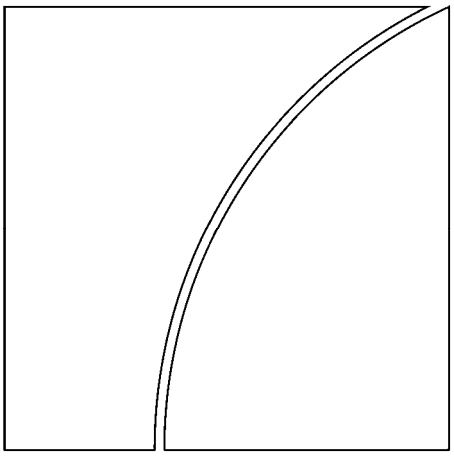
Macroeconomic Assessment Group

established by the
Financial Stability Board
and the Basel Committee on
Banking Supervision

Interim Report



Assessing the macroeconomic impact of the transition to stronger capital and liquidity requirements

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Executive summary

In December 2009, the Basel Committee on Banking Supervision (BCBS) proposed a set of measures to strengthen global capital and liquidity regulations. The aim of these measures is to improve the resilience of the financial system. The proposed reforms will generate substantial benefits by reducing both the frequency and intensity of financial crises, thereby lowering their very large economic costs.

A key factor determining banks' responses to new capital and liquidity standards is the length of the period during which the new requirements are phased in. If the transition period is short, banks may choose to curtail credit supply in order to lift capital ratios and adjust asset composition and holdings quickly. A longer transition period could substantially mitigate the impact, allowing banks additional time to adapt by retaining earnings, issuing equity, shifting liability composition and the like. Whether the transition is long or short, decisive action to strengthen banks' capital and liquidity positions could boost confidence in the long-term stability of the financial system as soon as implementation starts. Giving banks time to use these adjustment mechanisms would almost certainly mitigate any adverse effects on lending conditions and, eventually, on aggregate activity.

Cognisant of the need to phase in the new regulations in a manner that is compatible with the ongoing economic recovery, the BCBS and the Financial Stability Board (FSB) set up a group to assess the macroeconomic effects of the transition to higher capital and liquidity requirements. This Macroeconomic Assessment Group (MAG) brings together macroeconomic modelling experts from central banks, regulatory agencies and international institutions; and is chaired by Stephen G Cecchetti, Economic Adviser of the BIS. The MAG's work is intended to complement that of the BCBS's Long-Term Economic Impact Group. Close collaboration with the IMF is an essential part of the process.

The MAG has applied common methodologies based on a set of scenarios for shifts in capital and liquidity requirements over different transition periods. These scenarios served as inputs into a broad range of models developed for policy analysis in central banks and international organisations (semi-structural large-scale models, reduced-form VAR-type models, DSGE models). Ideally, one would like these models to capture the impact of the implementation of the new standards through all relevant mechanisms – including changes in lending spreads, short-term credit supply constraints and international spillover effects – and to take into account behavioural responses from banks and other market participants as well as monetary policy responses from central banks in line with their mandates. Unfortunately, standard macroeconomic models do not readily allow for direct investigation of the effects of prudential policy changes. While different models employed by the MAG capture many of the key aspects, there is no single model that incorporates all the relevant mechanisms.

In an effort to address the problem of model incompleteness and a greater than normal level of uncertainty about model specification, the study draws on results from a diversity of models and countries. Against this background, the presentation of the results focuses on the median outcome as a central estimate of the impact across models and countries, while also showing the range of responses obtained. These results can therefore be viewed as reasonably robust estimates of the costs of transition to the stronger standards in a representative case.

Main quantitative results

It is more expensive for banks to fund assets with capital than with deposits or wholesale debt. This suggests that, while banks facing stronger capital requirements will seek to increase capital levels by retaining earnings and issuing equity as well as reducing non-loan assets, they may initially increase the interest rates they charge borrowers and reduce the quantity of new lending. Any increase in the cost and decline in the supply of bank loans

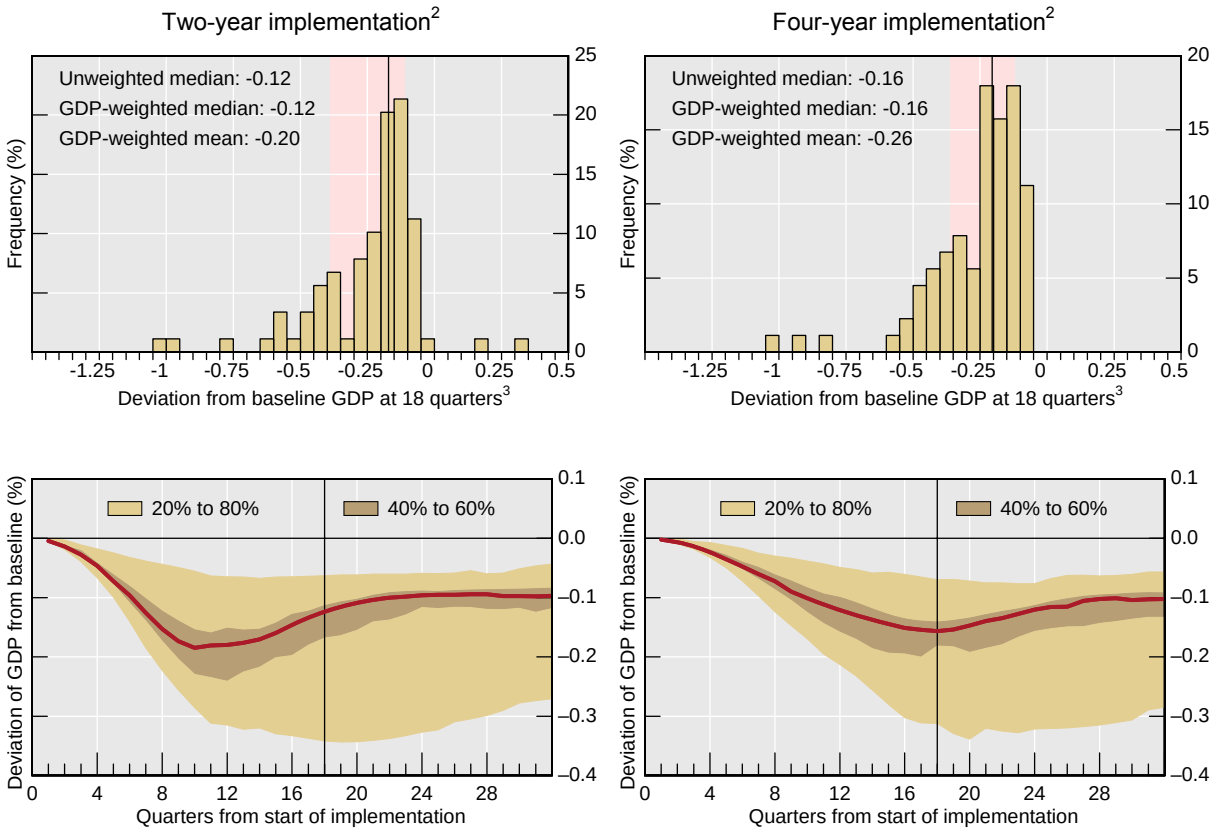
could have a transitory impact on growth, especially in sectors that rely heavily on bank credit. In the longer term, however, as banks become less risky, both the cost and quantity of credit should recover, reversing the impact on consumption and investment.

This intuition forms the basis for the results of the MAG. While Group members applied a number of different models and methodologies in order to understand these relationships, they felt most confident in the results obtained through a two-step approach. The first involves estimating the effect of higher capital targets on lending spreads and lending volumes using statistical relationships and accounting identities to predict how banks will adjust. The second step takes these forecast paths for lending spreads and volumes as inputs into standard macroeconomic forecasting models in use at central banks and regulatory agencies. These models are then used to estimate the effects of changes to lending spreads and bank lending standards on consumption, investment and other macroeconomic variables.

Graph 1

Aggregate impact of a 1 percentage point increase in the target capital ratio: distribution of estimated GDP deviation across all models[1]

In per cent



[1] Distributions are computed across all 89 models estimated. The shaded areas indicate the range between the 20th and 80th percentile. Figures do not include the impact of international spillovers. [2] The vertical line in the top panels indicates the unweighted median. The vertical line in the bottom panels indicates the 18th quarter, which was chosen because it represents the date of the largest GDP impact for the four-year implementation scenario. The three most negative values represent the outcome of models estimated by the Bank of Japan and the Federal Reserve, discussed in Sections 3.2 and 3.3 of the report. [3] Quarters measured from start of implementation.

Overall, the MAG's estimates suggest a modest impact on aggregate output of the transition towards higher capital standards. Taking the median across all the results obtained, a 1 percentage point increase in the target ratio of tangible common equity (TCE) to risk-weighted assets is estimated to lead to a decline in the level of GDP by a maximum of about 0.19% from the baseline path after four and a half years (equivalent to a reduction in the annual growth rate of 0.04 percentage points over this period). This figure of nearly two tenths of 1 percentage point per percentage point increase in the target capital ratio is the sum of 0.16%, the median GDP decline estimated for specific countries by national authorities, and 0.03%, which is the potential impact of international spillovers (reflecting exchange rates, commodity prices and shifts in global demand) as estimated by the IMF. It is important to note that these results apply to any increase in target capital ratios whether its source be higher regulatory minima, required buffers, changes in the definition of capital, the application of a leverage ratio, or some other change in standards.

The top panels of Graph 1 show the distribution of estimated GDP losses across all models (excluding the additional spillover effect) after 18 quarters for implementation horizons of two and four years. Focusing on the longer horizon in the right-hand panels, note that the vast majority of the estimation results are clustered around the median (with a range of 0.07–0.31% when the top fifth and bottom fifth of the distribution are excluded, in the four-year implementation case). A small number of estimates show a larger impact. These GDP effects reflect median increases in domestic lending spreads of about 15 basis points, and declines in lending volumes of 1.4%.

The median results are drawn from estimates based on a variety of modelling approaches. The majority of the models assume that tighter capital standards affect the economy as banks respond by increasing their lending spreads. A small number of models also allow for the possibility that banks constrain the supply of credit beyond what is reflected in the increase in spreads. Many models also assume that monetary policy responds to lower output levels and associated reduced inflationary pressures in line with central banks' mandates. Comparing results across the models making these different assumptions offers insights into the potential importance of these mechanisms.[1]

- Changes in *lending spreads* alone are estimated to reduce GDP relative to the baseline trend by roughly 0.16% in the four-year implementation case – about the same as the median decline across all results reported above.
- Estimates of the impact of *credit supply effects* suggest a somewhat larger transitional impact of raising capital standards on aggregate output. Taking account of these effects, by incorporating indicators of bank lending standards into models, yields a median reduction in GDP of 0.32% after four and a half years (again, per percentage point increase in the capital ratio). Models that incorporate the impact of both higher lending spreads and supply constraints tend to yield some of the largest impact estimates displayed on the far left of the top panels of Graph 1, perhaps because they were calibrated based on past data that include episodes when deep recessions coincided with persistent banking sector strains. This underlines the importance of implementing new regulatory requirements in a way that is compatible with the ongoing economic recovery.
- An easing of *monetary policy* reduces the estimated output losses. When it is assumed that the central bank responds to the incipient aggregate demand fall and reduced inflationary pressures precipitated by the regulatory changes, the central estimate of the maximum output loss shrinks significantly. Such offsets are

[1] The figures in this section do not include the additional effects of international spillovers.

especially pronounced in models that incorporate credit supply constraints, for which the GDP loss in the 18th quarter falls from 0.32% to 0.17%.

The effects estimated by the MAG are significantly smaller than some comparable estimates published by banking industry groups. For example, the MAG's median estimate of the GDP impact is roughly one eighth the size of the estimate computed recently by the Institute of International Finance (IIF).[2]

The bottom panels of Graph 1 show the distribution of estimated GDP losses over time. Compared with the four-year case, a two-year implementation period is associated with a slightly larger maximum temporary output loss, which occurs earlier (after two and a half rather than four and a half years). Extending the implementation horizon from four to six years makes little difference. In both the two- and four-year cases, GDP recovers to around 0.10% below baseline eight years after the start of the regulatory change.

The MAG also examined the impact of tighter liquidity requirements, which were modelled as a 25% increase in the holding of liquid assets, combined with an extension of the maturity of banks' wholesale liabilities. The estimations, which were run separately from those for higher capital standards, yield a median increase in lending spreads of 14 basis points and a fall in lending volumes of 3.2% after four and a half years. This is estimated to be associated with a median decline in GDP in the order of 0.08% relative to the baseline trend. It is important to emphasise that the estimates of the impact of enhanced liquidity requirements do not take account of their interaction with the capital rules. Because meeting one helps banks meet the other, the combined effect of both measures is almost certainly less than the sum of the individual impacts.

These results are presented in terms of the impact on a representative economy of generic changes in standards, namely a 1 percentage point increase in the target capital ratio and a 25% increase in liquid assets relative to total assets. The impact of the new regulatory framework on specific national financial systems will depend on current levels of capital and liquidity in those systems, and on the consequences of changes to the definitions used in calculating the relevant regulatory ratios. In many jurisdictions, banks have increased and are continuing to strengthen their capital positions and their holding of liquidity in response to market and supervisory pressure. As a result, many institutions are in the process of adjusting, and some will have met the new requirements even before any formal implementation of the new standards begins.

A simple example might help understand this result. Imagine a stylised bank with a balance sheet (where total assets equal risk-weighted assets) that has the following composition. On the liabilities side, there are deposits and debt, for which the bank pays an average of 5%, and capital, with a return of 15%. Assets are composed of two thirds loans and one third a combination of securities and cash (reserves). Now consider an increase in the capital ratio of 1 percentage point. This raises the cost of funds (the weighted average cost of capital plus deposits and debt) by 10 basis points. To maintain return on equity at 15%, the bank must

[2] For a 2 percentage point increase in Tier 1 and overall capital requirements, combined with other regulatory changes, the IIF's estimates suggest that GDP in the United States, the euro area and Japan will be 3.1% lower than the baseline five years following implementation. The comparable figure derived from the MAG estimates is a GDP reduction of 0.19% times 2, or 0.38%, on a global basis after four and a half years. In terms of the impact on growth rates, the industry estimate translates into a 0.6 percentage point reduction per year compared with 0.08 percentage points per year in this report. It is important to note that the two modelling efforts are based on different assumptions. For example, the industry estimates assume that, absent any strengthening of regulation, banks will prefer to increase their leverage in the coming years, returning to levels that prevailed immediately preceding the crisis; that the financial firms' required return on equity will rise as the government safety net is weakened; and that the link between aggregate credit growth and real GDP is roughly the average from the high-credit growth period preceding the crisis. See Institute of International Finance (2010).

recover this cost increase by raising the return on its assets. If this is done solely by raising rates charged to borrowers, since loans are two thirds of assets, it must raise lending rates by 15 basis points, very close to the MAGs estimate.

What is the impact of these 15 basis points on real output? The answer from the MAG work is that, ignoring international spillovers, such an increase results in a roughly equal decline in GDP. That is, for each 1 percentage point rise in the required target capital ratio, both the rise in lending spreads and the fall in the level of GDP (relative to the baseline) are around 0.15%.

Why the actual impact might differ

There are a variety of reasons why the actual impact of the transition towards higher capital and liquidity requirements on bank lending and GDP may well be *smaller* than the estimates MAG members have produced.

First, stronger banks are likely to face lower debt funding costs and required returns on equity as a result of their perceived greater robustness. Eventually this should reduce, or even eliminate, the need to either raise lending rates or curtail lending quantities.

Second, banks' behaviour will almost certainly be affected by a strengthened regulatory environment. For instance, banks are likely to further improve operational efficiency and to reduce compensation costs in an effort to cut non-interest expenses. Banks are likely to shed non-loan assets in order to lift capital ratios, and will adjust their business models in response to strengthened liquidity standards.

Finally, the availability of alternative sources of finance, eg capital markets and retained earnings for non-financial corporations, is likely to weaken the impact of changes in credit growth on economic activity.

At the same time, there are also a number of non-modelled factors which could result in a *greater* impact. For example, although the reforms will strengthen the banking sector as a whole, some banks may have to offer a higher return on equity to attract the required additional capital, especially if the transition period is short. Second, as banks increase holdings of liquid assets to meet the new liquidity standards, the price of such assets may increase markedly. Third, funding markets may take time to adapt to the longer-term liabilities that banks will need to issue. Fourth, banks in some countries may face a rise in non-performing loans, absorbing capital and provisions in the near future. And finally, bank-dependent small and medium-sized firms may find it disproportionately difficult to obtain financing. A longer implementation horizon is likely to mitigate each of these possible effects.

Implications for the choice of the transition period

The model-based estimates suggest that two- and four-year implementation periods are associated with a broadly similar temporary GDP loss. In both cases, each percentage point increase in the target capital ratio results in a maximum deviation of aggregate output from the baseline trend in the order of 0.19 to 0.22% (including international spillovers). However, the longer the implementation period, the smaller any potential transitory effects on credit availability and GDP are likely to be. First, the maximum GDP loss is estimated to occur around the end of the transition period, which could be at a more mature and resilient stage of the current recovery. Moreover, a number of the behavioural and market adjustments noted above that are not modelled will tend to reduce the GDP impact over time. On the other hand, some financial institutions may seek to comply with the new standards sooner than required, which would reduce the relevance of the transition schedule set by regulators.

The adjustment costs will need to be balanced against the benefits accruing from the introduction of stronger standards in the final decisions on the reform package. Assessments

of the potential significance of benefits and costs at the national level will be informed by the Basel Committee's Quantitative Impact Study (QIS). The most important benefits – confidence in the long-term stability of a system where banks are better capitalised and more liquid – should start to accrue as soon as the reform measures start to be implemented. In any case, policymakers should carefully monitor the development of financial and macroeconomic conditions in planning and proceeding with the implementation of the new regulation.

Final review of the potential significance of benefits and costs at the national level will be informed by the results of the Basel Committee's Quantitative Impact Study (QIS), which is compiling consistent information on the capital and liquidity positions of participating banks under the proposed regulatory standards. The MAG's final report will assess the impact of the calibrated global standards in the context of the QIS results.

1. Introduction

In December 2009, the Basel Committee on Banking Supervision (BCBS) issued for consultation a set of proposals for addressing the market failures revealed by the recent financial crisis. These proposals, which are intended to complement one another in forming the basis for a stronger global financial system, include:

- raising the quality, consistency and transparency of the capital base;
- strengthening the risk coverage of the capital framework;
- introducing a leverage ratio as a supplementary measure to risk-based capital requirements;
- a series of measures to promote the build-up of capital buffers in good times; and
- introducing a global minimum liquidity standard.

Pressure from markets and regulators has already influenced the global banking system, inducing a lowering of leverage together with substantial increases in the quantity and quality of capital and liquidity. Most observers and analysts agree that a less leveraged, more liquid system is both necessary and desirable. Nevertheless, concerns have emerged that, if regulatory requirements are tightened too rapidly, it could affect the progress of the uneven global macroeconomic recovery that is now under way.

In view of these concerns, in February 2010 the chairs of the Financial Stability Board and the BCBS established the Macroeconomic Assessment Group (MAG) to coordinate an assessment of the macroeconomic implications of the implementation of the Basel Committee's proposed reforms. The MAG, in collaboration with national authorities, was asked to develop and apply a framework for assessing the transitional macroeconomic impact of the implementation of the proposals that builds on national authorities' models and methodologies. The Group was asked to assess the costs associated with a range of transition paths. This work is intended to inform the BCBS's deliberations on the calibration of the stronger requirements that will take place in the second half of this year.

Stephen Cecchetti, Economic Adviser of the Bank for International Settlements (BIS), was asked to chair the Group. The membership of the MAG comprises macroeconomic modelling experts from central banks and regulators in 15 countries and a number of international institutions.[3] The Group also consulted with experts in the private sector and the academic world, through both one-on-one interactions and collective roundtables. These discussions provided important context for the MAG's work, particularly on issues that were not captured by members' macroeconomic models.

Close collaboration with the IMF has been an essential part of this process. The IMF provided inputs into the modelling efforts in the different subgroups, drawing on its own work on linkages between the financial system and the macroeconomy, and provided global macroeconomic forecasts that were used by the different national members to make consistent assumptions on important variables such as external demand, commodity prices, energy prices and exchange rates. The IMF also estimated a global model, applying common modelling techniques to data from the MAG's 15 member countries, which aided in quantifying the potential spillover effects across countries and served as a useful cross-check for the national results.

The MAG's work is part of the wider effort to assess the benefits and costs of stronger regulatory requirements. While the MAG was charged with assessing the transitional costs of

[3] The participants in the Group's work are listed in Annex 1.

moving to the new regulatory framework, the Basel Committee's Top-down Calibration Group (TCG) established a separate subgroup to evaluate the likely long-term economic (LEI) impact of stronger regulation once it is in place. The LEI subgroup, which engaged in regular consultation with the MAG, identified both benefits and costs of the new framework. Among the benefits identified are a reduced risk of crisis and lower volatility of GDP, while the potential costs were assessed in terms of an increase in banks' interest rate spreads and the related impact on steady-state output. Since these benefits reflect increased confidence in the long-term stability of the system, they should start to accrue as soon as banks start to implement stronger capital and liquidity positions. The results presented below should be viewed in the context of this overall balance of benefits and costs.

The core of the MAG's work involved the estimation of the impact of changes in the capital and liquidity holdings of banks on GDP through the application of a variety of modelling approaches to a common set of scenarios. The primary method was a two-step procedure in which members first estimated the impact of capital requirements on lending spreads and volumes based on econometric and accounting relationships, and then used these results as inputs to the macroeconomic forecasting models in use at central banks and regulatory agencies. This analysis was complemented by estimations using other approaches, including dynamic stochastic general equilibrium (DSGE) models that incorporate a banking sector and reduced-form models that focused on the historical statistical relationships among capital, growth and other variables. Given the uncertainties and limitations associated with any single modelling approach, the use of a variety of approaches helps provide more robust results and a better sense of the range of possible outcomes.

The remainder of this report is divided into five sections. Section 2 sets out the methodology employed, including the scenarios on which the simulation results are based. Included is a summary of the major results. Section 3 describes the estimates based on the semi-structural simulation models commonly employed by national authorities in their regular policy analysis exercise. Included are results based on a variety of cases in order to give a sense of the potential importance of tighter lending standards and the monetary policy response. Section 4 describes the results obtained from the bank-augmented DSGE and reduced-form models. An extended discussion of the factors that could not be formally considered in the models is the subject of Section 5. Section 6 concludes with an overall assessment.

2. Scenarios and methodology

This section outlines the capital and liquidity scenarios considered, and the implementation horizons used. It then discusses how the changes concerned are incorporated into existing macroeconomic models in order to assess their impact. The section ends with a brief summary of the main results.

2.1 Scenarios considered by the MAG

MAG members investigated the macroeconomic consequences of a common set of scenarios based on two key parameters of the proposed regulatory changes: first, bank capital ratios; and second, liquidity standards – specifically, rules about bank liquidity ratios and the duration of liabilities. The scenarios were also designed to assess the implications of changing the transitional period over which the regulatory changes will be implemented.

The scenarios formulated by the MAG were based on the discussion of potential changes to capital and liquidity rules under way in the private sector analyst community. Precise estimates of the impact of the agreed-upon reforms will require information not only on the exact nature of those reforms – the final calibration – but also on the current state of each country's banking system relative to the calibrated requirements that is being computed by

the Basel Committee's Quantitative Impact Study (QIS). The MAG plans to rerun the models developed to estimate the transitional impact of the final recommendations once the Basel Committee has completed its calibration.

In focusing on target capital and liquidity ratios and the implementation period, the MAG chose not to directly consider the impact of a number of other important changes in regulatory policy being discussed and implemented. These include changes to the definition of capital, deductions from capital, changes to accounting standards, the introduction of bank-specific taxes, the strengthening of resolution frameworks, and the reduction or phase-out of explicit and implicit official support. Some of these changes go beyond the MAG's mandate, which was to assess the transitional impact of the changes being considered by the Basel Committee. In other cases, national differences made it difficult to formulate meaningful scenarios that could be implemented by multiple authorities in a consistent way. In any event, the MAG's results apply to any increase in target capital ratios, regardless of the specific regulatory provision which led to the increase. This is the case irrespective of the initial level of the capital ratio.

For bank capital and liquidity, the MAG decided to model increases in *target* ratios (including voluntary capital buffers), and not the required minimum levels set by regulators. This approach allows for ready comparison of results across economies, avoiding the need to incorporate assumptions about how regulatory minima affect desired capital and liquid asset holdings in national models. Moreover, a broad increase in capital is intuitively easier to interpret, and provides some flexibility in assessing the impact of increases that are more or less than the modelled amount (especially since the results are roughly linear in the capital increase).

Concerning the definition of capital, most existing regulatory regimes, as well as most available data on bank capitalisation, refer to broad definitions such as Tier 1 or Total Capital. However, during and after the financial crisis market participants, and the banks themselves, increasingly focused attention on narrower concepts such as tangible common equity (TCE). MAG members therefore decided to frame the scenarios for capital in terms of the target ratio of TCE to risk-weighted assets. Where members lacked adequate historical data, common assumptions were made in order to ensure a consistent translation of the other capital measures to TCE-based ratios. In the common-increase scenarios, it was assumed that all capital ratio targets rise in parallel by the same amount.

Turning to the liquidity scenarios, the key changes of interest were the impact of the liquidity coverage ratio (LCR) on the holdings of liquid assets relative to conventional loans, and the impact of the net stable funding ratio (NSFR) on the structure of liabilities. With respect to the LCR, two scenarios were considered: one in which banks increase their holdings of liquid assets by 25%, and a second in which the increase is 50%. With respect to the NSFR, both liquidity scenarios postulated an increase of one year in the duration of non-deposit wholesale liabilities.

Given the complexity of the calculation of the LCR and NSFR, these scenarios are necessarily simple approximations for the impact on banks' operations of LCR and NSFR regulation. While it is relatively straightforward to compare banks' existing capital with a new regulatory minimum (abstracting from changes in the measurement of capital), LCR and NSFR regulations could have markedly different effects on different banks (and countries) depending on the existing structure of their balance sheets. For example, in the case of financial systems where banks already have a relatively high liquidity level, the results from these exercises are likely to overstate the impacts of changes in regulation.

Central to the MAG's analysis and mandate was the examination of the period of time within which banks would need to implement the modelled regulatory changes. It was decided to model three implementation periods – two, four and six years – and to run the model simulations for eight years (32 quarters). Implementation was assumed to take place smoothly (although, as will be discussed further below, there are reasons to believe it may

take place more rapidly than in the timetable set by regulators). For modelling purposes, the start date for the simulation exercise was set at the first quarter of 2011 and the end point at the fourth quarter of 2018, though this starting point could in principle be set at whatever date is chosen as the starting point for implementing the reforms.

The interactions between capital and liquidity standards were not considered by the MAG. In practice, however, efforts to meet these standards are likely to complement one another. An increase in the ratio of high-quality liquid to total assets on the balance sheet will result in a decline in risk-weighted assets relative to total assets. And a stronger capital position will help to meet the NSFR, by increasing the numerator of the target ratio (available stable funding). This implies that the interaction between the capital and liquidity requirements is likely to be offsetting (dampening the overall impact) rather than simply additive or reinforcing. However, rather than try to combine capital and liquidity scenarios, members estimated them separately. So, simply adding the estimated impacts of the capital and liquidity requirements would probably overstate the combined effects of these requirements.

It is important to emphasise that these results should be interpreted as the impact of a 1 percentage point increase in the target capital ratio and a 25% increase in liquid assets relative to total assets on a representative economy of generic changes in standards. The effect of the new regulatory framework on specific national financial systems will depend on current levels of capital and liquidity in those systems, and on the consequences of changes to the definitions used in calculating the relevant regulatory ratios. For example, countries in which banks already have large capital buffers in place are likely to see a relatively mild impact from strengthened capital requirements, while countries with low prevailing capitalisation levels are likely to see a greater impact.

2.2 Transmission of higher capital and liquidity targets to economic activity

The analysis of how changes in capital and liquidity ratios are transmitted to economic activity involves two distinct elements. The first is how banks will attempt to meet higher target ratios for capital and liquidity, and the second is how the responses from banks will feed through into aggregate economic activity.

In order to meet higher target capital adequacy ratios, banks can:

- issue new equity;
- increase retained earnings, by:
  - reducing dividend payments;
  - increasing operating efficiency, including by reducing compensation and other costs;
  - raising average margins between borrowing and lending rates;
  - increasing non-interest (fee) income;
- reduce risk-weighted assets, by:
  - lowering the size of loan portfolios;
  - reducing or selling non-loan assets;
  - shifting balance sheet composition towards less risky assets.

Existing studies, along with discussions with members of the financial sector and with academics, lead to the conclusion that banks are likely to use a combination of these methods, and that the approach will depend at least in part on the length of time over which capital needs to be increased. If higher capital requirements are implemented quickly, then it may not be possible to achieve the desired target purely through increases in retained earnings. Instead, banks might emphasise equity issuance, shifts in asset composition and

reduced lending. By contrast, with a longer implementation schedule, banks will have more flexibility as regards the mechanisms they use to achieve targets in the least costly and least disruptive way. More reliance may be placed on raising the additional capital primarily through retained earnings. Based on evidence of past episodes in which banks' capital had fallen below desired levels, the MAG's analysis assumes that increases in capital ratios will be achieved primarily through a combination of lending margin increases and reduced loan volumes. As discussed below, members explored the implications of a variety of assumptions as to whether banks would primarily react by raising spreads or would also reduce lending by tightening standards.

The proposed liquidity framework is likely to affect banks' behaviour in two basic ways. To meet the LCR, banks may seek to increase holdings of highly liquid but low-yielding assets, while the NSFR may lead them to lengthen the maturity structure of their liabilities. In either case, efforts to meet the requirements would tend to reduce profitability, leading to upward pressure on lending margins.

In the MAG analyses, it was assumed that increases in liquidity ratios would mainly be reflected in higher interest spreads. However, the impact on lending margins might be mitigated by complementarity between higher liquidity and capital ratio requirements. As noted above, increases in bank holdings of very liquid assets lower risk-weighted assets, reducing upward pressure on interest margins to meet capital ratio requirements.

Thus, increases in both liquidity and capital requirements are likely to be reflected in a widening of interest margins on lending, together with a tightening of lending standards, particularly in riskier parts of loan portfolios. These effects will almost surely be larger in the short term than over the long term. Even if lending spreads widen as banks build up capital ratios, once the target increases are achieved, spreads would be expected to gradually retrace at least some of this widening. Similarly, a tightening of lending standards in an effort to reduce the level of risk-weighted assets would be relaxed as the target level of assets is achieved.

The macroeconomic impact of these responses from banks will be transmitted through a variety of channels:

- Higher interest margins and tighter lending standards will reduce spending by both households and businesses, dampening consumption and investment expenditure in the short run. (These effects could be amplified if they led to declines in the prices of assets used as collateral for bank lending.)
- To the extent that tighter lending conditions and higher spreads induce a shift in credit supply towards the capital markets or non-bank financial intermediation, the impact of tougher regulatory standards in the banking sector would be dampened, as would the macroeconomic effect. If this were the case, the principal impact of the measures would be likely to fall on bank-dependent sectors, including households and small and medium-sized enterprises (SMEs). Large corporate borrowers would have scope to obtain their funding from other sources.
- If the tightening of capital and liquidity requirements were restricted to one country, the effect of weaker consumption and investment on GDP would be offset, at least in part, by weaker import demand and a resulting improvement in net exports. However, with a global tightening of regulatory requirements, all countries could experience some weakening of domestic spending. Consequently, the global nature of the regulatory changes could amplify the impact of any national regulatory tightening.
- Weaker GDP growth, and the associated downward pressure on prices and wages, would normally be expected to lead to a monetary policy response, with the central bank easing the stance of policy in order to counter the fall in output and inflation.

The macroeconomic models discussed in Sections 3 and 4 provide estimates of these effects of higher lending spreads and tighter lending standards. Section 5 reviews some aspects of the adjustment to tighter regulation that are less easily addressed by these models, including other changes in bank behaviour, the role of non-bank credit channels, and the capacity of markets to accommodate shifts in bank balance sheets.

2.3 Overview of results

Before turning to the specifics of modelling techniques and assumptions, it is worth taking a bird's eye view of the entirety of the results. Careful analysis of the MAG's findings suggests that the choice of the modelling approach is a predominant source of heterogeneity in the results, whereas other factors, notably including the country modelled, are less important. This, together with the relatively high degree of uncertainty surrounding the estimates, supports de-emphasising the cross-country dimension of the results and focusing instead on the central tendency of the estimates overall. Moreover, members found that the effects on lending variables and output are approximately linear in the size of the capital or liquidity increase that is simulated.[4] The following sections therefore only present results for a 1 percentage point increase in the target capital ratio and a 25% increase in the holding of liquid assets.

Graph 2 (an expanded version of Graph 1 in the Executive Summary) combines the results from all the 89 estimated models for a 1 percentage point increase in the target capital ratio using the standard approach, as discussed in Section 3.[5] Each model is estimated assuming implementation of the higher standards over two years (left-hand panels) and over four years (right-hand panels). The top four panels show the histograms of the deviation from the baseline at two points in time: after 10 quarters (corresponding to the date when GDP is lowest relative to baseline in the two-year-implementation scenario) and after 18 quarters (corresponding to the date when GDP is lowest relative to baseline in the four-year implementation scenario). The bottom two panels (the fan charts) illustrate the unweighted median estimated GDP path relative to baseline (and the range of paths above and below this median) in the two-year and four-year implementation scenarios for these 89 cases, representing 15 countries as well as estimates for the euro area and the global economy.[6]

From Graph 2 it is apparent that, in the vast majority of cases, the impact of a 1 percentage point increase in the target capital ratio is quite modest – less than one quarter of 1% at its worst. It is also notable that in a few instances MAG members reported impact figures in excess of one half of 1% (less than –0.50%); the three most negative values represent the outcome of models estimated by the Bank of Japan and the Federal Reserve, discussed in Sections 3.2 and 3.3 of the report (both institutions also estimated models with smaller effects under alternative assumptions). The impact after eight years is less than one sixth of 1%.

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[4] The estimated scenarios included 2, 4 and 6 percentage point increases in the target capital ratio, and 25% and 50% increases in the ratio of liquid assets to total assets.

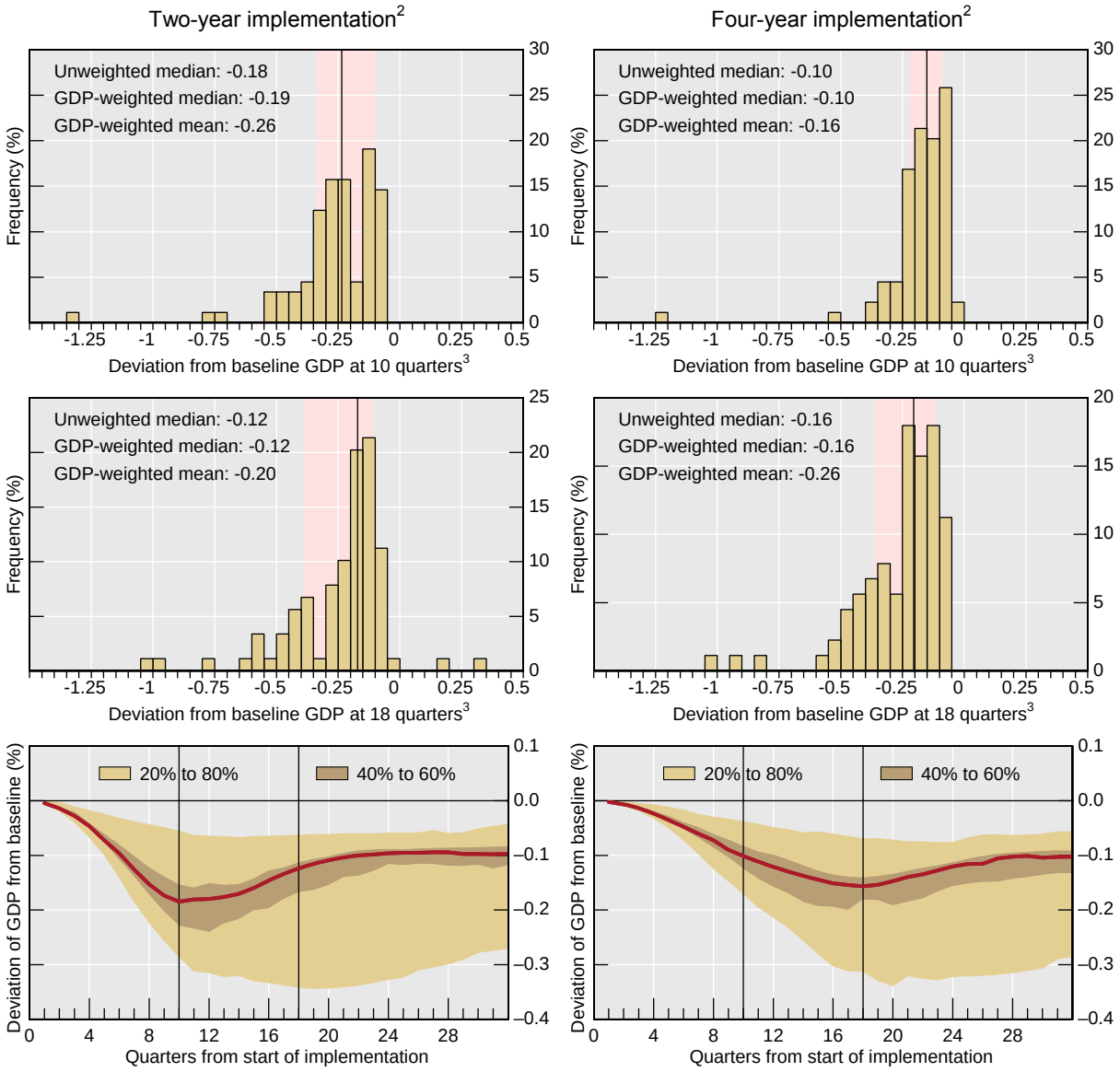
[5] These 89 cases comprise the models estimated using standard forecasting and policy analysis models, as discussed in Section 3, with the exception of a set of results produced by the IMF to estimate the impact of spillovers on national economies (the comparable IMF results without spillovers are among these 89 cases, however).

[6] The bank-augmented DSGE models produced results broadly in line with these. The reduced-form models tended to produce greater effects, though members were sceptical of some of these results, for reasons set out in Section 4.

Graph 2

Aggregate impact of a 1 percentage point increase in the target capital ratio: distribution of estimated GDP deviation across all models[1]

In per cent



[1] Distributions are computed across all 89 cases contributed to the MAG subgroup that made use of standard policy forecasting and simulation models, excluding those designed to measure the impact of international spillovers. The shaded areas indicate the range between the 20th and 80th percentile. [2] The vertical line indicates the unweighted median, while in the bottom two panels the vertical lines indicate the 10th and 18th quarters. The three most negative values represent the outcome of models estimated by the Bank of Japan and the Federal Reserve, discussed in Sections 3.2 and 3.3 of the report. [3] Quarters measured from start of implementation.

A simple example might help understand this result. Imagine a stylised bank with a balance sheet (where total assets equal risk-weighted assets) that has the following composition. On the liabilities side, there are deposits and debt, for which the bank pays an average of 5%, and capital, with a return of 15%. Assets are composed of two thirds loans and one third a combination of securities and cash (reserves). Now consider an increase in the capital ratio of 1 percentage point. This raises the cost of funds (the weighted average cost of capital plus

deposits and debt) by 10 basis points. To maintain return on equity at 15%, the bank must recover this cost increase by raising the return on its assets. If this is done solely by raising rates charged to borrowers, since loans are two thirds of assets, it must raise lending rates by 15 basis points.

What is the impact of these 15 basis points on real output? The answer from the MAG work is that, ignoring international spillovers, such an increase results in a roughly equal decline in GDP. That is, for each 1 percentage point rise in the required target capital ratio, both the rise in lending spreads and the fall in the level of GDP (relative to the baseline) are around 0.15%.[7]

Lengthening the implementation period from two to four years reduces the transitional GDP impact of the change somewhat and postpones the point in time when this impact is strongest. The difference in the GDP loss is not large – in both cases, each percentage point increase in the target capital ratio results in a maximum deviation of aggregate output from the baseline trend in the order of 0.19 to 0.22% (including international spillovers). However, the longer the implementation period, the smaller any potential transitory effects on credit availability and GDP are likely to be. First, the maximum GDP loss is estimated to occur around the end of the transition period, which could be at a more mature and resilient stage of the current recovery. Moreover, as discussed in Section 5, a number of the behavioural and market adjustments that are not modelled will tend to reduce the GDP impact over time. On the other hand, some financial institutions may seek to comply with the new standards sooner than required.

3. The impact of capital and liquidity requirements on GDP: a two-step approach

Most central banks, and many other economic agencies, have one or more large-scale, regularly updated macroeconomic models that have over time demonstrated their usefulness for forecasting and policy analysis purposes. While time-tested and well understood, these models suffer from the fact that they do not directly incorporate banking sectors in a way that would allow investigation of the impact of prudential policy changes. To overcome this challenge, the MAG employed a two-step approach, first using satellite models to estimate the impact of prudential policies on economy-wide lending volumes, credit spreads and lending standards, and then taking these results and using them as inputs into the macroeconomic models.

The results in this section are described mostly with reference to two statistical outcomes: the deviation of GDP from its baseline forecast level 18 quarters (four and a half years) after the start of implementation, and the deviation of GDP from baseline after 32 quarters (the end of the eight-year simulation horizon). This approach is adopted because these two figures capture the two aspects of the transition that are of most interest to policymakers, namely the most significant impact they are likely to see in the near future, and the impact that is likely over a somewhat longer time horizon. The 18th quarter was selected because that is the point at which (using median paths) the deviation of GDP from baseline is largest in a scenario where capital targets rise 1 percentage point over a four-year implementation period.[8] This is not surprising, given that the forecast path of lending spreads used as inputs

[7] It is worth noting that this is roughly equivalent to the impact of a permanent shock in the FRB/US model. See Brayton and Tinsley (1996, p 41).

[8] The actual scenarios implemented by members involved 2, 4 and 6 percentage point increases in the target capital ratio. But the results suggested a relationship that was nearly always linear in the target capital ratio.

to the macroeconomic models typically reached its maximum level after four years, when the tighter standards were postulated to be fully in place.

Median values are used to summarise results across groups of models. This is done because the median is a more robust estimate of the central tendency than the average when the distribution of outcomes is characterised by a few extreme values. In some cases, GDP-weighted medians,[9] in which results from relatively large economies have relatively higher influence, were also computed.

3.1 From capital and liquidity to lending volumes and spreads

The MAG's "satellite model" subgroup, coordinated by the UK Financial Services Authority (FSA), developed and implemented models that translate specified changes in bank capital and liquidity requirements into suitable proxy variables, namely lending spreads and lending volumes, which could then serve as inputs to the macroeconomic models.

Members used a number of techniques for this task.[10] When sufficient bank-level data were available, the preferred approach involved estimating banks' adjustments to their capital and assets in response to differences between their actual and target (desired) capital ratios. The estimated target ratio was inferred from the past behaviour of capital ratios (using an econometric model that also took account of other factors), or simply based on average capital levels over a specified period of time.[11] And most members assumed that the implied voluntary buffer – the distance between actual and target capital – remained a constant percentage point level above the regulatory requirements after the implementation of the changes in the regulatory regime.[12]

Members then estimated an econometric model in order to capture the response of various balance sheet items to the distance-from-target variable, while controlling for other factors such as GDP growth, the policy rate, inflation, and aggregate bank charge-offs. Based on these results, they estimated the likely response path of selected balance sheet items for individual banks to a postulated increase in capital and/or liquidity requirements. Individual bank balance sheet responses were then aggregated into a "model" or stylised bank that shows sector-wide outcomes. The model bank, representing the total banking sector, can therefore be as granular as the data allow. Where bank-level data were not available,

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So, for ease of exposition, the estimates based on a 2 percentage point increase were cut in half, and the presentation is in terms of a 1 percentage point increase.

[9] In a weighted median, the sum of the weights on the values above the median value equals the sum of the weights on values below the median. For the present exercise, the weights reflect the share of each country's GDP in the total GDP of the countries in the MAG analysis. In cases where there was more than one estimate for a given economy, the GDP weight would be equally divided among the different estimates. In calculating the GDP-weighted median, estimates that applied to more than one country (such as euro area or global estimates) were dropped.

[10] The satellite model protocol is presented in more detail in Annex 2.2.

[11] The modelling approach is described in Francis and Osborne (2009b), who draw on earlier work by Hancock and Wilcox (1994, 1998). This approach implicitly assumes that, absent regulatory interventions, banks seek to revert to the average leverage level that prevailed over the period used to estimate the model, typically the past 10 or 20 years. Industry estimates often make alternative assumptions; for example, the IIF (2010) assumes in its baseline scenario that banks will seek to return to leverage levels that prevailed immediately before the financial crisis. This has the effect of increasing estimates of the deleveraging that banks will need to engage in to meet higher capital targets.

[12] This can be regarded as a conservative assumption, given that banks are likely to build up their capital buffers in anticipation of regulatory action and in response to uncertain economic prospects, and in many cases have already started to do so. Thus, by the time the actual implementation begins, banks may well be holding larger voluntary buffers than they would hold under normal conditions.

members used aggregate figures, or constructed two or more "model banks" to capture the possibility that different sectors of their national banking systems would respond in different ways in order to capture the aggregate behaviour of the banking sector as realistically as possible.[13]

This technique facilitated estimation of the degree to which higher capital requirements, which induce banks to raise their target capital ratios as they seek to remain above regulatory minima, are likely to be met by reductions in loans, reductions in other assets and increases in capital (either through retained earnings or through new issuance).

For example, the UK FSA estimated that UK banks respond to an increase in their target capital ratio by making about half of the required change through a reduction in risk-weighted assets and about half through an increase in capital. About half of the reduction in risk-weighted assets in turn is in the form of a reduction in lending.

Members generally found that the percentage reduction in total assets resulting from a higher target capital ratio was greater than the percentage reduction in lending volumes. In other words, banks deleverage their non-core assets (such as trading assets) to a greater extent than they reduce their loan books. This result, which is consistent with the response of the Swiss banking system to the imposition of tighter capital requirements in 2009 (see Annex 3.2) suggests that banks employ a "pecking order" approach, in which they seek to achieve higher capital ratio targets by cutting non-core asset categories before reducing lending.

The median estimated decline in lending volumes in response to a 1 percentage point increase in the target capital ratio implemented over four years was roughly 1.4% after 18 quarters relative to the baseline scenario, and 1.9% by the end of the simulation (Table 1, first and second columns). Of the nine models that estimated lending volume effects, seven concluded that the decline in volumes at the end of the simulation for this scenario would be between 0.7 and 2.1%. When the implementation period is shortened to two years, the results are virtually the same.

Complementing these estimates of the impact of regulatory changes on lending volumes, members also estimated the impact on lending spreads. Most members computed these spread effects from elasticities estimated from historical data. This relationship was generally modelled by means of an error correction model, in which the quarterly change in lending spreads was regressed on capital and liquidity requirements, the prevailing level of lending spreads and control variables.[14]

Other members, in the absence of adequate bank-level data, used a simpler approach in which they calculated the lending spread that would be needed to keep the return on equity constant under the assumed capital or liquidity ratio, given current quantities of loans and liquid assets, rates of returns on those assets, and current debt and equity funding costs.

Based on these analyses, the median estimated increase in lending spreads in response to a 1 percentage point increase in the target capital ratio implemented over four years was roughly 15 basis points after 18 quarters and 16 basis points at the end of the simulation (Table 1, third and fourth columns). Of the 14 models that estimated lending spread effects, 11 concluded that the end-period rise in spreads for this scenario would be between 5 and

[13] Most of these estimations did not incorporate a response by monetary policy to macroeconomic conditions. An exception was one estimation by the UK FSA, which found that a monetary policy response could reduce the fall in lending volumes for a 1 percentage point increase in the target capital ratio by up to 1 percentage point and the increase in lending spreads by up to 2 basis points, with the largest effects at the very end of the simulation period.

[14] The approach is described in Barrell et al (2009).

23 basis points. Shortening the implementation period to two years produced virtually identical results.

Table 1

Estimated deviations of lending spreads and volumes from baseline forecasts

Scenario	Lending volume (in per cent)		Lending spreads (in basis points)	
	18th quarter	32nd quarter	18th quarter	32nd quarter
Capital target increases 1 percentage point				
over two years				
Median	–1.4	–1.9	17.3	15.3
Maximum	–0.7	–0.8	25.0	25.6
Minimum	–3.6	–3.6	5.1	5.1
over four years				
Median	–1.4	–1.9	15.4	16.1
Maximum	–0.6	–0.7	27.8	27.6
Minimum	–3.6	–3.6	4.9	5.1
Liquid assets/total assets increases 25%				
over two years				
Median	–3.2	–3.2	14.9	15.1
Maximum	–0.9	–0.9	29.2	32.1
Minimum	–8.7	–8.7	2.4	4.1
over four years				
Median	–3.2	–3.2	14.1	14.1
Maximum	–0.9	–0.9	29.0	29.1
Minimum	–8.8	–8.7	1.6	1.9

The table shows the medians of national estimates of predicted changes in lending spreads and volumes produced by participants in the "satellite model" subgroup of the MAG. The 18th quarter was identified as the date at which the median deviation of GDP from baseline was the greatest, in a scenario where capital ratio targets increase 1 percentage points over four years. The 32nd quarter was the end point of the simulation period.

The accounting-based approach produced forecast spread increases that were broadly similar to those from the regression approach. For example, based solely on an examination of balance sheet data, the Reserve Bank of Australia found that a 1 percentage point rise in the target capital ratio would lead spreads to rise by 20 basis points. The Netherlands Bank, which used both approaches, estimated a maximum spread-widening of 15 basis points in the 18th quarter using the regression approach and 24 basis points using the accounting approach. The Basel Committee's long-term economic impact assessment reported by the LEI group found similar results: a 1 percentage point increase in the capital ratio leading to a 15 basis point rise in lending spreads over the long term. These results are also consistent with those in Elliott (2009), who, using an accounting-based approach, concludes that each percentage point increase in the target capital ratio would lead to a 19 basis point increase in lending rates if other variables remained unchanged.

Those members who applied the regression approach to liquidity requirements found that a 25% increase in liquid assets implemented over four years produced a median spread increase of 16 basis points after 18 quarters. However, members were more uncertain about these results than those for capital, noting that the statistical relationship between liquidity ratios and lending spreads tended to be weak. Given data limitations, not all members were able to model the potential impact of the NSFR. Those who did so concluded that the additional impact of this requirement would be relatively small. For example, using simplifying assumptions that the range of liquid assets and spreads on long-term debt are unchanged, the Reserve Bank of Australia estimated that a 25% increase in liquid asset holdings would result in lending spreads increasing by 24 basis points, of which a little more than half came from the change in asset composition, with the remainder from lengthening liabilities.[15]

3.2 From lending spreads and loan volumes to GDP

A second subgroup, coordinated by the European Central Bank (ECB), used the lending spread and loan volume changes from the satellite models as inputs to their standard policy models.[16] Members used standard semi-structural macroeconometric models or DSGE models developed at their institutions. These models have, in the past, produced broadly reliable answers to important policy questions. To ensure consistent assumptions with regard to global conditions, members made use of forecasts for global growth and other global variables provided by the IMF.

Looking across all estimates produced by models that made use of these techniques, the median impact of a 1 percentage point increase in the target capital ratio implemented over four years was a decline in GDP of about 0.16% below its baseline level in the 18th quarter after the start of implementation. By the end of the simulation period four years later, GDP was estimated to have recovered slightly, to 0.10% below baseline. These medians were essentially the same whether weighted by GDP or not. A shortening of the implementation period to two years had only a minor impact on the estimated GDP decline in the 18th or 32nd quarters (Table 2, first and second columns).

[15] The LEI group, using a balance sheet-based approach for cases where sufficient data were available, calculated that the NSFR would cause lending spreads to rise in the long term by 15 basis points or less, once the synergies between capital and liquidity requirements were taken into account.

[16] The protocol for this workstream is presented in more detail in Annex 2.4.

Table 2

Estimated deviations of GDP from baseline forecasts

In per cent

Scenario	Standard approach[1]		Alternative approaches			
			Bank-augmented DSGE models		Reduced-form models	
	18th quarter	32nd quarter	18th quarter	32nd quarter	18th quarter	32nd quarter
Capital target increases 1 percentage point						
over two years						
Median	–0.12	–0.10	–0.11	–0.07	–0.30	–0.24
Maximum	0.39	0.03	–0.01	–0.02	0.18	0.02
Minimum	–0.96	–1.34	–0.41	–0.25	–0.87	–0.88
over four years						
Median	–0.16	–0.10	–0.14	–0.08	–0.36	–0.39
Maximum	–0.02	0.09	–0.01	–0.01	0.19	0.04
Minimum	–0.99	–1.25	–0.40	–0.30	–1.14	–0.55
Liquid assets/total assets increases 25%						
over two years						
Median	–0.11	–0.12	–0.14	–0.12	–1.20	–1.56
Maximum	–0.02	–0.01	–0.02	–0.01	0.61	–0.08
Minimum	–0.35	–0.29	–0.31	–0.20	–2.02	–2.62
over four years						
Median	–0.08	–0.13	–0.15	–0.09	–1.32	–1.67
Maximum	–0.01	–0.02	–0.09	–0.04	–0.12	–0.25
Minimum	–0.35	–0.28	–0.29	–0.20	–1.75	–2.45

The table shows the medians of national estimates of predicted changes in GDP produced by participants in the MAG. The figures are percentage deviations from baseline forecasts. The 18th quarter was identified as the date at which the median deviation of GDP from baseline was the greatest, in a scenario where capital ratio targets increase 1 percentage point over four years. The 32nd quarter was the end point of the simulation period.

[1] Refers to an estimation in which statistical or accounting-based models are used to derive lending spread and volume effects, which are then used as inputs into the standard policy models used at central banks. See text for discussion.

These broad results, however, conceal a variety of effects that acted in different ways under alternative modelling assumptions. A review of the estimates produced in models grouped according to broad assumptions offers insights as to the factors that are driving these results.

Credit spread-based models

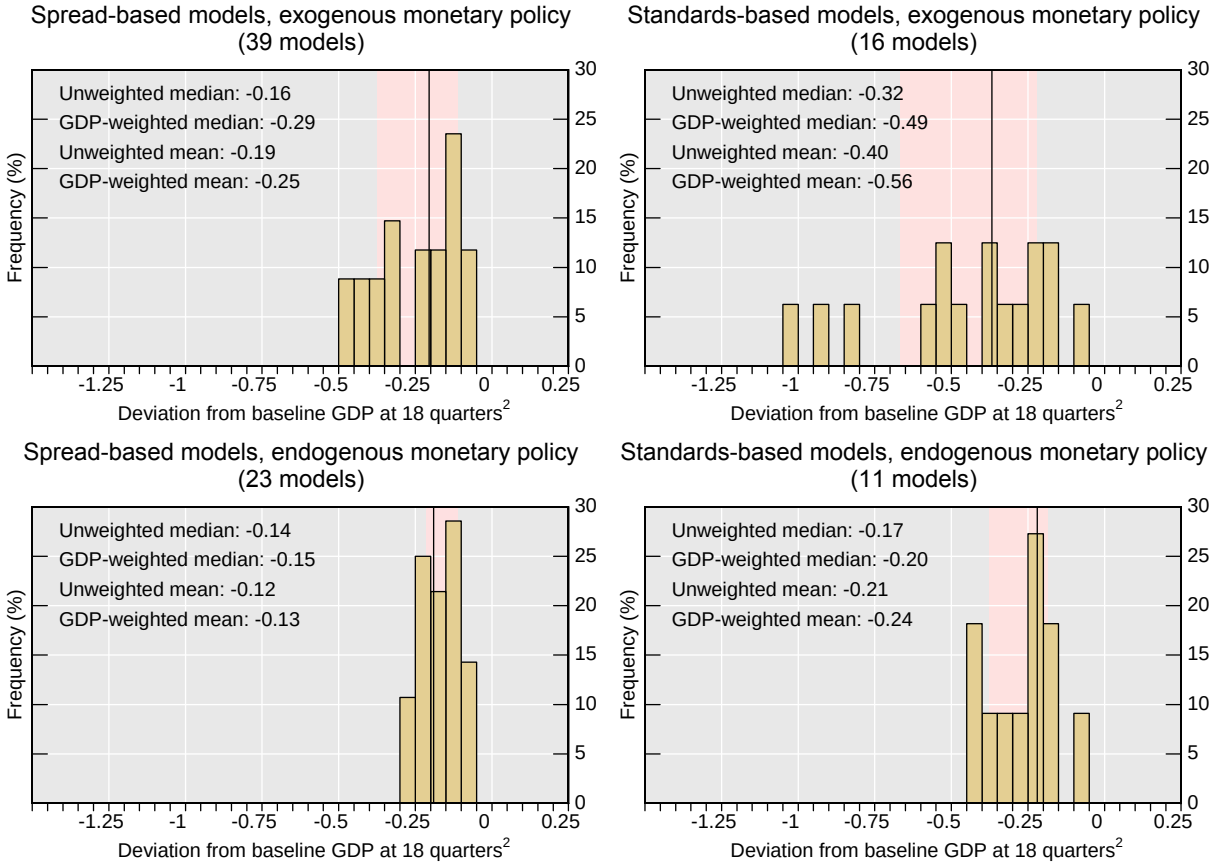
As a starting point, it is useful to consider those estimates that were produced under the assumption that central banks would not mitigate any recessionary growth or inflation impacts of the regulatory changes through shifts in monetary policy.[17] In the approach adopted by most members, the forecast path for bank lending spreads was used as a direct input in the macro model to obtain an adjustment path for GDP growth.

Considering the scenarios in which an increase in the target capital ratio is implemented over four years, with *exogenous monetary policy*, the unweighted median outcome of those models that looked only at the impact of *lending spreads* was that each percentage point increase in the target would result in a fall in GDP to 0.16% below its baseline level after 18 quarters. GDP was projected to remain at roughly that level up to the end of the simulation period (Graph 3, top left-hand panel). GDP-weighted medians of these estimates were somewhat larger, amounting to 0.29% for both the 18-quarter and the 32-quarter impact.

Graph 3

Aggregate impact of a 1 percentage point increase in the target capital ratio implemented over four years: distribution of estimated GDP deviation across selected models[1]

In per cent



[1] Distributions are computed across models that meet the specified criteria. The vertical line indicates the unweighted median. The shaded areas indicate the range between the 20th and 80th percentile. [2] Quarters measured from start of implementation.

[17] This was implemented either by holding the current policy rate constant or by setting the path of rates to the one currently predicted by private sector forecasters.

Across modelling approaches, investment tended to be more strongly affected than consumption. As discussed in more detail below, in the ECB's multi-country model (MCM) a 1 percentage point increase in the target capital ratio leads to a fall in investment to 0.38% below baseline, and a fall in consumption to only 0.06% below baseline after 18 quarters, resulting in a GDP decline of 0.08% (when the monetary policy response and lending standard effects are excluded).

Models incorporating lending standards

A number of MAG members investigated whether increased target capital ratios might exert additional effects on GDP by reducing bank lending volumes in ways that would not be captured by spread increases. This analysis draws on the insight that, because of informational asymmetries, credit markets may not clear at the observed market interest rate.[18] Instead, lenders are likely to engage in credit rationing, turning away borrowers who would be willing to take a loan at the market rate, on the grounds that the borrowers have private information that makes it likely that such loans are too risky from the point of view of the lenders (an adverse selection problem). To the extent that this phenomenon is present, observed lending rates alone would not be sufficient to describe conditions in bank credit markets. Instead, analysts need to look at other indicators that capture the willingness of banks to make loans at prevailing rates.

At times, these quantity effects have been substantial, and have exerted impacts on real activity that go well beyond what would be predicted by simply looking at lending spreads. For example, the weakness of bank balance sheets in Japan in the 1990s had significant negative effects on credit provision and growth (see Annex 3.1).

Economists have found that the surveys of bank loan officers that are conducted periodically in some economies, in which lenders are asked such questions as whether their credit standards for specified classes of loans or borrowers have tightened or eased, can serve as a useful source for this information. The results of such surveys often serve as a reliable early indicator of business cycle conditions.

In the context of the MAG, a critical question is whether tighter regulatory rules will lead to a tightening of lending conditions in a way that is not captured by prevailing lending rates or spreads already included in the models. As banks seek to build up their capital, they may cut back on lending by tightening lending standards vis-à-vis otherwise creditworthy borrowers. The macroeconomic effects could be expected to be similar to those that occurred in past episodes when banks tightened credit standards.

MAG members used a variety of approaches in an effort to capture the output effects of credit rationing. Typically, members made use of vector autoregressions (VARs) to estimate the relationship among lending standards, lending volumes, credit spreads, capital levels and other variables. The paths of spreads and lending volumes coming out of the estimation exercises described in Section 3.1 were then used to generate a path of projected lending standards, which could in turn be used as inputs into standard forecasting and policy analysis models. Where the models did not have a direct role for lending standards, this could be estimated by making use of the past statistical relationship between investment, consumption and lending standards. The projected lending standards were then translated into "add factors" that were used to modify the projected path of investment and consumption.

When the effects of lending standards on credit supply were incorporated in the models in this way, the impact on GDP was found to be larger. Members who performed this exercise

[18] See Stiglitz and Weiss (1981) for a seminal theoretical analysis of this phenomenon.

found that a 1 percentage point increase in bank capital targets implemented over four years resulted in a fall in GDP to 0.32% below its baseline level after 18 quarters, after which GDP recovered to around 0.27% below baseline by the end of the simulation period (Graph 3, top right-hand panel). The GDP-weighted median of estimates of the 18-quarter decline in GDP relative to baseline was 0.49%. These models also incorporated the impact of higher lending spreads. Thus, whether one uses unweighted medians or GDP-weighted medians, the *additional* impact of incorporating lending standards in the estimated GDP impact, for estimates that did not include the effects of monetary policy, is around two tenths of a percentage point.[19]

In some cases, however, the difference was more substantial. For example, in one model incorporating lending standard effects, the Bank of Japan estimated that a 1 percentage point increase in the target capital ratio would cause a decline in GDP of 1.2% relative to baseline after 11 quarters, and of 1.05% after 18 quarters. By contrast, under a spreads-based model, the BoJ estimated GDP declines of 0.07% at 11 quarters and 0.15% at 18 quarters. As was the case for most other estimates that attempted to capture the effects of tighter lending conditions, the greater GDP impact from tighter lending standards was not permanent. Forecast GDP at the end of the simulation period was roughly the same in both the spreads- and standards-based models estimated by the BoJ.

The response of monetary policy

To the extent that this is in accordance with their overall mandates, central banks will surely act to dampen any contractionary impact of the reforms on the macroeconomy. Some members of the MAG sought to estimate these effects, typically by modelling central bank behaviour as following a standard reaction function to output and inflation such as a Taylor rule (Taylor (1993)). When monetary policy endogenously reacts to the effects of a 1 percentage point increase in the target capital ratio implemented in four years, it reduces the median estimate for the fall in output at the 18th quarter, across *all* estimates (both spreads-based and standards-based), by 0.06 percentage points of GDP.[20] This effect was much stronger in cases where members modelled changes in credit standards (where the fall in output at the 18th quarter was reduced by 0.15 percentage points of GDP in terms of unweighted medians, or 0.29 percentage points using GDP-weighted medians; Graph 3, right-hand panels) than in cases where they modelled only the impact of credit spreads (where the effect was either negligible, in terms of unweighted medians, or a decline of 0.12 percentage points, in terms of GDP-weighted medians; Graph 3, left-hand panels).

Some results, however, showed a more substantial monetary policy impact. In estimates generated with the Federal Reserve Board's FRB/US model, for example, allowing a monetary policy response reduces both the peak GDP decline and the end-period GDP

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[19] When comparing the median impact across all models that relied on lending spreads (Graph 3, left-hand panels) with the median impact across all those that took account of lending standards (Graph 3, right-hand panels), it is important to keep in mind that not all MAG members estimated both kinds of models. In those cases where a member estimated *both* a spreads-based *and* a standards-based model using the same basic modelling approach, the GDP decline at the 18th quarter was 0.15 percentage points greater in the standards-based case.

[20] The unweighted median four-year GDP decline for *all* estimates that were generated by standard policy models and did *not* include a monetary policy response was –0.25%. This includes both models that used only credit spreads and models that made use of both credit spreads and lending standards. The unweighted median of this figure for *all* estimates generated by standard policy models that *did* include a monetary policy response, both spreads-based and standards-based, was –0.15%. For both of these sets of models, the GDP-weighted medians were roughly the same as the unweighted medians. Thus, whether one uses unweighted or GDP-weighted medians, the effect of adding a monetary policy response is to reduce the impact by about 0.1%.

decline by around 1 percentage point. But, given very low nominal policy rates in a number of jurisdictions, conventional monetary policy may be unable to fully offset any unexpectedly large drag on activity, and the effectiveness of unconventional measures remains uncertain. This would suggest that estimates of the mitigating effects of monetary policy may be overstated.

International spillovers

Most of the national models were estimated assuming that external conditions were fixed. An analysis by the IMF estimated the magnitude of the international spillovers that would result if the 15 largest economies simultaneously implemented regulatory changes that resulted in wider lending spreads.[21] The channels for these spillovers include effects on exchange rates, commodity prices, trade flows and global asset values. In the IMF's model, a 25 basis point increase in lending spreads, if implemented over four years, was found to reduce global GDP by 0.15% after 18 quarters when spillovers were not included, and by 0.18% when they were (in scenarios that simulate a monetary policy response). The spillovers thus appear to account for an additional 0.03% decline in GDP at the 18th quarter. In the 32nd quarter after implementation, the IMF projected a decline in global GDP of 0.08% relative to baseline when spillovers were not included and to 0.10% when they were, implying that spillovers account for an additional 0.02% of GDP decline at that point. These effects seem to be stronger for emerging economies: estimates of the additional GDP impact from spillovers for emerging market economies at the 18th quarter have a median of 0.06%, compared with 0.01% for advanced economies.

The Bank of Canada performed a similar exercise using its BoC-GEM-Fin model.[22] In that model, higher target capital ratios outside Canada affect Canadian real activity through both higher costs that domestic firms face when borrowing from foreign banks and the negative effects of the fall in output in other economies, which lower Canadian exports and negatively affect commodity prices. These spillover effects increased the impact of a 1 percentage point increase in the target capital ratio at the 18th quarter by 0.05 percentage points (in the case incorporating monetary policy response). By the end of the simulation period, the estimated GDP impact of global spillovers is somewhat larger (about one tenth of a percentage point of GDP) because GDP in the model with spillovers takes somewhat longer to return to baseline than it does in the model focused only on domestic effects.

Liquidity requirements

In the MAG's two-step approach, the impact of stronger liquidity requirements was estimated by translating higher liquid asset holdings into wider lending spreads, as discussed above. Estimation of the macroeconomic impact was thus qualitatively similar to the approach used for estimating the impact of tighter capital requirements, with the only difference being the degree of spread-widening. Those who estimated these effects found that an increase of 25% in liquid asset holdings implemented over four years resulted in a fall in GDP of 0.08% relative to baseline after four and half years, and that at the end of the simulation GDP fell further to 0.13% below the baseline scenario (Table 2, columns 1 and 2).

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[21] The model was estimated for the 15 countries represented on the MAG, except the Netherlands and Switzerland, plus India and Russia. Global figures were derived by applying GDP weights to the country-level results. The IMF used a model based on Vitek (2009).

[22] This model, a DSGE model incorporating financial frictions, is described in De Resende et al (2010).

3.3 Two examples: the ECB and the Federal Reserve

To illustrate the specifics of this two-stage estimation process, we consider the modelling procedures and outcomes of two members of the MAG: the ECB and the Federal Reserve Board (FRB).

European Central Bank

The ECB applied the "model bank" framework to 20 large and complex banking groups based in the euro area. For the scenario in which stronger capital requirements are implemented over four years, an approach based on balance sheet adjustments predicted that banks would reduce lending by 2% and increase credit spreads by 5 basis points relative to baseline levels for every percentage point increase in the target capital ratio. An alternative set of estimates, based on the long-term statistical relationship between lending spreads and capital ratios, implied a spread increase of 28 basis points for each percentage point increase in the target capital ratio.

The ECB also examined the behaviour of spreads in the MAG's scenarios for liquidity requirements. A regression-based approach predicted that a 25% increase in liquid asset holdings would increase lending spreads by around 15 basis points, while an accounting-based analysis of the impact of the NSFR suggested that meeting this requirement would raise spreads by between 57 and 71 basis points.

The ECB implemented the second step of the analysis by using these spread and volume projections as inputs into two macroeconomic models they regularly employ: the MCM (multi-country model) and the Christiano-Motto-Rostagno (CMR) model.[23]

The MCM is a large-scale model with a tight theoretical structure covering the five largest euro area countries (Germany, France, Italy, Spain and the Netherlands). This model predicted that, in the absence of any monetary policy response, a gradual 25 basis point increase in spreads over a four-year period (the upper end of the results discussed above for a 1 percentage point increase in the target capital ratio) would lead to an aggregate fall in GDP below baseline, across these five countries, of 0.08% after 18 quarters and 0.10% by the end of the estimation period, in a model in which lending spreads alone are considered. When the impact of lending standards is incorporated into the model, the GDP impact increases, to –0.19% after 18 quarters and to –0.13% at the end of the simulation. Monetary policy can offset some of this impact, with the GDP impact under this assumption projected to be –0.16% at 18 quarters and –0.10% at the simulation's end.

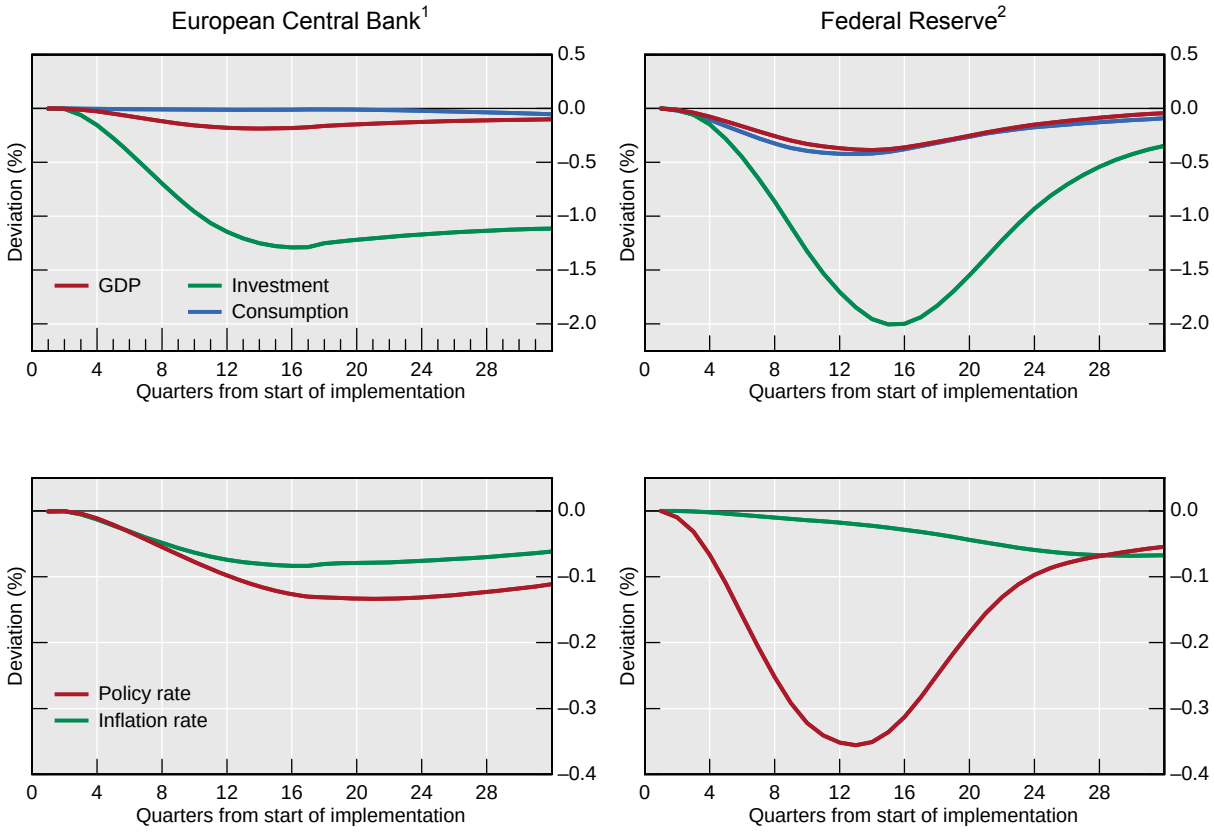
These GDP effects result primarily from a sharp fall in investment. In the MCM with endogenous monetary policy, investment falls to a level 1.4% below baseline in the 18th quarter, consumption to 0.02%, and GDP to 0.19% (Graph 4). The slowdown in GDP leads to a decline in inflation of 0.08% below its baseline level. This enables the monetary policy rate to be cut by 0.13% relative to baseline. Both the Federal Reserve (see below) and others who modelled these effects obtained qualitatively similar results.

Researchers applying the CMR model, a medium- to large-scale DSGE model used regularly at the ECB for policy analysis, to the same pattern of spread increases found somewhat stronger effects. This model forecast that GDP would fall 0.29% relative to baseline after 18 quarters and 0.41% by the end of the simulation period for each percentage point increase in the target capital ratio. When the model is altered to allow monetary policy to counteract the results, the impact on GDP is lessened to –0.23% at 18 quarters and to –0.25% at eight years.

[23] The MCM is described in Dieppe et al (2010a,b). The CMR model is described in Christiano et al (2010).

Graph 4

Impact of a 1 percentage point increase in the target capital ratio implemented over four years



[1] Multi-country model with endogenous monetary policy. GDP-weighted average of results for Germany, France, Italy, Spain and the Netherlands. [2] FRB/US model with endogenous monetary policy.

Federal Reserve

The results for the United States, conducted using the FRB/US model employed at the Federal Reserve Board, are based on two approaches. One involves a conservative application of the effects of the potential rise in spreads associated with higher capital and liquidity requirements. In particular, the model simulations examined the consequences of a 25 basis point increase in the lending spread (a figure at the high end of the per-percentage-point values obtained by the "satellite model" subgroup and by Elliott (2009)) transmitted to borrowing rates throughout the economy. Higher borrowing rates depress interest-sensitive spending, thereby lowering real GDP both directly and indirectly through consumption multiplier effects. In this case, and assuming no monetary policy response, the fall in real GDP (relative to baseline) was in the order of 0.79% after 18 quarters; if monetary policy acts to cushion the decline in real GDP through lower values of the nominal federal funds rate, the fall in real GDP declines to 0.36%.

The FRB also investigated the consequences of a more severe adverse effect on credit availability. Specifically, experience over the last two decades shows that periods during which banks are actively building reserves of capital are accompanied by higher spreads, tighter lending standards and a decrease in the supply of bank credit; these effects have appeared to amplify the impact on lending volumes and real GDP relative to the movements induced by higher spreads only. Estimates from reduced-form forecasting models (vector autoregressions) suggest that these effects can be substantial. Incorporating the tightening in

lending standards and amplification of the direct effects of higher equity capital on spreads, this scenario shows a more pronounced decline in investment and real GDP. Assuming no monetary policy response, real GDP falls (relative to baseline) by more than 0.89% after 18 quarters; if monetary policy is able to cushion the effect through a lower nominal federal funds rate, the decline in real GDP, relative to baseline, is 0.31%, and is virtually eliminated by the end of the simulation. Similar to the ECB's results, investment falls more sharply than consumption (Graph 4). The greater GDP impact leads to a somewhat stronger monetary policy response.

This adverse scenario illustrates two important points. First, the monetary policy implications of higher capital requirements implemented over a two-year horizon could be significant if they induce restrictions on credit availability. To see why, consider that in the FRB's simulation exercise, when they allow for a policy response, they estimate that the federal funds rate will need to fall by up to 40 basis points to counteract the impact of the regulatory changes. Given the low level of nominal interest rates globally, this is a very large number.

Second, the role of credit restrictions in the FRB's exercise is based on the relationship between capital levels and lending standards implied by data from the past two decades. It is likely that this relationship in the past has reflected episodes of banking strain, during which banks that had suffered loan losses rebuilt their capital in part by tightening standards. These episodes also typically coincided with times of recession or slow growth. While this certainly has also been the case in the recent post-crisis environment, it is not clear whether the same relationship would hold at some future date when economic conditions are more benign and banks are accumulating capital, not in direct response to recent losses but because of tighter regulatory rules.

4. Alternative approaches

As a complement to the estimates from the standard policy models, MAG members investigated how alternative modelling techniques could be applied to the issues under consideration. Two approaches were employed: DSGE models in which banks are assigned an explicit role; and reduced-form estimates, which rely mostly on past statistical relationships among the variables of interest.

Some members used these model estimates as their primary contribution to the MAG's assessment project. Taken together, the outcomes from these alternative approaches present a picture that is broadly consistent with the results reported above. That said, members also found that the results of the bank-augmented DSGE and reduced-form estimations were quite sensitive to the underlying assumptions, data ranges and input parameters. While these models were useful in providing alternative, supplementary estimates for the MAG assessment, it is important to keep the limitations of these models in mind when interpreting their results.

4.1 DSGE models that incorporate a banking sector

A third subgroup, chaired by the Bank of Canada, investigated DSGE models in which financial intermediaries and their balance sheets are modelled explicitly. A particular advantage of DSGE models is that they can provide a coherent framework for policy discussion and analysis by capturing the dynamic relationships among different macroeconomic variables while being grounded in microeconomic theory. In principle, this class of models can be used to identify sources of fluctuations, answer questions about structural shifts, forecast and predict the effect of policy changes, and perform counterfactual experiments.

Nevertheless, DSGE models have limitations. Prime among these is that they may be too stylised to fully capture the dynamics of the data. Moreover, fitting DSGE models to observable data is still quite challenging, even when using sophisticated econometric and statistical methods.

Most mainstream DSGE models do not allow for an interaction between credit markets and the real economy, making it challenging to assess the macroeconomic impacts of tightening capital and liquidity standards directly. As noted in Section 3, some members used such models to assess the impact of forecast spread and volume movements that had been estimated through other techniques, as part of the two-step procedure outlined above. However, the recent financial crisis has inspired modelling efforts to explicitly incorporate such interactions in a DSGE framework and use these augmented models to study the trade-offs between tighter regulatory standards and macroeconomic performance.

A number of participating authorities estimated one or more such enhanced DSGE models, taking account of institutional factors specific to their respective jurisdictions.[24] The estimates were used to make projections about the future paths of macroeconomic aggregates such as output, consumption, investment and inflation in the context of the specified capital and liquidity scenarios.[25]

The forecasts based on the bank-augmented DSGE models were quite similar to those produced by the standard approach, indicating that higher capital requirements will have a relatively small negative impact on the level of output throughout the period under investigation (Table 2, columns 3 and 4). The median (across models) of the projected impact that a 1 percentage point increase in the target capital ratio (implemented over a four-year period) will have on output was estimated to be –0.14% after 18 quarters and –0.08% after eight years. These models also tended to support the finding that lengthening the transition to higher standards reduces the maximum fall in GDP relative to baseline and delays it in time.

Tighter liquidity requirements are also projected to have a small negative output effect throughout the assessment period. The median of the projected impact on GDP in the 18th quarter of raising the ratio of liquid assets to total assets by 25% over four years was –0.15%. In each of the six scenarios which examine a tightening of liquidity standards, output returns fairly close to its trend by the last quarter of the simulation.

These models can often allow estimation of the interaction between different kinds of regulatory interventions. For example, estimates using the IMF's bank-augmented DSGE models suggest that the offset between capital and liquidity requirements would be substantial: perhaps as much as three quarters of the impact of a rise in liquidity requirements would be offset by the favourable impact of higher risk-weighted assets on the capital adequacy ratio.

They can also be useful in illuminating the channels through which policy changes influence economic outcomes. The insights of the BoC-GEM-Fin model on international spillovers have already been mentioned. A second bank-augmented DSGE model estimated by the Bank of Canada, based on Meh and Moran (2010) and Christensen et al (2010), focused on two kinds of moral hazard problems: the imperfect ability of banks to perfectly monitor the use of loans by entrepreneurs, and the imperfect ability of owners of equity in banks to perfectly monitor the banks' lending activities. In both cases, monitoring is costly, so it is not done to a

[24] The DSGE model protocol is presented in more detail in Annex 2.3.

[25] In other cases, participants made use of DSGE models that did not incorporate credit market effects, drawing on prior work on the reaction of spreads and lending volumes to the capital and liquidity scenarios; these results are discussed in the section on semi-structural macroeconomic models.

degree that would be economically efficient. As a result, both the borrowers and the banks are tempted to extract private benefits and to take on inappropriate levels of risk. In reaction to these two problems, agents must put some of their own funds at risk, in the form of equity participation on the part of borrowers and bank capital on the part of banks. When capital requirements are raised, banks cut back on lending, in part because they need to raise new capital funds from retained earnings, and in part because they need to increase the intensity of their monitoring and screening of borrowers, making lending more costly. The increase in the monitoring intensity also manifests itself in the form of credit rationing, where banks reduce loans to lower-quality borrowers. Put differently, higher capital requirements make banks exit riskier activities.[26]

The model employed at the Federal Reserve emphasised another channel – namely, the notion that external funds may be more costly, at least in the short run, than internal funds (such as retained earnings). Because of this mechanism, longer implementation periods are associated with smaller declines in lending and in real GDP, as banks have the opportunity to meet higher capital requirements by relying on retained earnings to a greater extent when the implementation period is longer.

4.2 Reduced-form estimation

A fourth subgroup, chaired by the Federal Reserve Bank of New York, used past statistical relationships among capital, growth and other variables to estimate the likely growth effects of tighter capital and liquidity regulation, through the use of reduced-form VAR models. Like structural macroeconomic models, forecasts based on VARs can be made conditional on the potential future paths of specified variables in the model. Further, researchers can impose particular assumptions about causal structures on the time series data under investigation, and thereby assess the causal impact of unexpected shocks, or innovations, to specified variables.

In contrast to structural models, VARs do not rely on detailed ex ante modelling of the relationships among the variables of interest. So long as they are present in the data during the period over which the model is estimated, many of the factors that need to be modelled separately by other estimation approaches – including international spillovers and the stabilising role of monetary policy – are incorporated implicitly. A disadvantage of VARs is that the results are heavily influenced by the market and macroeconomic conditions in place at the time of large past shifts in the modelled variables, so they may not be informative if similar shifts take place under different circumstances. Another is that the standard components of a monetary policy VAR, namely policy rates and macroeconomic variables, may be less appropriate for small open economies that in the past have not run an independent monetary policy. Furthermore, statistical relationships estimated from aggregate historical data may not be fully informative about how economic actors will respond to future policy changes (the Lucas critique).

In order to harmonise the modelling approach and to ensure that results are comparable across countries or regions, the variables in the VAR model considered by this subgroup included standard components of a monetary policy VAR, namely real GDP growth, a GDP deflator and an interest rate.[27] Variables on the banking side included aggregate bank loans to firms and consumers, the capital/assets ratio, and (where available) a measure of bank lending standards.

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[26] See Holmström and Tirole (1997) and Stiglitz and Weiss (1981) for the theoretical background.

[27] The reduced-form model protocol is presented in more detail in Annex 2.1.

Compared with the other models estimated by MAG members, the reduced-form models tended to forecast a more contractionary effect on GDP from the tightened requirements (Table 2, columns 5 and 6). The median fall in output for a 1 percentage point increase in the target capital ratio implemented over four years was 0.4% at the end of the simulation period. The forecast GDP decline was smaller for scenarios in which the capital adjustments are made over a shorter time period, perhaps because in such models the recovery towards baseline, which typically begins at the date when implementation is complete, has more quarters in which to run. The confidence intervals around the impulse responses to the VAR models are large, suggesting that there is substantial uncertainty about the results.

Across countries, the effects of increased target capital ratios on GDP estimated from these models vary substantially. For example, for the Netherlands, assuming a four-year implementation period, the negative deviation of GDP from the baseline after 18 quarters is 0.08% for each percentage point increase in the target capital ratio, with GDP recovering to the baseline by the end of the simulation. Results estimated by the ECB for the euro area as a whole are even larger, suggesting that a higher target capital ratio implemented over four years would generate a deviation of GDP from its baseline of 0.89% after 18 quarters for each percentage point increase in the target capital ratio, with a recovery to 0.39% below baseline at the end of the simulation. For the United States, a 1 percentage point increase in the target capital ratio implemented over four years results in a deviation of GDP from the baseline of 1.14% after 18 quarters, with GDP recovering to 0.38% below baseline by the end of the simulation period.

To assess the impact of tighter liquidity standards on GDP, the capital/assets ratio variable in the VAR model was replaced by the ratio of liquid assets to total assets. Simulation results for the impact of tighter liquidity standards varied widely, with a median GDP decline at the end of the simulation period of 1.7% for the scenario where the ratio of liquid assets to total assets is increased by 25% over four years. Reducing the length of the implementation period for the revised liquidity standards does not have material effect on the simulation results.

Overall, there was substantial variation in the reported national results from this subgroup, in part reflecting differences in the historical time period used for estimating the VAR model parameters and in the variables used. National results were also highly sensitive to changes in these assumptions and parameters. For this reason, the results generated for the MAG with these models should be treated with caution.

5. Factors not considered by the empirical estimations

This section looks at three sets of factors not considered in producing these model-based estimates reported above: (i) shifts on the part of the banks in their required returns and business activities; (ii) the role of other credit channels in supplementing banks' roles as credit providers; and (iii) the capacity of markets to accommodate banks' desired balance sheet adjustments. The first and second of these reduce the magnitude of the effects being considered, suggesting that the estimates produced in the preceding section are likely to overstate the probable GDP impact of tighter regulatory requirements. The third would increase the magnitude of the effects, though in a way that would dissipate the longer the implementation period.

5.1 Adjustment options available to banks

The empirical estimates in the previous section implicitly assumed that banks will respond mechanically in response to the new requirements, not really altering their behaviour. For example, the lending spread models generally assume that banks will strive to maintain their

return on equity at pre-crisis levels, and that they will do this faced with constant cost of funding. In reality, the returns on both debt and equity required by investors are likely to fall as bank balance sheets become stronger and less risky. Kashyap et al (2010) suggest that the only impact of capital and liquidity requirements would be due to effects that are not encompassed in Modigliani and Miller's idealised framework, notably the tax advantages of debt and the premium that banks would need to pay investors to hold longer-term, less liquid debt instruments.[28] Kashyap et al (2010) conclude that, in the long term, US lending spreads should rise by no more than 4.5 basis points for every 1 percentage point increase in the capital ratio. Even if one does not think that these conditions will hold, given competition among banks any reduction in funding costs is likely to feed into lower credit spreads.[29]

As a second example, the estimates of the impacts of liquidity requirements generally assumed that loans would be replaced one for one by liquid instruments, when in fact banks are likely to finance any additional holdings of liquid assets with a combination of portfolio shifts, new borrowing and capital increases (including retained earnings).

Banks are likely to change their behaviour in a number of other ways in response to the requirements that are not captured by the macroeconomic models.

- They may change the composition of their assets. The Swiss National Bank's case study (Annex 3.2) describes how banks in Switzerland reduced trading assets rather than conventional industrial and consumer loans. Other large banks may also choose to spin off or scale down their trading operations in response to the new capital framework. This will reduce their need for both capital and liquidity. A reduction in bank trading activity may alter whether and how investment banks support primary issuance on capital markets, but it is unlikely to have a first-order effect on growth. Banks without significant trading operations will still be able to restructure their portfolios in ways that reduce credit and liquidity risks. The model bank approach discussed earlier can model broad shifts in asset holdings, but not more granular ones. In particular, within their loan portfolios, banks are likely to try to maintain or increase lending to more creditworthy borrowers, while reducing riskier credits and, as a result, risk-weighted assets. If this is the case, the overall reduction in credit provision should be less than what the models predict. The IMF's DSGE analysis found that the real cost of adjustment via cuts in lending may be substantially mitigated to the extent that declines in lending are focused on the riskiest portions of bank loan portfolios. However, there may be economic losses if banks go too far in forgoing risky loans that nevertheless have a positive net present value.
- Rather than increasing credit spreads or reducing overall lending volumes, lenders may tighten loan covenants and reduce maturities in order to reduce risk exposures.
- Banks may respond to the shift in the regulatory environment with a broader restructuring of their business models, reducing inefficiencies and compensation costs, thus permitting them to remain profitable at narrower net interest margins.

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[28] Modigliani and Miller (1958) showed that, in ideal conditions, the weighted average cost of capital for a firm does not depend on the firm's capital structure. This would imply that a bank's capital ratio should be irrelevant to the rate that it charges on loans. If a bank holds more capital, its costs of both debt and equity should fall to the point where its weighted cost of capital is unchanged.

[29] Against this, it has been argued (for example, in Institute of International Finance (2010)) that bank funding costs may rise in the short term as the official sector phases out explicit and implicit guarantees of bank liabilities. This effect was not modelled by the MAG, since the extent to which such guarantees are reduced or removed will not be directly affected by changes to capital and liquidity requirements. It should be noted, however, that the guarantees will in fact be worth less to the extent that stronger bank balance sheets reduce the probability that they will be called upon.

- Banks may shift to business areas where income is primarily fee-based rather than based on interest margins. This would further reduce the riskiness of future earnings and take pressure off lending margins as a profit source.

All of these actions by banks work in a similar direction, namely reducing the increase in spreads that may result from tighter capital and liquidity requirements. Elliott (2009), who, as noted earlier, estimated that each percentage point increase in capital ratios would lead to a 19 basis point widening in lending spreads if other factors were kept constant,[30] concluded that the widening of spreads could be as low as 4.5 basis points if banks' return on equity, asset mix and other variables are allowed to change. A few of these bank responses might, however, result in a contraction in credit provision beyond what is estimated in the models.

5.2 Non-bank credit channels

Assessments about how tighter regulatory standards for banks may affect the supply of credit to the real economy need to take into account the ability of borrowers to make use of non-bank sources of credit. Corporate bond markets proved a useful alternative channel of finance when banks cut back on lending during the recent crisis. But bond issuance is only a ready option for large, creditworthy borrowers. Bank-dependent small and medium-sized firms may find it disproportionately difficult to obtain financing. In the years preceding the financial crisis, the strong growth of the non-bank or shadow financial system, and especially securitisation, increased credit supply to less well established borrowers, though of course the crisis brought to light serious flaws in the underlying risk management and incentive structures in the relevant markets.

Going forward, product innovation in securitisation and other non-bank credit channels will no doubt continue as participants discard unworkable structures and work to address known weaknesses in the remainder. While it is difficult to prejudge how such product innovation will evolve, non-bank channels of intermediation are likely to remain a permanent feature of the financial landscape, even in financial systems that are largely bank-centred.

An important challenge for policymakers will be ensuring that any shift (or return) of credit intermediation to securitisation channels, private equity and other elements of the shadow banking system takes place in a way that does not threaten financial stability. For example, an open issue is how the leverage demanded by the private equity and hedge fund industries will be funded. In the pre-crisis period, syndicated loans and prime brokerage lending performed this role. Tighter bank supervision and regulation may lead these activities to shift to the unregulated sector. Banking and market supervisors will need to develop and implement effective policies for making sure that the funding for these activities is properly priced and capitalised in a way that takes account of system-wide risks. Overall, however, the presence of these channels is likely to reduce the direct macroeconomic impact of any reduction in bank lending related to tighter regulation.

5.3 Market capacity

The proposed changes in capital and liquidity requirements will require banks to make adjustments to their asset and liability structures, in some cases substantial ones. These include new issues of equity capital, issues of long-term debt to replace short-term funding, and purchases of liquid assets to meet the LCR. The macroeconomic models typically assume that markets can accommodate these shifts without difficulty, which is one reason why the implementation period for tighter requirements tended not to make a substantial

[30] This estimate is almost five times lower than the estimated spread increase used by the IIF.

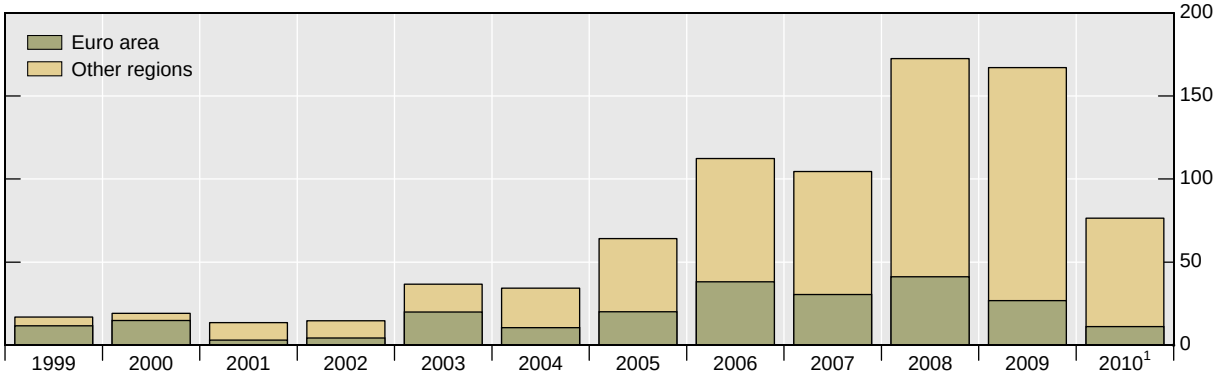
difference to the macroeconomic impacts estimated by the MAG. But if many banks attempt to make similar adjustments in a relatively short period of time, they may need to pay investors excess premia to induce them to make the corresponding shifts in their own portfolios. Banks that find it expensive to raise new capital may be more likely to meet the requirements by cutting back on lending.

These considerations suggest that modelled estimates may understate the impact of tighter bank regulations. However, it is very difficult to assess these costs quantitatively. The short-term elasticities of supply and demand for different classes of assets are difficult to measure and can sometimes change quickly. These considerations do, however, counsel that a longer transition period might be preferable to a shorter one. For example, the ECB estimated that a 2 percentage point increase in the target capital ratio would require the 20 largest banks in the euro area to accumulate roughly €114 billion (or about $140 billion) in additional Tier 1 capital, assuming that there is no assets side adjustment. This is broadly in line with estimates that have been produced by private sector analysts. For comparison, euro area bank equity issuance totalled some $20–50 billion annually during 2005–09, which spans the crisis period (Graph 5). The broader global total ranged from $50 billion to more than $150 billion during this period. This suggests that, given enough time, markets should be able to absorb the new capital that needs to be raised, especially if banks are able to use this time to accumulate additional capital through retained earnings, reduced dividends and lower costs.

Graph 5

Global bank equity and equity-linked offerings

In billions of US dollars



[1] Up to 4 August 2010.

Source: Bloomberg.

6. Conclusion: an assessment

This report has presented quantitative and qualitative factors bearing on the potential impact of stronger capital and liquidity requirements on growth over the next several years.

The variety of approaches has produced a wide range of results, highlighting the great deal of uncertainty surrounding our estimates. Viewed in terms of the medians across all national results that used the Group's standard approach, the empirical estimations found that a 1 percentage point increase in the target capital ratio implemented over four years will lead to a reduction in GDP to a level 0.16% below its baseline level after four and a half years, followed by a recovery of GDP to some 0.10% below its trend level after eight years.

The IMF found that international spillovers, through trade and financial channels, *increase* the negative GDP impact, by roughly 0.03% of GDP (in models that incorporate a response by monetary policy) at the 18th quarter, and 0.02% at the 32nd quarter. The Bank of Canada found similar results. Adding the IMF's estimates for these spillover effects to the above median estimates yields a temporary output loss of 0.19% relative to the baseline trend four and a half years after implementation, and 0.12% eight years after implementation, for each percentage point increase in the target capital ratio. In terms of annual growth rates, this translates into a reduction in the annual growth rate of 0.04 percentage points during the four and a half years following implementation. After the 18th quarter, annual growth increases by 0.02 percentage points for the next three and a half years.

These figures are medians from a set of estimates that include models based on a variety of underlying assumptions. Grouping models according to common assumptions produces additional insights into the effects of interest, allowing one to separate the modelled effects as follows:

- The unweighted median of estimates for the decline in GDP as of the 18th quarter of the simulation across models that do not allow monetary policy to respond to falling GDP and do not take account of credit rationing effects (as measured by the tightening of lending standards) was about 0.16%.
- Contractions in the supply of credit are estimated to *increase* the short-term negative GDP impact by roughly 0.16 percentage points of GDP, before the impact of monetary policy is taken into account.
- Allowing monetary policy to respond to lower GDP levels and the associated fall in inflationary pressures *reduces* the impact by approximately 0.15 percentage points of GDP.

Adding up these effects and the impact of international spillovers (0.03%) would give a net maximum decline in GDP of 0.20% in the 18th quarter. It is important to bear in mind, however, that these individual effects cannot be disentangled in a consistent way for all estimates. Differences in sample size and composition, and the resulting greater weight that is given to credit supply constraints, explain why adding up the individual effects mechanically yields a maximum temporary GDP loss which is slightly higher than the unweighted median across all cases (0.19%).

Using GDP-weighted medians produces a slightly higher overall result, though some of the intermediate steps are larger and some are smaller. The starting point (for models that do not take account of either lending standards or a monetary policy response) is somewhat higher, with GDP at 0.29% below baseline. The effect of adding lending standard effects into the models is the same as is measured using unweighted medians, namely an additional fall in GDP of 0.20 percentage points. Introducing monetary policy has a stronger effect, however, when measured with GDP-weighted medians, since in this case the GDP deviation (for models that incorporate lending standards) is reduced by 0.29 percentage points of GDP. When the 0.03 percentage point impact of international spillovers is added, the cumulative impact of a 1 percentage point increase in the target capital ratio at the 18th quarter, using GDP-weighted medians, is 0.23% of GDP, which is very close to the unweighted median.

A 25% increase in liquid asset holdings is estimated to lower GDP by a maximum of 0.13% of GDP. However, some of this impact would be reduced to the extent that efforts to meet the capital requirements make it easier to meet the liquidity requirements, and vice versa.

Added to these estimated effects are the factors identified in Section 2.2 and elaborated upon in Section 3, which, as noted, are difficult or impossible to quantify. These include:

- Banks' adjustments to their portfolio composition and business models, and their efforts to reduce costs. These factors would *reduce* the GDP impact.

- A decline in the funding costs and return on equity demanded by investors, as bank balance sheets become less risky. This would *reduce* the GDP impact.
- The availability of credit through capital markets and other non-bank channels. This would vary depending on the characteristics of borrowers and national financial systems. In any event, the presence of such channels would *reduce* the GDP impact.
- Differences in the impact of a cutback in bank lending across sectors. If tighter regulatory requirements lead to a disproportionately large cutback in lending to a sector, such as small and medium-sized enterprises, that has a relatively large role in supporting growth; this would *increase* the GDP impact.
- Limits to the ability of markets to rapidly accommodate the balance sheet adjustments desired by banks. This would include the ability of markets to absorb (a) new issues of bank equity, (b) new long-term debt issues to replace short-term liabilities and fund additional liquid asset holdings, and (c) any assets that banks may wish to shed. This factor would *increase* the GDP impact.

The model-based estimates performed by the MAG tended to find that delaying the implementation of tighter requirements, say from two years to four years, had a relatively small effect on outcomes in terms of GDP losses. However, when one takes account of the non-modelled factors listed above, several channels emerge through which a longer implementation period would result in a relatively smaller GDP impact. A longer implementation period would (a) give banks more time to adjust their business models and cost structures, (b) allow more time for stable non-bank channels of credit intermediation to develop, (c) reduce the severity of the impact of lending cuts on bank-dependent sectors, and (d) give markets more time to absorb the asset sales, debt issues and equity issues that might accompany balance sheet adjustments by banks. Thus, a longer implementation period would be likely to *reduce* any negative impact resulting from the requirements.

At the same time, it should be noted that the banks' timetable for adopting the new requirements may not be the same as that adopted by supervisors. During roundtable discussions, some private sector analysts predicted that, once supervisors announce the parameters for capital requirements, markets are likely to press banks to achieve these ratios rapidly regardless of the official implementation date. In view of this, it will be important for the revised framework to include phase-in arrangements to allow banks to adjust to the new standard from different starting points and circumstances.

Finally, the case studies considered in Annex 3 point to the importance of the economic and financial environment in which banks need to restore capital levels. In Japan, the shock to capital resulting from losses experienced in the 1990s led to a sharp pullback in lending, because banks faced an environment of weak asset prices and poor growth prospects throughout the economy. In Switzerland, the large banks were able to meet tighter regulatory requirements in 2009 rapidly and with little impact on domestic credit markets, because despite a weak economy they had large holdings of non-loan assets that they were able to sell relatively quickly and could restore their profitability.

Taken together, these findings suggest that, while tighter capital and liquidity requirements of the magnitude which corresponds to our central scenario (ie a 1 percentage point increase in the target capital ratio) may well have an impact on bank lending during the transition period, these effects will not be large, as long as downside risks are contained by ensuring that the implementation period is sufficiently long, and conditions elsewhere in the economy and the financial system are supportive of the necessary adjustments. However, the intensity of the impact in any given national financial system will depend on the distance between currently prevailing capital levels and the new regulatory targets. Policymakers should therefore carefully assess current capital levels and monitor the development of financial and

macroeconomic conditions in planning and proceeding with the phased implementation of tighter requirements.

As noted earlier, the present report offers an interim assessment of the effects of interest, and is focused on a representative economy. Final review of the potential significance of benefits and costs at the national level will be informed by the results of the BCBS's Quantitative Impact Study (QIS), which is compiling consistent information on the capital and liquidity positions of participating banks under the proposed regulatory standards. The MAG's final report will assess the impact of the calibrated global standards in the context of the QIS results.

Annex 1:
Participants in the Macroeconomic Assessment Group

(The names in bold are the primary representatives of the respective institutions.)

Chairman	**Stephen G Cecchetti** Bank for International Settlements
Reserve Bank of Australia	**Jonathan Kearns** Chris Becker Dan Fabbro Adam Gorajek Jarkko Jääskelä David Jennings
Central Bank of Brazil	**Nelson F Souza Sobrinho**
Bank of Canada	**Césaire Meh** Neville Arjani Paul Corrigan Carlos De Resende José Dorich Rhys Mendes Nikita Perevalov
People's Bank of China	**Hong Zheng**
Bank of France	**Laurent Clerc** Jean-Pierre Villetelle Simon Dubecq Antipa Pamfili Eric Mengus Olivier Loisel Benoît Mojon
Deutsche Bundesbank	**Thilo Liebig** **Alexander Schulz** Sandra Eickmeier Victoria Galsband Michael Scharnagl Volker Schieck Niels Schulze
Bank of Italy	**Paolo Angelini** Andrea Gerali Alberto Locarno
Financial Services Agency, Japan	**Satoshi Ikeda**
Bank of Japan	**Ryo Kato** Toyo Shirota Wataru Hirata Ryoma Ikeda
Bank of Korea	**Byunghee Seong** Jaerang Lee Hueechae Jung

Bank of Mexico	**Daniel Samano Peñaloza** Miguel Díaz Díaz
Netherlands Bank	**Jan Willem van den End** Beata Bierut Robert-Paul Berben
Bank of Spain	**Angel Gavilan** Samuel Hurtado Eva Ortega Alberto Urtasun
Swiss National Bank	**Carlos Lenz**
Financial Services Authority, UK	**Peter Andrews** Michael Straughan Matthew Osborne Sebastian De Ramon Zanna Iscenko
Bank of England	**Jack McKeown**
Board of Governors of the Federal Reserve System	**Michael Kiley** Jae Sim
Federal Reserve Bank of New York	**Simon Potter** Vasco Curdia
European Commission	**Werner Roeger**
European Central Bank	**Frank Smets** Diego Rodríguez-Palenzuela Matthieu Darracq-Pariès Christoffer Kok-Sørensen Roberto De Santis Marek Jarociński Alastair Dieppe Alpo Willman Alberto González-Pandiello Roberto Motto
International Monetary Fund	**Scott Roger** Jan Vlček Francis Vitek
Financial Stability Board	**Nigel Jenkinson**
Basel Committee on Banking Supervision	**Neil Esho**
Bank for International Settlements	**Benjamin Cohen** (Secretary) Stefan Avdjiev Dietrich Domanski Srichander Ramaswamy Jhuvesh Sobrun Jimmy Shek

Annex 2:
Research protocols

2.1 Reduced-form models

This is a high-level sketch of how we might proceed with measuring the effects on GDP of an increase in capital ratios using time series models.[31] A similar approach could be used for liquidity ratios. Some of the calculations (particularly the simulations) might not be available in some software packages, but routines in MATLAB and Gauss could be provided if required. Unless there is a desire for a unified estimation approach, each country should use its own – subject to some caveats described below.

Variables

The minimum set of variables is real GDP and capital and assets of the banking sector.[32] Ideally, the measure of capital should be tangible common equity and that of assets would be the regulatory one adjusting for risk, but in many cases this is likely to lead to a very short time series. The measures of capital and assets should be deflated by the GDP deflator to obtain real variables. The maintained assumption is that the measurement will be at the quarterly frequency. If only annual data are available, this will limit the number of additional variables that can be included.

In order to capture linkages between the banking sector and the real economy, where possible these minimum variables should be augmented with other time series variables such as:

- Aggregate bank loans to firms and consumers (deflated by the GDP deflator).
- Bank lending standards measures.
- Central bank policy rate.
- Inflation.
- Country-specific variables that have been shown in the existing literature to improve forecasts of real GDP growth.
- When appropriate, dummy variables that capture specific past events. When dummy variables are used, there should be some documentation for the reason:
  - One type is to remove outliers caused by natural events/strikes, etc.
  - Another is to allow for level shifts.

Two samples should be used in the estimation of parameters: one that stops before the effects of the global financial crisis, and another which includes all available data. To ensure conformity, the assumption will be that the last observation before the financial crisis was Q3 2008. Earlier dates for the onset of this crisis can be used with a clear explanation for the choice.

[31] We are not aware of any previous work that uses them in these types of VAR models.

[32] If capital and assets are not available separately, then a capital/assets ratio can be used.

Model structures

Two basic model structures should be investigated:

- An unrestricted vector autoregression in log changes of the three core variables. An alternative is to use only the capital/assets ratio and not use the separate measures of assets and capital.[33] Additional variables should be transformed to stationarity if required.
- A vector autoregression with an error correction term in the logarithm of the capital/assets ratio. Additional variables should be transformed to stationarity if required. Where appropriate, the vector error correction model (VECM) can be allowed to load on the additional variables.

With the error correction term structure, three different specifications can be investigated:

1. No intercept assumed in the VECM.
2. Intercept in the VECM estimated or based on regulatory requirements.
3. Time-varying intercept in the VECM, with the time variation being of the standard random walk assumption.

These specifications are described in more detail below.

Estimation

Specific estimation methods (Bayesian, maximum likelihood, ordinary least squares) are of less importance than finding a model specification where quantities in the banking system affect GDP growth. For example, in the Berrospide-Edge model presented at the MAG meeting on 15 March, the use of lending standards was important for establishing a quantity channel, and even in this case the effects on GDP growth were small. This will be the most difficult part of the exercise, since it is unusual to search through specifications looking for a specific effect. This search should be conducted as soon as possible.[34] One should view the results from such an exercise as putting an upper bound on the size of (negative) effects on GDP growth.

Estimation of the vector error correction model (VECM) with a time-varying intercept in the EC term will require more advanced techniques – if there is interest, some programs could be developed for this.

For Bayesian techniques that use informative priors, some standardisation might be required. In addition, for countries with only a short span of data available, some common set of priors might be useful to reduce sampling uncertainty in a standard manner. This might be particularly important for obtaining estimates with the available span of data on tangible common equity (TCE) and risk-weighted assets.

Simulations

The objective is to obtain estimates of the effects on GDP of a specified increase in the capital/assets ratio. There are numerous ways to obtain these estimates. In order to simplify, it will be very useful to work under the assumption that the innovations to the time series models estimated are multivariate Gaussian. Under this assumption, techniques described below can be used to produce expected paths for output growth given a path for the

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[33] Such an approach does not necessarily ensure stationarity in the capital/assets ratio.

[34] The chosen specifications can then be used in the more specialised routines.

capital/assets ratio. For the moment, assume that the baseline of no regulated changes in the capital/assets ratio is given by the predictions from the model. Then three main alternative paths can be simulated:

1. Condition on the prespecified path or terminal target level for the capital/assets ratio only (that is, the decrease in leverage can be achieved with any combination of capital and asset changes).
2. Condition on the prespecified path or terminal target level for the capital/assets ratio and a non-decreasing path for capital (that is, assume that regulators prevent banks from reducing the capital in the system from current levels as banks react to the new regulations).
3. Condition on the prespecified path or terminal target level for the capital/assets ratio, and imposing that assets cannot decline below the initial value.

The idea behind this approach is to examine different shocks that could produce the same capital/assets ratio.

The multivariate Gaussian structure will allow for path-like conditions to be placed on other variables in the model as well. For example, countries in the euro zone might want to condition on a single path for the policy rate, or other countries might want to condition on the market expectation for the policy rate. These conditions should be applied in the baseline and alternative simulations.

One obvious choice for the alternative path calculated for GDP growth is the conditional mean. To capture estimation uncertainty, the 15th and 85th percentile should be calculated from a Monte Carlo simulation that takes into account parameter uncertainty. The median of this simulation could be viewed as a good summary statistic.

Results

Assuming that the time horizon for the exercise starts in 2010, three terminal dates can be examined: 2012, 2014 and 2016. There will be 12/20/28 quarters of deviations of GDP growth from the baseline available from each combination of simulation and model. One simple summary statistic for each combination will be deviation in the level of GDP by the terminal date. Another will be the maximum deviation in the annual growth rate. Subject to issues over model specification described above, each country should provide at least a range for the two main summary statistics. The range should be the minimum to the maximum and include the model and alternative simulation associated with each one. For the minimum and the maximum used in the range, the 15th and 85th percentile from Monte Carlo simulation should be made available.

Some technical details

The focus will be on describing the four types of models and then providing detail on the simulation techniques. Without loss of generality, we can assume a first-order system:

$$\begin{bmatrix} \Delta y_t \\ \Delta k_t \\ \Delta a_t \\ x_t \end{bmatrix} = \begin{bmatrix} c_y \\ c_k \\ c_a \\ \mathbf{c}_x \end{bmatrix} + \Phi \begin{bmatrix} \Delta y_{t-1} \\ \Delta k_{t-1} \\ \Delta a_{t-1} \\ x_{t-1} \end{bmatrix} + \Theta \left(k_{t-1} - a_{t-1} - \gamma_{t-1} \right) + \mathbf{V}_t,$$

$\gamma_t = \gamma_{t-1} + \varepsilon_t$, γ_1 fixed,

where y_t is the log of GDP, k_t is the log of real capital in the banking sector, a_t is the log of real assets, x_t are J additional variables transformed to stationarity that are helpful in linking quantities in the banking system to real GDP growth, Φ is a $(J+3)\times(J+3)$ matrix, Θ is a

(J+3)×1 vector, $V_t \sim IIDN(0,\Sigma)$ and $\varepsilon_t \sim IIDN(0,\eta)$. Restrictions on parameters produce the less general models (ie $\Theta = 0$, $\eta = 0$, $\gamma_1 = 0$).

It is useful to write this VECM in the following form, which gives a transition equation for the capital/assets ratio itself and allows for a direct state space implementation:

$$\begin{bmatrix} \mathbf{w}_t \\ z_t \\ \gamma_t \end{bmatrix} = \begin{bmatrix} \mathbf{c}_w \\ c_k - c_a \\ 0 \end{bmatrix} + \begin{bmatrix} \Phi & \Theta & -\Theta \\ \Psi & 1+(\theta_k-\theta_a) & -(\theta_k-\theta_a) \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \mathbf{w}_{t-1} \\ z_{t-1} \\ \gamma_{t-1} \end{bmatrix} + \begin{bmatrix} I_{J+3} & 0 \\ \Lambda & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} \mathbf{V}_t \\ \varepsilon_t \end{bmatrix},$$

where $z_t = k_t - a_t$,

$$\mathbf{w}_t = \begin{bmatrix} \Delta y_t \\ \Delta k_t \\ \Delta a_t \\ x_t \end{bmatrix},$$

Λ = [0,1,-1,0,...,0] and $\Psi = \Phi_2 - \Phi_3$, where Φ_ℓ is the ℓ^{th} row of a matrix. In order for the simulations to make sense, we will need to ensure that the eigenvalues of

$$\begin{bmatrix} \Phi & \Theta \\ \Psi & 1+(\theta_k-\theta_a) \end{bmatrix}$$

are inside the unit circle or, in the case that $\Theta = 0$, the largest eigenvalue is on the unit circle.

Simulation technique

One approach will be to use the Kalman filter to generate forward forecasts conditional on a path or terminal target level for the capital/assets ratio. The Kalman filter will produce a multivariate Gaussian distribution for non-specified paths. In the case of no additional conditioning information and the assumption that banks exactly meet the capital/assets path or terminal target levels, the Kalman smoother can be used to produce an expected path for the other variables. If there is additional conditioning information on a particular path or terminal value for other variables, then it can be added in a similar manner.[35] However, inequality restrictions on capital and assets will require generating many draws from the full multivariate distribution underlying the Kalman smoother and calculating the average after discarding the paths that violate the inequality condition.

Note that the simulation should not stop at the terminal date for calculating the effects on GDP, since holding the capital ratio at or above a prespecified level past the terminal will influence that Kalman smoother's value for GDP in the earlier period.

An alternative approach is to use the internal dynamics of the VECM alone to calculate the multivariate distribution at some date past the terminal one. This can be interpreted as a run of the Kalman filter without any conditioning information. The simulation would then proceed by generating draws of the capital ratio that were at least as large as the prespecified terminal value. Conditional on these draws, the other variables would be drawn. Using standard techniques, the multivariate distribution for the previous period would be updated

[35] If no additional information is used in the baseline, then the linearity of the VAR implies that the results for an increase of 1 percentage point can be scaled to determine the impact of any increase. If additional information is used, then it will require separate evaluations for each increase.

and then another marginal draw of the capital ratio subject to the inequality condition would be made.

2.2 Satellite models

Purpose

The purpose of developing the satellite models in this workstream is to provide a methodology for calculating an adjustment path for key elements of banks' balance sheets, and to make some calculations of the impact on banks' lending margins. This allows an examination of the extent to which the intermediation sector of the economy may shrink in response to higher regulatory requirements.

Estimating impacts on banks' balance sheets

Background

The impact of changes to regulatory requirements can be modelled by considering the adjustments that banks make to their balance sheets to achieve a particular capital ratio. The model developed below assumes that banks target a desired capital ratio that is based on their regulatory requirements as well as other bank-specific factors, and that banks adjust both the level of capital and risk-weighted assets over time to achieve this desired capital ratio. The model therefore provides a possible adjustment path through time of key items of banks' balance sheets, which can include elements such as total lending.

Estimating parameters

The methodology relies on generating adjustment parameters for the speed of adjustment of banks' capital and assets such that they reach a desired capital ratio. Outputs from this methodology can be in terms of values, or measured as deviations from an estimated path for assets (linked to nominal output), to enhance the consistency with other working groups.

The UK FSA has developed a methodology for calculating the relative speed of adjustment for capital and assets. In brief, the methodology proceeds using a three-step approach:

(i) determining each bank's internal desired capital ratio, which may vary over time as the bank's risk profile and business model changes;

(ii) calculating how banks' actual capital ratio deviates from the long-run desired ratio;

(iii) determining the differential rates at which banks adjust key elements of their balance sheets when there is a difference between actual and desired capital ratios.

A bank *i*'s desired capital ratio ($k^{*}_{i,t}$) at time *t* is assumed to be a function of a number of *n* factors which capture bank- and time-specific characteristics ($X_{n,i,t}$) as well as a fixed effect for each bank (η_t):

$$k^{*}_{i,t} = \eta_i + \sum_{n=1}^{N} \theta_n X_{n,i,t}$$

While the desired capital ratio is unobservable, if banks are assumed to adjust towards the desired capital ratio by some fraction λ in each period, an estimate of θ_n can be derived indirectly.[36]

This estimate of bank *i*'s desired capital ratio is then used to calculate the surplus or deficit ($Z_{i,t}$) of the bank's actual capital ratio to the desired level:

$$Z_{i,t} = 100\left(\frac{k_{i,t-1}}{k_{i,t}} - 1\right)$$

Estimates of the rate at which banks adjust their levels of both capital and assets to achieve their desired capital ratio can then be calculated by simultaneously regressing the change in the level of assets (ΔA_t) and capital (ΔC_t)) on the surplus (or deficit) of capital ($Z_{i,t}$) as well as a number of control variables which may affect bank behaviour, such as real GDP growth (*GDP*), inflation (*INF*), the change in the bank rate (*BANKR*) and bank charge-offs (as a proportion of bank assets) (*CHARGE*). The final equation estimated in the FSA research was as follows:

$$\begin{Bmatrix} \Delta A_{i,t} \\ \Delta C_{i,t} \end{Bmatrix} = \sum_{j=1}^{2} \lambda_j \Delta A_{i,t-j} + \beta Z_{i,t} + \sum_{j=1}^{2} \left(\delta_{1,j} \Delta GDP_{t-j} + \delta_{2,j} \Delta BANKR_{t-j} + \delta_{3,j} INF_{t-j}\right)$$
$$+ \delta_4 CHARGE_{t-1} + \sum_{s=1}^{4} \rho_s Q_s + \varepsilon_{i,t}$$

with the coefficient vector β containing the estimates of the differential rates at which banks adjust key elements of their balance sheets (the adjustment parameters). Note that this procedure estimates adjustment parameters that represent the average rate of adjustment for key elements of banks' balance sheets across the whole banking system (β is not specific to bank *i*). That is, estimates are representative of the aggregate adjustment speed for the sector. This outcome will allow "stylised" banks to be modelled in simulations (see "Simulation methodology" below).

The key elements of balance sheets considered in the FSA analysis are: total capital, Tier 1 capital, risk-weighted assets, total lending and total assets. Other/different balance sheet items could be added, but inclusion will depend on data availability and the available degrees of freedom given the data.

An issue with the FSA's methodology is that it may be difficult to reproduce for other countries. Key limitations are not only the availability of banks' specific data, but also the degree of variation in countries' regulatory requirements (if capital requirements are fixed at one level and invariant through time for all banks in the system, there is no variability to estimate). However, there are a number of possibilities for calculating the adjustment parameters:

1. The FSA's methodology could be duplicated if sufficient data are available for individual banks. In particular, this requires data on individual firm- and time-specific capital requirements.[37]

2. Where a country has not imposed variable capital requirements, or where there are no data on these, the method can be simplified to consider deviations from a long-

[36] See Francis and Osborne (2009b, p 20) for details: http://www.fsa.gov.uk/pubs/occpapers/op36.pdf.

[37] If national supervisors do not collect these data themselves, data from sources such as BankScope may be sufficient.

run target capital ratio, which can be proxied by the mean for each bank, or the fitted long-run values from a regression on firm characteristics.[38] Data could be drawn from BankScope if regulatory returns are not available.

3. Aggregate econometric data could be used if individual bank data are not available. However, there is a problem of identification of supply and demand side effects, as we need to isolate the supply side shocks to analyse the impact of capital requirements. Hence, instruments may need to be developed in order to overcome this identification problem.[39]

In the absence of sufficient data to generate econometric estimates, parameters could be taken from estimates of other countries with similar characteristics, or calibrated given national supervisors' experience of their own banking sectors.

Simulation methodology

Required inputs

The required inputs for this approach include balance sheet data for individual banks in each country. The responses modelled for these banks can be aggregated to obtain an economy-wide response for input into other workstreams. The overall number of banks it will be necessary to model will depend on the concentration and homogeneity of the banking sector in each economy:

- More concentrated banking systems may only need data on a small number of the largest banks to be sufficiently representative of the system as a whole.
- Representative members of sets of homogeneous banks could be modelled and the results appropriately weighted to represent the group.

For each bank, data will be required for the most recent period available on total capital, Tier 1 capital, total assets, risk-weighted assets and total loans.

Model calculations

The model requires calculation of the actual and the (risk-weighted) capital requirement for each bank considered. Assuming a level for banks' buffer holdings of capital above the requirement (see below), any change in the capital requirements will generate a gap between a bank's desired and actual trigger ratios, and elicit an adjustment to both capital and assets. The rates at which capital and assets adjust are likely to be different, so the overall impact on the *levels* of capital and assets will depend on the relative speed of adjustment. Adjustment is assumed to stop as soon as the new desired ratio is reached.

The model does not require estimates for individual banks' adjustment parameters, but rather uses only an average for the banking sector. However, the eventual impact of changes in capital requirements on the system will depend critically on the initial levels of capitalisation for individual banks used in the simulation. Banks that are less well capitalised (actual capital is close to regulatory requirements) will make larger adjustments (in monetary terms) to balance sheet items in each period, at least initially, in order to move their actual capital ratio towards the desired level.

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[38] Examples of alternative approaches include Berrospide and Edge (2009), Gambacorta and Mistrulli (2004) and Hancock and Wilcox (1994).

[39] Estimation processes such as Zellner's Seemingly Unrelated Regressions could be used to overcome this identification problem.

An advantage of this approach is that the extent to which different-sized banks are more or less well capitalised can be taken into account, and then aggregated across all banks to obtain a system-wide estimate.

The model calculations can be done in a relatively straightforward spreadsheet model, an example of which the FSA can readily supply. Each bank can be simulated on the spreadsheets, and then capital and assets can be aggregated to obtain an idea of the impact on the system as a whole.

Consideration of banks' buffers

The buffer between the trigger ratio and regulatory requirements will depend on the characteristics of individual banks. Changes to banks' buffers could be modelled separately,[40] but to avoid unnecessary complication it seems this step could be simplified.

A simple assumption is that, going forward, banks maintain a buffer similar to the average of the past few years. More complicated assumptions could be included, but would need to be appropriately rationalised:

- it could be assumed that banks are currently in disequilibrium, and are already adjusting their balance sheets. The buffer could therefore be calibrated initially such that there is an immediate difference between a bank's actual and desired capital ratio; and
- the buffer could also be adjusted to a lower level than the average over time if it is assumed that higher capital requirements will lower volatility and/or the riskiness of the bank. The FSA has used such assumptions in its simulations.

Estimating the impact on funding costs

For the economy-wide exercise, one approach is to estimate the impact of regulatory changes on banks' "lending wedge" – the difference between borrowing and lending rates. Models can be derived by considering reasonably straightforward error correction models using macroeconomic aggregate data. Equations could be estimated for the average lending wedge for all bank lending or, if data are available, for a number of sub-markets (for example, household and corporate loans).

Required inputs

Data can be sourced from central banks / national regulators on aggregate capital and liquidity ratios for the banking sector. The aggregate trigger ratio and ratio of liquid assets to risk-weighted assets for the sector should be included as explanatory variables in the models, as these variables will be the key policy inputs in any equation.

Data on the lending wedge can be approximated by the difference between central bank rates and lending rates in the market considered. For example, in the UK mortgage market, the lending wedge can be defined as the difference between the bank rate and mortgage lending rates in the economy. Both series are sourced from the Bank of England.

Other variables to include in the equations will most likely differ from country to country. Some variables to consider would be indicators of wealth in the economy and the level of arrears or defaults for loans in the economy.

[40] See, for example, Francis and Osborne (2009a): http://www.fsa.gov.uk/pubs/occpapers/op31.pdf.

Methodology

The methodology is straightforward. Variables should be checked for stationarity, and the lending wedge can then be estimated as a function of the policy variables and other economic variables.[41]

For example, in the United Kingdom, the consumer lending wedge is modelled using the following equation:

$$\Delta lendw_t = -0.000128 - 0.446002\left(lendw_{t-1} - 0.06levrr_{t-3} - 0.006arr_{t-4} + 0.003nwpi_{t-1}\right)$$

where *lendw* is the lending wedge, *levrr* is the aggregate trigger ratio, *arr* is mortgage arrears, and *nwpi* is the ratio of net personal wealth to personal income.[42]

2.3 Bank-augmented DSGE models

Relevant variables to report for each experiment

Each country could report changes in relevant variables over three time periods: (i) 2011–12, (ii) 2011–14 and (iii) 2011–16. The variables will include: GDP, inflation, bank lending, spreads (where the spread is defined as the lending rate minus the risk-free rate) and the policy rate.

Higher capital requirements

DSGE models with bank capital

Let us first consider models that have capital requirements. In this case, banks or financial intermediaries are subject to the following regulatory capital constraint:

$$L_t \leq \gamma^{-1} \mathcal{E}_t \qquad (1)$$

where L_t is the amount of bank lending, γ is the regulatory capital requirement parameter and E_t is the amount of equity capital of the bank. Given the technical difficulties of solving DSGE models with occasionally binding constraints, DSGE models are solved in general by assuming that the regulatory constraint given by equation (1) is binding.[43]

Imposing higher capital requirements means increasing the regulatory parameter γ. This parameter could also represent the lending standard. The experiment can be conducted under three possible strategies depending on technical difficulties.

Strategy 1. Increase the initial capital requirement γ by X% either permanently or for a particular time horizon (t =1, ..., T). This can be seen as an announcement of the different paths of capital requirements. The announcement of a tighter path of capital requirements will affect the behaviour of banks. For example, the banks could increase lending spreads and/or deleverage (by raising costly capital, increasing retained earnings or cutting bank lending).

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[41] Vector error correction models could be used if separate sub-markets are estimated.

[42] Source: Barrell et al (2009, p 27) (http://www.fsa.gov.uk/pubs/occpapers/op38.pdf).

[43] Some authors have solved DSGE models by assuming that banks face a quadratic cost when capital deviates from a target level.

Solve the equilibrium and report the relevant variables. Solving the model will require some type of perfect foresight and the computation of both the initial and final steady states.

Strategy 2. This second strategy is relatively easier to implement since it does not require solving the model under perfect foresight when the capital requirement is increased. Basically, it consists in a persistent increase in the capital requirement γ. For example, one can postulate the following AR(1) relationship:

$$\gamma_t = \gamma + \rho\gamma_{t-1} + \varepsilon_t \qquad (2)$$

where $\rho \in (0,1)$ is the persistence and ε_t is *iid* distributed with mean zero. Specifically, it consists of an unexpected increase in γ_t combined with a very high value of ρ (eg one can set $\rho = 0.999$). The relevant variables can be reported for the first T periods.

Strategy 3. This is a third strategy that can be followed for the analysis. It amounts to a way to calibrate impulse responses to a shock changing bank behaviour, so as to keep the capital ratio and/or the liquidity ratio along a given predetermined path. First, match the model to projections for GDP and inflation along the baseline path for the capital ratio and for the liquidity ratio. For models (such as our model) where banks operate a production function that transforms two inputs (capital and liquidity) into deposits/loans, these ratios can be treated as observable variables both in the estimation procedure and in out-of-sample simulations. Second, manipulate the shock (shocks) that governs banks' preference for capital (and/or banks' preference for liquidity buffers) so as to engineer an alternative path for the capital ratio (and/or an alternative path for the liquidity ratio). Third, re-simulate the model and compute the difference between the alternative scenario(s) and the baseline. In practice, this means running conditional forecasts.

Remark. This methodology does not require taking a stand on whether the change in the capital ratio (and/or liquidity ratio) is required or not. It is implemented by manipulating the shocks that calibrate banks' preference for the two production inputs (capital and liquidity). For a Cobb-Douglas production function such as ours, these shocks move the bank's output shares of capital and liquidity.

DSGE models without bank capital

In this subsection, we consider how the experiment of a higher capital requirement can be conducted when the DSGE model features financial frictions but not bank capital. Two broad classes of models can be considered:

Financial frictions à la Bernanke et al (1999). In this class of models, firms face an external financial premium when they borrow. A higher capital requirement can be translated into a higher external finance premium. For example, for a given leverage ratio, the external finance premium will be larger the higher the capital requirement is.

Financial frictions à la Iacoviello (2005). In this class of models, households face a collateral constraint of the form $B_t \leq \theta V_t$, where B_t is the amount of debt of households, V_t is the expected market value of the collateral (eg housing equity) and θ is the loan-to-value ratio. Note that, in DSGE models, the collateral is assumed to bind. A higher capital requirement (a tighter credit condition) can be approximated by a smaller loan-to-value ratio θ.

Higher liquidity requirements

It is important to note that, in most DSGE models, the notion of liquidity is not well established.[44] However, some researchers at the New York Fed with Kiyotaki have started incorporating this notion of liquidity into New Keynesian DSGE models (Del Negro et al (2010)). However, these models do not have banking and bank capital.

Overall, the experiments to be conducted for higher liquidity requirements are similar to those when the capital requirement increases (as in Section 2). Several cases can be followed:

DSGE models with bank capital and no "liquidity": one can proxy the increase in liquidity requirement by a higher capital requirement. In this case, the increase in the capital requirement will be higher than the one in Section 2.

DSGE models without bank capital or "liquidity": the increase in liquidity requirement can be translated (i) into a larger external finance premium in the Bernanke et al (1999)-type models, and (ii) into a smaller loan-to-value ratio in the Iacoviello (2005)-type models.

If the DSGE model has a banking sector, then on the assets side of the bank's balance sheet a higher liquidity requirement may consist in requiring the bank to hold more risk-free assets (eg government bonds or fiat money).

Remark. Translating a higher liquidity requirement into an equivalent capital ratio can be done with the "satellite model" subgroup. A similar conversion can be done for the case of models without bank capital/liquidity.

General principle

To the best degree possible, members should each carefully calibrate or estimate the model based on data (aggregate data and institutional factors) from their own country. This would provide some level of comfort in the quantitative predictions. If the analysis is meant to be qualitative in nature, each study should clearly state it and describe the analysis. In short, a variety of models can be used.

It is important to clearly state if banks are forward-looking or not. In a model where bankers are long-lived and face financial constraints, bank capital (net worth) is accumulated and constitutes the memory between periods. In this case, in order to conduct the experiment with static (less forward-looking) banks, one can reduce the discount factor (or reduce the probability of survival) of bankers. Examples of models where bankers are long-lived but invest in short-term projects can be found in Meh and Moran (2010) and Gertler and Karadi (2010).

Keep the dividend policy of banks constant.

To the extent possible, monetary policy should remain constant. If this is technically difficult to achieve, one can use a standard Taylor rule with different weights on inflation and output.

Given the similarities between the models used by our subgroup and those used by the LEI group, it will be useful to maintain close communication between the two subgroups. The two groups, of course, have different mandates.

2.4 Standard policy models

Each participating country provided a baseline:

[44] A recent class of general equilibrium models that include liquid and illiquid assets is Kiyotaki and Moore (2008).

- Minimum variables: real GDP growth, GDP deflator, inflation and short-term interest rate.
- Optional variables: demand components, bank interest rate spreads, bank loan growth, etc.
- Forecasting period: 2010–18.
- The common international environment is based on the *World Economic Outlook* projections provided by the IMF.

The scenarios were implemented in two alternative ways. Assume a tightening path (relative to baseline) for capital/liquidity requirements of a certain size over a relevant time period, call it $\{dk_j\}_{j=t+1}^{T}$, where t is the current period and T the final quarter of the forecast horizon.

(i) The first approach focused on bank interest rate spreads. In this case, satellite models or micro evidence were used to find a path for the bank interest rate spread likely to be caused by the regulatory change; let this path be $\{ds_j\}_{j=t+1}^{T}$. Members used the path for bank interest rate spreads as an input into the macro model to obtain the adjustment path for GDP growth and inflation. For those models in which only one interest rate (say the short-term rate or a longer-term government bond rate) features, members attempted to translate a widening of the bank interest rate spread into the overall cost of capital. This will, for example, depend on the share of bank financing amongst other factors.

(ii) The second approach was based on the idea that credit rationing is a missing variable in the consumption and investment equations, whose impact can be assessed by regressing the corresponding residuals on bank lending standards. In this alternative approach, the tightening path for capital/liquidity requirements was translated into a tightening path of bank lending standards, $\{dl_j\}_{j=t+1}^{T}$. To implement this procedure, members included into the add factors of the consumption and/or investment equations an adjustment term equal to $\{\hat{\rho} dl_j\}_{j=t+1}^{T}$, where $\hat{\rho}$ is the coefficient of the regression of the residuals on the BLS indicator. This approach could be implemented by countries that have bank lending standards indicators.

The two alternative approaches were implemented in two steps:

(i) In the first step, a *common* standardised set of spread and lending standard scenarios were implemented in all countries. This allowed members to acquire a sense of the differences in the multipliers across countries. The common set of scenarios was based on the need to increase the capital ratio by approximately 2 percentage points respectively until 2012, 2014 and 2016.

(ii) In the second step, the input on country-specific increases in bank interest rate spreads and lending standards coming from the satellite model subgroup was simulated. This input was based on the need for the banking system to attain 6%, 8% and 10% capital ratios by 2012, 2014 and 2016, respectively, and depended on the initial conditions of the banking sector in the country. A similar set of scenarios could be provided for increased liquidity requirements. As an alternative to new simulations, the multipliers from the first step could be used to calculate the country-specific spread (and possibly lending standard) effects.

The scenarios were simulated under unchanged monetary policy (in terms of the short-term nominal interest rate) relative to the baseline. In addition, a standard monetary policy reaction was simulated by some members.

Annex 3:
Case studies

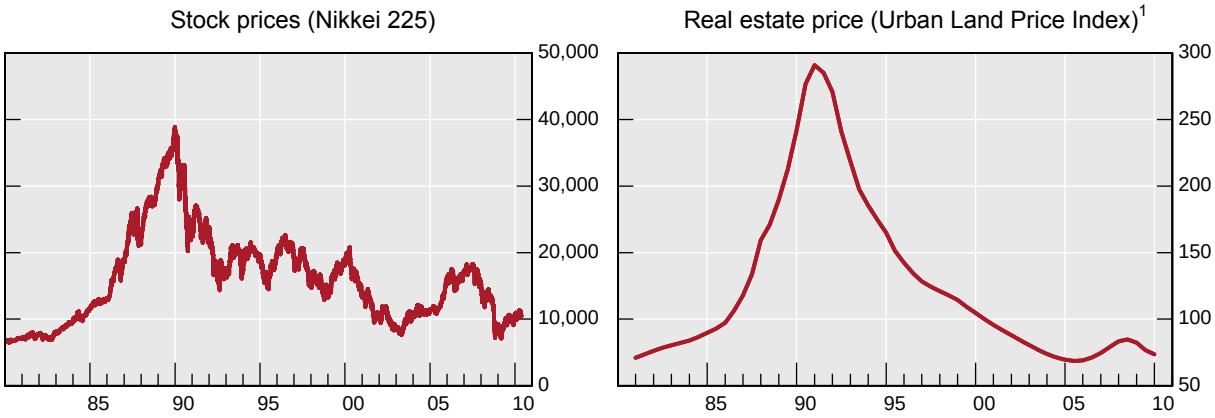
Given the many complex factors that influence banks' responses to changes in their capital positions, it helps to review past episodes where banks were required to adjust to a fall in their available capital buffers at relatively short notice. This annex considers two such episodes: the experience of Japan in the early 1990s, when sharp losses on their portfolios of real estate loans and equities left many banks short of capital; and that of Switzerland in 2009, when regulatory standards were strengthened for the country's two large global banks.

3.1 The Japanese experience in the 1990s

In the wake of the bust of the bubble economy in Japan, stock prices experienced a plunge, which was followed by a protracted real estate market slump. From the peak to the trough, the stock prices fell by 80% and the land price index declined by 76% (Graph A3.1).

Graph A3.1

Asset prices in Japan



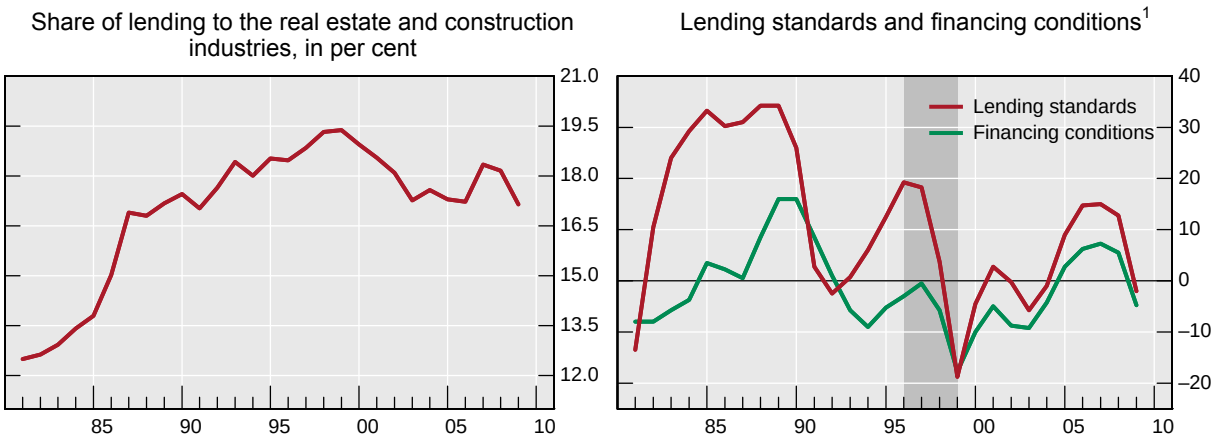
[1] 2000 = 100.

Source: Bank of Japan.

Japanese banks had significant exposures to the real estate markets and other related severely hit industries. The share of lending to those industries was about 20% at the peak. The increase in non-performing loans prompted banks to tighten their lending standards by an unprecedented magnitude (Graph A3.2).

Graph A3.2

Lending for real estate and construction and lending standards



[1] Diffusion index.

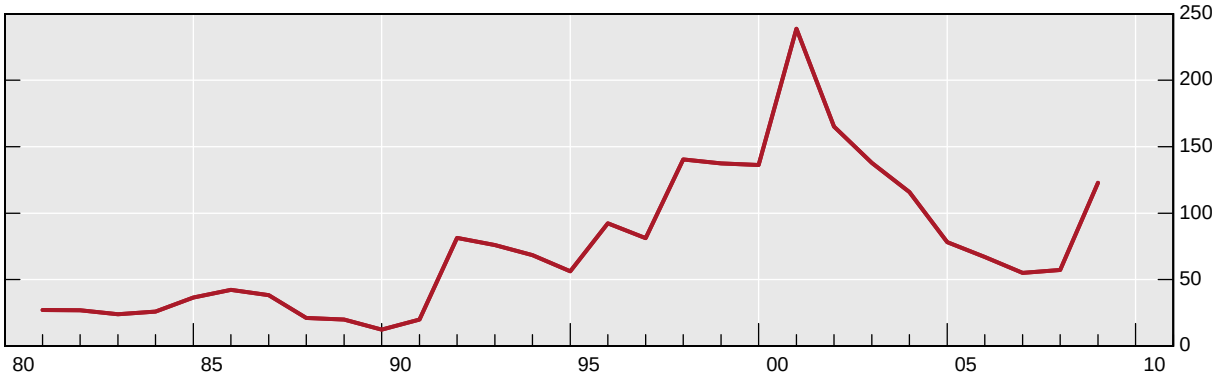
Source: Bank of Japan.

Prompted by the tightened lending standards, a severe credit crunch precipitated a number of small and medium-sized firms into downsizing and defaults. The total number of defaults in the late 1990s quadrupled compared with the level in the early 1990s (Graph A3.3).

Graph A3.3

Total defaults

In billions of yen

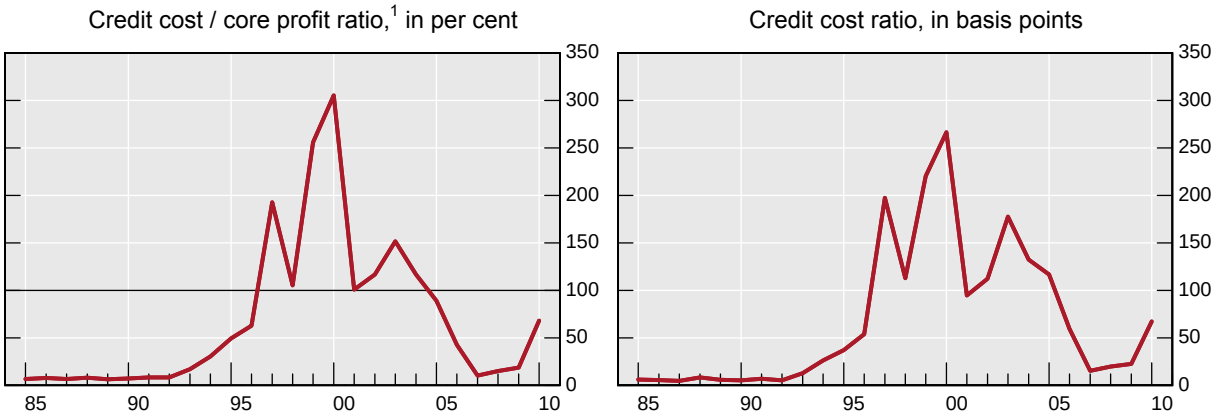


Source: Bank of Japan.

One side effect was the increased credit cost/loss for Japanese banks, which rose due to the surge in non-performing loans. The credit costs skyrocketed when several large financial institutions failed, further eroding bank capital (Graph A3.4).

Graph A3.4

Credit costs



[1] Credit cost divided by the core operational profits of banks. If it exceeds 100%, then banks face more credit costs than they can cover from their core profit.

Source: Bank of Japan.

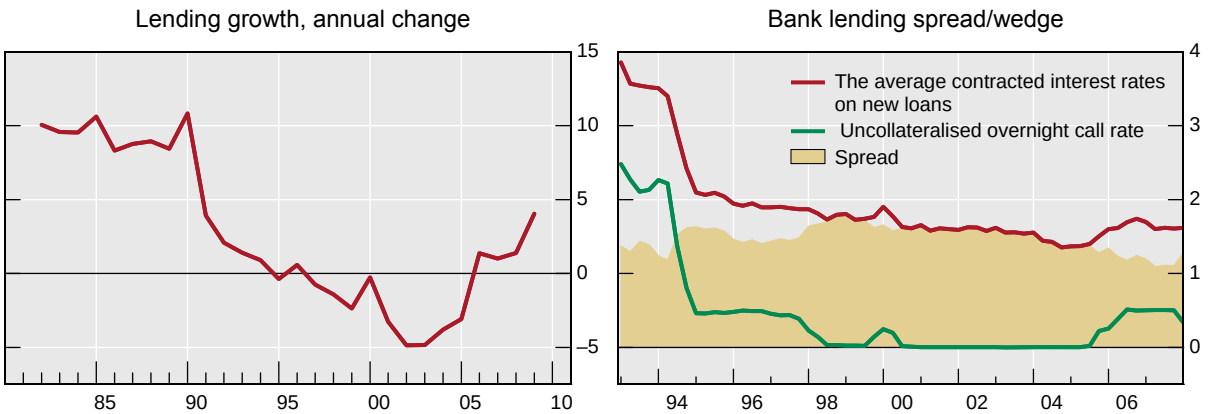
Under these severe conditions, banks needed to meet capital requirements. As a result, banks cut risky assets aggressively, shedding 20% of their assets.

In contrast to the credit quantity, the spread between the lending rate and the call rate (a typical interbank funding rate such as the federal funds rate) remained by and large steady during this period (Graph A3.5). The adjustment thus materialised via quantity rather than price.

Graph A3.5

Lending growth and lending spreads

In per cent



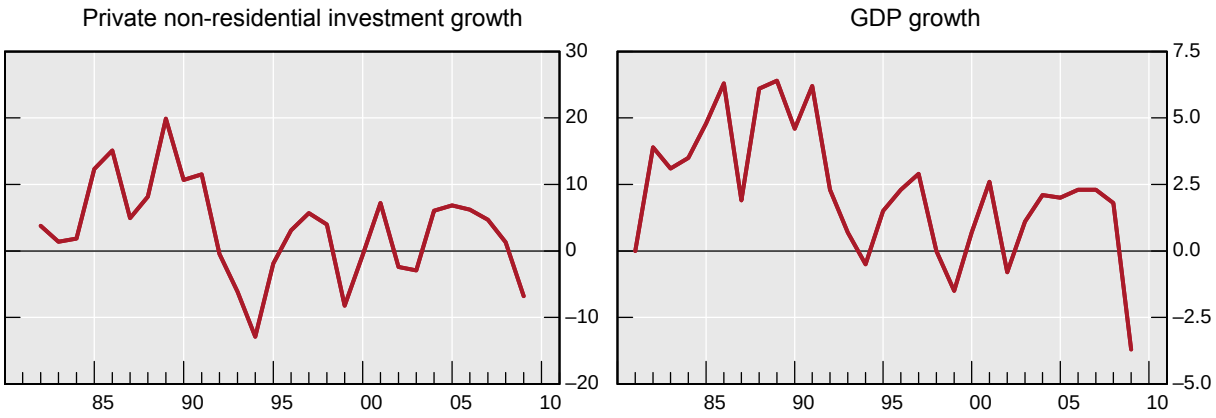
Source: Bank of Japan.

The reduced bank lending translated into lower growth of the overall economy over time. In particular, non-residential investment, for which credit availability was crucial, fell substantially. On average, the growth rate of output fell by 4% and that of non-residential investment by 12.6% during the 1990s (Graph A3.6).

Graph A3.6

Investment and GDP

Annual change, in per cent



Source: Bank of Japan.

3.2 The Swiss experience in 2009

Revision of capital requirements in Switzerland

In December 2008, the Swiss Financial Market Supervisory Authority, Finma, introduced new capital requirements on the two big banks (UBS and Credit Suisse). There are two complementary actions at the heart of the new capital requirements: first, an increase in risk-weighted capital requirements; and second, the introduction of a leverage ratio, ie a nominal cap on debt levels regardless of the risk involved. The risk-weighted capital requirement is calculated as the ratio of total eligible capital to risk-weighted assets. The Finma leverage ratio defines the proportion of Tier 1 capital to total adjusted assets (excluding domestic lending).

In good times, ie when banks make profits, the two big banks have to meet a risk-weighted capital ratio of at least 16%. Not only has the definition of total eligible capital been tightened (it now has to be predominantly Tier 1 capital) but also the target has been raised substantially (6.4 percentage points higher than the former target of 9.6%). Furthermore, in good times, the banks' leverage ratio as defined by Finma has to be least 5%.

To prevent a procyclical impact, these targets have to be met by 1 January 2013. This should leave the banks with enough time to build up capital. Furthermore, they will be allowed to temporarily fall short of these targets in bad times. This ensures that losses can be absorbed by the capital cushion without automatically triggering a damaging adjustment process. However, at any time, the leverage ratios must not fall below 3% at the financial group consolidated level and below 4% at the level of the individual institutions. If either bank falls short of either of the prescribed targets of 16% and 5%, steps must be taken to ensure that it is able to meet these targets again within an appropriate time frame. At the very least, restrictions should be imposed on dividend payments and on asset growth as long as the capital targets are not being met.

Development of capital

Graph A3.7 (left-hand panel) shows the development of the risk-weighted capital ratio for UBS and Credit Suisse. As can be seen, their risk-weighted capital ratio increased

substantially after the introduction of the new capital requirements. The two banks had already met the new target requirements by the end of 2009 – even though those requirements will not be binding before 2013.

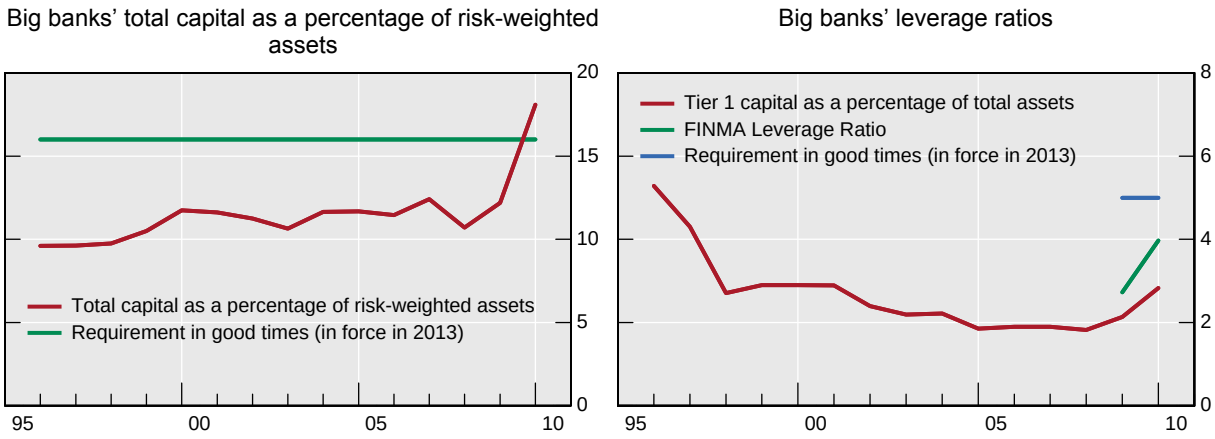
The right-hand panel of the graph shows the development of the leverage ratios. The blue line shows the ratio between Tier 1 capital and total assets. The green line represents the banks' *leverage ratio* as defined by Finma, ie excluding domestic loans. As can be seen, the ratios increased after the introduction of the new capital requirements that will set an upper limit to the banks' leverage as of 2013. This increase was driven by a material decrease in the banks' balance sheets.

In sum, the two banks increased their capital ratios substantially and swiftly after the introduction of the new capital requirements in 2008.

Graph A3.7

Capital ratios and leverage ratios for the two Swiss big banks

In per cent



Source: Swiss National Bank.

Development of the big banks' loans

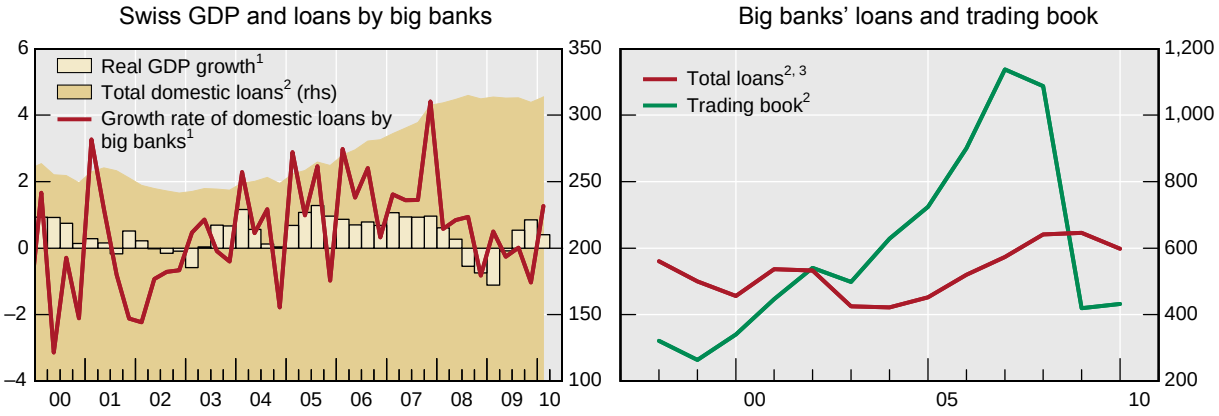
Graph A3.8 (left-hand panel) shows quarterly growth rates of real Swiss GDP and domestic loans provided by the two big banks. As can be seen, Swiss GDP growth became negative in Q3 2008 as a consequence of the financial crisis. In February 2008, the growth rates for the two banks' domestic loans peaked before receding rapidly, closely following the development of Swiss GDP growth, before the regulatory change. In Q1 2009, the growth rates of domestic loans provided by the two banks also turned (slightly) negative. This pattern is not atypical: credit volumes tend to co-move with the business cycle. Loans grow faster in booms and grow slower, or even shrink, in recessions. GDP growth leads loan growth by two quarters according to the maximum cross-correlation between the two variables.

The recent contraction of loans at the big banks, however, was very limited given the severity of the recession and the high volatility of these banks' domestic loans observed in the past. Between Q4 2008 and Q1 2010, the two banks' domestic loans remained virtually unchanged (–0.3%) in spite of the fact that both – in particular, UBS – were severely hit by the crisis and despite the new capital requirements. During the same period, their total loans (domestic and foreign – see Graph A3.8) declined by 8.5%, returning to their end-2006 level. For instance, between Q4 2001 and Q4 2002 their domestic (–4.5%) and total (–20%) loans shrunk by much more although GDP declined by less.

Of course, the monetary easing in response to the financial crisis helped prevent a credit crunch in Switzerland. From Q4 2008 to Q1 2010, total bank loans (across all categories of banks, most of which were not negatively affected by the crisis) in Switzerland increased by about 6%. However, taking all this into consideration, there is no evidence that either the substantial tightening of the risk-weighted capital requirements (both on the banks' domestic and on their foreign loan portfolio) or the introduction of the leverage ratio has been a key factor behind the recent stagnation of the two banks' domestic lending or the moderate decline in their foreign lending. The major driver of their balance sheet reduction since the onset of the crisis in 2007 is the decrease in their trading book (Graph A3.8, right-hand panel). Most of this decline occurred through a reduction in foreign assets, which account for around 98% of the combined trading portfolios of the two banks.

Graph A3.8

Swiss GDP and domestic lending, and lending and assets by Swiss big banks



[1] Quarter-on-quarter changes, in per cent. [2] In billions of Swiss francs. [3] Domestic and foreign loans, excluding reverse repos and securities borrowing.

Source: Swiss National Bank.

Development of lending standards for 20 Swiss banks

The red lines in Graph A3.9 show changes in credit standards and demand for loans as reported by 20 Swiss banks (including UBS and Credit Suisse, which have a cumulated market share exceeding 30%) in a quarterly bank lending survey. Banks are asked to report changes as compared with the previous quarter. Their responses are weighted with their respective credit volumes in the domestic market. A negative number represents a tightening of standards.

The left-hand panel shows changes for loans provided to firms. Between Q4 2008 and Q2 2009, banks reported – on average across all banks as well as for the big banks – a tightening of their lending standards. This is consistent with the presumption that banks tighten their lending standards in recessions in order to protect themselves against higher default risk. Demand for loans was reported to have increased between Q2 2008 and Q2 2009. Since Q3 2009, no further changes have been reported. However, the tighter lending standards have hardly affected loan volumes given the increased demand: we observe positive, but declining growth rates of firm loans in 2009.

The right-hand panel shows changes for mortgages provided to households. As with business loans, many banks reported that they tightened their standards for mortgage loans between Q4 2008 and Q2 2009. Unlike for lending to firms, the tightening was reported by fewer banks. One explanation is that the credit risk for mortgages is considered to be

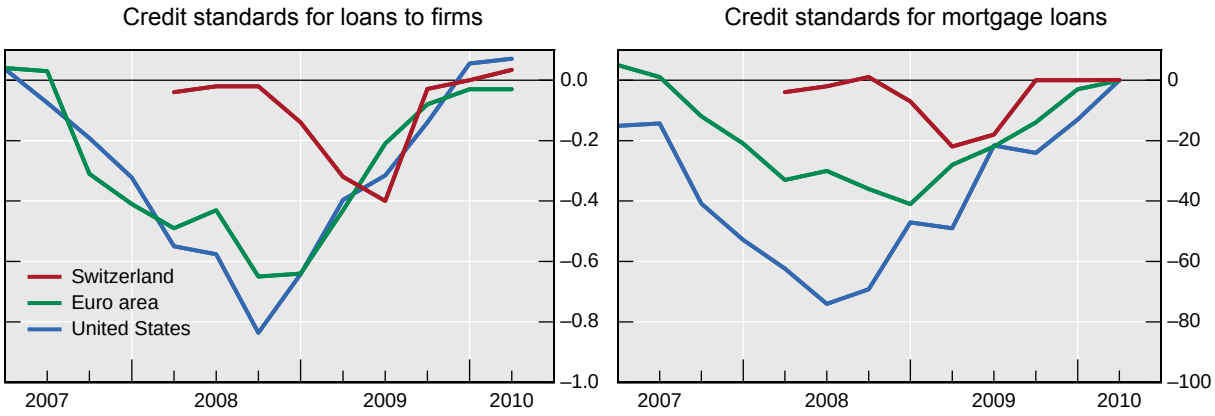
smaller, as they are collateralised. The demand for mortgages increased in the first three quarters of 2009 and declined thereafter. Again, the tightening has barely affected mortgages to households given the increased demand: we observe positive growth rates throughout 2009.

As can be seen in Graph A3.9, compared with banks in the euro area and the United States, (i) fewer Swiss banks reported a tightening of lending standards and (ii) the tightening was reported for a shorter time span. In Switzerland, mortgages to households and loans to firms exhibited still positive growth rates in 2009 despite (i) the high level of stress being experienced by the two big banks, (ii) the recession and (iii) the tightening of capital requirements for the two big banks, whose cumulated market share of domestic lending, as already noted, exceeds 30%. While, as also mentioned earlier, the big banks' domestic lending remained virtually constant between Q4 2008 and Q1 2010, total domestic loans increased by 6% over the same period. Hence, the increasing loan demand reported during this period was able to be met by banks with a domestic business focus.

In sum, these graphs suggest that Swiss banks – including banks that were not affected by the new capital regulation – tightened their lending standards somewhat during 2009. Based on the banks' answers to the survey, the tightening was due to the increased risk perception, while capital and liquidity restrictions were barely mentioned as a driving factor.

Graph A3.9

Credit standards for loans to the corporate and household sectors:[1] Switzerland, the euro area and the United States



[1] Negative numbers reflect tightening standards.

Sources: ECB; Swiss National Bank; US Federal Reserve.

3.3 Conclusion

In Switzerland, new and significantly tighter capital requirements were introduced for the two big banks in 2008. According to the new rules, the two will have to meet a risk-weighted BIS capital ratio (predominantly Tier 1 capital to risk-weighted assets, including domestic lending) of at least 16% and a Finma leverage ratio (Tier 1 capital to total assets, excluding domestic lending) of at least 5% in good times as of 2013.

In 2009, both banks' capital situation – measured by their risk-weighted capital ratios and by their leverage ratios – improved considerably towards the new target levels. As a result, the two banks had already met the new target requirements for risk-weighted capital ratios by the end of 2009.

During the same period, the size of their total loan books (domestic and foreign) declined somewhat while their domestic loan book remained almost constant after an episode of high growth rates. The evidence strongly suggests that the dynamic in the two banks' loan book was not driven by the substantial tightening of their risk-weighted capital requirements (on both their domestic and on their foreign loan portfolio) or by the introduction of the leverage ratio. First, a decline in lending by the big banks is typical during recessionary periods; in fact, the recent decline in domestic loan growth at the big banks was less pronounced than during the preceding two episodes of negative GDP growth rates. Furthermore, the growth rates for the two banks' domestic loans declined before the regulatory change occurred. Second, in a bank lending survey, Swiss banks report that they have tightened their credit standards somewhat as a result of increased risk perception, while capital and liquidity restrictions are barely mentioned. Finally, the tightening of lending standards observed in Switzerland was less pronounced than in the euro area or the United States, where banks did not experience a similar increase in the severity of capital requirements.

Annex 4:
Consultations with private sector and academic experts

The initial letter from the FSB and BCBS Chairmen setting out the MAG's mandate instructed the MAG to "draw on all available information and conduct focused outreach to external constituents, such as the academic community". In addition to numerous bilateral contacts and discussions, the MAG Chairman and members engaged in a series of in-depth, off-the-record discussions with private sector and academic experts.

1. BIS Meeting of Private Sector Chief Economists, Basel, 16 April. This event was chaired by the MAG Chairman, in his capacity as Economic Adviser of the BIS. Attendees included top economists at a number of globally active private sector financial institutions in Europe, Japan and the United States. Participants discussed the potential impact of the new regulatory standards on banks and the economy. A central theme was the potential significance of technical details in the new regulatory framework, such as changes to the definition of capital, and the risk of unintended consequences from the interaction of the many changes being considered. Participants agreed that banks were likely to look more closely at the returns on equity and capital needs of different activities during the transition period, and that this could affect business models as well as patterns of lending to different sectors and geographical regions.

2. FSB Standing Committee on Supervisory and Regulatory Cooperation, Meeting with Private Sector, Basel, 12 May. This roundtable discussion brought together members of the FSB's Supervisory and Regulatory Committee with top executives from leading private sector banks, as well as representatives of the Institute of International Finance, to exchange views on issues of common interest, including the impact of the new regulatory standards on banks and the economy. The MAG Chairman reported on the Group's workplan and overall approaches. Participants emphasised the importance of phasing in measures slowly in view of ongoing fragility in economies and financial systems. Private sector representatives urged the MAG to be as transparent as possible regarding its assumptions and results.

3. MAG Private Sector/Academic Roundtable Meeting, Basel, 17 May. At this event, MAG members exchanged views with leading academic and private sector experts on financial regulation and the financial industry. Participants discussed the range of options available to banks for adjusting to the new requirements, including shifts in business models and strategies. While they noted that a longer transition period should allow for less costly issuance of new equity by banks, it was also suggested that banks are likely to strive to meet new capital and liquidity requirements soon after they are announced, in order to demonstrate their strength to the market. Some participants expressed concern at the potential for credit rationing and other "non-linear" events to occur in consequence of the new requirements.

4. Roundtable on the Macroeconomic Impact of Strengthened Capital and Liquidity Requirements, New York, 16 June. This event brought together selected MAG members and leading academic experts, including several authors of the Squam Lake Report (French et al (2010)). Participants suggested that capital ratios should matter *only* for lending spreads and other decisions by banks in the short term, since in the long term the Modigliani-Miller (1958) theorems should hold. There was also an emphasis on the risk that strong capital requirements on banks would drive credit intermediation into the shadow banking system, which would reduce the macroeconomic impact but raise financial stability issues. One way for regulation to address this would be to set capital requirements on the basis of assets (such as minimum haircuts and LTV ratios) rather than institutions.

Annex 5:
National results

Tables A5.1 and A5.2 present the number of model outputs that were submitted by members of the various MAG subgroups. National authorities generally estimated results for their national economies, except for one model estimated by the Bank of Italy for the euro area. The European Commission (EC) submitted a model output for the euro area. The ECB results covered France, Germany, Italy, the Netherlands, Spain and the euro area. The IMF estimated a global model, applying common modelling techniques to data from 15 countries, and a DSGE model with results for the United States and the euro area.

Table A5.1

Number of model outputs submitted to MAG subgroups

Country/ institution	Satellite models[1]	Bank-augmented DSGE[2]	Reduced-form[3]
Australia	1	…	2
Brazil	…	…	…
Canada	...	3	…
ECB	2	3	1
European Commission	…	1	…
France	2	…	…
Germany	1	…	1
IMF	…	4	…
Italy	…	1	…
Japan	1	…	…
Korea	…	…	1
Mexico	2	…	1
Netherlands	2	…	1
Spain	1	…	…
United Kingdom	3	…	…
United States	…	1	1

[1] Models that estimated changes in lending spreads and volumes resulting from specified changes in target capital and liquidity ratios. [2] Dynamic stochastic general equilibrium models incorporating banking sectors and financial frictions. Note that the standard policy models in Table A5.2 include a number of DSGE models that do not directly model banks or financial sectors. [3] Vector autoregression and other reduced-form models.

Table A5.2

Number of model outputs submitted to MAG subgroups

Country/ institution	Standard policy models[1]		
	By national authority	By IMF[2]	By ECB
Australia	2	2	…
Brazil	3	2	…
Canada	…	2	…
China	…	2	…
France	3	2	4
Germany	1	2	4
India	…	2	…
Italy	2	2	4
Japan	2	2	…
Korea	4	2	…
Mexico	…	2	…
Netherlands	4	…	4
Russia	…	2	…
Spain	2	2	4
United Kingdom	3	2	…
United States	7	2	…
Euro area	…	…	6
Sum of the above	33	30	26

[1] Standard semi-structural and DSGE models used for policy analysis and forecasting. [2] These models produced two sets of estimates, depending on whether or not international spillover effects were included.

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