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

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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.

[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

[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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