following quarter. Prior to QE, the availability of credit declined, and it did not show much improvement until QE commenced. The survey response is further disaggregated into different factors, and it appears that the key factor driving the improvement was the changing cost and availability of funds, followed by the increasing availability of loans in the market. Both of these factors suggest that QE was affecting the loan supply.

[7] The non-deposit liabilities (net) category consists of capital and other non-deposit liabilities of UK banks less their investments in UK banks and other non-financial assets. In the Bank of England series used (series code LPMVRHV), a negative value indicates an increase in non-deposit liabilities and downward pressure on broad money.

[8] The response to these questions is presented in the Bank of England's Credit Conditions Survey, which is conducted monthly, with results published quarterly. The survey asks lenders a series of questions to identify trends and developments in credit conditions over the past three months, and to ascertain their expectations for the coming three months. All lending is from UK-based institutions, but it includes both sterling lending and foreign-currency-denominated lending. The survey does not solicit information about capital issuance by the lenders, but asks about available supply and demand conditions. The information here comes from the Bank of England's Credit Conditions Survey for the 3rd Quarter of 2011, Annex 3: Corporate Lending Questionnaire Results.

In fact it appears that firms' confidence in the availability of funds was expressed in a decision to bypass the banking system altogether and issue capital directly. Figure 6 shows net capital issuance by PNFCs.[9] This consists of UK-based primary-market issuance of bonds, commercial paper and equity financing in both domestic and foreign currencies by entities domiciled in the UK.[10] Specifically, the majority of assets issued over the QE period by PNFCs were bonds, with shares in second place. The net issuance of commercial paper was generally negative. Overall, there is some evidence that PNFCs stepped up their net capital issuance during the QE period, and although this may simply reffect continuing problems with bank financing, the fact that credit conditions were seen to have improved suggests that it may have been motivated by a desire to tap capital markets flush with the proceeds of gilt sales to the QE programme.

To summarise, the period covered by the Bank of England's asset purchase programme can be described as one of low but positive growth in deposits, counteracted by heavy debt and equity issuance in the corporate sector, and to some degree in the financial sector. Overall, although monetary aggregates or their counterparties show little improvement over the QE period, suggesting little clear expansion by the banking sector, corporates seemed to have responded to QE by issuing capital directly.

3. QE and the yield curve

As we have seen in the previous section, a fundamental problem in assessing the impact of QE on the monetary sector is to define the appropriate counterfactual. In this section we attempt to estimate such a counterfactual for the nominal gilt yield curve, to assess whether yields were significantly influenced by QE. Our approach is to estimate a simple term structure model driven by several macroeconomic factors. This model is then used to estimate a predicted yield curve over the QE period, and so the difference between the predicted and actual yield curve over this period can be interpreted as an estimate of the portfolio-balance impact of QE, since QE itself is not included as a factor. Of course any macro impact of QE should be reflected in the macro factors that drive our yield curve model, so this exercise can only identify the extent to which large-scale purchases shifted the yield curve directly. This approach, which is similar to that used by Bernanke, Reinhart and Sack (2004), can be thought of as a sophisticated event study where the market model is our macro term structure model. As well as a counterfactual approach, we use some admittedly ad hoc assumptions to identify the impact of QE using the estimated parameters of our model, providing an alternative route for estimating the portfolio-balance effect of QE. Both approaches have the advantage of allowing us to estimate the longer-term impact of QE, not simply high-frequency announcement effects.

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[9] The data are available in the Bank of England's Bankstats, Table 3.1. There are also data for building societies (B63M) and resident banks (B32M). The data here go through 2009 only. They are not plotted, but are available on request. The codes for the data in the order presented in Figure 5 are B83I, B79I and B82I.

[10] The bonds issued are not part of any specific programme, and represent assets that will have an ongoing series of issues. The commercial paper issued include maturities up to and including one year. The shares consist of both preferred and ordinary shares making up the firm's share capital. Shares can also be bought back for the purpose of being cancelled, or to be held in treasury. Net capital issuance is the difference between issuance and repayments for the three financial instruments.

3.1 A benchmark term structure model

Our macro-finance term structure model is estimated in two stages. The first stage involves putting the term structure into the functional form proposed by Svensson (1994). We employ an approach similar to that of Diebold et al (2006) and Afonso and Martins (2010), obtaining the four latent factors – level, slope and two curvatures – by means of the Kalman filter. The second step is to relate these latent factors to a representative set of macroeconomic variables through a SUR regression.

The functional form proposed by Svensson is:

$$y(\tau) = \beta_1 + \beta_2\left(\frac{1-e^{-\tau\lambda_1}}{\tau\lambda_1}\right) + \beta_3\left(\frac{1-e^{-\tau\lambda_1}}{\tau\lambda_1} - e^{-\tau\lambda_1}\right) + \beta_4\left(\frac{1-e^{-\tau\lambda_2}}{\tau\lambda_2} - e^{-\tau\lambda_2}\right) \quad (1)$$

This factor model approach expresses a large number of yields of various maturities as a function of a few unobserved factors. The yield is denoted as $y(\tau)$, where τ denotes the maturity and β_1, β_2, β_3, β_4, λ_1 and λ_2 are parameters. The parameters λ_1 and λ_2 govern the rate of exponential decay. The smaller the value of lambda, the slower the decay and the greater the fit at the longer maturities; the larger the value of lambda, the faster the decay and the greater the capacity of the fit at shorter maturities. The lambda is also used to determine the maximum loading of β_3 and β_4. The parameters β_1, β_2, β_3 and β_4 are the parameters which correspond to the appropriate factor loadings. The loading on β_1 is 1. Termed the level, it is constant and can be seen as a long-term factor. Any shift in it will have an equal effect across all yields. The factor loading of β_2 has a functional form that starts at 1 but decays monotonically and quickly to 0. It is considered a short-term factor and is called the slope factor. Any change in β_2 will have a greater effect on the short-term yields than on the longer-term ones, thereby changing the slope of the yield curve. The final two factors, β_3 and β_4, have loadings that begin at 0, so they are not short-term. However, they increase and then decay back to zero, so they cannot be long-term either. This type of factor is a medium-term factor and is termed the curvature. Any changes in β_3 and β_4 will have very little effect on either the short or long end of the yield curve, as the yield curve has very little loading on these maturities. Hence, any increase in these factors will increase medium-term yields and consequently increase the curvature of the yield curve. Therefore, the Svensson representation can now be interpreted as a dynamic latent factor model where $\beta_1, \beta_2, \beta_3$ and β_4 become time-varying parameters that capture the level (L), slope (S), first curvature factor (C_1) and second curvature factor (C_2) of the yield curve at time t.

Like Diebold et al (2006) and Afonso and Martins (2010), we assume that L_t, S_t, $C_{1,t}$ and $C_{2,t}$ follow a first-order vector autoregressive process which allows the model to form a state-space system. The Kalman filter is then used to obtain maximum-likelihood estimates of the parameters and the implied estimates of L_t, S_t, $C_{1,t}$ and $C_{2,t}$. This estimation is performed for the nominal curve, and estimation details are available on request.

In order to relate these factors to macroeconomic variables we estimate a SUR model of the following general form:

$$Y_t = \alpha + \rho Y_{t-1} + \beta X_t + d\delta + \varepsilon_t \quad (2)$$

Y is a 4x1 vector of dependent variables (the level, slope and curvature factors identified above), α is the vector of constants, ρ is a vector of coefficients for the lagged dependent variables and β is a matrix of coefficients of the independent variables X_t. The final equations have been determined by a general-to-specific approach performed simultaneously across all four equations. The analysis of the coefficients and their significance is taken a step further after estimation. We test exclusion restrictions on each one of the four coefficients from each equation for each macroeconomic variable, and assess whether it could have been excluded from the system (see Table 1). The standard estimator for SUR is feasible generalised least squares (FGLS). We use FGLS, as we do not know the true variance-covariance matrix. Using the SUR estimator with the information in the system of equations is more efficient than using an estimator on individual equations. FGLS is preferable to OLS for two reasons: the more correlation there is between the residuals, the greater the efficiency gain attributed to FGLS; and the less correlation there is between the X_t matrices, the greater the gain to FGLS.

3.1.1 Data

We fit the nominal term structure using maturities of 9, 12, 15, 18, 21, 24, 30, 36, 48, 60, 72, 84, 96, 108 and months for the zero coupon forward curve[11] at a monthly frequency between March 1993 and December 2008. The macroeconomic variables are divided into 5 groups – inflation, real activity, policy, foreign and financial – and tested down from over 30 variables. For inflation we use inflation expectations, which is the average one-year-ahead inflation forecast from HM Treasury.[12] Real activity is represented by two variables, a real activity index and unemployment. For policy, we include the Bank of England's monetary policy interest rate; for our measure of the net supply of bonds we use the debt-to-GDP ratio; and to measure duration effects we use the ratio of long term bonds (>15 years residual maturity) to nominal debt outstanding. Unfortunately, more precise measures of the duration of government debt were not available over the whole sample. For foreign variables we include the effective exchange rate, German retail sales, the IFO index of business climate, US Non-Farm Payrolls expressed as year-on-year changes, and the Fed Funds Rate. The final group of macroeconomic variables is the financial group. For this we use an index of the annual returns of three different equity series, and a measure of the Libor spread, which is the difference of the three-month Libor and the monetary policy rate of the Bank of England. Normally, the Libor spread is the difference between the 3-month Libor and Overnight Interest Rate Swaps, but as the OIS data do not go back to 1993 we use the policy interest rate as a proxy. Under the financial group of variables we also include a measure of real money.[13]

We create an index of real activity using principal component analysis from three different measures of real activity: UK production, UK retail sales and the claimant count. These variables were recast as year-on-year change before the first principal component was extracted. We also create an index of financial returns by taking the annual returns of three different equity series: the Standard and Poors 500, the DAX 30 and the FTSE 100. As in the case of the real activity index, we use the first principal component of the three series. We also include time trends.

The descriptive statistics of this model are given in Table 2. The R^2s are high across all four of the equations, for the level and slope equations in particular, but the two curvature factors

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[11] The estimates for the yields are derived with a cubic spline technique. See Anderson and Sleath (1999).

[12] For further information, we refer the reader to "Forecasts for the UK Economy: a Comparison of Independent Forecasts".

[13] The measure of real money is the Bank of England's notes and coin in circulation (series code LP-MAVAB) deflated by RPI. Notes and coin is used to represent narrow money. M0 was the Bank's main narrow money measure. When the Bank introduced its Money Market Reform in May 2006, the Bank ceased publication of M0 and instead began publishing a series for reserve balances to accompany notes and coin in circulation. Notes and coin is the longest available measure of narrow money.

do less well. As occurs in the other macro-finance literature, we struggle to find a better macroeconomic explanation for the curvature factors. These results are corroborated by analysis of root-mean-square errors, with the resulting errors being smaller for the very well explained level and slope. The tests for autocorrelation, heteroscedasticity and normality show that the residuals do not suffer from autocorrelation at one or five per cent. Heteroscedasticity is not a problem in the residuals either. The only problem that is apparent is normality. For the level and the second curvature factors we reject the null hypothesis that the errors are normally distributed at both one and five per cent We also reject the null hypothesis at five per cent for the slope, but this is a more satisfactory result. It is only the first curvature factor where we accept the null hypothesis at both one and five per cent. ADF tests (not presented) confirm that the forward curve factors are stationary.

3.1.2 Impulse responses

Figure 7 shows the estimated responses of the nominal forwards to 1% shocks in the final set of variables used to fit the term structure. The dotted lines represent one standard deviation on either side. Rather than discuss each impulse response we draw attention to one simple example: that a permanent 1% shock to inflation expectations raises nominal forwards by 1% at the ten-year horizon. In terms of the possible impact of QE, we find that the net public debt-to-GDP ratio has a small upward impact on forwards of between 3 and 9 basis points for each 1% of held as a fraction of GDP. A reduction of debt amounting to just under 25% of GDP might therefore have an effect of some 75 to 225bp on yields (depending on maturity). We also find that the effect of a 1% increase in the fraction of long term bonds outstanding is to increase 5-year yields and beyond by some 13–15bp. We use these results in the simulation below, in which we interpret QE as reducing net debt outstanding and also as changing the duration of that debt.

3.2 An assessment of QE through a macro term structure model

In this section we assess the pure portfolio-balance impact of QE using our term structure model. (As noted above, any macro impact of QE should feed through the macro drivers of our model). We do this in two ways. First, we create a dynamic forecast of the yield curve using our macro factors to estimate the impact of QE under the assumption that QE is a key driver of prediction errors over this period (ie that QE is responsible for a portfolio-balance effect that causes the curve to deviate from its predicted level). Second, through a number of assumptions, we identify QE with parameters of the model itself and so undertake a simulation of the impact of QE on the term structure. Both approaches have their drawbacks, but it is somewhat reassuring that they deliver similar estimates.

3.2.1 QE counterfactual

To construct a counterfactual path for bond yields (ie one that does not include the portfolio-balance effects of QE), we simply project a path for the term structure using the model described above and using the actual outturns for the macro variables as the only inputs. Our projection starts in January 2009 and continues over the whole QE period. The 1-, 5- and 10-year fitted forward rates and forecast errors are shown in Figure 8. We find that the model generally overpredicts the actual forward curves observed from around March onwards, at horizons longer than approximately 24 months. This overprediction averages 67bp at the 5-year maturity, and 46bp at the 10-year, over the period in which QE operated. This result is consistent with a QE portfolio-balance effect in timing, direction and duration (in the sense that only yields above the 2-year maturity level seem affected, that yields are lower than predicted and that the overprediction kicks in precisely when QE was announced and implemented). There is also little evidence of a pre-announcement effect, in that the fall in bond yields seems to have occurred in March when the programme was announced. In fact, in the two months prior to the QE operations, the model underpredicts the medium- to long-end of the term structure by some 45 bp on average at 5 years, and by 80bp at the 10-year horizon[14]. One explanation for this underprediction before QE may be that there were heightened concerns over UK solvency over those two months. Thus, although our model includes the debt-to-GDP ratio as a factor, it is unlikely to capture these solvency concerns, for reasons we discuss below.

Figure 9 shows the behaviour of UK Government Credit Default Swaps (CDS) over this period. It shows that there was indeed a large spike in perceived default risk just prior to QE and a significant decline as QE was implemented. If we adjust bond yields for this CDS effect we find that the model's underprediction in January and February is more than explained by this credit risk effect, and indeed some – though not all – of the drop in yields that occurred subsequently was associated with reduced credit risk. Of course one might reasonably argue that QE was the cause of the fall in perceived credit risk that occurred around March 2009, though we cannot test this proposition using our model.

3.2.2 QE simulation

Although our counterfactual path gives an intuitively appealing estimate of the QE effect, it is hardly definitive. Firstly the difference between the actual and predicted path of forward rates is not statistically significant according to our standard errors. Second, one might reasonably argue that so much was going on over this period that the difference between the two paths could be explained by any number of factors not captured in our model, not solely by QE. Thus, in this section we take a different approach to estimating the QE effect, simulating the estimated effect of QE using the estimated parameters of our model.

In order to do so, we need to make a number of assumptions that allow us to proxy QE with factors that drive our model.

1) We assume that the variable debt-to-GDP captures a pure supply effect on the yield curve, and not other factors like credit risk (since a high debt-to-GDP increases the perceived likelihood of default). This assumption can be partially justified by observing that perceived credit risk was insignificant over almost all of the model's estimation period (apart from the last few months).

2) Given our first assumption, we then assume that a reduction in the supply of gilts available to the private sector through QE has the same impact as an equivalent reduction in the overall debt-to-GDP ratio. These two assumptions then mean that we can interpret the overall impact of QE as a reduction in the debt-to-GDP ratio.

3) In a similar way, we assume that our duration variable captures a pure supply effect on long-duration debt, and hence can be used to capture the impact of a change in the average duration of debt available to the private sector due to the pattern of purchases associated with QE.

4) Finally, we make the assumption that the reduced debt-to-GDP effect of QE occurred when details of the amount to be purchased were announced, while the duration effect occurred when debt purchases were implemented (since market participants would not know the precise duration breakdown of QE purchases until a few weeks before they were implemented).

Given these assumptions, we can directly estimate the impact of QE on bond yields as the the total reduction in the supply of gilts available to the private sector, combined with the change in the average duration of the remaining gilts attributable to QE. As noted above, we assume the debt-to-GDP effect occurred when the amount to be purchased was announced

[14] The forecast errors and standard deviations by maturity for each month of Quantitative Easing are available upon request.

at each MPC meeting (£75bn in March, £50bn in May, £50bn in August and £25bn in November). Following the March announcement, the amount of purchases led to a 5.35% drop in the debt-to-GDP ratio, and at the end of the QE purchases the figure was 14% of GDP.

To calculate the duration effect we use the estimated duration parameter from our yield curve model. This can be seen in the impulse response shown in Figure 7, which is based on the share of long-dated gilts (>15 years residual maturity) relative to the total stock of nominal bonds. To calculate the effect that QE had on the duration of the portfolio we determine the amount of long bonds and the total amount of nominal in issue. We measure the amount of long-term bonds purchased in the reverse auctions, and subtract this from the total amount of long-term bonds already in issue. Then we divide this amount by the total portfolio of nominal bonds minus total QE purchases. The difference between the two series (long-term bonds as a share of the total, relative to long-term bonds as a share of the total after adjusting for QE purchases) shows that the duration of debt according to our measure actually rose initially as a result of QE, since QE operations were initially focussed on bonds of 5- to 15-year residual maturity. However, around July 2009 operations in long-dated bonds increased significantly, so that the average duration of outstanding debt began to fall (see Figure 1). This pattern means that for much of the QE period the duration effect actually led to higher, not lower, longer-term yields.

Table 3 displays these effects in detail for 5- and 10-year forward rates, showing how the debt-to-GDP effect of QE rose steadily over the period as the amounts to be purchased increased. The duration effect initially offset the debt-to-GDP effect to a degree, as the average duration of remaining debt rose somewhat and then fell again. It is interesting to compare the predicted QE effect from our simulation with the prediction errors described in the previous subsection. Over the whole QE period, the average QE effect predicted by our simulation was to reduce 5-year forward rates by 63 basis points, while the model's overprediction was 67bp on average. The corresponding figures for 10-year forwards were 87bp and 45bp. Similarly, the peak impact of QE according to our simulation was 111bp and 136bp for 5- and 10-year forwards respectively, while the model's overprediction was 110bp and 99bp for those maturities. Thus, the two approaches give reassuringly similar results.

4. Liquidity effects of individual operations

Having estimated the long-range effect of the whole QE programme on the yield curve, we now turn our attention to higher-frequency (daily) estimates of the impact of individual QE operations. Looking at individual QE operations has two significant advantages over examining the overall QE effect described above. First, the sample of operations is large, and so standard statistical techniques have some power. Second, these operations were, of course, entirely anticipated, and so any effect we find is entirely due to liquidity. In this section we look at the market impact of these operations to assess the extent to which they produced a pure liquidity effect in the gilt market and other markets. This not only allows us to confirm that QE did indeed influence the bond market, but gives us an opportunity to test whether QE influenced other asset prices. Of course, it is quite possible that the entire market impact of QE occurs through announcement effects rather than through actual implementation, as market participants perhaps position themselves in preparation for absorbing the previously announced market operation. In fact, some studies – such as Beneish and Whaley (1996) in the case of changes in the S&P index, and Hau, Massa and Peress (2010) in the case of the MSCI-Global index – have found price reversals at the implementation date, meaning that the market impact of an announcement is reversed at implementation (as implied in the market maxim "Buy the rumour, sell the fact"). In our case, however, we do indeed find a significant market impact, with bond prices rising before each

QE operation and then falling back subsequently, as might be expected if liquidity effects are important.

To estimate the magnitude of the liquidity effect of QE operations we turn to a simple event study. Overall, while there are 576 individual bond purchase operations in our sample, these operations tended to be grouped together on a single day, with the actual gilts eligible for each operation being announced the previous week (though by looking at previous operations, market participants would have been able to make a well-educated guess as to which gilts would be eligible). In practice, we treat a group of operations on a single day as a single operation, giving us a sample of 92 events (taking the average impact across all the gilts purchased in the operation occurring on a particular day). We then look at daily movements in bond prices, using end-of-day midquote data supplied by the UK Debt Management Office in connection with these QE operations. We use prices rather than yields in this analysis, as they form a natural starting point from which to look at other assets such as equities and the exchange rate. In our first analysis, which focuses purely on bonds eligible for the relevant operation, we look at price movements relative to two benchmarks. First, a simple "no change" scenario, so that the significance of price movements around QE operations is judged against the hypothesis that prices should on average be unchanged across the whole event window. Second, we construct a counterfactual daily path for bond prices based on a linearly interpolated prediction from the yield-curve model described above. This effectively helps control for any trend in prices over the event window that are due to underlying macroeconomic developments, and is analogous to the use of a market model in conventional event studies.

Table 4 summarises the results of these event studies. It shows a significant operation-day effect (column t) whereby the price accepted at the QE operation is more than 0.1 per cent higher than the average price at the end of the operation day. Looking at model 2 in particular, there also seems to be a steady upward move in price in the 15 days before the operation, followed by an offsetting decline in the 15 days after the operation, with prices rising about 0.6 per cent in the run up to the operation (relative to the price accepted in the operation) and then falling about 0.6 per cent (as shown in Figure 10). At first sight, the length of time over which this price effect occurs may seem surprisingly long. However, given the relatively low level of turnover in non-benchmark bonds and the opacity of pricing in the gilt market (see, for example, Nath, 2004), slow price responses are often observed in this market. In particular, the pattern we see here is very similar (though of opposite sign) to the path of bond prices in the period around a bond auction (see Ahmad and Steeley, 2007).

Given the likely heteroscedasticity in both price and yield responses to QE operations, we test for the significance of these liquidity effects using a non-parametric Wilcoxon test. The results show that when using the average price accepted in the operation as a benchmark, these liquidity effects are highly significant, particularly in the period after the operation. However, relative to the price at the end of the operation day, the effects are somewhat less significant, and though significance at conventional levels occurs at a number of horizons, it does not occur as consistently.

Since Table 5 shows a generally significant liquidity effect on gilts selected for QE operations, it is interesting to see whether this effect is also observable in other bonds, and indeed in other asset prices. Bearing in mind a large number of caveats (not least of which is that liquidity effects may not influence other asset prices in the same way as the overall impact of QE), such an exercise does perhaps give us some insight into the extent to which QE influences financial markets in general rather than just government bonds. Table 5 shows the behaviour of the rest of the government bond market (based on average prices of bonds in each maturity range as calculated by the Financial Times) and other asset prices around these operations. In all cases the table compares prices at various time horizons with prices at the end of a QE operation date. Starting with the gilt market, it shows that, apart from the 0- to 5-year sector, QE operations seem to have an impact on the average price of bonds (including those not purchased in the QE operation) in the sense that there are significant price different relative to the day of a QE operation on at least one time horizon. This impact seems to carry through to 10-year corporate bonds (both AA and BBB) as well as swaps, where the price impact of these operations is comparable with the impact on the 10-year sector of the gilt market. The impact on 10-year OIS is weaker, but this is probably related to the low liquidity of such a long-dated overnight interest-rate swap. Turning to the exchange rate and equity prices, however, we find little discernible QE effect. In the case of the equity market this seems to suggest that the reduction in duration risk associated with QE did not feed through to other long-duration assets like equity. Overall, these results suggest that the liquidity effect of QE was felt across the whole bond market, but did not spread beyond that market. However, such a conclusion is clearly tentative.

5. Conclusion

Quantitative easing has become an important monetary policy tool in many countries over recent years, but its effectiveness is still open to considerable doubt. In this study we have taken several approaches to assessing the financial market impact of QE, and in all cases have found it to have a significant and economically important impact on the bond market. In fact, along with the growing body of evidence for the US, it seems that our evidence is contributing to a growing consensus that QE is indeed effective in terms of influencing longer-term bond yields through a portfolio-balance effect. However, the broader impact of QE on other assets and on the economy in general remains controversial, as our qualitative description of the impact of QE on monetary aggregates confirms. Certainly, that fact that QE was implemented during a credit crunch – a period when even conventional monetary policy has uncertain effects – probably means that this broader question is likely to remain unresolved for some time.

Tables

Table 1

Exclusion restrictions tests on the estimated term structure model

Exclusion restrictions within equations	
Level	5798.85 [0.0000]**
Slope	5462.55 [0.0000]**
Curv. 1	1628.32 [0.0000]**
Curv. 2	772.02 [0.0000]**
Exclusion restrictions across equations	
Inf. Exp.	10.27 [0.0059]**
Real Activity	12.75 [0.0004]**
BoE Policy Rate	68.67 [0.0000]**
Debt to GDP	10.33 [0.0013]**
UK Eff. ER	32.84 [0.0000]**
IFO	12.59 [0.0004]**
German Retail Sales	28.34 [0.0000]**
$\left(\frac{M}{P}\right)$	19.80 [0.0000]**
Libor	19.71 [0.0000]**
Duration	4.96 [0.0259]*

Note: This table represents tests for the exclusion of variables within and across equations, and only includes those variables used in the final specification. All tests are chi^2 with four degrees of freedom.

Table 2

Descriptive statistics for estimated term structure model

	Factor			
	Level	Slope	Curv.1	Curv.2
R^2	0.950	0.954	0.863	0.725
RMSE	0.490	0.531	1.141	1.866
Durbin-Alt	0.020 [0.8865]	0.307 [0.5798]	0.760 [0.3834]	4.835 [0.0279]*
Breusch-Pagan	2.98 [0.0844]	1.63 [0.2018]	1.48 [0.2238]	6.56 [0.0104]*
Normality	19.085 [0.0000]**	6.2886 [0.0162]*	0.62410 [0.7319]	39.278 [0.0000]**

Note: The Durbin-Alternative test (with one lag), with the null hypothesis that the errors are homoscedastic, with one degree of freedom. The Breusch-Pagan test also has one degree of freedom, and the null hypothesis is that there is no autocorrelation. The normality test has two degrees of freedom, and the null hypothesis is that the errors are normally distributed. All tests have a chi^2 distribution and **represent rejection of the null at the 1% level and *represent rejection of the null at the 5% level.

Table 3

Estimates of the impact of QE on 5- and 10-year forward rates

(in basis points)

	5 Year Forward				10 Year Forward			
	Counterfactual.	Simulation.			Counterfactual.	Simulation		
	Prediction error.	Debt effect	Duration effect	Total.	Prediction error.	Debt effect	Duration effect	Total
Feb '09	35	0	0	0	104	0	0	0
Mar '09	-99	-37	3	-34	-50	-48	2	-46
Apr '09	-47	-37	14	-23	-7	-48	11	-37
May '09	-18	-62	21	-41	50	-80	16	-64
Jun '09	-54	-62	27	-35	-35	-80	21	-59
Jul'09	-38	-62	35	-27	-47	-80	27	-53
Aug '09	-75	-87	26	-61	-70	-112	20	-92
Sept '09	-110	-87	7	-80	-99	-112	6	-106
Oct '09	-65	-87	0	-87	-57	-112	0	-112
Nov '09	-91	-98	4	-94	-87	-126	3	-123
Dec '09	-67	-98	2	-96	-50	-126	2	-124
Jan '10	-73	-98	-13	-111	-54	-126	-10	-136

Note: Prediction error is actual minus predicted path of yield, as described in subsection 3.2.1. Debt and Duration effects are the estimated impact of QE through reduced overall debt and changes in the duration of remaining debt available to the private sector, as described in subsection 3.2.2. Total is simply the sum of debt and duration effects.

Table 4

Bond prices around QE operations

	t-15	t-10	t-5	t	t+1	t+5	t+10	t+15	t+20
Model 1: 'No Change'									
Relative to operation price	-0.38	-0.32	-0.21	-0.12	-0.21	-0.43	-0.63	-0.85	-0.84
	[0.33]	[0.09]	[0.12]	[0.01]	[0.09]	[0.03]	[0.00]	[0.00]	[0.00]
Relative to end-day price	-0.26	-0.20	-0.09		-0.08	-0.31	-0.51	-0.73	-0.71
	[0.39]	[0.26]	[0.26]		[0.27]	[0.09]	[0.06]	[0.01]	[0.00]
Model 2: Interpolated Model									
Relative to operation price	-0.56	-0.44	-0.27	-0.12	-0.20	-0.37	-0.51	-0.67	-0.60
	[0.14]	[0.06]	[0.04]	[0.01]	[0.09]	[0.06]	[0.00]	[0.01]	[0.01]
Relative to end-day price	-0.44	-0.33	-0.15		-0.08	-0.25	-0.39	-0.55	-0.48
	[0.20]	[0.12]	[0.21]		[0.27]	[0.14]	[0.06]	[0.14]	[0.03]

Note: The table presents average price differential (per cent) between either the average price accepted in the QE operation or the price at the end of the operation day, and the price at various horizons. In the case of model 2 the price differential is adjusted for the predicted movement in prices from an interpolated version of the yield curve model described above. Figures in square brackets represent the probability that the price differential is zero, based on the two-sided Wilcoxon Rank Test.

Table 5

Asset price movements around QE operations

	t-15	t-10	t-5	t+1	t+5	t+10	t+15	t+20
APF Gilts	-0.44	-0.33	-0.15	-0.08	-0.25	-0.39	-0.55	-0.48
	[0.20]	[0.12]	[0.21]	[0.27]	[0.14]	[0.06]	[0.14]	[0.03]
Gilts 0-5 years	-0.19	-0.12	-0.07	-0.01	0.04	0.08	0.12	0.19
	[0.21]	[0.33]	[0.21]	[0.39]	[0.79]	[0.46]	[0.61]	[0.54]
Gilts 5-10 years	-0.24	-0.15	-0.08	-0.04	-0.07	-0.17	-0.22	-0.20
	[0.12]	[0.79]	[0.39]	[0.06]	[0.12]	[0.00]	[0.12]	[0.03]
Gilts 10-15 years	-0.25	-0.16	-0.10	-0.05	-0.10	-0.26	-0.36	-0.36
	[0.09]	[0.61]	[0.39]	[0.21]	[0.16]	[0.02]	[0.09]	[0.01]
Gilts 15-25 years	-0.58	-0.35	-0.18	-0.06	-0.18	-0.43	-0.53	-0.52
	[0.26]	[0.61]	[0.12]	[0.54]	[0.39]	[0.01]	[0.03]	[0.04]
Gilts 25 years+	-0.58	-0.38	-0.25	-0.06	-0.07	-0.26	-0.24	-0.18
	[0.04]	[0.03]	[0.12]	[0.54]	[0.67]	[0.39]	[0.21]	[0.39]
Effective Exchange Rate	-0.01	-0.04	-0.03	0.01	0.07	0.13	0.27	0.18
	[0.39]	[0.26]	[0.21]	[0.39]	[0.67]	[0.74]	[0.88]	[0.79]
FTSE 100	-0.02	-0.01	-0.01	0.00	0.01	0.01	0.03	0.03
	[0.09]	[0.26]	[0.26]	[0.88]	[0.39]	[0.67]	[0.74]	[0.79]
10 year AAA bonds	-0.09	-0.06	-0.05	0.01	0.01	-0.02	-0.04	-0.05
	[0.33]	[0.39]	[0.26]	[0.33]	[0.33]	[0.04]	[0.06]	[0.01]
10 year BBB bonds	-0.13	-0.09	-0.07	-0.00	-0.05	-0.06	-0.09	-0.15
	[0.33]	[0.54]	[0.06]	[0.26]	[0.91]	[0.04]	[0.09]	[0.33]
10 year Swap	-0.03	-0.01	-0.01	-0.01	-0.02	-0.05	-0.08	-0.07
	[0.02]	[0.33]	[0.21]	[0.26]	[0.39]	[0.06]	[0.46]	[0.21]
10 Year OIS	0.00	0.02	-0.00	-0.01	-0.3	-0.07	-0.11	-0.11
	[0.16]	[0.46]	[0.61]	[0.67]	[0.21]	[0.06]	[0.21]	[0.12]

Note: The table presents average price differential (per cent) between price at end of day of QE operation and price at various horizons. In all cases the asset price is adjusted for any trend over the sample, in most cases through a simple linear trend adjustment, but for APF gilts using the yield curve model. Thus, the first row reproduces the results of the final two rows of table 5. Figures in square brackets represent the probability that the price differential is zero, based on the two-sided Wilcoxon Rank Test. OIS data courtesy of the Bank of England.

Figure 1

Bank of England's balance sheet

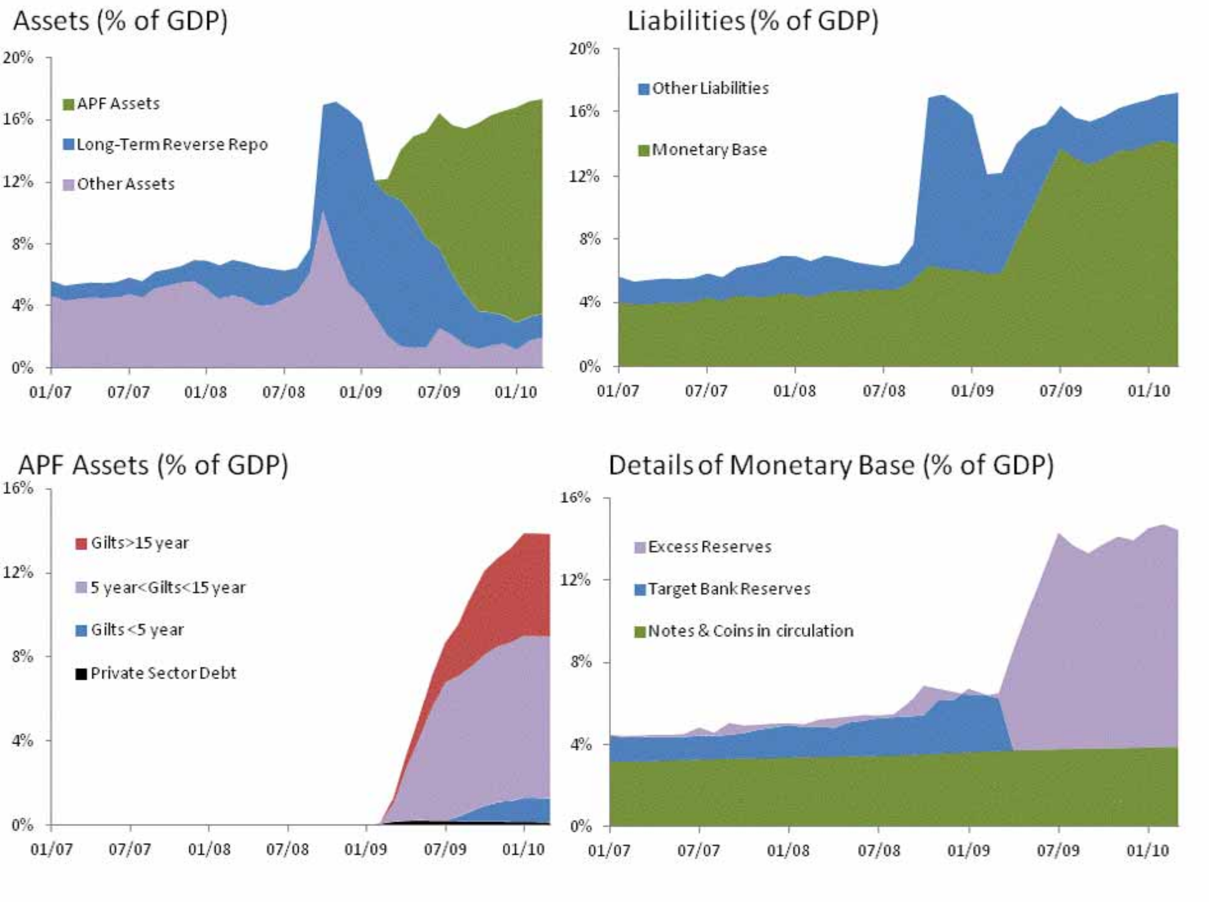


Figure 2

Gilt holdings by sector as a fraction of GDP

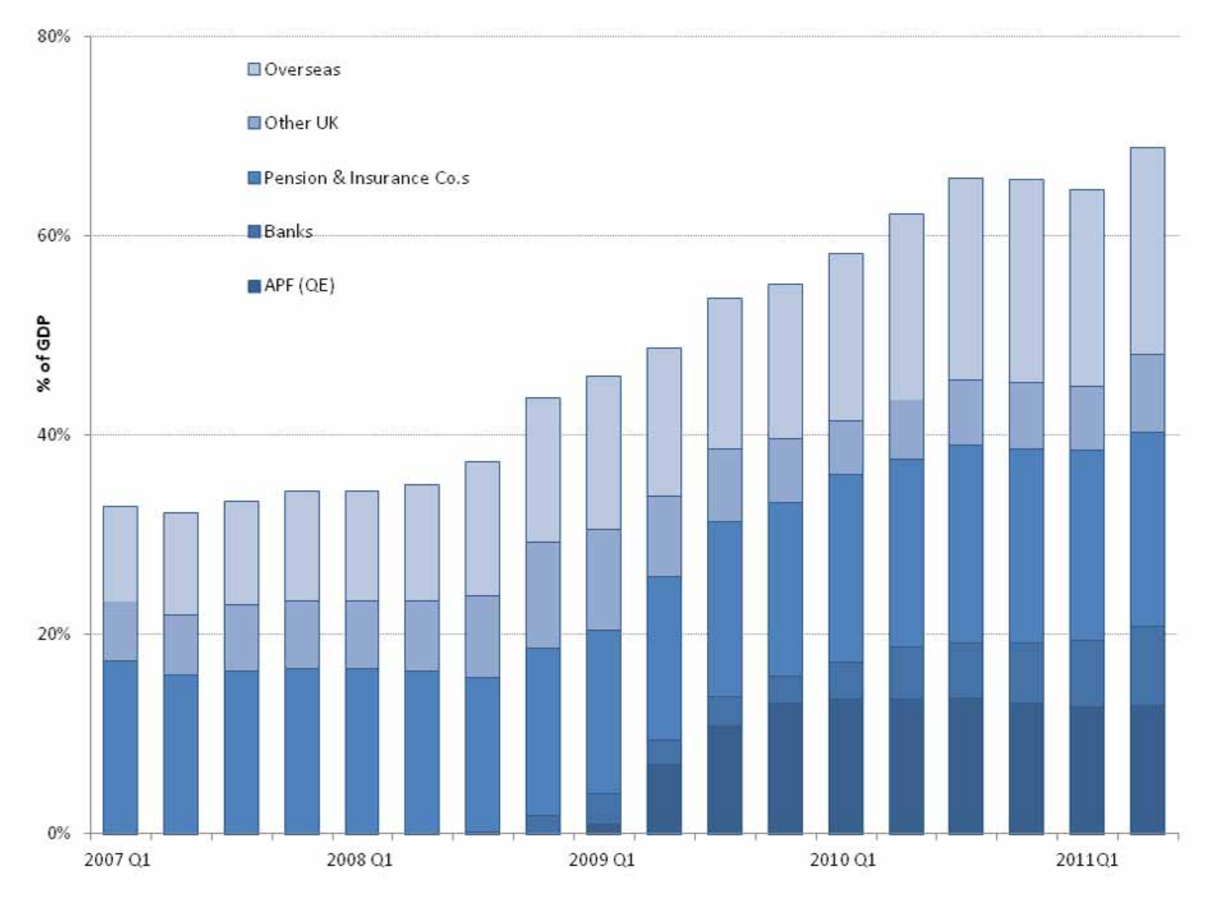


Figure 3

M4x and year-on-year growth of M4x

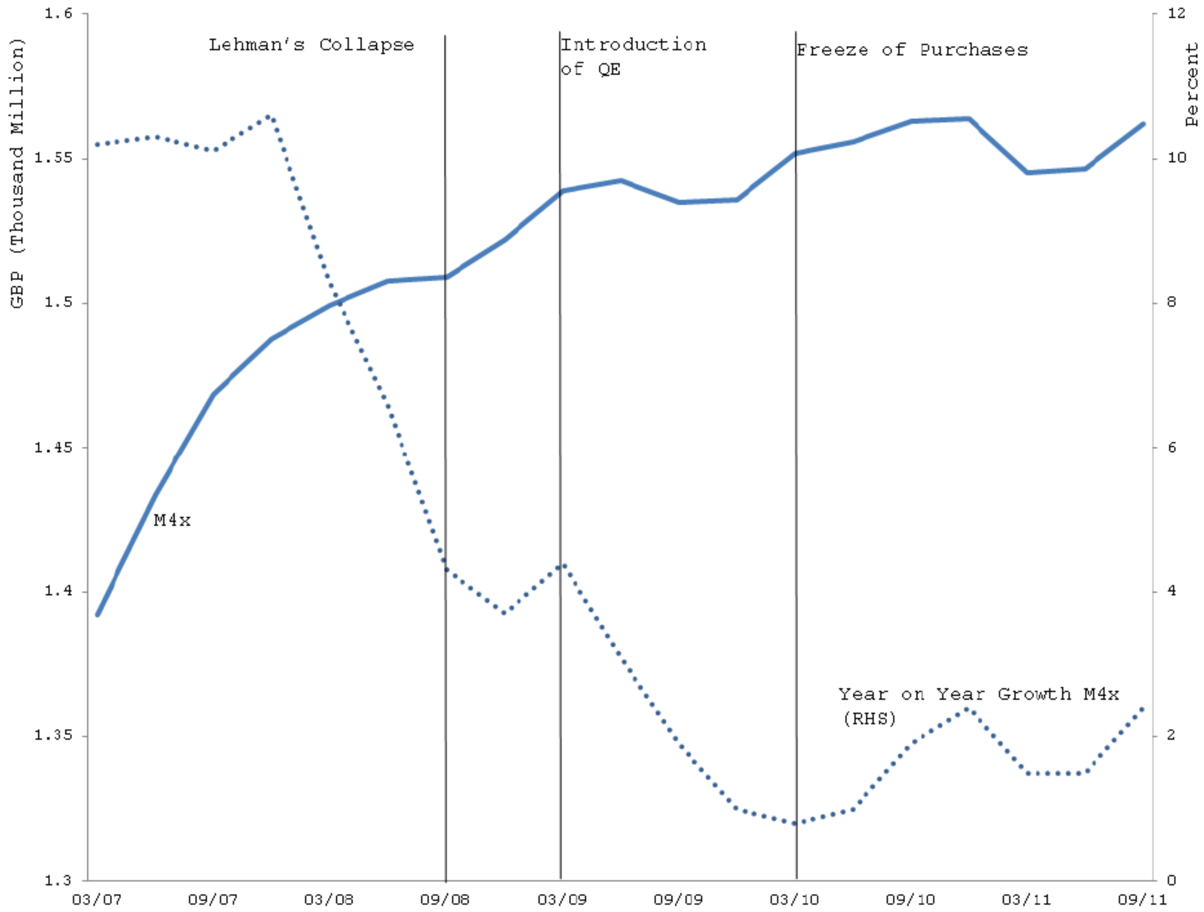


Figure 4

Year-on-year growth in total M4x lending to households and to PNFCs

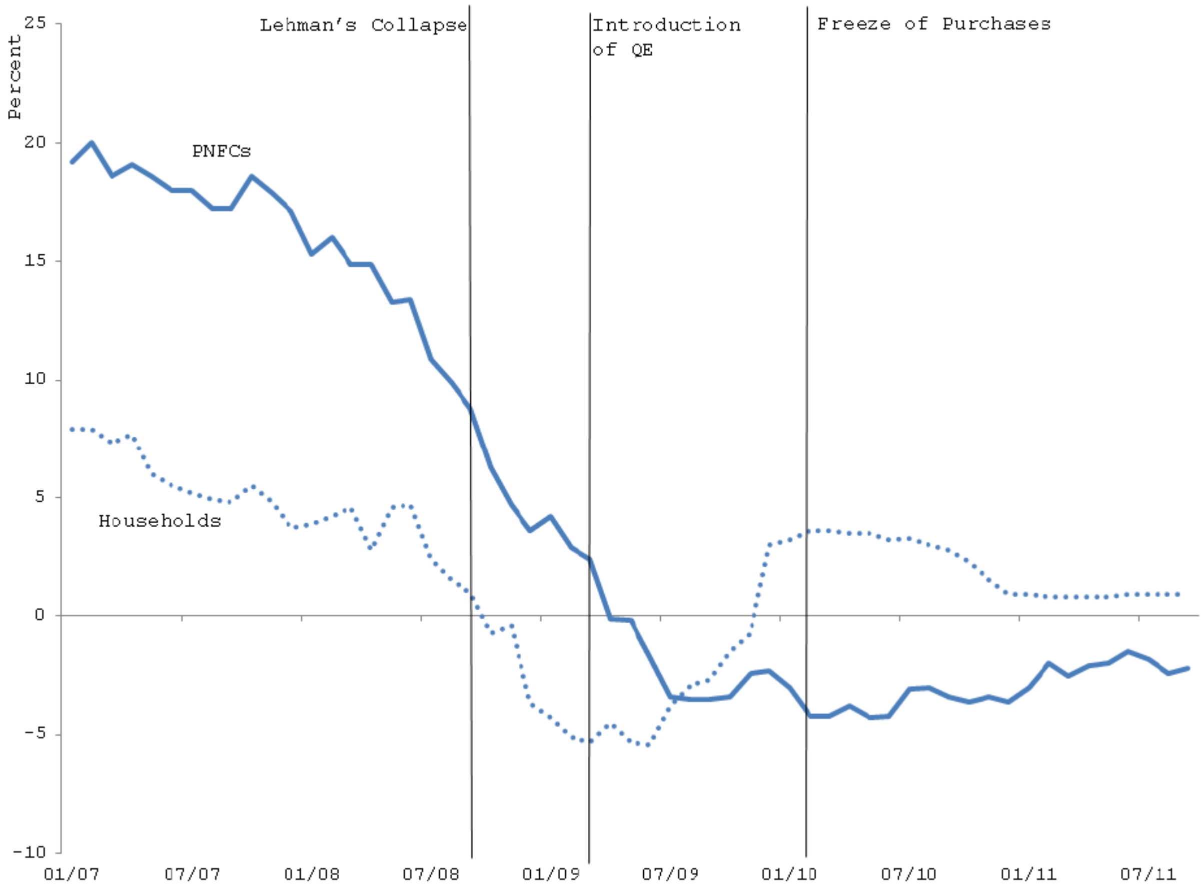


Figure 5

The availability of corporate credit

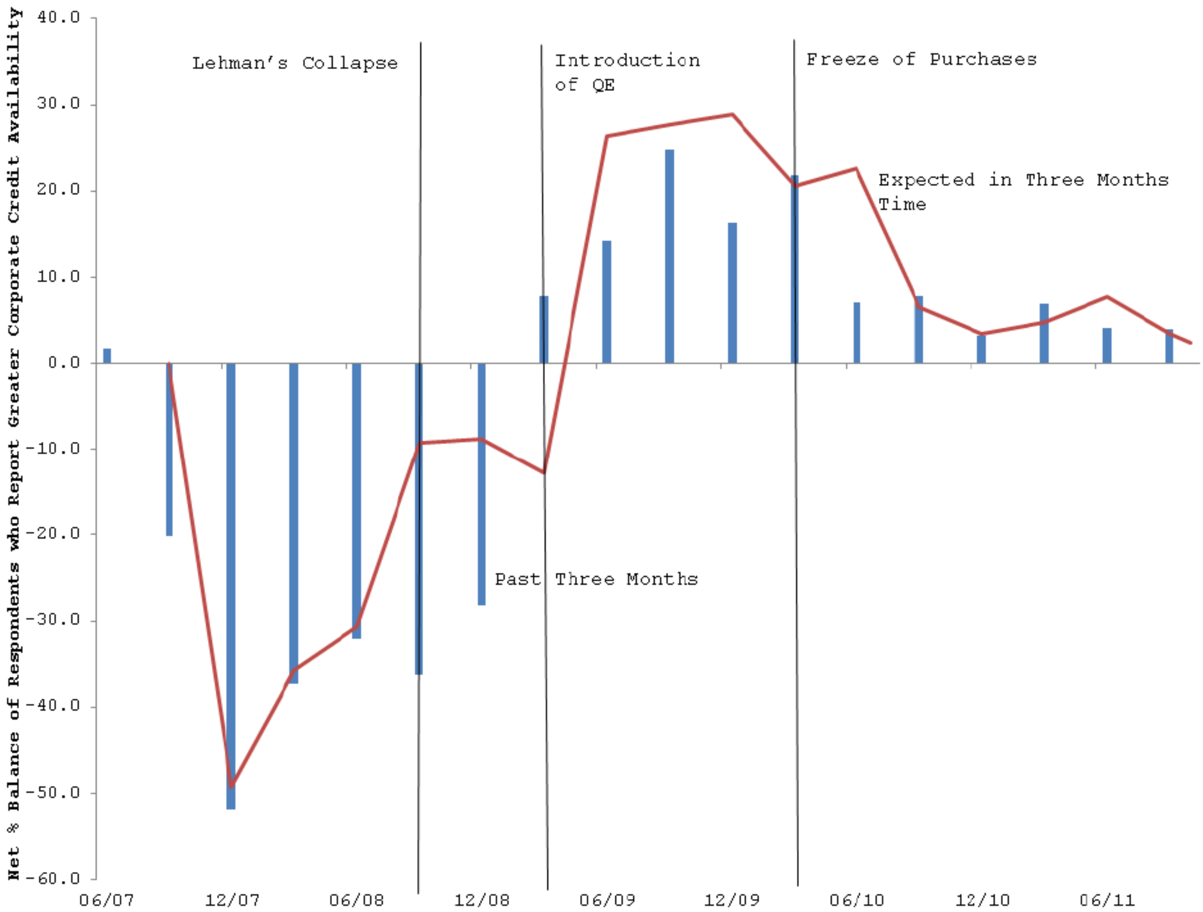


Figure 6

Monthly net capital issuance by sector

Figure 7

Impulse responses of forward curve to 1% shock in macro factors

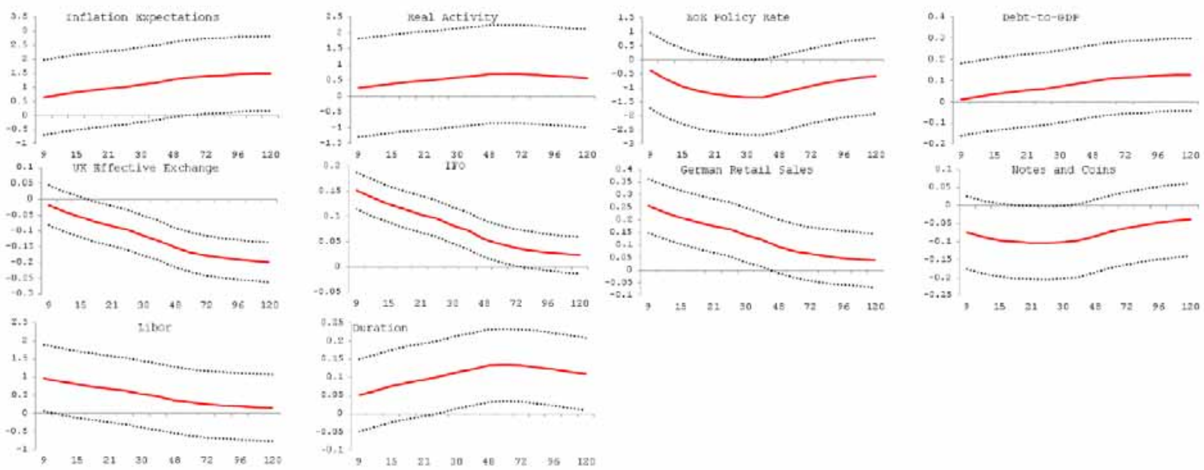
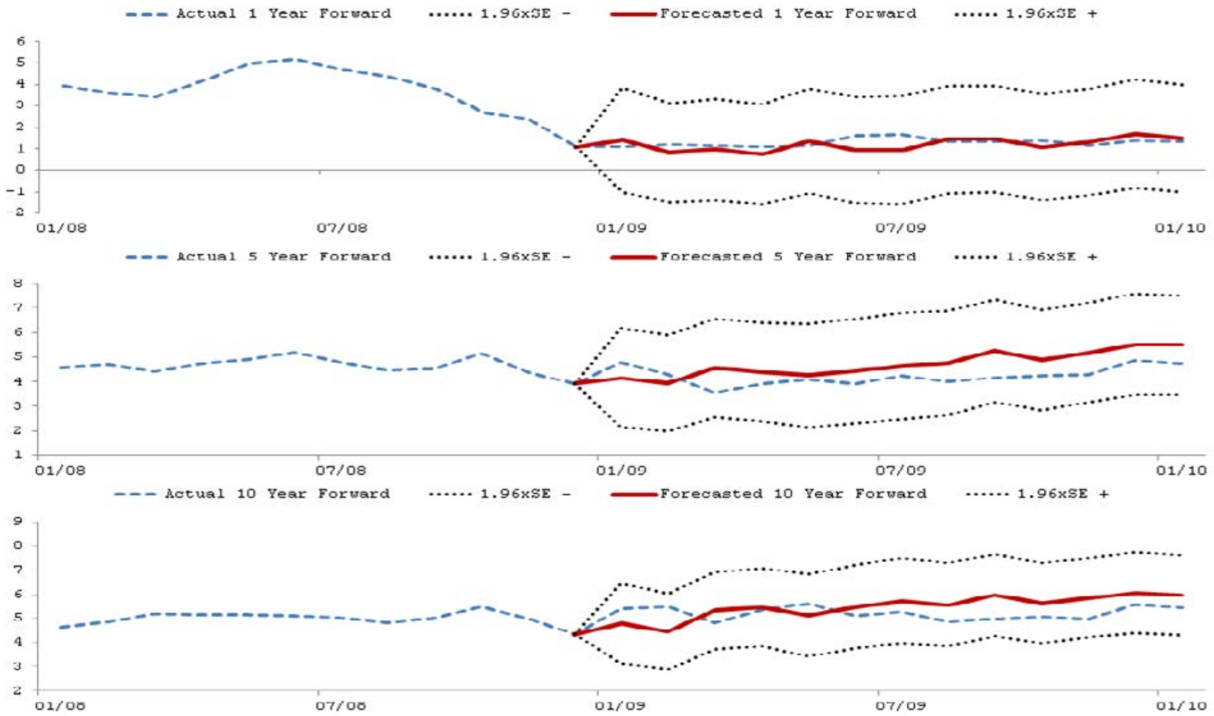


Figure 8

1-, 5- and 10-year actual and forecast forward rates



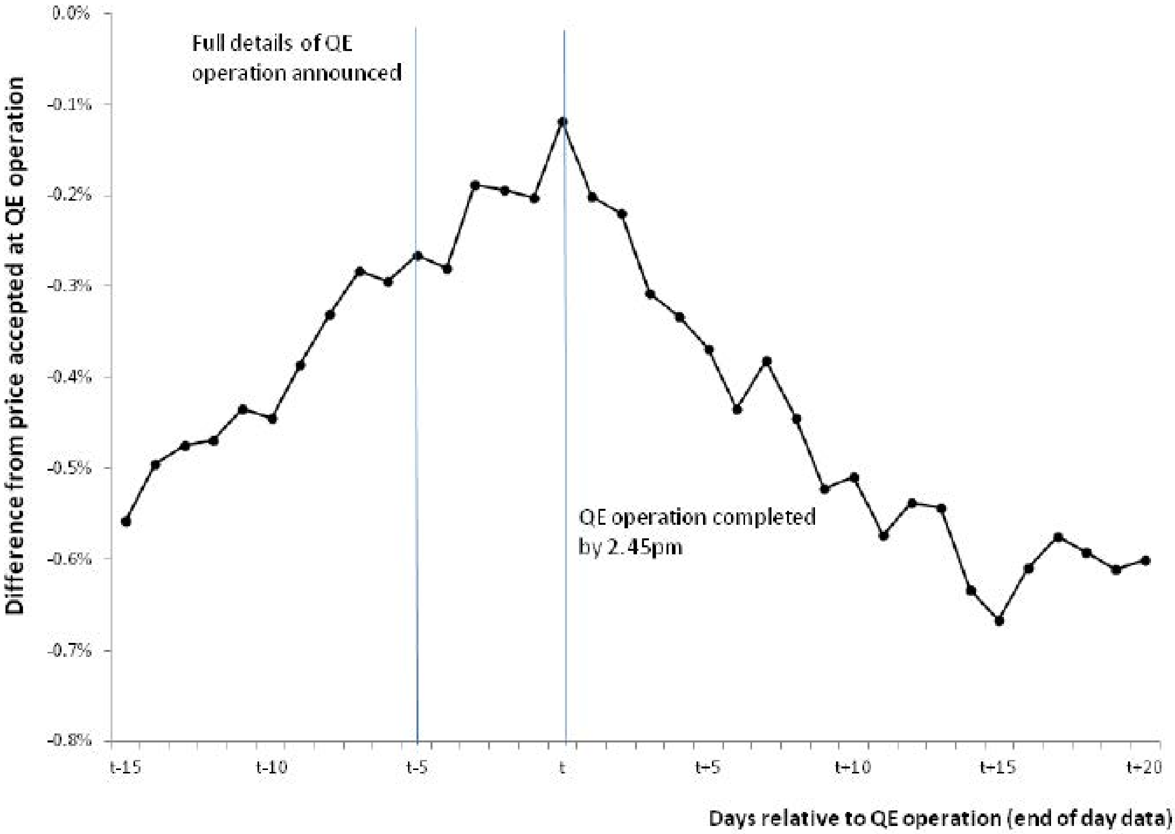
Note: Figure 8 presents the actual forwards from January 2008 to January 2010. We also include the forecast and the forecast interval (95% confidence). To construct the forecast interval for each forward (1-, 5- and 10-year) we take the forecasted factors from the SUR regression and multiply these estimated factors by the appropriate factor-weighting for each maturity from the Svensson methodology, across each of the forecast periods. We then construct a joint forecast error from each of the different factors for each forecast observation, also multiplying the forecast error by each factor weight so that it is scaled accordingly.

Figure 9

5- and 10-Year UK government debt credit default swap spreads

Figure 10

Average price response around QE operations



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