INTERNATIONAL MONETARY FUND

THE INTERACTION OF MONETARY AND MACROPRUDENTIAL POLICIES—BACKGROUND PAPER

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I. INTRODUCTION

1. This paper provides background material to support the Board paper on the interaction of monetary and macroprudential policies. It analyzes the scope for and evidence on interactions between monetary and macroprudential policies. It first reviews a recent conceptual literature on interactive effects that arise when both macroprudential and monetary policy are employed. It goes on to explore the "side effects" of monetary policy on financial stability and their implications for macroprudential policy. It finally addresses the strength of possible effects of macroprudential policies on output and price stability, and draws out implications for the conduct of monetary policy.

2. The paper then presents empirical analysis of these issues. Using cross-country data on the use of macroprudential policy tools from 2000 to 2011 in 36 countries, the paper assesses empirically the effects of macroprudential policy on financial variables—such as credit and asset prices—as well as their effects on the real economy. This analysis also investigates how the effects of macroprudential policy tools may depend on financial and economic conditions and whether the strength of effects of macroprudential tools depends on whether the tools are tightened or loosened.

3. The paper finally collects a number of country case studies that were prepared to shed light on the interplay between macroprudential and monetary policies in practice. These examine the experience in Central, Eastern, and South-Eastern Europe, Brazil, Turkey, Korea, and the United States. Brief summaries of these case studies are in Box 1.

4. The rest of the paper is organized as follows. Section II considers theory and existing evidence on policy interactions. Section III presents empirical evidence. Section IV assembles country case studies on the interplay between monetary and macroprudential policy tools.

Box 1. Case Studies on Monetary and Macroprudential Policies

Central, Eastern, and South-Eastern Europe. A salient feature of the experience in Central, Eastern, and South-Eastern Europe ahead of the crisis was a pronounced increase in foreign currency (FX) lending. This case study examines the experience of five inflation targeting countries in the region and investigates whether interest rate spreads stimulated the increase in FX lending. It also studies macroprudential policy responses that were taken to reduce the systemic risk associated with such lending. The study finds that where interest rates were low relative to advanced country rates, the increase in FX lending was less pronounced, other things equal. It also finds that the strongest macroprudential measures were effective in counteracting the increase.

Brazil. Brazil has been an active user of both monetary and macroprudential policies. Its experience during the post-crisis period illustrates well the complementary relationship between the two policies. Monetary policy was used countercyclically in macroeconomic management, and macroprudential instruments were also used to contain the potential buildup of systemic risks from rapid credit growth. As these policies leaned against the business and financial cycle, synchronized during this period, the policy mix was appropriate to meet two objectives—price and financial stability—with two instruments.

Turkey. In the aftermath of the global financial crisis, the Turkish authorities faced a challenging environment, characterized by widening current account deficits, strong short-term capital inflows, and rapid credit growth. In response, the Central Bank of the Republic of Turkey (CBRT) adopted a new "policy mix" that emphasized financial stability objectives, while other macroprudential measures were taken only with some delay. This case study examines the policy outcomes and points to the importance of coordination and clear communication in responding to building financial imbalances.

Korea. During the 2000s, Korea experienced housing price boom-busts and a sharp increase of short-term foreign currency (FX) borrowing in its banking system. While the Bank of Korea focused on price and output stability under a flexible inflation targeting framework, financial imbalances in the housing market were addressed with targeted macroprudential policy measures, such as limits on loan-to-value (LTV) and debt-to-income (DTI) ratios. More recently, restrictions on FX derivative positions, and a Macroprudential Stability Levy were brought in to curb excessive short term foreign currency borrowing. This case study shows that such macroprudential measures have clear advantages over the use of monetary policy, which is too blunt to deal with housing market developments and can worsen external vulnerabilities in an economy with a fully open capital account like Korea

United States. The United States offers prime terrain to study financial instability in the years leading up to the financial crisis of late 2007. Did an overly loose monetary policy and absence of macroprudential measures undermine financial stability? The study finds some, though weak, evidence that interest rates were too low relative to an optimal monetary policy response. It also finds that a relaxation of regulations and the absence of an institutional framework geared explicitly to financial stability contributed to the growing leverage of large investment banks, though other factors may also have been at play. Moving forward, it will be essential to improve the effectiveness of macroprudential policies in advanced economies.

II. INTERACTIONS BETWEEN MONETARY AND MACROPRUDENTIAL POLICY

A. Policy Interactions—Conceptual Framework

5. Recent advances in analytical modeling offer a simple conceptual framework for thinking about policy interactions between monetary and macroprudential policies. This literature examines the interaction between macroprudential and monetary policy in theoretical (DSGE) models with borrower collateral constraints and a banking sector. In these models, monetary policy controls the risk free interest rate and macroprudential policy the risk premium, or the spread between lending rates and the risk free rate.[1]

6. A basic result is that, in the presence of macroprudential policy, it is optimal for monetary policy to stay focused on price stability. In particular, the optimal calibration of the reaction of monetary policy to output and inflation does not change markedly when macroprudential policy is also used, and instead remains close to that commonly found in traditional models without financial sector distortions or macroprudential policy.

7. In practice, macroprudential policy may not be fully effective in containing systemic risk. The assumption made by the models is that the available macroprudential instrument is perfectly targeted and fully offsets financial shocks. In practice, this is unlikely to be the case. For instance, political economy considerations may limit the deployment of certain, unpopular, macroprudential instruments, in particular when use of the instrument has strong distributional implications. In addition, institutional arrangements may limit the frequency with which macroprudential policy may be used, as when parliamentary or political approval is required to reset an instrument.

8. As a result, monetary policy may still need to respond to financial conditions. Indeed, in models where macroprudential policy is absent or time invariant, but in the presence of financial sector distortions, it is optimal for monetary policy to consider financial shocks.[2] In such contexts, optimal monetary policy responds to the growth in credit (in addition to the output gap and deviations of inflation from target).[3] By extension, when macroprudential policy is imperfectly targeted, it can be desirable for monetary policy to respond to financial conditions.

[1] This literature includes Baillu and others (2012), Kannan and others (2009), Unsal (2011), Angelini and others (2011), Bean and others (2010), Christensen and others (2011), and Cecchetti and Kohler (2012).

[2] See, for example, Woodford (2011). Kannan and others (2009), as well as Christensen and others (2011), also find that optimal monetary policy responds to credit when macroprudential policy is switched off.

[3] Where there is a response to the credit gap, the optimal sensitivity parameters of monetary policy to the output gap and deviations of inflation from target do not change markedly.

9. In these models, having two policies to achieve both price and financial stability enhances welfare. Moreover, in practice, especially when capital accounts are fully open, achieving both objectives with one instrument may not be feasible. For example, when capital inflows appreciate the currency and lead to imbalances, increases in policy rates cannot reduce incentives for (foreign exchange) wholesale funding or credit expansion. Conversely, the literature shows that when monetary policy is constrained or absent, using macroprudential policy in the place of monetary policy to control output and inflation is inefficient and costly, as it severely constrains the financial sector and output.[4]

10. More generally, the literature points to synergies, rather than conflicts, even if the optimal policy mix can vary with the type of shock hitting the economy. In the presence of a financial shock, most models imply that only macroprudential policy should be used since it is more targeted at the distortion.[5] In the presence of aggregate demand (preference) shocks that induce an increase in both credit and inflation, both policies are tightened, complementing each other in responding to the shock. In the presence of productivity shocks, conflicts can arise since a positive supply shock can lead asset prices and credit demand to rise but dampens goods market inflation. The optimal policy mix then depends on the strength of the externality from increases in credit to aggregate financial risks. If this externality is strong, the accommodative monetary policy response to the productivity shock is complemented by targeted macroprudential policy to contain the build-up of leverage that may be induced by the shock.[6]

11. While structural models offer clear insights into policy interactions, their downside is their simplicity. This includes the abstraction in the majority of cases from modeling the side effects of monetary policy on financial stability, described in the next section; and the lack of realistic modeling of the transmission of macroprudential instruments to financial and output stability, which is explored further below. Moreover, the adaptation and calibration of models to country circumstances is often yet to be undertaken and hindered empirically by limited (cross-country) experiences with both policies.

B. Monetary Policy and Side Effects on Financial Stability

12. It has long been understood that monetary policy can affect financial stability. This section offers a taxonomy of these—beneficial or adverse—effects. It also considers the factors that may impact the strength of the effects and explores how well-designed macroprudential policies have the potential to contain the adverse effects of monetary policy on financial stability.

[4] See, e.g., Unsal (2011).

[5] As in Baillu and others (2012), Kannan and others (2009), Unsal (2011), Angelini and others (2011), and Bean and others (2010).

[6] As in Christensen and others (2011).

13. Building on the financial markets' imperfections literature, there are a number of channels by which monetary policy can affect financial stability. It can affect the tightness of borrowing constraints and likelihood of default; the risk seeking incentives of intermediaries; and externalities operating through aggregate price variables, such as asset prices and exchange rates. Table 1 shows for each channel the prediction from theoretical models of the effects of changes in the monetary policy stance on financial stability. It also summarizes related empirical evidence.[7] An appendix in the main paper reviews the empirical evidence in more detail.

Table 1. Monetary Policy Effects on Financial Stability[1/]

Sources of Financial Instability	Channel	Predicted Effect (↑ improves stability)		Selected Empirical Evidence	
		↓ r	↑ r		
Borrowing Constraints	Balance Sheet (default) Channel	↑	↓	Sengupta (2010) Jiménez and others (2009) Gertler and Gilchrist (1994) Asea and Blomberg (1998)	↑ r , ↓ ↑ r , ↓ ↑ r , ↓ ↑ r , ↓
Risky Behavior of Financial Institutions	Risk-taking Channel	↓	↑	Jiménez and others (2009) Ioannidou and others (2009) Merrouche and Nier (2010)	↓ r , ↓ ↓ r , ↓ X
	Risk-shifting Channel	↑	↓	Gan (2004) Landier and others (2011)	↑ r , ↓ ↑ r , ↓
Externalities through Aggregate Prices	Asset price Channel	↓	↑	Altunbas and others (2012) Del Negro and Otrok (2007) IMF (2009)	↓ r , ↓ ↓ r , ↓ X
	Exchange rate Channel	↑	↓	Hahm and others (2012) Merrouche and Nier (2010) Jonsson (2009)	↑ r , ↓ ↑ r , ↓ ↑ r , ↓

Source: IMF.

1/ ↓ r means a decrease of policy rates, ↑ r means an increase of policy rates, "↓" means a decline of stability, "↑" an improvement, and "X" no statistically significant effect.

14. Changes in the monetary stance can affect the tightness of borrowing constraints and the likelihood of default. Monetary easing relaxes collateral constraints, mitigating financial distortions both on the demand and supply side of credit. Conversely, a tightening of rates can adversely affect borrowers' quality, leading to higher default rates and potentially precipitating a crisis (Allen and Gale, 2000; Illing, 2007, Goodhart and others, 2009).

15. Changes in the monetary stance can affect the risk-seeking behavior of financial intermediaries in multiple ways. Two channels may move in opposite directions, as follows:

[7] These channels are formalized in theoretical work, but empirical evidence on these effects faces challenges, including the absence of a counterfactual path for monetary policy and difficulties in telling apart the effects on the demand and supply of credit. Most of the papers cited in Table 1 can be interpreted as indirect evidence.

- **Risk-taking.** Low monetary policy rates can create incentives for banks to expand their balance sheets and reduce efforts in screening borrowers (Borio and Zhu, 2008). They can also lead other agents to seek more risks in order to achieve higher returns (Rajan 2006). These effects are likely to be worse if monetary policy is (too) accommodative for too long during expansions. If monetary policy is expected to be lowered during recessions to support the financial system, this may create additional incentives to correlate risks (Farhi and Tirole, 2012).

- **Risk-shifting.** Increases in policy rates can reduce intermediation margins, and lead lenders, especially poorly capitalized intermediaries, to seek more risk (Bhattacharya, 1982). This channel may be stronger just ahead of a crisis, when intermediary leverage is high and competition limits the pass-through of policy rates to lending rates. More generally, a flattening of the yield curve associated with increases in policy rates can lead banks to seek risk in order to maintain profits (Merrouche and Nier, 2010).

16. Monetary policy can affect externalities operating through aggregate financial prices, including asset prices and exchange rates. By affecting asset prices and exchange rates, monetary policy affects the value of collateral, which influences the tightness of borrowing constraints.

- **Asset prices.** Low interest rate can increase asset prices, which can trigger further increases in leverage and lead to asset price booms, exacerbating the financial cycle (Bernanke and Gertler, 1989). Conversely, a tighter monetary stance can cause collateral constraints to bind, fire sales to follow, with resulting adverse asset price externalities (Shin, 2005).

- **Exchange rates.** In open economies, interest rate increases can attract capital flows, appreciating the currency, leading to excessive borrowing in foreign currency and laying the ground for exchange rate externalities during the depreciation phase (Bruno and Shin 2012, Hahm and others, 2012).

17. The intensity of these effects can depend on the point in the financial cycle. As financial imbalances build up, low monetary policy rates reduce current defaults, but can induce banks to make riskier loans and increase leverage. When rates are increased close to the peak of the financial cycle, this can induce risk-shifting and borrower defaults. Moreover, incentives to correlate risks due to the expectation of future monetary easing can be stronger in the upswing of the financial cycle.

18. The strength of the effects can also depend on financial structure and capital account openness. For example, securitization generally reduces the strength of the effects of monetary policy on credit extension by banks (e.g., Altunbas, and others 2012). But the importance of risk-taking and risk-shifting channels may not diminish, since they come to work through both banks and non-banks. Moreover, in open and financially-integrated economies, domestic monetary policy has a weaker influence over domestic long-term rates and asset prices, but exchange rate externalities become more important.

- In open economies, high policy rates can encourage capital inflows and foreign exchange borrowing. In a number of countries in emerging Europe, foreign exchange (FX) lending to

households increased ahead of the crisis, with tighter monetary policy aggravating the situation, as it provided further incentives for borrowing in FX (case study, Section IV). At the same time, when the central bank lowers rates to support the economy in a downturn, this can lead to a depreciation and worsen exchange rate externalities arising from tightening constraints.

- As international financial integration increased over the past decades, domestic monetary control has weakened for both advanced countries and emerging markets. Bernanke (2005) argued that a global saving glut reduced long-term rates in advanced economies, and that as a result the relationship between short rates and long rates had become weak (Greenspan conundrum), thereby reducing the pass-through of policy rates to asset prices.

- For emerging economies, similarly, the correlation between domestic short and long rates has weakened (Moreno, 2008) and the importance of foreign factors strengthened. Increased cross-border banking contributes to these effects since for cross-border banks, global monetary conditions seem to matter more than local conditions (Cetorelli and Goldberg, 2012; Shin, 2011).

19. First principles suggest that well-targeted macroprudential policies have the potential to contain the undesirable effects of monetary policy. Where the side effects of monetary policy on financial stability are expected to be undesirable, this can create conflicts between financial and price stability objectives. Appropriate macroprudential policies can attenuate these side effects, thereby reducing policy dilemmas and creating additional "room for maneuver" for monetary policy. For most of the channels discussed above, a range of specific macroprudential instruments may reduce the effect when brought in ex ante.

- The impact on defaults from a tightening of monetary policy can be contained by macroprudential tools, such as a limit on DTI. A conservative DTI ratio may reduce the effect of increases in policy rates on debt affordability, thereby lessening an unwanted transmission of increased policy rates to household default rates (Igan and Kang, 2011). This in turn can help protect bank balance sheets and reduce the force of fire-sale dynamics for asset-backed securities.

- A range of macroprudential measures can affect the risk-taking channel. Increases in capital requirements or a tight leverage ratio can help contain increases in bank leverage in response to low policy rates and reduce the incentives to take risk (Farhi and Tirole, 2012). Such measures also create additional buffers to absorb risks from an erosion of lending standards. However, where shadow banks are important providers of credit, macroprudential tools are needed that control leverage both inside and outside of the banking system (United States case study, section IV). The regulation of margin in securities lending is an example (Kashyap and others, 2010).

- Risk-shifting incentives associated with increases in policy rates could also be addressed through appropriate macroprudential tools. Liquidity measures, such as the Basel Net Stable Funding ratio, encourage banks to seek stable and longer-term funding. Where funding is longer term, this can reduce the impact of a monetary policy tightening on lending margins and profits and

attenuate the incentive for intermediaries (banks and non-banks) to seek further risk exposure in response to increases in policy rates.[8] Capital buffers can also reduce risk-shifting incentives from a compression of margins (Bhattacharya 1982, Hellmann and others, 2000).

- When accommodative monetary policy drives up asset prices, macroprudential measures, such as limits on LTV ratios, can tame house price boom-busts. When low policy rates encourage borrowing and greater credit in turn drives up asset prices, a lower LTV ratio can counter this effect. Some studies have found that a conservative LTV ratio can contain the feedback loops between credit and house prices (IMF, 2011b). Moreover, studies have found that a tightening of LTV ratios can slow the rate of house price appreciation, thereby reducing the potential for a housing bubble to emerge (Crowe and others, 2011; Igan and Kang, 2011; Wong and others 2011).

- The policy dilemma that may arise from interactions between domestic monetary policy and capital flows can be addressed by macroprudential measures. Macroprudential measures can affect gross flows and help change the composition of flows away from short-term and FX denominated liabilities issued by banks, thereby reducing the systemic risk associated with capital flows (Hahm and others, 2012).[9] Examples are FX reserve requirements (RRs) implemented in Romania and the levy on FX denominated non-core liabilities introduced in Korea. In addition, where high domestic rates encourage corporations or households to borrow in FX, macroprudential measures can reduce heightened default risks, including higher risk weights and tighter LTV ratios, as well as limits on FX lending, as applied in a number of countries in emerging Europe (case study, section IV).

20. In sum, in its transmission, monetary policy can interact with financial distortions in several ways, with the net effect on financial stability often ambiguous. Several channels may be at work, operating simultaneously with their strength varying with the stage of the financial cycle, financial structure, and other country characteristics. Where the side effects are expected to be undesirably strong, well-designed macroprudential policies that are brought in ex ante can attenuate these effects.

[8] English and others (2012) find empirically that a flatter yield curve is associated with lower net interest margins, with the size of the effect increasing in the maturity mismatch between bank assets and bank liabilities.

[9] As long as the measures do not affect the size of the net inflow, overall leverage may continue to rise.

C. Macroprudential Transmission and Effects on Real Economic Outcomes

21. This section presents a closer examination of existing literature on the transmission of macroprudential policies and traces out implications for monetary policy. This analysis focuses on tools that have traditionally been used most frequently in emerging markets and those that are likely to be used most actively in future, in both advanced and emerging economies, such as dynamic capital buffers, limits on loan-to-value ratios and RRs. [10] For each of these tools, the paper traces out the transmission to reduced systemic risk, as well as real economic outcomes, and draws out implications for monetary policy.[11]

Capital buffers

22. The main objective of an increase in the dynamic capital buffer is to increase the *resilience* of the banking system. The idea is that when credit grows strongly, the quality of the credit portfolio is likely to deteriorate, increasing the likelihood of future losses. When high credit growth triggers an increase in the dynamic capital buffer in good times, the buffer can cushion the effect of losses on bank balance sheets and thus help maintain the flow of credit when losses materialize.

23. The effect of increases in the dynamic capital buffers on aggregate credit is likely to be weak, in principle. When credit growth is strong, banks have ample profits that can be used to build up the buffer through retained earnings. In addition, theory suggests that asymmetric information and the resulting adverse signaling effects are among the main reasons for banks' reluctance to issue new equity (Myers and Majluf, 1984; Kashyap and others, 2010) or to cut dividend payouts (Bhattacharya, 1979). These effects are likely to be weak in good times. Moreover, since the increase in capital is mandated, adverse signaling effects from a decrease in the dividend payout ratio or from issuing new equity are likely to be small. On the other hand, since banks must fear losing profitable business if they increase lending rates or cut exposures outright, they may be less likely to pursue these strategies to meet the capital buffer.

24. In practice, increases in the buffer may still reduce credit and output for a number of reasons, which may need to be offset by monetary policy. First, if the increase in the buffer is brought in fast, banks will not be able to accumulate it through retained earnings alone. Second, further distortions, such as the tax benefits of equity may make banks reluctant to issue new equity. In some countries, in addition, banks may not have easy access to capital markets, or are privately or cooperatively held, making it difficult for these banks to issue new equity. In the presence of such distortions, some effect on aggregate credit and output is to be expected. Existing evidence suggests, however, that the effects on output of increases in capital requirements may be relatively

[10] The analysis focuses on macroprudential tools whose benefit is seen as containing a "time dimension" of systemic risk, or the risk of "procyclical" increases in the risk of financial instability.

[11] CGFS (2012) provides further analysis of the transmission of macroprudential tools.

modest (BIS 2010, Jimenez and others 2012). This implies that any dampening effect exerted by an increase in the buffer can be countered by more accommodative monetary policy, if necessary, as long as monetary policy is effective.[12]

25. On balance, stronger effects are likely in bad times when the accumulated buffer helps sustain the provision of credit to the economy. Existing evidence points to stronger effects of capital buffers on credit in bad times. Nier and Zicchino (2008) find that a larger capital buffer mitigates the adverse effect of loan losses on loan growth and that this effect is stronger in crisis times. Jimenez and others (2012) show that the effects of varying dynamic provisions on credit in Spain were much stronger in crisis times than they were ahead of the crisis. New results presented in Section III are also consistent with stronger effects on credit in bad times.

26. Where a dynamic capital buffer is in place, this will therefore reduce the need for monetary policy makers to offset the effects of tighter credit conditions on output. In response to a tightening of the availability of credit from October 2008, many advanced country central banks cut interest rates aggressively in an effort to support the financial system. When capital buffers are built up ahead of the downturn, the buffers can help sustain the provision of credit to the economy and reduce the depth of the downturn. The presence of a dynamic capital buffer may then lessen the risk that monetary policy runs into the constraints posed by the lower bound on nominal rates and complement monetary policy in bad times, resulting in a smoother path of monetary policy through the cycle.

27. In addition, when capital buffers have been built up in the upswing of the financial cycle, the buffers may help keep open the transmission of monetary policy. In the absence of sufficient buffers, the erosion of capital may lead banks to reduce the supply of credit to the economy. Even where policy rates are lowered aggressively, this may not be enough to counter banks' reluctance to lend. A bigger capital buffer that banks are allowed to run down can help unblock the transmission of monetary policy to the provision of credit (Turner, 2012).

Loan-to-value ratios

28. Limits on loan-to-value (LTV) and debt-to-income (DTI) ratios are increasingly being viewed as useful to contain potentially damaging boom-bust cycles in residential housing markets (Igan and Kang, 2011; IMF, 2011b; Crowe and others, 2011). An LTV ratio imposes a cap on the size of the loan relative to the value of the property, thereby imposing a minimum down payment. In principle, even a static, but conservatively calibrated LTV ratio can strongly affect house-price dynamics. Its effect can be enhanced when the calibration is varied with cyclical conditions in the housing market (as in Korea and Hong Kong SAR), or when it is complemented with a DTI ratio

[12] Complications can arise when capital requirements are tightened in bad (crisis) times, and when monetary policy is already close to its lower bound. In this case, the risk of deleveraging is greater and cannot easily be countered by monetary policy.

(as in Poland and many other countries). A DTI ratio caps total loans to a fixed multiple of household income and may help contain unsustainable increases in household debt more broadly.

29. These measures have been found successful in containing house price accelerations in the upswing. Limits on LTV ratios can reduce financial accelerator mechanisms that otherwise lead to a positive two-way feedback between credit and house prices. A number of cross-country studies have found that positive shocks to household income or the size of the population translates into larger house price increases where prevailing leverage ratios are higher (Almeida and others 2005; IMF, 2011b). Moreover, a number of studies have found that a tightening of LTV ratios can slow the rate of house price appreciation, thereby reducing the potential for a housing bubble to emerge (Igan and Kang, 2011; Wong and others, 2011; Crowe and others, 2011). For example, Crowe and others (2011) find that a 10 percentage point tightening of the LTV ratio leads to a decline in the rate of house price appreciation of between 8 and 13 percentage points.

30. Where these measures limit house price acceleration and household indebtedness, they may also dampen the associated increases in aggregate demand, in turn modifying optimal monetary policy. LTV and DTI measures may reduce the response of residential investment and household consumption to positive financial shocks. When they reduce the strength of financial accelerator mechanisms in the upturn, this may allow monetary policy to be somewhat looser than in the absence of these measures (IMF, 2008).

31. A growing body of evidence also points to the benefit of LTV and DTI ratios in containing the severity of the property bust when the housing market turns.

- In theory, where leverage is high, even a relatively small fall in house prices may lead borrowers to become underwater. This creates incentives to default strategically, which in turn imparts further downward pressure on prices. Consistent with this, IMF (2011b) show that across OECD countries over the 1980 to 2010 period, conditional on a housing bust occurring, the fall in property prices is less steep where LTV ratios are tight.

- A housing bust can put stress on financial intermediaries' engaged in mortgage credit, and tight LTV ratios can reduce these impacts. High rates of default can reduce profitability and deplete banks' capital cushions. Wong and others (2011) document that, for a given fall in house prices, the incidence of mortgage default is higher for countries without a LTV ratio limit than it is for countries with such a tool. They also show that losses sustained by lenders for a given fall in house prices are lower.

- Stress on financial intermediaries can lead to a contraction of mortgage credit and credit more broadly, adversely affecting both household consumption and business investment. Based on 1960–2007 cross-country data, Claessens, Kose, and Terrones (2008) show that output losses in recessions accompanied by housing busts are two to three times larger than otherwise. Moreover, housing busts tend to prolong recessions, as falling house prices act as a further drag on household consumption and residential investment, while putting financial intermediary balance sheets under stress.

32. By reducing the depth and duration of the downturn, limits on LTV and DTI ratios can also lessen the risk that monetary policy will run into its lower bound. When tight LTV and DTI ratios contain mortgage defaults and losses sustained by financial intermediaries in the wake of a fall in house prices, this can also reduce output losses from the property bust. A milder downturn can in turn reduce the need for monetary easing that would otherwise be necessary to counter the financial headwinds from the property bust. IMF (2008) shows formally that offsetting the deflationary impact of a negative financial shock requires a larger accommodative monetary policy response in an economy with a high LTV ratio and a smaller response where LTV ratios are tight.

33. These complementarities are further strengthened by the effects of LTV and DTI ratios on the transmission of monetary policy. As seen in many advanced countries since the crisis broke, when a large fraction of borrowers have high LTV mortgages, this can clog up the transmission of lower policy rates on conditions in mortgage markets after the bust. After a fall in house prices, high LTV borrowers will find themselves unable to refinance their loans since the principal exceeds the value of their property. These borrowers will then not be able to take advantage of lower mortgage rates that an easing of monetary policy may help bring about. A tighter LTV constraint going into the property bust can mitigate this and help strengthen the transmission of monetary policy after a house price falls (Geanakoplos, 2010).

34. Limits on DTI and LTV ratios can also affect developments in the composition of output that are not easily controlled by monetary policy. First, a tightening of these measures can, by slowing housing transactions and dampening house price growth, reduce the share of residential construction in GDP (see Section III for empirical evidence). Second, to the extent that these measures contain increases in household leverage, they can help control a rise in debt-financed consumption spending that worsens the current account. Along with other policy measures (such as structural and fiscal policies), LTV and DTI policies may thus contribute to a reduction of external imbalances.

Reserve requirements

35. Central banks can use variations in the level of RRs to affect broader credit conditions. When RRs are remunerated below the policy rate or are unremunerated, a variation in the level of the requirement imposes a tax on lending. This tax is expected to increase the spread between lending and deposit rates as banks pass on increased costs to their customers (Gray, 2011; Tovar and others 2012; Glocker and Towbin, 2012a). Independent of the incidence, since the tax will lead to a fall in deposit supply, or a contraction of loan demand, or both, the amount of credit provided to the economy is expected to fall. By increasing the spread between lending and deposit rates, RRs will then lower the amount of credit provided to the economy, acting as a "speed limit."

36. Inflation targeting central banks will typically offset the impact on banking system liquidity and interbank interest rates of a change in RRs. The volume of open market operations can be adjusted to offset the impact on banking system liquidity and to keep interbank rates close to the target rate. But even if the monetary effect of changes in RRs is sterilized, there can be a

macroprudential effect, which works through an increase in the spread between lending and deposit rates. See further the case studies for Brazil and Turkey in Section IV of this paper.

37. Empirical studies tend to find evidence in support of an effect on credit. Vargas and others (2011) study the experience in Colombia and find that RRs have a strong and lasting effect on lending rates charged on business loans. Glocker and Towbin (2012b) estimate a structural vector autoregressive (VAR) model for the Brazilian economy. They find that a one percentage point increase in the RRs leads to a peak increase in the spread between lending and deposit rates of 80 basis points. Moreover, domestic credit falls on impact by about 2.5 percent and remains below trend for close to two years. The empirical exercise reported in Section III is also consistent with a significant effect on credit.

38. However, increases in RRs do not increase resilience and can have unintended side effects. Unlike an increase in capital requirements, an increase in RRs has no impact on the resilience of the banking system to loan losses. In addition, an increase in RRs can exacerbate risk-shifting incentives. When RRs squeeze profitability this can lead banks to shift into higher margin, but higher risk segments, in an effort to restore return on equity. In Turkey, for instance, relatively aggressive increases in RRs in early 2011 may have further spurred banks' consumer lending, which was ultimately addressed by increases in regulatory risk weights on such lending (Turkey FSAP and case study). [13]

39. An increase in RRs can lead to nominal depreciation and affect capital inflows. In small open economies, increases in the monetary policy rate will tend to attract capital inflows and lead to an appreciation of the currency. Increases in RRs tend to have the opposite effects, since they will tend to decrease returns on domestic and FX deposits (Glocker and Towbin, 2012a). [14] Using data from Brazil, Glocker and Towbin (2012b) find that an increase in the reserves requirement by one percentage point leads to a 2 percent depreciation of the domestic currency. Evidence presented in Tovar and others (2012) confirms the effects of RRs on exchange rates, even if their results point to a more transitory depreciation. New evidence presented in Section III suggests that RRs have the potential to affect the composition of capital inflows, away from bank portfolio flows.

40. The effects of increases in RRs on output are ambiguous in theory. The rise in bank lending rates should tighten credit and lead to a decline in investment spending. However, the fall in deposit rates may decrease domestic savings and increase consumption. Moreover, any depreciation resulting from the increase in RRs would lead to an increase in net exports that boosts aggregate demand. This implies that while an increase in RRs unambiguously lowers aggregate

[13] These adverse effects of increases in RRs contrast with bank capital requirements. An increase in the latter leaves banks' return on total assets unaffected and in general reduces rather than increases banks' incentives to take risk.

[14] Since an increase in RRs will lead to a decline in deposit rates, under uncovered interest parity, net capital inflows will fall. An alternative explanation is that the tax reduces total expected return for foreign investors (Gray 2011).

credit, its net effect on output may be relatively small (Glocker and Towbin, 2012a).[15] Empirical results presented in Section III suggest that there is no measurable effect of an increase in RRs on output.

41. RRs provide a potential way to curb excessively strong credit growth, while effects on other economic variables are quite different from that of monetary policy. In contrast to increases in policy rates, an increase in RRs can reduce excessive credit growth without attracting net capital inflows and appreciating the exchange rate. Moreover, when increases in RRs dampen capital inflows, this can give greater room for maneuver for monetary policy to increase interest rates, as has been the experience in Peru (Tovar and others 2012).

42. Equally, in economic downturns, a relaxation of RRs can stimulate credit growth without this leading to a depreciation of the exchange rate or capital outflows. This contrasts again with the effects of an easing of the monetary policy rate, which is likely to contribute to a fall in the currency and capital outflows, especially in bad times (Federico, Vegh, and Vuletin, 2012).

43. In sum, the transmission of macroprudential policy tools and the implication for the conduct of monetary policy may differ with the tools considered.

- Some tools, including the dynamic capital buffer and limits on LTV ratios, increase the resilience of the economy against aggregate shocks, mitigating the effects on output of a credit crunch and housing bust. This can reduce the need to for accommodative policy in such scenarios and makes it less likely that monetary policy will hit the constraint imposed by the lower bound. It can also help keep open monetary transmission channels in a downturn scenario.

- When capital requirements and LTV ratios are tightened in upturns, they may have effects on credit and asset prices, and hence, potentially on aggregate output. Where these effects are sizable, they can be offset, as necessary, by more accommodative monetary policy.

- RRs may be a useful complement to monetary policy, especially in open economies, since use of this tool can control credit growth. This can give greater room for maneuver for monetary policy in the face of potentially destabilizing capital flows. The effect of an increase in RRs on output is ambiguous, though, and empirically found to be small.

III. EMPIRICAL ANALYSIS

A. Macroprudential Policies—Effects on Credit, House Prices, and Output

44. This section describes empirical analysis of the effects of macroprudential policy measures. Several empirical studies show that macroprudential policy instruments can be effective

[15] Empirically, Glocker and Tobin (2012b) find that increases in RRs increase unemployment in Brazil, but that this effect is half that from an equivalent variation in the monetary policy rate.

in addressing systemic risk externalities, if used appropriately. Lim and others (2011) find that macroprudential instruments may reduce the correlation between credit growth and GDP growth, and several studies show that limits on LTV and DTI ratios can curb the feedback loop between mortgage credit availability and house price appreciation. However, few studies consider differential effects across macroprudential tools. Moreover, there is to date only a very limited analysis of any macroeconomic effects of the use of macroprudential tools.

45. Our analysis expands on the existing literature in several ways.

- First, the direct effects of macroprudential measures on financial outcomes—credit growth and housing price appreciation—are tested.
- Second, we perform analysis of "side effects" of the macroprudential tools on economic growth, residential investment, and capital inflows.
- Third, we investigate whether the strength of these effects differs with measures of the economic and financial cycle.

Model specification and data

46. We focus on (varying) capital requirements (CR), limits on LTV ratios, caps on DTI ratios, and RRs. For each macroprudential instrument, an index variable is constructed. This index increases by 1 whenever an instrument was introduced or tightened and decreases by 1 whenever the instrument is loosened, resulting in a series that looks like a step function. The index variable captures both semi-quantitative effects and the average treatment effects of the instrument. Countries and periods in which instruments are not used are included as counterfactuals and help in identifying the effects of key control variables. The information required on the use of the instruments is obtained and extended from the 2010 IMF survey (Lim and others, 2011).[16]

47. A fixed-effect dynamic panel regression is used with the following specification:

$$\Delta Y_{i,t} = \alpha + \beta \cdot MaPP_{i,t} + \gamma \cdot \Delta Y_{i,t-1} + \delta \cdot X_{i,t} + \theta \cdot (MaPP \cdot X)_{i,t} + \varepsilon_{i,t}$$

For each country i, $Y_{i,t}$ and $MaPP_{i,t}$ represent changes of outcome variables and a time-series index of one of the four macroprudential measures respectively, where the coefficient β captures the effects of macroprudential measures on the outcome. $X_{i,t}$ denotes a set of control variables and $(MaPP \cdot X)_{i,t}$ is included to capture the interaction between the control variables and the macroprudential instruments. Throughout, we include time-fixed effects, to account for common variation across countries, as well as country-fixed effects, to account for time-invariant country-

[16] We would like to acknowledge Ivo Krznar's contribution to this section. The data comes mostly from Krznar and others (forthcoming) and the regressions extend the framework in Arregui and others (forthcoming).

characteristics. Our regressions also control for monetary policy rates and dummy variables denoting phases of credit and economic cycles.[17,18]

48. The measurement of the effects of policy changes on both financial and aggregate variables is subject to well-known endogeneity problems. This issue is shared by most existing studies on the effects of macroprudential policy study (e.g., Lim and others, 2011). When macroprudential policy responds to credit and asset prices, rather than output, this bias should in principle be stronger when measuring the effect on credit and asset prices—as does much of the existing literature—and weaker when investigating aggregate effects—which is the focus here. Moreover, as long as the problem does not differ across tools considered it may not affect comparisons across tools in their relative effects. Throughout, we lag all policy variables by one quarter in an attempt to address endogeneity biases.[19] Nonetheless, we take the results as only suggestive of the relative strength of the effects across tools, rather than as a reliable measure of the size of each effect.[20]

49. Quarterly data from 2000 to 2011 were used for 36 countries,[21] including 21 emerging market economies (EMEs) and 15 advanced economies (AEs).[22] Most of the data are collected from official and commercial sources, such as IFS, central banks, national statistical offices, Haver Analytics, and CEIC database, being specified along the results. Detailed information on countries which have used macroprudential policies can be found in Table 2.

[17] Variables in the form of dummies are constructed to control for the stages of financial and economic cycles. First, a credit bust is classified as a stage with either of the two following conditions being satisfied: (i) the deviation from a HP filtered trend is smaller than 1.5 times its standard deviation; or (ii) the quarterly credit growth rate is lower than a long-run average by 1.5 times its standard deviation. Second, a recession dummy is equal to one on the quarters when the output gap, using the HP filter, is negative for previous six consecutive quarters.

[18] In addition, interactions between monetary and macroprudential policies are analyzed, but no significant empirical evidence is found. We created dummy variables indicating whether the monetary stance is tight, or whether it is loose and estimated interactions between the macroprudential tools and the monetary policy dummies. This result is in line with results obtained by Dell'Ariccia and others (2012). Coefficients on the interaction terms are unstable and rarely significant across all macroprudential tools. Similarly we do not find that effectiveness of macroprudential policy depends on the monetary and FX regime, echoing results already documented by Lim and others (2011).

[19] In order to try to reduce the endogeneity problem, one quarter lagged policy variables are used for the main results, and a robust test is conducted with concurrent variables, which shows similar results.

[20] As mentioned in Lim and others (2011), the estimation of a dynamic panel by OLS with country and time fixed effects will be biased, since by construction there is a positive correlation between the lagged dependent variable and the unobserved individual level effects. We dropped the lagged dependent variable as a robustness check, and found that the main results do not change materially.

[21] The countries in the sample are as follows: Argentina, Austria, Brazil, Bulgaria, Canada, Chile, China, Colombia, Croatia, Estonia, Hong Kong SAR, Hungary, India, Indonesia, Ireland, Israel, Italy, Latvia, Malaysia, Mexico, Netherlands, Norway, Peru, Poland, Romania, Russia, Serbia, Singapore, Slovak Republic, South Korea, Spain, Sweden, Thailand, Turkey, Uruguay, and U.S.

[22] As of September 2012, the number of countries in the sample with each de facto exchange rate regime is as follows: free floating (10), floating (15), fixed (3) (of which currency board (2) and conventional peg (1)), and others (8) (of which crawl like (3), other managed (4), and stabilized (1)).

Table 2. Use of Macroprudential Measures Across Countries

	Advanced Economies			Emerging Market Economies		
	(Free) Floating	Fixed	Other Managed	(Free) Floating	Fixed	Stabilized or Other Managed
Capital requirement	Estonia, Israel, Korea	Ireland, Spain	—	Argentina, Brazil, Mexico, India, Thailand, Turkey	Bulgaria	China, Malaysia, Croatia
Limits on LTV ratio	Canada, Norway, Korea, Sweden	Hong Kong SAR, Netherlands	Singapore	India, Thailand, Hungary, Romania, Turkey	Bulgaria, Latvia	China, Malaysia
Caps on DTI ratio	Canada, Korea, Norway	Hong Kong SAR	—	Thailand, Poland, Romania, Hungary, Serbia	—	—
Reserve requirements	Korea	—	—	Argentina, Brazil, Chile, Colombia, Peru, Uruguay, India, Indonesia, Romania, Serbia	Bulgaria	China, Croatia, Russia

Sources: Lim and others (2011) and IMF staff.

Results—effect on financial variables

50. Investigating the effects on credit growth, we find statistically significant effects for both (varying) capital requirements and RRs (Table 3). For capital requirements in particular, we find that the effect on credit growth is stronger during credit busts. For a subsample containing EMEs only, we find that limits on LTV and DTI ratios are also associated with lower credit growth. In this subsample, the effect of RRs is little changed relative to the full sample. The effect of capital requirements on credit growth weakens, but remains stronger during credit busts.

Table 3. Effects of Macroprudential Measures on Credit Growth[1/]

All: 36 Countries	Credit Growth Rate (%, q-o-q)												
Credit Growth Rate (-1)	0.40	0.39	0.40	0.40	0.40	0.39	0.39	0.39	0.40	0.39	0.40	0.39	0.40
GDP Growth Rate	0.23	0.22	0.22	0.23	0.23	0.23	0.22	0.23	0.23	0.21	0.22	0.22	0.22
Interest Rate (-1)	-0.04	-0.04	-0.04	-0.04	-0.04	-0.05	-0.05	-0.05	-0.04	-0.04	-0.04	-0.04	-0.04
Credit Bust						0.88	0.44	0.56	0.48				
Recession										-0.61	-0.53	-0.56	-0.60
Capital Requirement (-1)		-0.51				-0.37				-0.59			
Limits on DTI Ratio (-1)			-0.21				-0.32				-0.22		
Limits on LTV Ratio (-1)				-0.13				-0.18				-0.15	
Reserve Requirements (-1)					-0.32				-0.36				-0.38
CR(-1)*Credit Bust						-1.38							
DTI(-1)*Credit Bust							1.60						
LTV(-1)*Credit Bust								0.16					
RR(-1)*Credit Bust									0.36				
CR(-1)*Recession										0.16			
DTI(-1)*Recession											-0.04		
LTV(-1)*Recession												0.14	
RR(-1)*Recession													0.16

EME: 21 Countries	Credit Growth Rate (%, q-o-q)												
Credit Growth Rate (-1)	0.42	0.42	0.42	0.41	0.41	0.40	0.40	0.39	0.40	0.41	0.41	0.40	0.41
GDP Growth Rate	0.28	0.28	0.26	0.26	0.28	0.24	0.21	0.22	0.24	0.26	0.25	0.24	0.26
Interest Rate (-1)	-0.04	-0.04	-0.04	-0.04	-0.04	-0.05	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04
Credit Bust						1.24	0.49	0.77	0.69				
Recession										-0.97	-0.92	-1.08	-1.12
Capital Requirement (-1)		-0.23				-0.19				-0.34			
Limits on DTI Ratio (-1)			-0.63				-0.80				-0.67		
Limits on LTV Ratio (-1)				-0.79				-0.73				-1.01	
Reserve Requirements (-1)					-0.40				-0.51				-0.51
CR(-1)*Credit Bust						-1.44							
DTI(-1)*Credit Bust							2.69						
LTV(-1)*Credit Bust								0.27					
RR(-1)*Credit Bust									0.21				
CR(-1)*Recession										0.17			
DTI(-1)*Recession											-0.01		
LTV(-1)*Recession												0.68	
RR(-1)*Recession													0.46

Source: IMF staff estimates.

1/ Green, orange, and yellow color in each cell indicate significance at 1, 5, and 10 percent level, respectively.

51. When investigating effects on house price appreciation rates we find statistically strong effects for limits on LTV ratios and capital requirements, but not for RRs. This suggests that in our sample, variation in capital requirements might have been specifically targeted at housing credit in a number of countries, such as higher risk weights on mortgage loans, while RRs by construction do not differentiate between asset classes, and are therefore less likely to have an effect on a particular asset price. Interestingly, the effects of macroprudential tightening (or loosening) on house prices is estimated stronger during recessions across most measures, while for

house prices the stage of the credit cycle appears to play less of a role. Throughout, the evidence for direct effects of variation in the DTI ratio on house prices is in general not as strong (Table 4).

Table 4. Effects of Macroprudential Measures on House Price Appreciation[1/]

All: 36 Countries	House Price Appreciation Rate (%, q-o-q)												
House Price (-1)	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.38	0.39	0.39	0.39
GDP Growth Rate	0.48	0.48	0.49	0.48	0.48	0.47	0.49	0.47	0.48	0.48	0.49	0.48	0.50
Interest Rate (-1)	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
Credit Bust						-0.26	-0.03	-0.18	-0.19				
Recession										0.20	0.08	0.33	0.43
Capital Requirement (-1)		-0.57				-0.64				-0.33			
Limits on DTI Ratio (-1)			0.30				0.33				0.33		
Limits on LTV Ratio (-1)				-0.34				-0.42				-0.22	
Reserve Requirements (-1)					-0.09				-0.13				0.10
CR(-1)*Credit Bust						0.72							
DTI(-1)*Credit Bust							-0.38						
LTV(-1)*Credit Bust								0.37					
RR(-1)*Credit Bust									0.42				
CR(-1)*Recession										-0.77			
DTI(-1)*Recession											-0.19		
LTV(-1)*Recession												-0.86	
RR(-1)*Recession													-1.19

EME: 21 Countries	House Price Appreciation Rate (%, q-o-q)												
House Price (-1)	0.39	0.39	0.39	0.38	0.39	0.31	0.32	0.31	0.38	0.38	0.39	0.37	0.38
GDP Growth Rate	0.40	0.40	0.41	0.37	0.40	0.25	0.26	0.22	0.51	0.42	0.41	0.38	0.43
Interest Rate (-1)	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.02	-0.03	-0.03	-0.03	-0.03
Credit Bust						-0.50	-0.22	-0.37	-0.08				
Recession										0.37	0.13	0.54	0.85
Capital Requirement (-1)		-0.21				-0.48				0.08			
Limits on DTI Ratio (-1)			0.53				0.40				0.52		
Limits on LTV Ratio (-1)				-1.05				-0.99				-0.66	
Reserve Requirements (-1)					0.05				-0.19				0.25
CR(-1)*Credit Bust						0.93							
DTI(-1)*Credit Bust							0.11						
LTV(-1)*Credit Bust								0.67					
RR(-1)*Credit Bust									0.42				
CR(-1)*Recession										-0.85			
DTI(-1)*Recession											0.05		
LTV(-1)*Recession												-1.21	
RR(-1)*Recession													-1.26

Source: IMF staff estimates.

1/ Green, orange, and yellow color in each cell indicate significance at 1, 5, and 10 percent level, respectively.

Results—effect on macro variables

52. Turning to the effects on output, the results of the main panel regressions suggest that limits on LTV ratio have an impact on output growth, and that this may work through a negative impact on investments in construction (Table 5). After controlling for monetary policy rates and foreign exchange rates, the coefficient on limits on LTV ratio across different regression equations is statistically significant in the whole sample. Especially for EMEs, a higher LTV ratio is associated with smaller investments in construction.

Table 5. Effects of Macroprudential Measures on Output Growth and Residential Investment[1/]

All: 36 Countries	Growth Rate (%, q-o-q)												
GDP Growth Rate (-1)	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.06	0.06	0.06	0.06
Exchange Rate	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Interest Rate (-1)	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Credit Bust						-0.05	0.01	-0.03	-0.05				
Recession										-0.26	-0.27	-0.29	-0.27
Capital Requirement (-1)		-0.08				-0.12				-0.12			
Limits on DTI Ratio (-1)			-0.11				-0.12				-0.15		
Limits on LTV Ratio (-1)				-0.12				-0.17				-0.15	
Reserve Requirements (-1)					0.16				0.12				0.12
CR(-1)*Credit Bust						0.30							
DTI(-1)*Credit Bust							0.02						
LTV(-1)*Credit Bust								0.23					
RR(-1)*Credit Bust									0.30				
CR(-1)*Recession										0.06			
DTI(-1)*Recession											0.21		
LTV(-1)*Recession												0.17	
RR(-1)*Recession													0.13

EMEs with De Facto Floating Exchange Rate Regime: 14 Countries	Residential Investment (Construction GDP) (%, as a percent of GDP)						
Residential Investment (-1)	0.99	0.99	0.99	0.98	0.99	0.98	0.99
Industrial Production	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Housing Price	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Interest Rates (-1)	-0.03	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
Credit Bust				-0.17	-0.16		
Recession						0.00	0.05
Limits on DTI Ratio (-1)		-0.06		-0.06		-0.05	
Limits on LTV Ratio (-1)			-0.09		-0.09		-0.08
DTI(-1)*Credit Bust				0.03			
LTV(-1)*Credit Bust					0.05		
DTI(-1)*Recession						-0.03	
LTV(-1)*Recession							-0.15

Source: IMF staff estimates.

1/ Green, orange, and yellow color in each cell indicate significance at 1, 5, and 10 percent level, respectively.

53. For other macroprudential tools, we find little evidence of a direct effect on output. The coefficients on capital requirements, caps on DTI ratio and RRs are not statistically significant, indicating weaker effects on output than found for the LTV ratio. It is possible that for capital and RRs statistically significant effects could be picked up in larger samples or using a different study design. However, the results also confirm existing studies that tend to find modest effects of these tools on output. See BIS (2010) and Glocker and Towbin (2012b), respectively.

54. By contrast, throughout, we find that variation in the policy rate has a statistically strong effect on output growth. These findings suggest that some macroprudential policy tools may be able to separately target a specific component of domestic demand, unlike monetary policy, but that the effect of these macroprudential tools on aggregate output is more limited. Conversely, the policy rate affects all economic activity regardless of which sector is vulnerable to systemic risks, and may then have stronger effect on output growth.

55. It is possible that the effects are too small to show up as statistically significant in our panel analysis. An indirect way of gauging the effects on output is to extrapolate from the effect on credit growth. A number of empirical studies show the effects of credit supply shocks on output growth, ranging from 0 to 0.34, that is, a one percent decline in credit supply induces a drop in the GDP growth rate of up to 34 basis points. Thus, combining with results in Table 5, some macroprudential policy instruments may still affect output growth to a meaningful degree.

Results—effects on capital flows

56. We finally turn to an investigation of the effect of macroprudential measures on capital inflows. Monetary policy is often said to be constrained in open economies since policy rate hikes to contain financial exuberance are likely to trigger more capital inflows. Some macroprudential tools, on the other hand have been found in the literature to be useful to affect gross flows and the composition of capital inflows.

57. We specifically investigate the determinants of portfolio investments. The specification is similar to those employed before. However, we now account for the effect of the spread between the domestic rate and the federal funds rate. In particular, we create a dummy variable that indicates whether this spread is unusually high, relative to the average in the country concerned.

58. The results of this exercise are contained in Table 6. We find that where the interest spread is high, this stimulates portfolio inflows. Moreover we do not find that capital requirements, LTV and DTI ratios have any effect on the strength of portfolio inflows. By contrast, we find statistically strong evidence that increases in RRs reduce portfolio inflows in emerging economies with floating exchange rates. These results chime with those found elsewhere in the literature: increases in RRs lead to a depreciation of the currency. They can also, more mechanically, arise when RRs apply to FX debt securities issued by banks.

Table 6. Effects of Macroprudential Measures on Capital Inflows [1/]

EMEs with De Facto Floating Exchange Rate Regime: 14 Countries	Portfolio Investment Inflows (%, as a percent of GDP)												
Portfolio Inflows (-1)	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.04
Growth Rate Differential	0.16	0.17	0.15	0.15	0.16	0.17	0.10	0.15	0.16	0.16	0.14	0.13	0.15
Current Account	-0.12	-0.12	-0.12	-0.12	-0.13	-0.11	-0.12	-0.12	-0.13	-0.12	-0.12	-0.13	-0.14
Interest Rate Spread	0.46	0.50	0.48	0.50	0.51	0.51	-0.01	0.52	0.54	0.52	0.46	0.45	0.53
Credit Bust						-0.31	-0.59	-0.45	-0.53				
Recession										-0.39	-0.38	-0.46	-0.41
Capital Requirement (-1)		0.87				0.94				0.61			
Limits on DTI Ratio (-1)			-0.06				0.16				-0.16		
Limits on LTV Ratio (-1)				-0.24				-0.29				-0.30	
Reserve Requirements (-1)					-0.37				-0.50				-0.53
CR(-1)*Credit Bust						-0.50							
DTI(-1)*Credit Bust							0.58						
LTV(-1)*Credit Bust								0.42					
RR(-1)*Credit Bust									0.73				
CR(-1)*Recession										2.10			
DTI(-1)*Recession											0.70		
LTV(-1)*Recession												1.54	
RR(-1)*Recession													1.04

Source: IMF staff estimates

1/ Green, orange, and yellow color in each cell indicate significance at 1, 5, and 10 percent level, respectively.

B. Effects of Macroprudential Policy Measures—Symmetric or Asymmetric?

59. This section describes additional empirical tests to investigate potential asymmetries in the effectiveness of macroprudential measures. From a policy perspective, it is important to ascertain whether the size of the effect of a tightening of a macroprudential policy tool differs from that of a loosening of the tool, or whether the effectiveness of macroprudential measures is symmetric.

60. Table 7 documents the number of instances, for each macroprudential tool, in which the measures were tightened and loosened. This suggests that for most measures, the number of tightening events is far greater than that of loosening events. This is a key limitation for the empirical analysis, since if there are few instances of loosening this will reduce the power of any test of differential effects. Inspection of the table suggests that this is a major issue in particular for capital requirements and DTI ratios. For RRs in particular, the situation is somewhat better with a ratio of tightening to loosening events roughly 3 to 1.

Table 7. Number of Macroprudential Measures—Tightening or Loosening

	Total Sample	Tightening	Loosening
Capital Requirements	1728	21	3
Limits on DTI Ratio	1728	17	2
Limits on LTV Ratio	1728	34	5
Reserve Requirements	1728	28	9

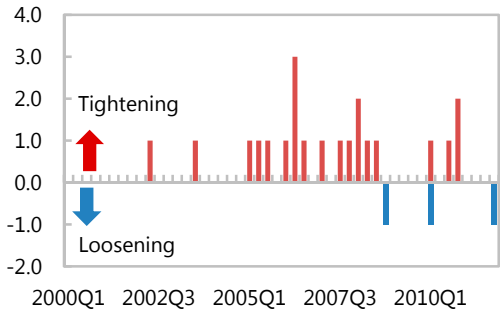
Sources: Lim and others (2011) and author's extension.

61. The potential for asymmetric effects is gauged by interaction exercises. The basic strategy followed is to interact the measure of the tightness of the macroprudential tool (the step function used previously) with dummy variables that indicate, for each change in the step function, whether the change is an increase (tightening) or a decrease (loosening). We examine the issue of symmetry for the key financial variables investigated before. That is, our dependent variables are credit growth as well as the growth of asset prices.

62. Figure 1 suggests that loosening events tend to occur from 2008, when in many countries there would have been financial stress as a result of the global financial crisis. This suggests that countries are more likely to loosen macroprudential policy tools when the financial system is in need of support. Our empirical analysis takes account of the resulting potential measurement bias by including dummy variables that indicate financial stress, such as credit bust, asset price busts and recession, as well as interactions with these variables that capture differential effects of macroprudential policy in times of stress.

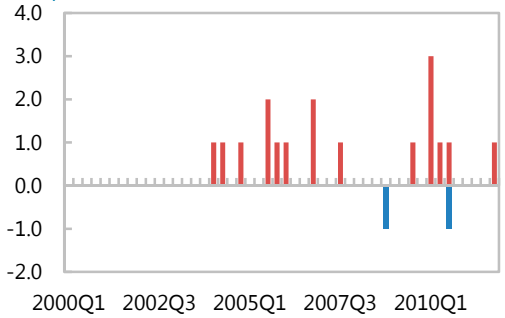
Figure 1. Number of Macroprudential Measures—Tightening or Loosening

Number of Tightening or Loosening of Capital Requirements (Sample: 36 countries)



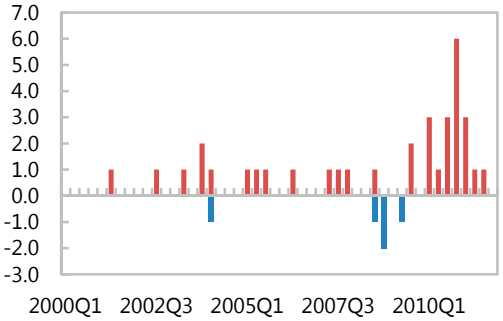
Source: IMF staff calculations.

Number of Tightening of Caps on Debt-to-Income Ratio (Sample: 36 countries)



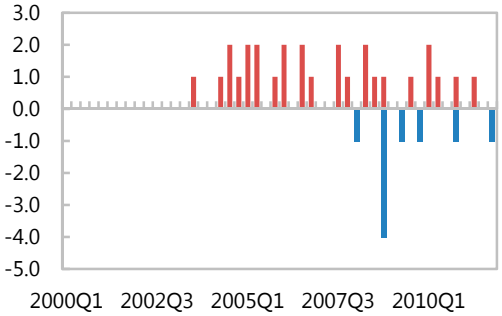
Source: IMF staff calculations.

Number of Tightening of Limits on Loan-to-Value Ratio (Sample: 36 countries)



Source: IMF staff calculations.

Number of Tightening of Reserve Requirements (Sample: 36 countries)



Source: IMF staff calculations.

63. Overall we cannot reject the hypothesis that the effect of macroprudential policy tools is symmetric, rather than asymmetric. The results on credit growth suggest that, if anything, a loosening of RRs has a stronger effect on credit growth than a tightening of RRs (Table 8). However,

for the other macroprudential tools, there are no measurable differences. The results on house prices suggests that, if anything, a tightening of LTV ratios appears to have a stronger effect than a loosening does, while, for other macroprudential tools there is no measurable difference (Table 9).

Table 8. Effects of Macroprudential Policy Stance on Credit Growth

	Credit Growth Rate (%, q-o-q)												
Credit Growth Rate (-1)	0.40	0.39	0.39	0.39	0.39	0.39	0.39	0.40	0.40	0.39	0.39	0.39	0.39
GDP Growth Rate	0.23	0.23	0.23	0.23	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.21
Interest Rate (-1)	-0.04	-0.05	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04
Credit Bust		0.88	0.43	0.55	0.49								
House Price Bust						-0.69	-0.66	-0.71	-0.58				
Recession										-0.62	-0.56	-0.65	-0.59
Capital Requirement (-1)		-0.33				-0.49				-0.56			
Limits on DTI Ratio (-1)			-0.25				-0.20				-0.17		
Limits on LTV Ratio (-1)				-0.07				-0.04				-0.04	
Reserve Requirements (-1)					-0.28				-0.23				-0.29
Other Measures(-1)		-0.13	-0.23	-0.27	-0.21	-0.14	-0.22	-0.29	-0.21	-0.14	-0.23	-0.31	-0.22
CR(-1)*Credit Bust		-1.44											
DTI(-1)*Credit Bust			1.90										
LTV(-1)*Credit Bust				0.11									
RR(-1)*Credit Bust					0.41								
CR(-1)*House Price Bust						0.74							
DTI(-1)*House Price Bust							0.82						
LTV(-1)*House Price Bust								0.45					
RR(-1)*House Price Bust									-0.10				
CR(-1)*Recession										0.20			
DTI(-1)*Recession											-0.02		
LTV(-1)*Recession												0.24	
RR(-1)*Recession													0.14
CR(-1)*CR_tight(-1)		0.20				0.13				0.14			
DTI(-1)*DTI_tight(-1)			-0.11				0.10				0.08		
LTV(-1)*LTV_tight(-1)				0.14				0.11				0.12	
RR(-1)*RR_tight(-1)					0.19				0.16				0.17
CR(-1)*CR_loose(-1)		-0.77				-1.11				-0.74			
DTI(-1)*DTI_loose(-1)			-0.67				-0.12				-0.07		
LTV(-1)*LTV_loose(-1)				-0.48				-0.35				-0.41	
RR(-1)*RR_loose(-1)					1.78				1.83				1.62
T-test (H0: two coefficients equal)		0.94	0.70	0.65	1.69	1.00	0.28	0.49	1.75	0.84	0.19	0.57	1.53
P-value		0.35	0.49	0.51	0.09	0.32	0.78	0.63	0.08	0.40	0.86	0.57	0.13

Source: IMF staff estimates.

1/ Green, orange, yellow color in each cell indicate significance at 1, 5, and 10 percent level, respectively.

64. These results need to be interpreted with great caution. As pointed out above, for some of the macroprudential tools, in particular capital requirements and DTI ratios, the incidence of

loosening events may be too small to detect differences that are statistically significant in a small sample. That is, it is quite possible that differences could be detected in samples with a greater number of observations.

Table 9. Effects of Macroprudential Policy Stance on House Price Appreciation

	House Price Appreciation Rate (%, q-o-q)												
House Price (-1)	0.39	0.38	0.39	0.40	0.39	0.38	0.38	0.38	0.38	0.38	0.39	0.40	0.39
GDP Growth Rate	0.48	0.48	0.48	0.48	0.48	0.39	0.41	0.40	0.41	0.48	0.48	0.47	0.49
Interest Rate (-1)	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
Credit Bust		-0.26	-0.03	0.31	-0.20								
House Price Bust						-4.89	-4.88	-5.09	-4.99				
Recession										0.20	0.02	-0.18	0.39
Capital Requirement (-1)		-0.65				-0.53				-0.39			
Limits on DTI Ratio (-1)			0.37				0.29				0.39		
Limits on LTV Ratio (-1)				0.04				-0.28				-0.21	
Reserve Requirements (-1)					-0.01				0.00				0.18
Other Measures(-1)		0.03	-0.25	-0.04	-0.17	-0.07	-0.29	-0.11	-0.22	0.03	-0.25	-0.05	-0.12
CR(-1)*Credit Bust		0.70											
DTI(-1)*Credit Bust			-0.43										
LTV(-1)*Credit Bust				-0.97									
RR(-1)*Credit Bust					0.46								
CR(-1)*House Price Bust						-1.41							
DTI(-1)*House Price Bust							-2.57						
LTV(-1)*House Price Bust								-0.28					
RR(-1)*House Price Bust									-0.72				
CR(-1)*Recession										-0.72			
DTI(-1)*Recession											-0.20		
LTV(-1)*Recession												0.38	
RR(-1)*Recession													-1.10
CR(-1)*CR_tight(-1)		-0.02				0.13				0.11			
DTI(-1)*DTI_tight(-1)			0.11				-0.01				0.03		
LTV(-1)*LTV_tight(-1)				-0.79				-0.36				-0.67	
RR(-1)*RR_tight(-1)					-0.20				-0.25				-0.20
CR(-1)*CR_loose(-1)		-1.06				1.51				-0.68			
DTI(-1)*DTI_loose(-1)			0.16				-0.12				0.11		
LTV(-1)*LTV_loose(-1)				-0.29				-0.59				-0.42	
RR(-1)*RR_loose(-1)					-1.90				-0.90				-1.41
T-test (H0: two coefficients equal)		0.90	0.06	0.23	1.38	1.06	0.13	0.23	0.55	0.68	0.09	0.49	0.98
P-value		0.37	0.95	0.82	0.17	0.29	0.89	0.82	0.58	0.50	0.93	0.62	0.33

Source: IMF staff estimates.

1/ Green, orange, and yellow color in each cell indicate significance at 1, 5, and 10 percent level, respectively.

IV. COUNTRY CASES

A. Selected Central, Eastern, and South-Eastern Europe Countries[23]

A salient feature of the experience in Central, Eastern, and South-Eastern Europe (CESEE) ahead of the crisis was a pronounced increase in foreign currency (FX) lending. This case study examines the experience of five inflation targeting countries in the region and investigates whether interest rate spreads stimulated the increase in FX lending. It also studies macroprudential policy responses that were taken to reduce the systemic risk associated with such lending. The study finds that where interest rates were low relative to advanced country rates, the increase in FX lending was less pronounced, other things equal. It also finds that the several macroprudential measures were effective in counteracting the increase.

65. This case study focuses on five inflation-targeting countries in Central, Eastern and South-Eastern Europe (CESEE): The Czech Republic, Hungary, Poland, Romania, and Serbia. The first three countries joined the European Union in 2004, the fourth in 2007, and the fifth became an EU accession candidate in 2012. The five countries have strong linkages to the Euro Area and have banking sectors dominated by large Euro Area banking groups.[24] The euro is their domestic currencies' natural cross.

66. The dispersion in the five countries' monetary policy rates has narrowed over time but remains large. The Czech Republic was the earliest inflation targeting adopter and has managed to maintain low inflation and low policy rates over the past several years, suggesting a high degree of policy credibility (Table 10). At the other end of the spectrum, Serbia has struggled to meet increasingly more ambitious inflation targets, with inflation overshooting the target by more than 5 percentage points in 2011, and policy rates remaining close to double-digits.

Table 10. Selected CESEE Countries: Inflation Target, Inflation Outturn, and Policy Rates, 2006–11

(in percent)

	Date of inflation targeting adoption	2011			2006		
		Target	Average inflation rate	End-year policy rate	Target	Average inflation rate	End-year policy rate
Czech Republic	1998	2±1	1.9	0.75	3±1	2.5	2.50
Poland	1999	2.5±1	4.2	4.50	2.5±1	1.1	4.00
Hungary	2001	3±1	4.0	7.00	3.5±1	3.9	8.00
Romania	2005	3±1	5.8	6.00	5±1	6.6	8.75
Serbia	2006	4.5±1.5	11.2	9.75	7-9	11.8	14.00

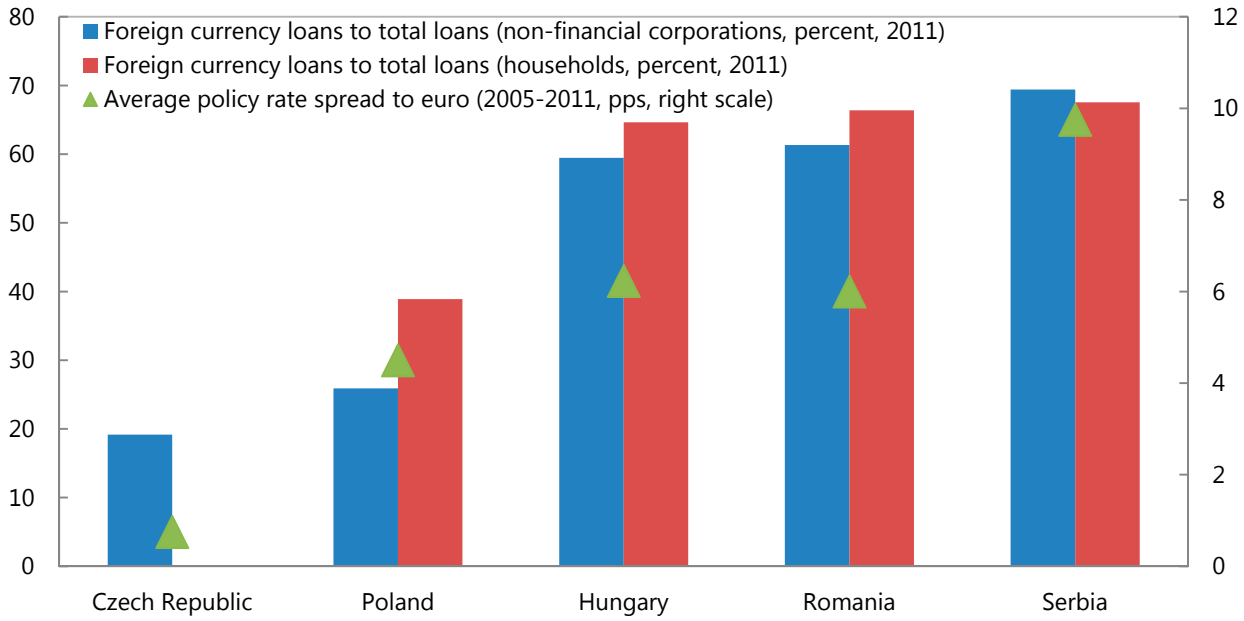
Sources: National central banks' websites, IFS, and authors' calculations.

[23] Prepared by Jerome Vandenbussche (EUR).

[24] See Chapter 4 of IMF (2011).

67. Higher policy rates are associated with a higher share of foreign currency (FX) loans across this group of countries (Figure 2). FX lending has been a long standing feature in a large part of CESEE and increased further during the credit boom of the last decade.[25] While there are multiple demand and supply factors that explain the currency composition of credit, and each of them is likely to have played a role in favoring the growth of FX loans in the region over time, it is striking to see that among our group of five inflation targeters, the level of the monetary policy rate is very strongly associated with the share of foreign currency loans.[26] Except for the Czech Republic, interest rates on domestic currency loans are generally higher than on FX loans, due to lower monetary policy credibility and/or higher inflation volatility in the domestic economy. The lower interest rate charged on FX loans may be too salient a feature for the typical unhedged borrower to appropriately factor the risks of FX appreciation into his or her decision. Indeed in many countries in the CESEE region, especially those with fixed or appreciating exchange rates, FX loans were perceived to be cheaper. This was especially the case for mortgages: mortgages in Euros and Swiss francs (and even in some cases in Japanese yen) carried a much lower interest rate—and longer maturity—than in local currency.

Figure 2. Selected CESEE Countries: Foreign Currency Loans and Policy Interest Rate Spreads, 2005–11



Sources: IMF BSA database, Haver, and author's calculations.

[25] See Dell'Ariccia and others (2012) for a description of the 2003-2008 credit boom in CESEE.

[26] Besides interest rates, other demand-side determinants include expectations of euro adoption, underestimation of foreign currency risk, and natural hedges. Major supply side determinants include deposit euroization and foreign funding of the banking system. Some determinants, such as institutional quality and exchange rate volatility operate both through the demand and the supply side. See, among others, Rosenberg and Tirpak (2008); Pann, Seliger and Ubelies (2010); Zettelmeyer, Nagy and Jeffrey (2010); and Steiner (2011).

68. To prevent the emergence of FX loans on a large scale, policy intervention may be needed. There are three main reasons for this. First, large aggregate unhedged FX exposures create negative externalities because they are a significant source of systemic risk in the banking system during crisis times (as greater installments increase the probability of default), and they generate greater macroeconomic volatility and limit macroeconomic policy options (because policy makers internalize the adverse balance sheet effects of devaluations or large depreciations on unhedged FX borrowers). Indeed, the Czech National Bank was able to reduce its policy rate by 150 bps between end-June and end-December 2008, while the Serbian National Bank increased its policy rate by 200 bps during the same period. Second, such exposures are subject to moral hazard related to implicit bailout guarantees. Third, a FX loan may expose the borrower (whether hedged or unhedged) to greater liquidity risk than a domestic currency loan if the bank supplying the loan is funded through international wholesale markets rather than more stable sources of funding (such as domestic deposits). All of these considerations may therefore justify policy action—on macroeconomic management and financial stability grounds—to limit the extent of FX borrowing in the economy. In addition, policy intervention may also be required for customer protection motives if some borrowers misunderstand and/or are not properly alerted to exchange rate risks.

69. Across the five countries, policy-makers addressed the risks associated with FX loans differently and at different stages of the recent boom-bust cycle (Table 11).[27] The Czech policy-makers did not have to intervene, as FX loans in their country were mostly to hedged corporations and remained stable throughout the past decade. Romania and Serbia, which have a large share of euroized liabilities, increasingly differentiated the rate of RRs by currency starting in 2004/05.[28] They also differentiated loan classification and provisioning rules by currency (in 2005 in Romania and in 2008 in Serbia). Higher risk-weights on FX loans above a certain threshold amount were introduced in Serbia in 2006, and higher risk-weights on FX mortgages were introduced in Poland in 2008. Poland (in 2006) imposed stricter debt-to-income (DTI) and loan-to-value (LTV) ratios on new FX mortgage holders (through the so-called "Recommendation S"). Romania imposed a maximum ratio of FX loans to unhedged borrowers to own funds between 2005Q3 and its entry into the European Union in 2007Q1, and tightened DTI limits for households for a short period in 2008-09. As the macroeconomic and financial costs of FX loans to unhedged borrowers became apparent during the post-Lehman bust, Hungary introduced LTV and DTI regulation differentiated by currency before banning FX mortgages altogether in 2010. More recently, Poland further increased risk-weights on FX household loans while Romania introduced differentiated LTV limits by currency. Across the CESEE region, there is now greater consciousness among policymakers of the need to develop local currency capital markets so that banks can decrease their reliance on FX

[27] For a comprehensive description of the recent boom bust cycle in CESEE and each of its individual countries, see Bakker and Klingen (2012).

[28] A significant part of FX loans in Hungary and Poland were funded through FX swaps, making differentiated RRs by currency in those two countries a less relevant possible instrument.

funding for long maturities,[29] while, at the European Union level, the European Systemic Risk Board has published a set of recommendations on lending in FX (ESRB, 2011).

Table 11. Selected CESEE Countries: Use of Macroprudential Measures Addressing Foreign Currency Loans, 2002Q1–2012Q1

	Czech Rep.	Hungary	Poland	Romania	Serbia
Differentiation of reserve requirement rate by currency				+	+
Differentiation of provisioning requirement by currency				+	+
Higher risk-weights for FX loans			+		+
Lower Loan-to-value ratio for FX loans		+	+		
Lower debt-service-to-income ratio for FX loans		+	+	+	
Maximum ratio of FX loans to capital				+	
Quantitative restrictions on the share of FX mortgages		+			

Sources: Vandenbussche-Vogel-Detragiache (2012) database and national central banks' websites.

70. A panel regression analysis confirms that greater interest rate spreads increase the share of FX loans within countries (Table 12). Explanatory variables included in the regression include the spread between the domestic policy rate and the policy rate of that currency's natural cross, the volatility between the domestic currency and that cross currency, and the past appreciation of the domestic currency relative to the cross currency. The natural cross currency is taken to be the euro in all cases. While higher spreads and greater recent appreciation are expected to stimulate demand for FX loans, exchange rate volatility is expected to reduce their attractiveness. Regression results, both for FX loans to non-financial corporations and to households, are consistent with these priors but only the interest spread is consistently significant.

71. At the same time, the several macroprudential measures have been effective in counteracting that effect. The various types of macroprudential measures discussed above are also included in the regression. Because policy-makers are likely to take measures against unhedged FX loans when they anticipate that unhedged FX borrowing would otherwise be strong, endogeneity likely biases the estimates for the effect of these measures. In spite of endogeneity, we do find that the strongest measures—a maximum ratio of FX loans to own funds as in Romania, and quantitative restrictions on the share of FX mortgages in Hungary (0 percent of the flow)—and that stricter debt-to-income ratios for FX loans had an impact.[30] The availability of funding in FX, captured by the change in the share of FX deposits and by the itraxx index (which is correlated with funding pressures of large Western European banks), does not enter significantly in the regression results.

[29] See European Bank Coordination ("Vienna") Initiative (2011).

[30] It is likely that more conservative LTV limits for FX loans helped keep default rates relatively low, even if—at least according to our analysis—they may not have done much to slow FX lending.

Table 12. Selected CESSE Countries: Determinants of the Share of Foreign Currency Loans, 2001Q1–2012Q1[1/]

	Non-financial corporations	Households
Explanatory variables:		
Macro variables		
Spread to EUR (or CHF) 1/	+ (**)	+ (**)
2-year volatility of EUR (or CHF) 1/	-	- (**)
2-year appreciation relative to EUR (or CHF) 1/	+	+
Macroprudential policy variables		
Maximum ratio of FX loans to own funds	- (**)	- (***)
Difference of reserve requirement rate by currency	+	-
Differentiation of provisioning requirement by currency	-	-
Higher risk-weights for FX loans	-	+
Lower LTV for FX loans		+ (*)
Lower DTI for FX loans		- (*)
Other restrictions on mortgages		- (*)
Bank funding variables		
Change in logistic transformation of share of FX deposits	+	+
Itraxx index	+	-

Sources: Haver, IFS, Vandenbussche-Vogel-Detragiache (2012) database, national central banks' websites, and authors' calculations.

1/ The dependent variable is the quarter-on-quarter change in the logistic transformation of the share of foreign currency loans (adjusted for exchange rate movements). The unbalanced panel covers the Czech Republic, Hungary, Poland, Romania and Serbia during 2002Q1-2012Q2 and contains 160 observations. The estimation method is fixed effects with robust standard errors. All explanatory variables are lagged one period. One (resp. two, three) stars indicates significance at the 10 (resp. 5, 1) percent confidence level. A "+" or "-" indicates the sign of the estimated coefficient. The strength of each type of macroprudential measure is measured using the same method as Vandenbussche-Vogel-Detragiache (2012). A dummy for Hungary in 2012q1 is included to account for the drop in the share of household foreign currency loans by about 6 percentage points because of the mortgage early repayment scheme initiated by the government.

2/ The euro is used as the cross currency in all cases but two. Because most FX loans to households in Poland and Hungary are in Swiss franc, the Swiss franc is used in those two cases.

72. We conclude that policy rate differentials have been one of the key drivers of changes in FX lending in our group of five CESEE inflation targeters, and that at least some macroprudential measures can contain vulnerabilities from FX lending by reducing the extent of the build-up. The case study confirms that strong monetary and macroprudential policies can have mutually reinforcing effects. If a country has a credible monetary policy regime, policy rates can stay relatively low, reducing the incentive for unhedged FX borrowing. Conversely, strong macroprudential policies can help enrich the set of feasible monetary policy options and sustain monetary policy transmission in small open economies. In the case of countries with a high degree of foreign ownership of the banking system, as in the CESEE region, circumvention of domestic macroprudential measures can be a relatively greater concern, and close home-host supervisory cooperation is therefore a requirement to enhance the effectiveness of both macroprudential and monetary policies.

B. Brazil[31, 32]

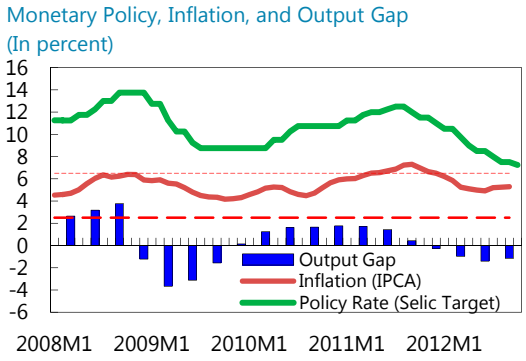
Brazil has been an active user of both monetary and macroprudential policies. Its experience during the post-crisis period illustrates well the complementary relationship between the two policies. Monetary policy was focused on ensuring price stability, and macroprudential instruments were used to contain the potential buildup of systemic risks from rapid credit growth. As these policies leaned against the business and financial cycle, synchronized during this period, the policy mix was appropriate to meet two objectives—price and financial stability—with two instruments.

Macroeconomic conjuncture and monetary policy

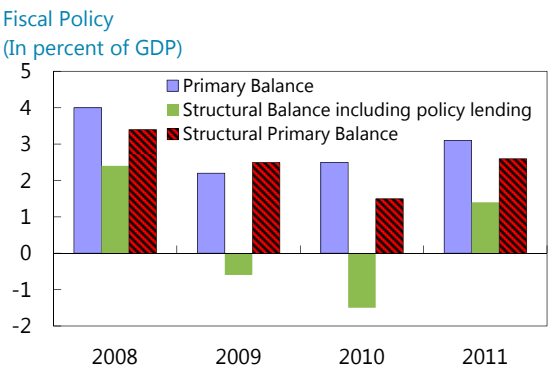
73. Brazil experienced a short but sharp swing in economic activity and inflation after the global financial crisis. Until early 2011, the real economy had rebounded strongly from the global financial crisis, even showing signs of overheating, and inflation was driven by buoyant domestic demand and high food and commodity prices. But the economy subsequently slowed sharply, and inflation dropped from the second half of 2011 on the back of policy tightening and in a globally more uncertain environment.

74. Monetary policy was used countercyclically in macroeconomic management during the post-crisis period. In response to rising inflation and the fast-paced economic rebound, the Banco Central do Brasil (BCB) raised the policy (Selic target) rate by 200 bps in 2010, which was followed by a 175 bps increase in the first half of 2011, amounting to a cumulative rate hike of 375 bps. But as global economic deterioration adversely affected confidence and trade, contributing to the sharp slowdown of economic activity, the policy rate was recently eased substantially, by 525 bps.

Figure 3. Brazil: Macroeconomic Conjuncture and Policy Responses



Sources: Banco Central do Brasil, IMF staff calculations.



Source: IMF staff reports.

[31] Prepared by Heedon Kang (MCM).

[32] The case study draws on the 2012 Article IV staff report, the latest FSAP update, Financial Stability Reports of the BCB, several published papers from the IMF and the BCB.

Credit expansion and macroprudential policies

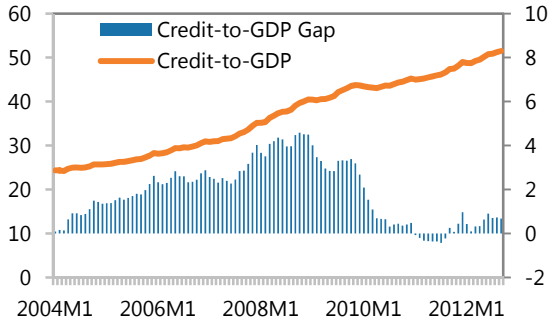
75. Credit expanded rapidly since 2004, supporting economic growth and financial inclusion, but also posing risks, particularly to the household sector (Figure 4).

- Credit-to-GDP in Brazil has risen fast, even if from a low base (from 24 percent of GDP in 2004 to 51 percent in 2012). To date though, its level remains relatively low by international standards.[33] Moreover, the pace of credit expansion has moderated recently, shrinking the estimated credit-to-GDP gap significantly.

- While household debt is still in line with that of regional peers, debt service-to-income and NPL ratios are high in comparison to those peers, reflecting high lending rates and short maturities, which are sources of vulnerability. Even though the growth of credit to households decelerated somewhat during the post-crisis period, the debt service-to-income ratio rose to 22 percent (18 percent at end-2008), and the NPL ratio increased to 8 percent.

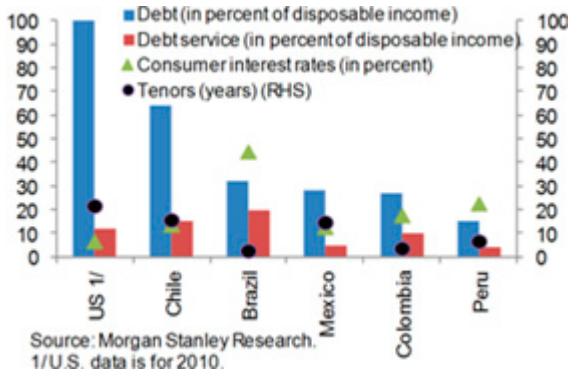
Figure 4. Brazil: Credit Expansion

Credit-to-GDP and Credit-to-GDP Gap
(In percent of GDP)

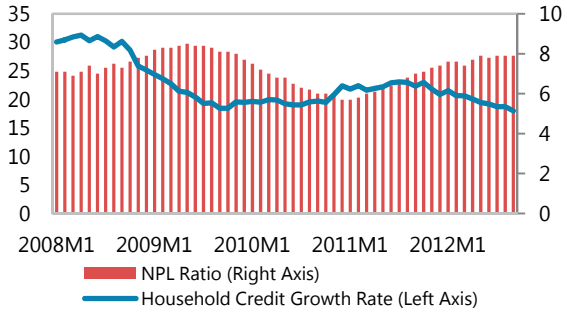


Sources: Haver Analytics, IMF staff calculations.

Latin America—consumer indebtedness, 2011

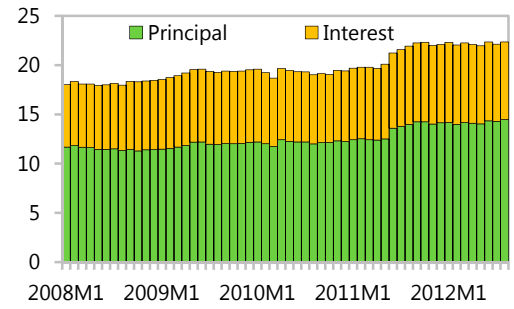


Household Credit Growth Rate and NPL Ratio
(In percent (YoY), in percent)



Sources: Banco Central do Brasil, Haver Analytics.

Household Debt Service to Income Ratio
(In percent)



Source: Banco Central do Brasil.

[33] See Dell'Ariccia and others (2012) for an international comparison of the credit-to-GDP ratio.

76. The BCB used macroprudential measures (MaPPs), such as reserve and capital requirements, to manage liquidity and contain the potential buildup of systemic risks from rapid credit growth and household leverage.

- The BCB changed RRs frequently to manage credit cycles in a countercyclical manner (Figure 5). Right after the onset of the global financial crisis, the BCB eased RRs to avoid a credit crunch in the financial system. Since then, the BCB used tighter requirements as speed limits, to slow down overall credit growth, in the conjunction with more targeted measures on consumer loans.

- Capital requirements on new loans to households were tightened in December 2010 (Table 13). The measure focused on vehicle financing, payroll-deducted loans, personal credits, involving longer maturities and higher loan-to-value (LTV) ratio. In November 2011, the BCB recalibrated the measure by removing the LTV condition on vehicle loans and lowering risk weights on shorter-term loans. A hike of the minimum payment for credit card bills to 15 percent from 10 percent was announced in December 2010 and implemented in June 2011, and the IOF (a financial transaction tax) on consumer credit operations was hiked to 3 percent from 1.5 percent in April 2011.[34]

Table 13. Brazil: Changes of Capital Requirements on Consumer Loans

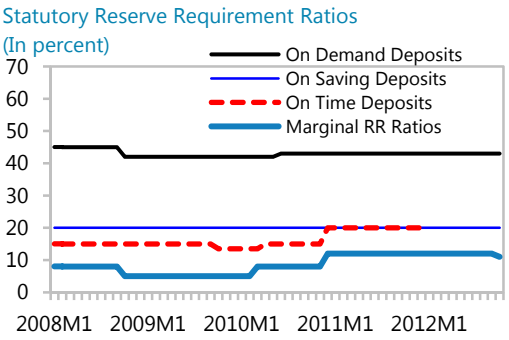
Operation	Conditions	Capital Requirement (In percent)
	(December 2010)	
Vehicles loans	Maturity between 24 and 36 months and LTV > 80 percent Maturity between 36 and 48 months and LTV > 70 percent Maturity between 48 and 60 months and LTV > 60 percent Maturity higher than 60 months and any LTV	16.5
Payroll deduction loans	Maturity higher than 36 months	
Personal loans	Maturity higher than 24 months	
Other consumer loans classified as retail		8.5
	(November 2011)	
Vehicle loans	Maturity under 60 months and classified as retail	8.25
	Maturity under 60 months and not classified as retail	11.0
	Maturity higher than 60 months	16.5
Personal Loans	Maturity under 36 months	8.25
	Maturity between 36 and 60 months	16.5
	Maturity higher than 60 months	33.0
Other consumer loans classified as retail		8.5

Source: Banco Central do Brasil.

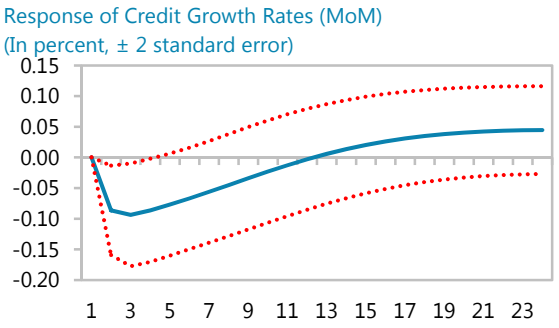
[34] This measure was to be tightened further to 20 percent in December 2011, but was not implemented.

77. Increases in RRs were temporarily effective in raising interest rate spreads and curtailing credit growth. The recent FSAP report shows impulse responses to a one percent shock in weighted average RRs that suggest a moderate but transitory slowing of credit growth (Figure 5). Glocker and Towbin (2012b) document that, when tightened in a bank-based economy like Brazil, RRs act as a tax on banks, increasing lending rates relative to deposit rates, contributing to a depreciation of the currency, and thereby reinforcing the dampening effect of tighter RRs on credit.[35]

Figure 5. Brazil: Impacts of RRs Tightening (1 percent) on Credit Growth



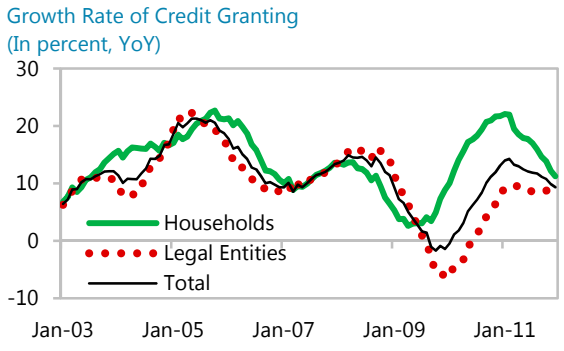
Source: Banco Central do Brasil.



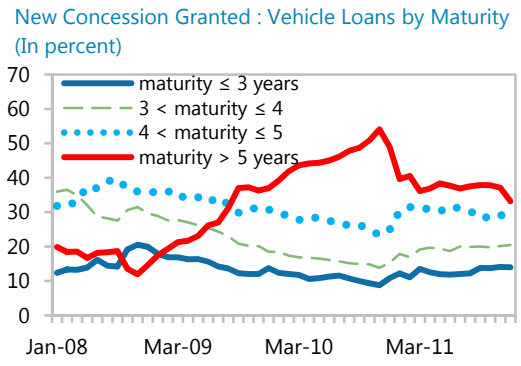
Source: IMF staff calculation.

78. Increases in the capital requirements on consumer loans contributed to reducing the speed of household credit growth (Figure 6). After the implementation of the December 2010 measure, the growth rate of credit to households decreased 11 percentage points (from 22 percent in December 2010 to 11 percent in December 2011).[36] And the proportion of vehicle loans with maturity higher than 60 months in total vehicle loans fell by about 20 percentage points.

Figure 6. Brazil: Effectiveness of Changes of Capital Requirements on Consumer Loan



Source: Banco Central do Brasil.



Source: Banco Central do Brasil

[35] The BCB sterilizes impacts on overall liquidity of changes in RRs via open market operations, in order to maintain the Selic rate close to its target, as decided by the Monetary Policy Committee (COPOM).

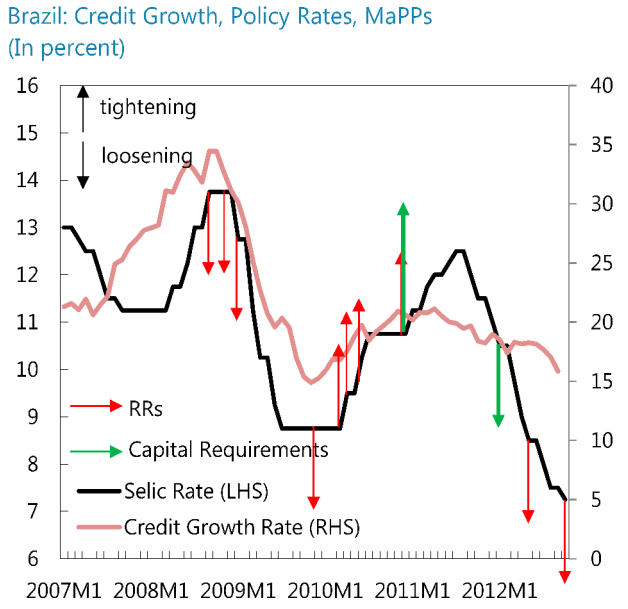
[36] It should be noted that the decrease occurred against the backdrop of a slowing economy.

Policy coordination

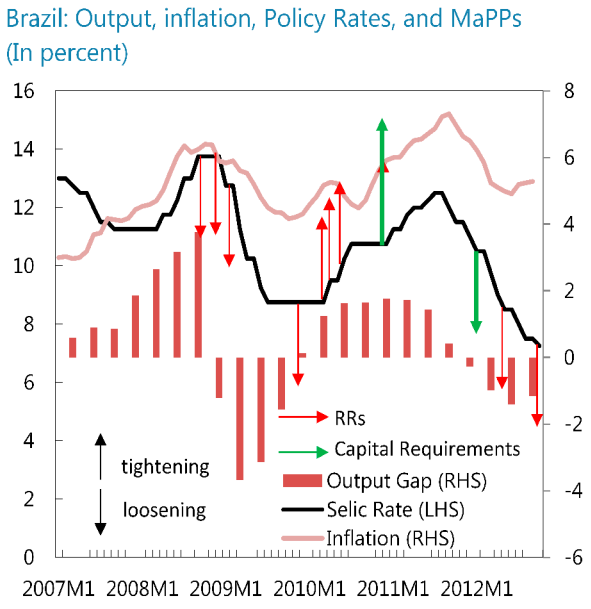
79. Since the fast economic recovery was synchronized with a rapid credit expansion, especially in the household sector, monetary and macroprudential policies appeared to be complementary.[37] From the first half of 2010 to mid-2011, the BCB raised its policy rate by 375 bps and tightened reserve and capital requirements. The policy mix was effective in managing aggregate demand and inflation pressures, as well as in reducing the pace of credit growth (Figure 7).

80. The BCB played a leading role in macroprudential policies with a broad range of tools at its disposal as both the monetary and supervisory authority. Based on guidelines of the national monetary council (CMN), the BCB executes monetary policy, and regulates and supervises the banking sector. It established a financial stability committee (COMEF) in May 2011 to separate more clearly the prudential policy function from the monetary policy function. The committee monitors sources of systemic risk, defines strategies to mitigate such risks, and allocates responsibilities among departments within the BCB.[38]

Figure 7. Brazil: Monetary and Macroprudential Policy Coordination



Source: Haver Analytics.



Source: Haver Analytics.

[37] The credit growth rate is strongly and positively correlated with the output gap and the inflation rate, from the second half of 2009. The correlation coefficients are 0.62 and 0.52, respectively.

[38] The BCB's mission is defined by its Board of Governors: "to ensure the stability of the purchasing power of the currency and the soundness and efficiency of the financial system."

C. Turkey[39]

In the aftermath of the global financial crisis, the Turkish authorities faced a challenging environment, characterized by widening current account deficits, strong short-term capital inflows, and rapid credit growth. In response, the Central Bank of the Republic of Turkey (CBRT) adopted a new "policy mix" that emphasized financial stability objectives, while other macroprudential measures were taken only with some delay. This case study examines the policy outcomes and points to the importance of coordination and clear communication in responding to building financial imbalances.

81. In the aftermath of the global financial crisis, the Turkish authorities faced a challenging environment. From late 2010, strong capital inflows led the Turkish lira (TL) to appreciate, undermining competitiveness, and fueled a credit boom, adding to inflationary pressures and increasing imports, leaving the economy exposed to the risk of a sudden capital flow reversal. Were the inflows to dry up—either in response to Turkey's imbalances or because of changes in the global risk appetite—the lira would have rapidly depreciated, adding to inflationary pressures (this time through the exchange rate pass-through), affecting balance sheets of banks and corporates that had been borrowing in FX, and undermining overall confidence. Indeed, earlier examples of such reversals led to sharp contractions of output.[40]

82. The CBRT, operating as an inflation-targeting central bank since 2006, became increasingly vocal about financial stability in mid-2010. It pointed to rapid expansion of domestic credit and an increase in external borrowing by corporates and banks,[41] with a significant share of it happening on a short-term basis. Together with real appreciation of the Turkish lira—significantly above what the CBRT considered to be consistent with the fundamentals and driven both by inflation differentials and nominal strengthening of the currency—this initiated a sharp widening of the current account deficit (Figure 8).

83. In absence of an active and timely response from the financial supervisor (BRSA), the CBRT was prompted to employ less traditional tools. This was done with an explicit purpose of addressing both price *and* financial stability concerns. The strategy was built around several instruments, with the emphasis shifting among them as ongoing developments provided insights into the usefulness of various elements of the continuously evolving framework.

84. A cornerstone of the strategy employed until mid-2011 was the policy-induced uncertainty in short-term market rates. Initially, in order to prevent fast appreciation of the lira, the CBRT relied on the preannounced FX purchasing auctions, the volume of which was increased as capital flows strengthened. Seeing them as ineffective, the CBRT lowered sharply the overnight

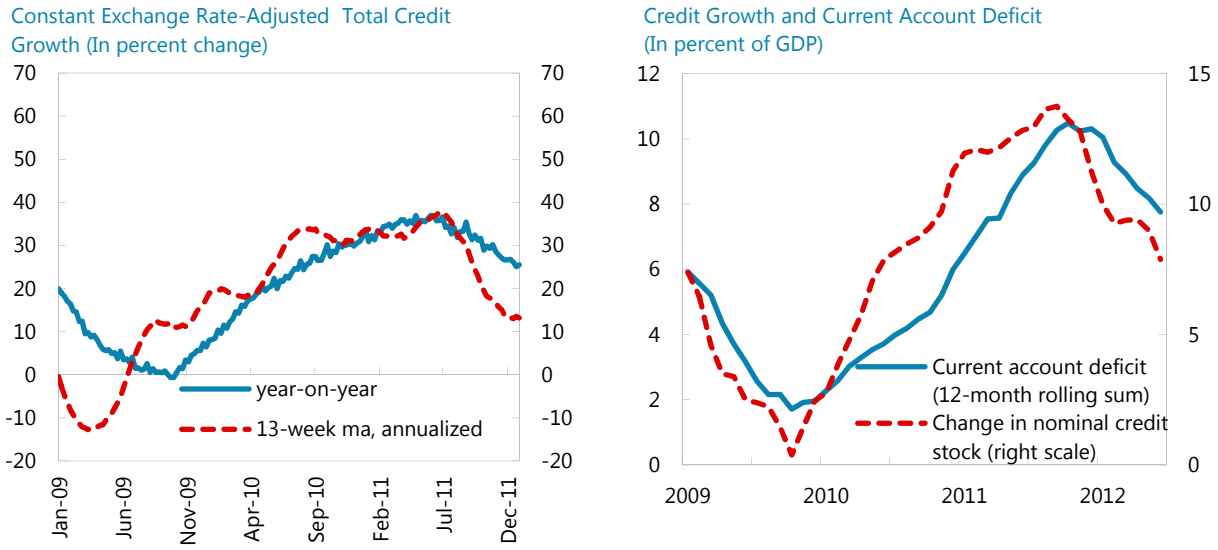
[39] Prepared by Robert Tchaidze (EUR) and Heiko Hesse (MCM).

[40] In 2001, seasonally-adjusted GDP fell by 11 percent from peak to trough and in 2009 by 13 percent.

[41] Households are not allowed to borrow in FX since 2009.

borrowing rate—from 6.5 percent in September 2010 to 1.75 percent in November—and, by varying the volume of liquidity provided via the repo auctions, opted to generate a lot of volatility in the overnight market rate.

Figure 8. Turkey: Credit Growth and Current Account Deficit



Source: Central Bank of the Republic of Turkey.

85. This "interest rate corridor"—formed by the CBRT's overnight borrowing and lending rates—came to serve as a signaling device. In May 2010, the CBRT introduced a policy rate, at which it would provide liquidity through quantity repo auctions. Initially, the overnight interbank rates used to be kept close to this policy rate, and thus, the latter was indicating what a short-term investor was likely to earn. As the interest rate corridor was "opened down," the volatility of the market rates was allowed to increase proportionally with it, even if on average they continued to remain close to the policy rate. Thus, now it was the floor of the corridor that came to indicate a guaranteed rate of return. This, it was hoped, would deter speculative inflows and reverse appreciation of the lira.

86. In addition, in order to impact lending directly, the CBRT turned to the RRs. While it saw them as the last tool to be used (after short-term interest rates and liquidity management) when price stability was at stake, it also saw them as the first line of defense when it came to financial stability. The CBRT argued that elasticity of demand for credit to interest rates is low and that instead it had to rely on the RRs. Thus, the CBRT started to increase them (in June 2010 for FX denominated liabilities and in November 2010 for TL), ceased to remunerate them (September 2010),[42] and finally started to differentiate them by maturity (since February 2011 for TL

[42] On TL liabilities. RRs on FX denominated liabilities have been unremunerated since December 2008.

and since June 2011for FX). By June 2011, the RRs on short-term TL liabilities were increased to 16 percent, from 5 percent in October 2010.

87. By then, the policy response had predominantly been led by the CBRT, and macroprudential tools that were in the domain of the BRSA had been relatively underutilized. In response to the global financial crisis, the BRSA took some steps in 2008–09 that helped safeguard the domestic financial sector: in October 2008, banks' dividend payouts were sharply curtailed to bolster bank retained earnings and capital (renewed in following years); and in June 2009, banks were prohibited to lend to consumers in FX. The BRSA took some further steps in December 2010, when it introduced de jure loan-to-value limits on real estate loans and allowed regulatory forbearance measures introduced following the global crisis to lapse in March 2011. Finally, the authorities used moral suasion to target a uniform 25 percent increase on banks' annual loan growth for 2011, which appeared to have become binding for some banks in mid-2011.

88. The key macroprudential measures were introduced by the BRSA in June 2011. It increased risk weights for new general purpose (consumer) loans and raised general provisioning requirements for banks with high levels of consumer loans or non-performing consumer loans. While the June measures on consumer loans were brought in with a delay, together with the credit growth cap and the worsening external market conditions, they have contributed to the sharp slow-down in credit growth in the second half of 2011. The BRSA also limited credit card payments in July 2011, introduced capital surcharges for large exposures to interest rate risk (August 2011), and amended minimum capital requirements for banks with strategic foreign shareholders (September 2011).

89. Even though the macroprudential measures helped slow down credit growth, in late 2011 the monetary framework had to be significantly altered. At that time, in part reflecting jitters in the global financial markets, the currency depreciated beyond what had been the intention, and the inflows weakened. The depreciation fueled inflation, which by end-year stood at 10.4 percent against the target of 5 percent. The CBRT switched to FX selling auctions and even undertook direct interventions. The RRs were lowered. The overnight borrowing rate was raised back to 5 percent in August, while the overnight lending rate was increased in October from 9 percent to 12.5. In spite of all this, the current account deficit ended up at 10 percent of GDP, the second highest in the world in dollar terms.

90. In principle, changes to the RRs could have impacted credit growth in two different ways, monetary and macroprudential. First, and in principle, a tightening of RRs withdraws liquidity from the market and may thus increase interbank market rates, thereby providing for monetary tightening. However, by injecting liquidity through open market operations, the CBRT chose to offset this monetary effect, in an effort to maintain market rates close to the policy rate, on average. Second, and even if the monetary effect is offset, there can be a macroprudential effect: a tightening of RRs forces banks to widen net interest margins, since it is a tax levied on banks' liabilities, which can be offset either by lowering deposit rates or by raising lending rates or both. In both cases, lending would be negatively affected, either through a reduction in available funds or through weakened demand for credit.

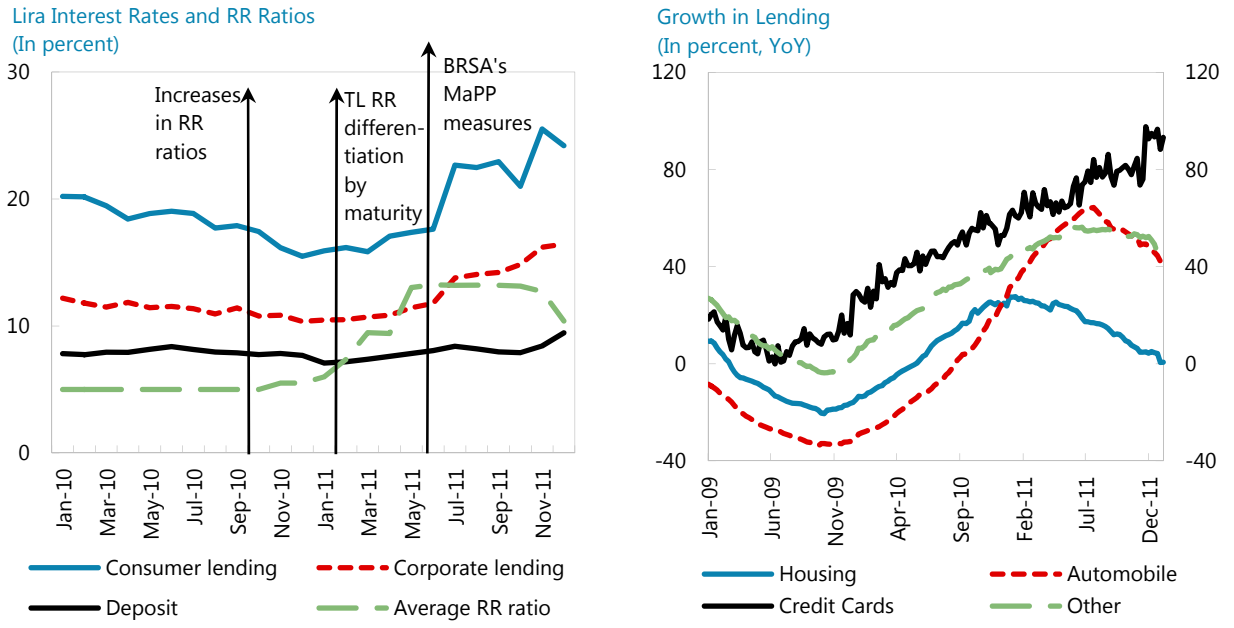
Table 14. Turkey: Macroprudential Measures Undertaken in 2008–11

Measure	Description	Adoption Date
Dividend policy	Requires banks to seek approval from the BRSA before distributing dividends. The maximum dividend payout for CAR>18 percent is 20 percent, for 16 percent<CAR<14 percent is 15 percent and for 13 percent<CAR<16 percent is 10 percent.	October 2008; extended in 2010 for 2009 profits; and again in 2011
Restrictions on FX lending	Allows non FX-earnings companies to borrow in FX from local banks (previously, only FX-earning companies could borrow FX), provided FX loan amount is greater than US$5 million and maturity date is longer than a year; bans consumers from taking out FX-linked loans	June 2009
Loan-to-value (LTV) ceilings	Implements loan-to-value ceilings on housing loans to consumer (at 75 percent) and on purchases of commercial real estate (at 50 percent)	December 2010
Guidance to Credit Growth Cap	The authorities provided guidance to banks that credit growth (adjusted for FX movements) in 2011 should not exceed 25 percent.	Spring 2011
High risk weights for consumer loans	Higher risk weights introduced for fast growing consumer loans. For new general purpose loans with maturities below two years, the risk-weighting increased to 150 percent (from 100 percent). For new general purpose loans with maturity greater than two years, the risk-weight increased to 200 percent (from 100 percent)	June, 2011
Increased provisions for consumer loans	For new (performing) general purpose loans, general provisions were increased from 1 percent to 4 percent. Specific provisions for (pre-nonperforming) loans increased from 2 percent to 8 percent. The higher provisioning requirements are conditional on banks having a consumer loan portfolio exceeding 20 percent of total loans or having a general purpose loan NPL greater than 8 percent.	June 2011
Limits to credit card payments	If three or more monthly payments within a calendar year are less than half of the outstanding balance for the period, the individual credit card limits cannot be increased and cash advances for such credit cards cannot be permitted, unless the outstanding balance for the period is fully covered.	June 2011
Interest Rate Risk	Announced by the BRSA to contain interest rate risk through capital changes on large maturity mismatches, discouraging duration gaps. Effective from 2012.	August 2011
Changes to minimum Capital Adequacy Requirements	Amended by the BRSA in September 2011 to apply to banks with foreign strategic shareholders as of January 2012. The minimum ratio would depend on various factors such as the CDS spread of the parent and its sovereign, EBA stress test results and the public debt ratio in the country of origin.	September 2011

Sources: Turkish authorities and IMF staff.

91. The effectiveness of macroprudential measures in controlling credit growth is not easy to judge from the data. When the RRs started to increase, lending rates were at first declining, while the deposit rate decreased with a lag and only marginally. As the RRs were increased further and became differentiated by maturity, lending rates started to rise. However, so did the deposit rate, suggesting that banks continued to expand credit, possibly moving further into the higher return, higher risk segments, and with that in mind, trying to attract more deposits. By contrast, as the BRSA measures were introduced, the impact on lending became more pronounced, with the credit growth rates declining and the lending rates increasing much faster. This suggests that the BRSA measures were more effective in curbing credit growth, in particular in 2011Q4. Increases in lending rates also suggest that the slowdown in credit can be at least partly attributed to these measures, rather than implying a slowdown in credit demand as a result of the cooling economy.

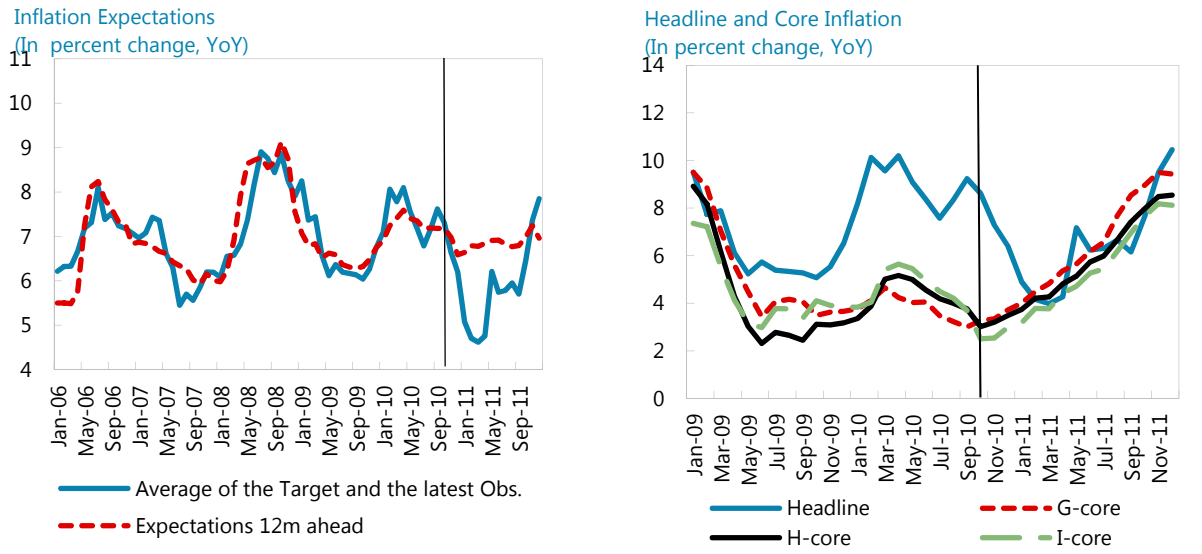
Figure 9. Turkey: Interest Rates, Reserve Requirement Ratios, and Growth of Lending



Sources: Central Bank of the Republic of Turkey and BRSA.

92. The mechanics of the framework had also negatively affected the primary objective of the CBRT—inflation and inflationary expectations. In spite of favorable developments, with inflation dropping in early 2011 to a 40-year low, the core inflation measures started to accelerate again from October 2010, when the new framework was put in place, a trend changed only in early 2012. As for the inflationary expectations, until the inception of the new framework, they were well approximated by an average of the inflation target and the latest observation. Under the new framework, expectations have remained broadly flat at around 7 percent, suggesting that the link broke and that survey participants simply reported the numbers around the top of the CBRT's inflation target band.

Figure 10. Turkey: Inflation Expectations and Inflation Rates



Sources: Central Bank of the Republic of Turkey and IMF staff calculations.

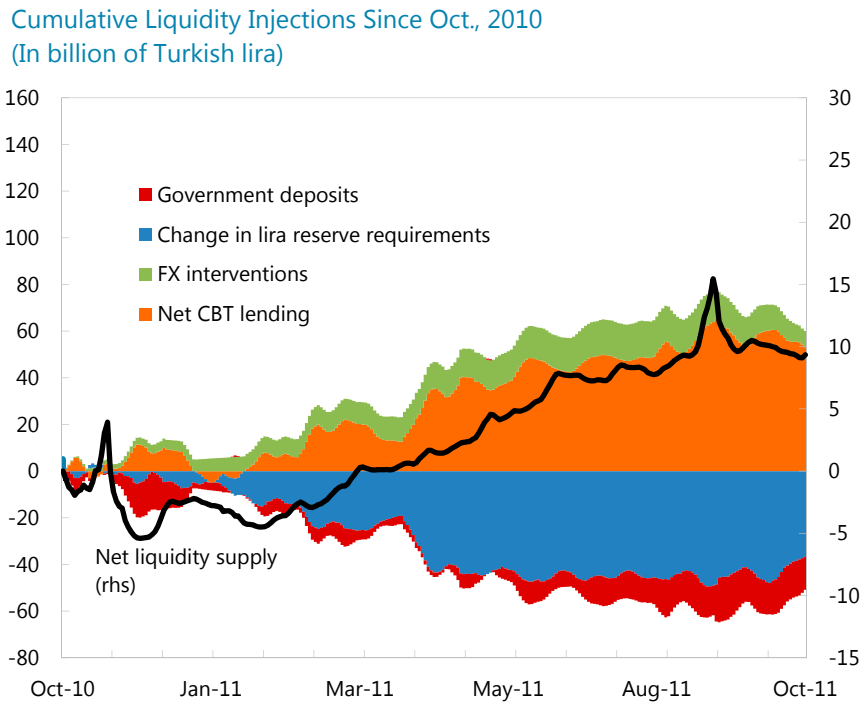
93. While it is hard to pinpoint factors that led to these developments, two hypotheses can be put forward. First, the reliance on the RRs to deliver both financial and price stability was miscalculated, particularly since an increase in the volume of the open market operations offset the liquidity withdrawal, so that the overnight market interest rates would remain on average close to the policy rate by (a strategy abandoned in 2012). The second is that with too many objectives and too many tools, market participants became disoriented and confused when trying to deduce the prioritization of the various objectives and the ultimate goal of these policies. For instance, in August 2010, the CBRT cut its policy rate by 50 basis points, something one would expect either in the face of a slowdown or strong inflows, but the RRs were kept high and the FX purchasing auctions had already been canceled.

94. Altogether, Turkey's 2010–11 experience demonstrates the importance of policy coordination. Had macroprudential measures been employed in Turkey in a more timely fashion, they could have relieved pressure on the central bank, which was trying to address financial stability concerns while attempting to prevent the emergence of imbalances, manifested in heightened inflation and the large current account deficit.

95. Other lessons can be drawn as well. Firstly, a clear assignment of tools to the policy objectives is needed: interest rate based policies, part of a central bank's tool-kit, are better suited to dealing with the price stability objective, while the macroprudential policies, which apart from the RRs are in a financial supervisor's domain, are better suited to dealing with the financial stability objective. Secondly, communication, in particular in times of frequent and large policy changes, is of utmost importance to guide market's expectations. The expectations channel of monetary policy breaks down easily and repairing it requires time and significant efforts when the authorities abandon a clear assignment of tools to objectives. Finally, to ensure financial stability,

macroprudential policy action needs to be timely and well-coordinated among several agencies, ensuring that the chosen policy-mix is most effective in dealing with emerging financial imbalances.

Figure 11. Turkey: Cumulative Liquidity Injections



Source: Central Bank of the Republic of Turkey.

D. Korea[43, 44]

During the 2000s, Korea experienced housing price boom-busts and a sharp increase of short-term foreign currency (FX) borrowing in its banking system. While the Bank of Korea (BOK) focused on price and output stability under a flexible inflation targeting framework, financial imbalances in the housing market were addressed with targeted macroprudential policy measures, such as limits on loan-to-value and debt-to-income ratios. More recently, restrictions on FX derivative positions, and a Macroprudential Stability Levy were brought in to curb excessive short term foreign currency borrowing. This case study shows that such macroprudential measures have clear advantages over the use of monetary policy, which is too blunt to deal with housing market developments

[43] Prepared by Heedon Kang (MCM).

[44] The case study draws on the IMF Article IV staff reports, Monetary Policy Reports and Financial Stability Reports of the Bank of Korea (BOK), working papers from the IMF and the BOK, and several journal articles.

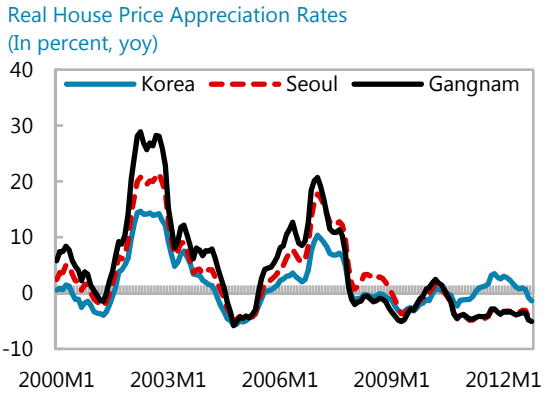
and can worsen external vulnerabilities in an economy with a fully open capital account like Korea.

Housing price boom-bust and limits on LTV and DTI ratios

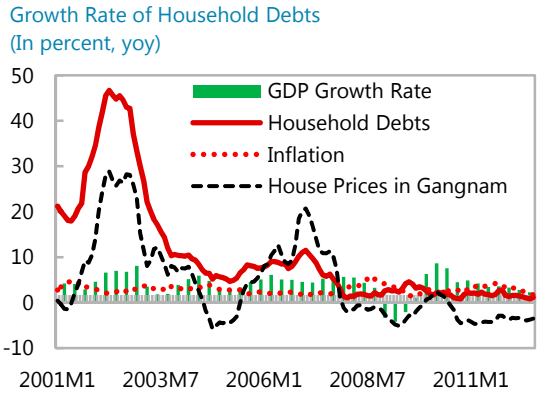
96. Korea experienced two housing price booms during a period of macroeconomic tranquility prior to the financial crisis. During these periods, both house prices and mortgage loans increased in a synchronized fashion, demonstrating the two-way feedback loop (Figure 12).[45] The booms began with a sharp house price increase in a prime location, the "*Gangnam*" district in the southern part of Seoul, followed by increases in other parts of Seoul and other regions in Korea with time lags. The expansion of bank credit to households, especially mortgage loans, was also fuelled by other factors, such as the liberalization of the housing finance system,[46] the resulting severe competition for mortgage market share, and the preferred treatment of mortgage loans in the BIS capital adequacy ratio calculation (Igan and Kang, 2011; Lee, 2012).

97. The authorities were aware of the dangers of house-price boom busts and responded. Since the house price booms were financed through mortgage loans, the balance sheet of households was likely to deteriorate sharply when the boom turned into bust, which in turn could lead to a credit crunch, with negative consequences for real economic activity (Crowe and others, 2011). One of the lessons, which policymakers in Korea took away from the Asian crisis in 1997–98, was that a credit boom-bust can trigger fire-sales of assets and a devastating recession, and it paved the way for strong policy reactions by Korean authorities to tame the house price booms, in order to prevent the recurrence of financial crises.

Figure 12. Korea: House Prices and Household Debts



Source: Kookmin Bank.



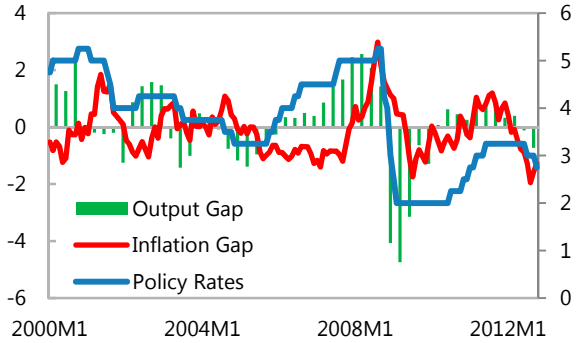
Sources: Bank of Korea and Kookmin Bank.

[45] During the 2000s, prior to the financial crisis, the economic growth rate remained around 5 percent and CPI inflation stabilized around 3 percent.

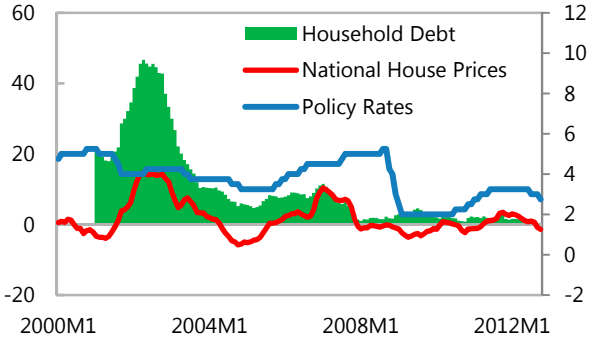
[46] The housing finance system was deregulated from the second half of 1990s. Particularly, commercial banks actively provided mortgage loans in 1996, followed by the 1997 privatization of the Korean Housing Bank (KHB), the monopolistic provider of low-interest and long-term housing loans.

98. However, the sector- and region-specific feature of the booms made it difficult to use a policy tool, which affects the economy at large, such as monetary policy. As a flexible inflation targeting central bank, the Bank of Korea (BOK) used its policy rates as a countercyclical tool to achieve price and output stability, rather than as a tool to influence house price dynamics (Figure 13). Between January 2000 and September 2008, the correlation coefficient between policy rates and the output gap (inflation gap) is calculated as 0.68 (0.19), while the one between house prices and policy rates is only 0.03. This also reflects the fact that house price cycles were weakly or even negatively correlated with inflation and output cycles (-0.40 and 0.24) during the period.

Figure 13. Korea: Monetary Policy as a Countercyclical Tool



Sources: Bank of Korea and IMF staff calculations.



Sources: Bank of Korea and Kookmin Bank.

99. The Korean authorities used limits on loan-to-value (LTV) and debt-to-income (DTI) ratios on mortgage lending to contain systemic risks from the housing price boom and the associated household debt growth. Since their launch in September 2002 and August 2005, the LTV and DTI limits have targeted speculative regions in the real estate market, rather than the whole housing market on a nationwide basis. Their specific conditions have also been flexibly adjusted in terms of maximum limits, loan types, and covered financial institutions. The measures were tightened six and five times respectively, and loosened four times (Table 15).

100. Several studies show that the two measures reduced house price volatility, tamed speculative incentives, and promoted the soundness of financial institutions, by keeping households' default rates low, but that they were less effective in curbing rising household debts.

- Igan and Kang (2011) present econometric results that house price appreciation slowed down and transaction activity dropped in the six-month and three-month window following a tightening of LTV and DTI limits. In addition, they find that the impact worked through the expectations channel: tightening measures curbed households' expectations about future gains from house price appreciation, which reduced housing demand and alleviated pressures on house prices. However, the authorities had to adjust them frequently and close loopholes in order to maintain their effectiveness.

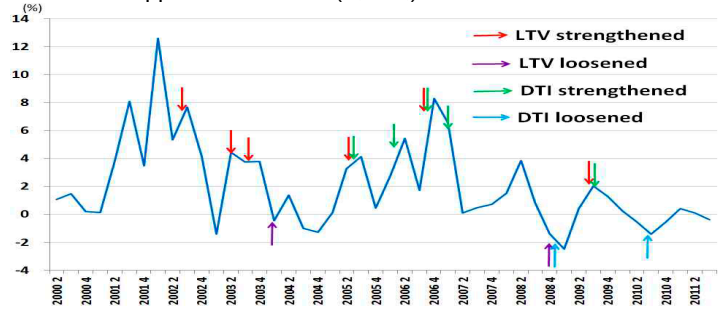
- Housing prices fell from 2008, but the delinquency ratio on household loans remained below 1 percent even until September 2012. This implies that strict implementation of limits on LTV and DTI ratios prevented households' defaults even as house prices fell, thus reducing financial institutions' credit risks. From this standpoint, the measures were helpful to secure the soundness of financial institutions (Lee, 2012).

- Household debt continued to expand even under the LTV and DTI limits, mainly for two reasons. First, incentives to expand mortgage loans were strong from banks' perspectives due to profits from higher lending rates than on corporate loans, and the preferred treatment of household loans in the BIS capital adequacy ratio calculation (Lee, 2012). Second, nonbanks expanded credit to households, for which the authorities needed to close gaps by extending the regulations to nonbanks. While the growth of bank credit to households declined to less than 10 percent from 2007, nonbank credit continued to expand briskly at 16 percent until the financial crisis began (IMF, 2012).

- Indeed, it is conceivable that the expectations that macroprudential measures would be taken to support house prices in downturns may have indirectly contributed to the continuing growth of household debt. Greater reliance on market driven price corrections might have helped prevent excessive leverage (see 2012 Article IV Staff Report, Box 2). While the targeted use of LTV and DTI ratios can be seen as successful in Korea, asymmetric use of such measures can be a potential pitfall.

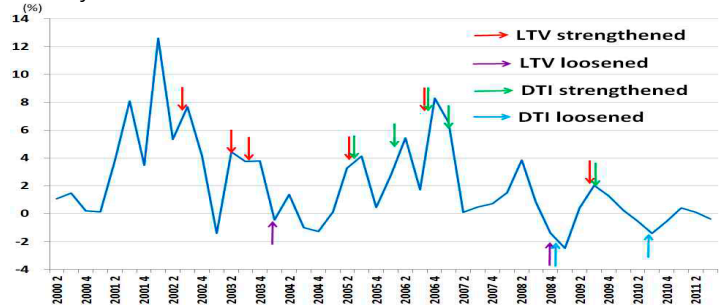
Figure 14. Korea: Effectiveness of Limits on LTV and DTI Ratios

House Price Appreciation Rates (Q-o-Q)



Source: Lee (2012).

Quarterly Provision of Household Loans



Source: Lee (2012).

Table 15. Korea: Changes of Limits on LTV and DTI Ratios

Date	Limits on LTV Ratio	Coverage	Direction
Sep. 2002	Introduced limits on LTV ratio as 60 percent.	Banks	Inception
Jun. 2003	Reduced the LTV ratio from 60 to 50 percent for loans of three years and shorter maturity to buy houses in the speculative zones.	Banks	Tighten
Oct. 2003	Reduced the LTV ratio from 50 to 40 percent for loans of 10 years and shorter maturity to buy houses in the speculative zones.	Banks	Tighten
Mar. 2004	Raised the LTV ratio from 60 to 70 percent for loans of 10 years or longer maturity and less than one year of interest-only payments.	All Financial Institutions	Loosen
Jun. 2005	Reduced the LTV ratio from 60 to 40 percent for loans of 10 years and shorter maturity to buy houses worth W 600 million and more in the speculative zones.	Banks	Tighten
Nov. 2006	Set the LTV ratio as 50 percent for loans of 10 years and less maturity to buy houses worth W 600 million and more in the speculative zones and originated by all financial institutions.	All Financial Institutions	Tighten
Nov. 2008	Removed all areas, except "Gangnam Three" districts, off the list of speculative zones.	All Financial Institutions	Loosen
Jul. 2009	Reduced the LTV ratio from 60 to 50 percent for loans to buy houses worth W 600 million and more in the metropolitan area.	Banks	Tighten
Oct. 2009	Extended the LTV regulations to all financial institutions for the metropolitan area.	All Financial Institutions	Tighten

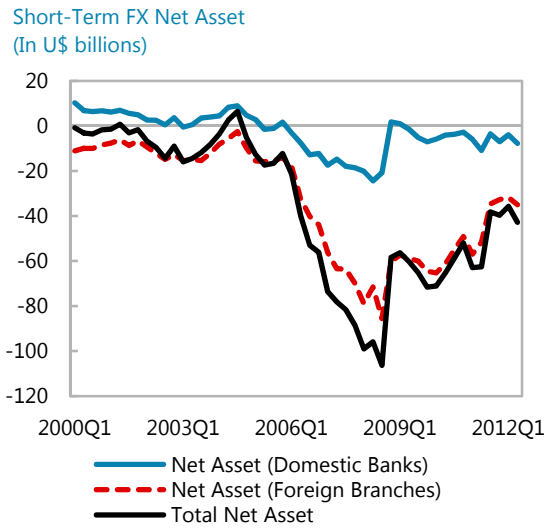
Date	Caps on DTI Ratio	Coverage	Direction
Aug. 2005	Introduced caps on DTI ratio as 40 percent for loans to buy houses in the speculative zones only if the borrower is single and under the age of 30 or if the borrower is married and the spouse has debt.	All Financial Institutions	Inception
Mar. 2006	Set the DTI ratio as 40 percent for loans to buy houses worth W 600 million and more in the speculative zones.	All Financial Institutions	Tighten
Nov. 2006	Extended the DTI regulation to overheated speculation zones in the metropolitan area.	All Financial Institutions	Tighten
Feb. 2007	Set the DTI ratio as 40–60 percent for loans to buy houses worth W 600 million and less.	Banks	Tighten
Aug. 2007	Set the DTI ratio as 40–70 percent for loans originated by non-bank financial institutions.	All Financial Institutions	Tighten
Nov. 2008	Removed all areas, except "Gangnam Three," districts off the list of speculative zones.	All Financial Institutions	Loosen
Sep. 2009	Extended the DTI regulation to the non-speculative zones in Seoul and the metropolitan area ("Gangnam Three" 40 percent, non-speculative zones in Seoul 50 percent, the other metropolitan areas 60 percent).	Banks	Tighten
Aug. 2010	Exempted the loans to buy houses in the non-speculative zones of the metropolitan area if the debtor owns less than two houses (set to expire by end-March 2011).	All Financial Institutions	Loosen
Apr. 2011	Reinstated as planned: 40 percent in "Gangnam Three" districts, 50 percent in other Seoul metropolitan areas, and 60 percent in non-Seoul metropolitan areas.	Banks	Tighten

Source: Igan and Kang (2011).

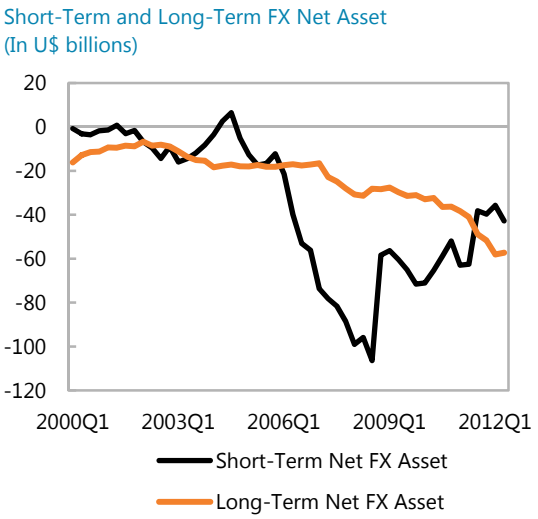
External vulnerability and FX-related macroprudential policies

101. In Korea, FX liquidity and maturity mismatches were another key vulnerability in the years leading up to the financial crisis. From 2005, Korean banks rapidly increased short-term non-core FX liabilities, creating FX liquidity and maturity mismatches. The key underlying structural reason was that they bought dollar forward from exporters and asset management companies who expected trend appreciation of the Korean won, and then hedged their long dollar positions with short-term external FX borrowing. The aggregate short-term net external debt of Korean banks rose to U$106 billion in the third quarter of 2008 from U$12 billion at end-2005 (Figure 15).

Figure 15. Korea: External Net Assets of Banking Sector



Source: Bank of Korea.

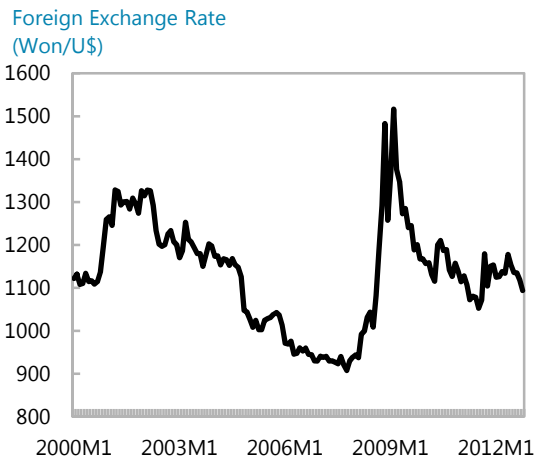


Source: Bank of Korea.

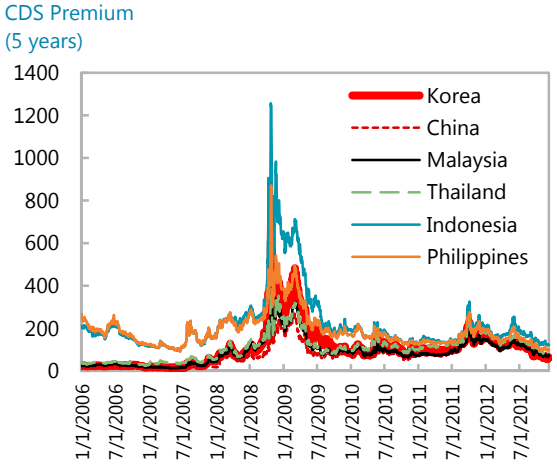
102. Given the FX mismatches, a sudden stop in capital flows hit Korean banks and the macroeconomy hard after the Lehman Brothers bankruptcy, and Korea came close to suffering another currency crisis. When the international wholesale funding market froze, domestic banks and foreign banks' branches were unable to roll over their maturing short-term external liabilities, and short-term net external debt was sharply curtailed by U$50 billion within two quarters. The Korean won depreciated rapidly and the CDS premium on Korean government bonds, after having been at a level similar to those in China, Malaysia, and Thailand, rose to become much higher, similar to that of Indonesia and the Philippines (Figure 16).[47]

[47] The rollover ratio of short-term external debt fell rapidly right after the financial crisis, from 99.8 percent in September 2008 to 39.9 percent in October 2008 (Lee, 2012).

Figure 16. Korea: Foreign Exchange Rates and CDS Premium



Source: Bank of Korea.



Source: Bloomberg.

103. Domestic monetary policy may not be an effective tool to lean against the excessive growth of the short-term non-core FX liabilities in an economy with fully open capital account. Raising policy rates would encourage more carry trades and capital inflows, which can in turn fuel credit booms. Moreover, there is evidence that Korean banks' non-core liabilities are much more (negatively) related to the United States policy rate than to the domestic policy rate. When global liquidity conditions are lax, financial intermediaries are more engaged in the carry trade of borrowing at low foreign interest rates and investing at higher domestic interest rates (Hahm and others, 2012).

104. To address these vulnerabilities, the authorities implemented an array of macroprudential measures, such as ceilings on banks' FX derivative positions (June 2010 and July 2011) and a macroprudential stability levy on non-core FX liabilities (August 2011).[48] The combination of these two measures was meant to target both the source and the costs of the excessive dependence on short-term non-core FX borrowings, and to encourage long-term and stable sources of funding. The levy is adjustable and can be used as a countercyclical tool when capital flow surges seriously threaten financial stability, with the maximum rate being 50 bps. Its proceeds flow into the Foreign Exchange Stabilization Fund, which is separate from the government budget and can be used as a buffer in the event of financial crises.

[48] FX derivative positions were limited to 50 percent of capital for domestic banks and 250 percent for foreign banks' branches in June 2010, and the limits were lowered to 40 percent and 200 percent in June 2011. The macroprudential stability levy is currently charged at between 2–20 bps, depending on the maturities of debts: 20, 10, 5, and 2 bps on short-term FX liabilities with maturity of one year or less, less than three years, less than five years, and more than five years, respectively. The levy base is calculated as the daily average outstanding balance of banks' eligible liability for the year at each maturity.

105. The measures appear to have been reasonably effective in curbing banks' reliance on short-term FX funding and in reducing vulnerabilities from FX liquidity mismatches and their links to exchange rate volatility (IMF, 2012; Ree and others, 2012).[49]

- Short-term net external debt, mostly of foreign banks' branches, declined steadily from US$65 billion in June 2010 to US$43 billion in June 2012. On the other hand, long-term net external debt increased during the period to US$25 billion.
- Rollover risks for domestic banks have contracted as residual maturities of their external debt have increased (IMF, 2012).
- The sensitivity of exchange rate volatility to changes in VIX declined substantially since the financial crisis, reflecting lower FX liquidity mismatches (Ree and others, 2012).
- The measures has reduced the channeling of global banking funds into Korea and also moderated the sensitivity of capital flows to external financial conditions (Bruno and Shin, 2012b).

Macroprudential policy coordination

106. To support the macroprudential policy function, a formal coordination committee was newly set up in July 2012, the "Macroeconomic and Financial Committee (Macroprudential Committee)." Prior to July 2012, systemic risks in the foreign exchange market and domestic financial sector were assessed separately by the "FX Market Stabilization Committee" and the "Economic and Financial Market Monitoring Committee." Four different agencies are members of the new committee–the Ministry of Strategy and Finance (MOSF), the Bank of Korea, the Financial Services Commission, and the Financial Supervisory Service. It is led by the MOSF and convened every quarter. The Macroprudential Committee assesses external and domestic systemic risks and coordinates the use of macroprudential instruments. In the meantime, each agency still conducts its primary policy independently.

E. United States[50]

The United States offers prime terrain to study financial instability in the years leading up to the financial crisis of late 2007. Did an overly loose monetary policy and absence of macroprudential measures undermine financial stability? The study finds some, though weak, evidence that interest rates were too low relative to an optimal monetary policy response. It also finds that a relaxation of regulations and the absence of an institutional framework geared explicitly to financial stability contributed to the growing leverage of

[49] Since these measures were brought in only recently, firm conclusions on their effectiveness would need more thorough analysis as more data become available.

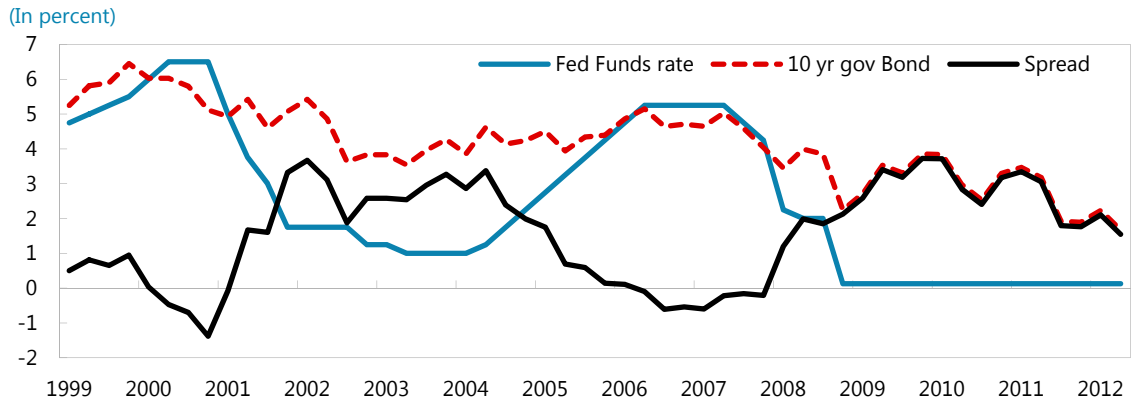
[50] Prepared by Francesco Columba (WHD) and Tommaso Mancini-Griffoli (MCM).

large investment banks, though other factors may also have been at play. Moving forward, it will be essential to improve the effectiveness of macroprudential policies in advanced economies.

Monetary policy

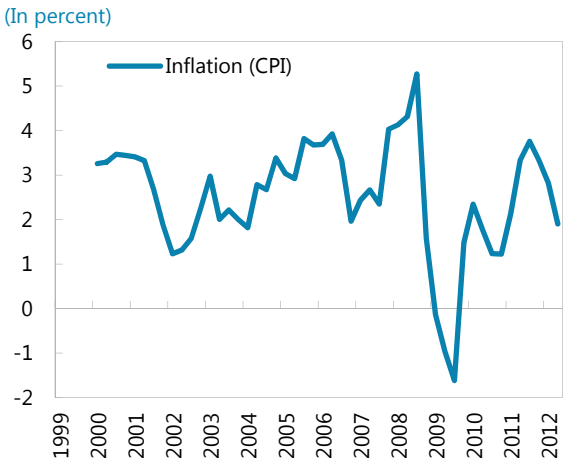
107. Monetary policy began the 2000s with a sharp cut in interest rates to help the economy emerge from the 2001 recession (Figure 17). Rates remained low until 2004, and then rose steadily until 2006. As the financial crisis hit, rates were cut starting in 2007Q3, gradually at first, then sharply, until they hit the zero lower bound in 2008Q4. Up to the financial crisis, inflation remained relatively stable and the output gap closed, though with output somewhat above potential (Figure 18).

Figure 17. United States: Interest Rates

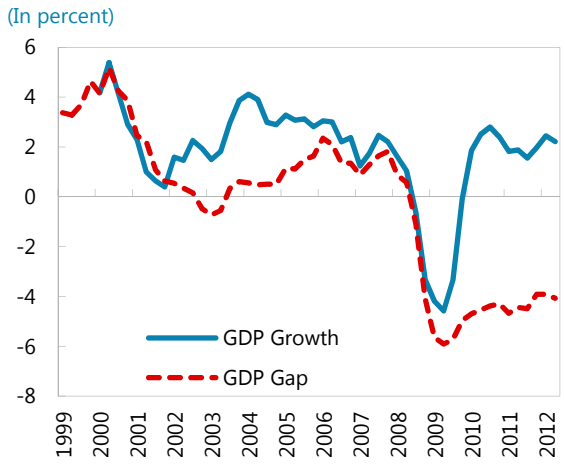


Source: Haver Analytics.

Figure 18. United States: Inflation Rates and GDP Growth Rates



Source: Haver Analytics.



Sources: Haver Analytics and IMF staff estimates.

108. Some have asked whether persistently low interest rates, especially in the lead up to the financial crisis, induced excessive borrowing and undermined financial stability. Indeed, the risk taking and asset price channels of monetary policy suggest—in theory—that low interest rates may lead banks to expand their balance sheets and take on additional risks, especially if asset prices boost the net worth of lenders and borrowers.

109. Were interest rates "too low for too long?" A measure of the potential misalignment between the policy rate and an optimal rate can be gauged with Taylor rules. Such simple rules are widely shown to replicate well optimal monetary policy especially under model uncertainty (Williams, 2003; Levin, Wieland and Williams, 2003; Orphanides and Williams, 2006, 2008; Taylor and Wieland, 2009). But as Bernhard and Mancini-Griffoli (2011) point out, there is a wide variety of possible Taylor rule specifications. More importantly, Taylor rules recommend significantly different interest rate paths depending on the data fed into them.

110. We investigate a range of Taylor rules, where the optimal rate is formulated from a baseline and various alternative Taylor rules, following Bernhard and Mancini-Griffoli (2011). The baseline rule responds contemporaneously to CPI inflation deviations from target and deviations of output from potential as computed by the CBO, with common sensitivity parameters of 0.5 on each deviation.[51] A variety of other Taylor rules is also considered, allowing interest rates to respond to (i) inflation and output gap forecasts; (ii) other measures of inflation (PCE, CPI and PCE core and the GDP deflator); (iii) realized (revised) data; as well as (iv) different sensitivity parameters.

111. Results show some evidence that interest rates were somewhat "too low for too long," at least between 2002 and 2004. Figure 19 shows that the Federal Funds rate recommended by the baseline Taylor rule is noticeably higher than the actually targeted Federal Funds rate. Yet, recommended interest rates come down markedly when the Taylor rule is optimized to best capture the Fed's reaction function (by minimizing the root mean squared error) over the 1990–10 sample (Figure 19).[52] If the Taylor rule is instead optimized to fit the 2002–07 period, the gap between the recommended and targeted interest rate shrinks further (Figure 20).[53] In all cases, though, a gap larger than was ever the case since 1990 arises, at least between 2002 and 2004.

112. These results appear to be quite robust. The "best fitting" Taylor rules shown in Figures A4 and A5 are robust to changes in specification and data. There are no statistically significant gains from responding to forecasts of inflation or the output gap, or indeed revising the rule's sensitivity

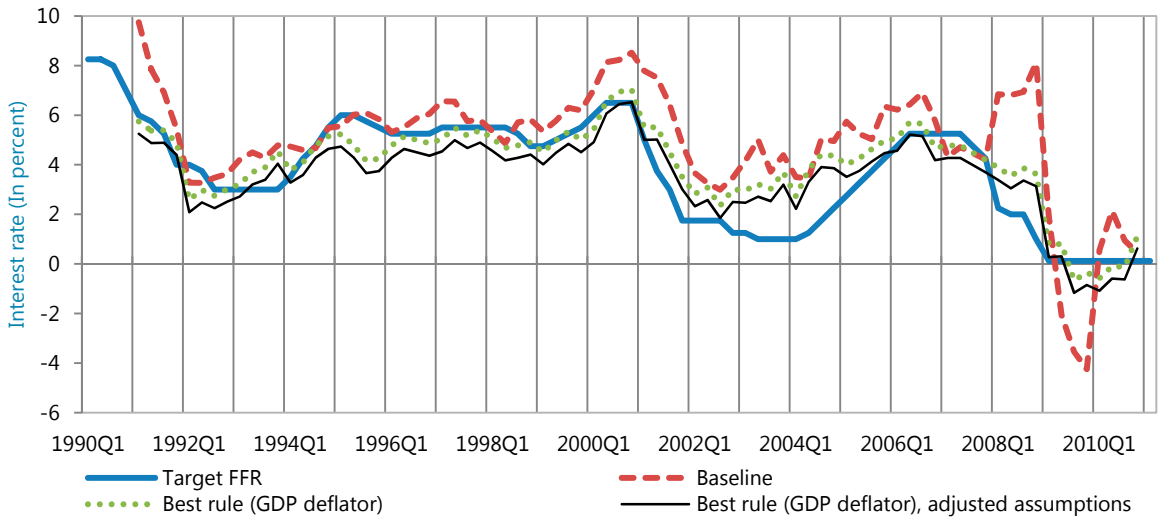
[51] The baseline rule can be written as: $i_t = r + P_t + 0.5(P_t - P_t^*) + 0.5(Y_t - Y_t^*)$ where r is the natural real interest rate consistent with inflation at target and a closed output gap, r is taken to be 2.5, the average CBO estimate of potential output growth from 1990, P_t is inflation, P_t^* is the inflation target, taken to be 2 percent, and $(Y_t - Y_t^*)$ is the output gap.

[52] The corresponding rule responds to the GDP deflator, a more stable inflation rate.

[53] The resulting rule responds to core PCE inflation.

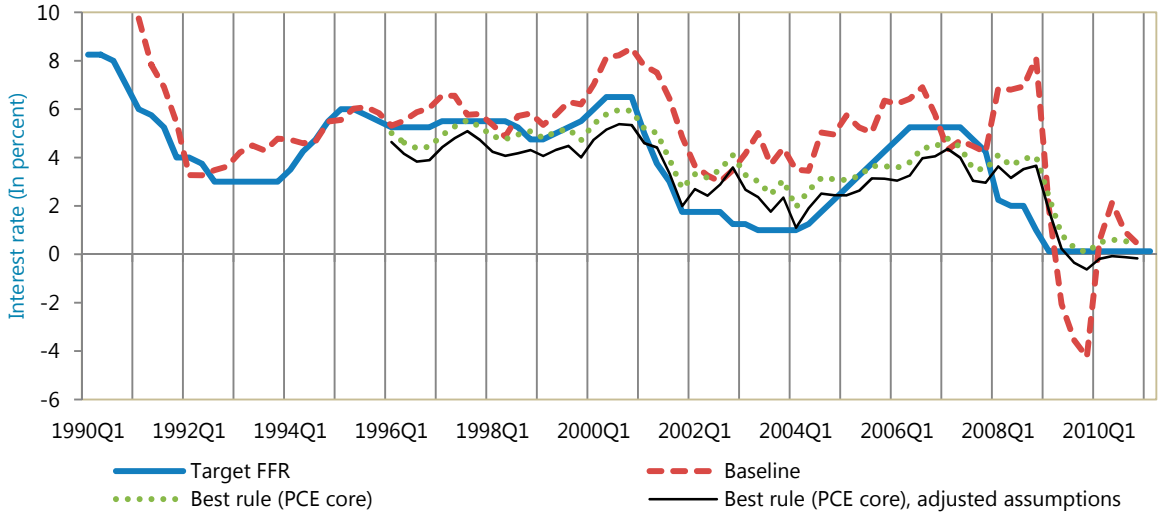
parameters (according to Giacomini and White, 2008, tests of predictive ability; details are available in Bernhard and Mancini-Griffoli, 2011).[54]

Figure 19. United States: Recommended Policy Rates from Baseline Taylor Rule Responding to CPI Inflation and A Variant Responding to the GDP Deflator



Sources: The Federal Reserve Bank of St. Luis (Alfred), Federal Reserve Bank of Philadelphia (PHIL), Federal Reserve Board, Congressional Budget Office, IMF staff calculations.

Figure 20. United States: Recommended Policy Rates from Baseline Taylor Rule Responding to CPI Inflation and A Variant Responding to Core PCE Inflation



Sources: The Federal Reserve Bank of St. Luis (Alfred), Federal Reserve Bank of Philadelphia (PHIL), Federal Reserve Board, Congressional Budget Office, IMF staff calculations.

[54] Instead, Taylor rules responding to inflation rates other than the CPI can be shown to be statistically different from the baseline rule in their ability to forecast the Federal Funds rate.

Leverage and house prices

113. There is little evidence, though, that the "too low" policy rates from 2002 to 2004 were transmitted to higher leverage and house prices. In theory, there are good reasons not to expect low interest rates to strongly undermine financial stability through leverage. Low interest rates come at a time of economic downturn; not the environment in which one would expect the risk taking or asset price channels of monetary policy to be particularly strong. In addition, the steeper yield curve typically accompanying a cut in interest rates, and observed in the United States between 2002 and 2004 (Figure 17), supports bank profits through maturity transformation, taking pressure off banks to seek profits elsewhere, in more risky assets.[55]

114. Empirically, the correlation between deviations from Taylor rules and increases in leverage is weak. Indeed, it is interesting to observe that leverage of United States investment banks—which if excessive can lead to financial instability—did not increase until after interest rates were raised towards their optimal rate in 2004. This is illustrated in Figure 21, focusing on investment banks as opposed to commercial banks, which mostly kept leverage relatively low throughout the period.[56]

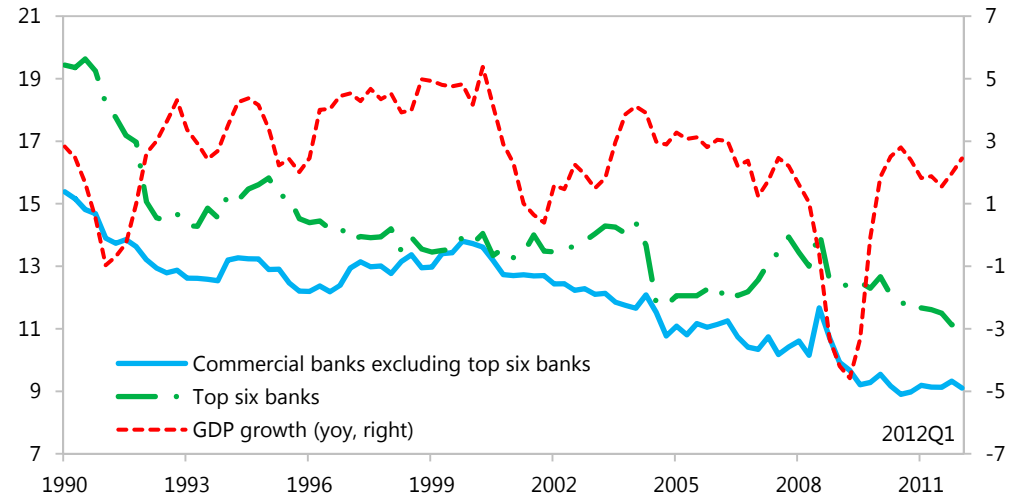
115. The tri-party repo market also shows that leverage did not rise in the period of particularly expansive monetary policy. The tri-party repo market is a major source of wholesale funding for investment banks, which anecdotal evidence suggests account between 65 percent and 80 percent of the total United States repo market. Repo funding of broker dealers displayed a spectacular boom between 2004 and 2008—at a time of rising policy rates—while repo funding of commercial banks increased at a pace mostly unchanged since 1990 (Figure 22).

[55] A steeper yield curve comes from (i) expectations of higher inflation and thus higher short rates once the economy recovers; and (ii) a higher risk premium induced by the downturn (Cochrane, 2007). Both, argue Rudebusch, Sack and Swanson (2007), account for the steepening of the U.S. yield curve between 2002 and 2004.

[56] The role of excessive leverage in the financial sector in propagating financial instability has been underscored by a number of studies (Adrian and Shin, 2010; Brunnermeier, 2009; Brunnermeier and Pedersen, 2009; Panetta et al. 2009).

Figure 21. United States: Leverage Ratio

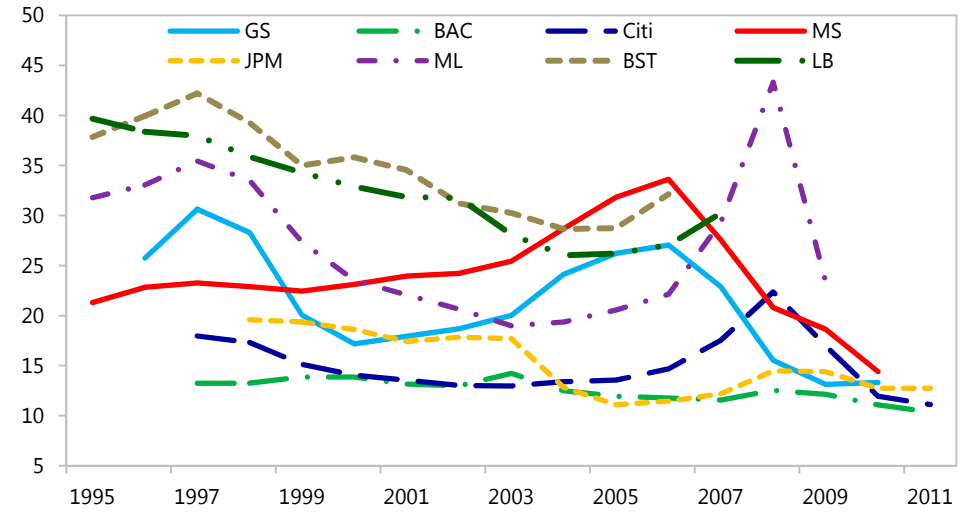
Leverage Ratio (Total Assets/Capital)
(In percent)



Source: SNL Financial.

Note: Commercial banks refer to the largest 19 U.S. bank holding companies. The top 6 bank holding companies are Bank of America, Citigroup, Goldman Sachs, JPMorgan, Morgan Stanley and Wells Fargo. Goldman Sachs and Morgan Stanley were investment banks under SEC supervision prior to the crisis. Bank of America and JPMorgan acquired respectively the investment banks Merrill Lynch in 2009 and Bear Stearns in 2008.

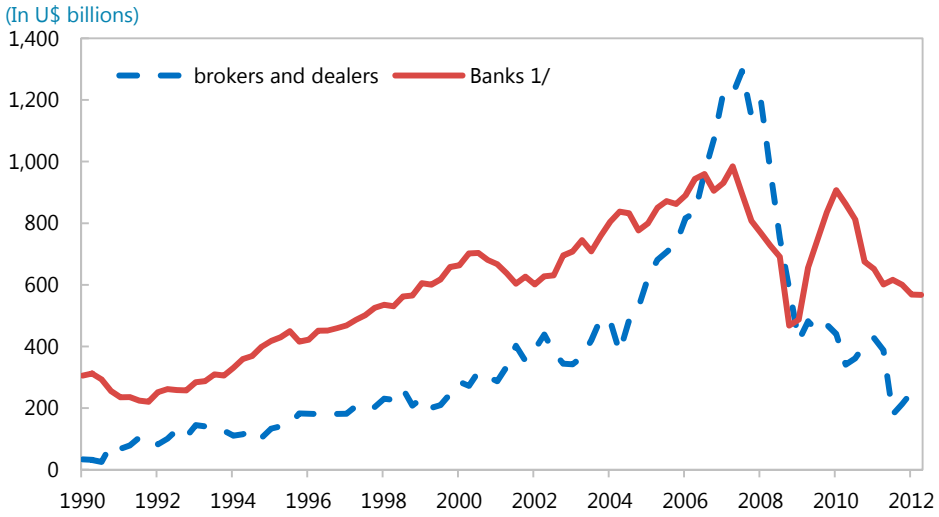
Leverage Ratio (Average Total Assets/Average Total Common Equity)[1/]
(In percent)



Source: SNL Financial.

1/ Investment banks: GS = Goldman Sachs, LB = Lehman Brothers, ML = Merrill Lynch, MS = Morgan Stanley, BST = Bear Stearns, Commercial banks (for comparison): BAC = Bank of America, Citi = Citigroup, JPM = JP Morgan Chase.

Figure 22. United States: Net Federal Funds and Security Repo Funding to Banks and Brokers-Dealers



Source: Haver Analytics - Federal Reserve Board Flow of Funds.
1/ Private Depository Institutions: U.S. chartered depository institutions, foreign banking offices in U.S., and credit unions.

116. A number of studies find a link—though small—between United States policy rates and house prices and credit. Overall, while most studies find an effect of policy rates on house prices, the economic magnitude is often found to be quite small. Indeed, as pointed out by Shiller (2007), the recent United States house price boom started as far back as July 1998 and continued exponentially until its peak in June 2006, without an obvious impact of changes in policy rates on the time profile of house price increases (Figure 23). Formal evidence often finds that the impact of policy rates on asset prices is small and that other factors are likely to have been at play.

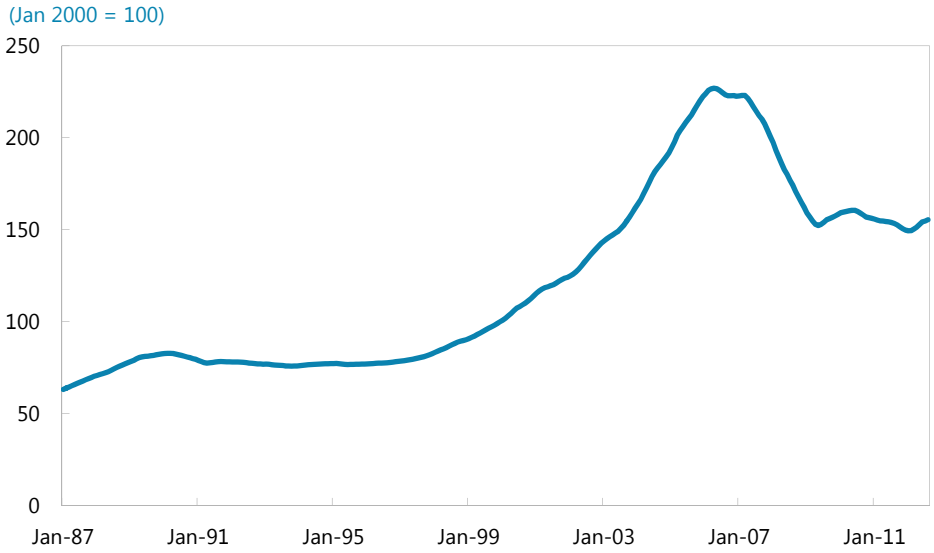
- Del Negro and Otrok (2007) found that the impact of accommodative monetary policy on United States house prices had been small relative to the overall housing price increase.

- Cardarelli and others (2008) find that the stance of monetary policy had an effect on the housing market in the United States although its effect was magnified by the loosening of lending standards.[57]

- Bean and others (2010) present a counterfactual experiment that has policy rates roughly 200 basis points higher than the actual path over the 2003–06 period. They find that the impact on house prices and credit is quite weak, overall. Real house prices would have peaked around 7.5 percent lower. But the stock of real credit would have been just 3 percent lower by the end of 2006, compared with an actual expansion in credit of almost 30 percent.

[57] Similar findings are emphasized in Taylor (2007) and Iacoviello and Neri (2010).

Figure 23. United States: Case-Shiller Home Price Index



Source: Haver Analytics.

Macroprudential policy and leverage

117. If monetary policy was not the main culprit behind the bubble in United States real-estate prices and the financial crisis, perhaps the lack of a macroprudential policy framework did play a role? As the introduction of the Dodd-Frank Act notes, the financial crisis of 2007–08 generated a consensus on the need to introduce a regulatory framework to preserve financial stability.

118. There is some evidence that a relaxation of regulatory standards did affect leverage in the United States, and thus undermined financial stability. The leverage of investment banks rose significantly after 2004 (Figure 21), while leverage at commercial banks remained relatively low heading into the crisis. The divergence can be explained in part by the different regulatory provisions on leverage. Commercial banks had to respect a leverage ratio unchanged since 1991,[58] while in 2004 a change in SEC regulation allowed investment banks to raise their leverage from 15:1 to 40:1.[59] Indeed, evidence from other countries also suggests that regulation does affect leverage.[60]

[58] The maximum leverage ratio is 33:1 for banks rated "strong" and 25:1 for all other banks. Banks are also subject to prompt corrective action rules requiring them to maintain a minimum leverage ratio of 20:1 in order to be considered well capitalized.

[59] Broker-dealers were subject to supervisory rules limiting the debt to net equity ratio to 15:1 until 2004, when investment banks opted for consolidated oversight (requiring that capital and risks be computed on a group-wide basis) that allowed them to increase leverage to 40:1 in some cases.

[60] Caps were imposed since the early 1980s on banks and other deposit-taking institutions in Canada. Similar limits have been adopted in Switzerland in 2008 and have been considered in the United Kingdom.

The rapid rise of shadow banking, largely outside the reach of regulation, also explains the high leverage of the United States financial system between 2005 and 2007 (Pozsar and others, 2010).[61]

119. There is evidence also that an erosion of lending standards and increases in household leverage contributed to the house-price boom-bust. Geanakoplos (2010) documents that the average downpayment on Alt-A and subprime mortgage loans fell steadiliy over the pre-crisis period. By 2006, the average downpayment had fallen to 2.9 percent, from 13 percent in 2000, corresponding to an increase in household leverage for these borrowers from 7.7 to 37. Sengupta (2010) documents significant loosening of underwriting standards and increased offering of adjustable rate contracts in subprime and Alt-A mortgages, especially in mortgages originated from 2004, which led to sharp increases in defaults on these vintages as interest rates increased. Wider empirical evidence suggests that the relaxation of regulatory constraints and lending standards, combined with financial innovation and changes in market structure, including increased competition, may have fueled the recent boom and bust pattern in the United States (Dell'Ariccia and others, 2012a; Favara and Imbs, 2010; Mian and Sufi, 2009).

120. Insufficiently tight regulation was not the only cause of the increase in leverage. The recovery that had emerged by 2004 probably also contributed to the increase in leverage. Indeed, especially among investment banks, leverage has been documented to be pro-cyclical (Adrian and Shin, 2010). The post 2004 peak of the largest banks' leverage, or that just of investment banks, merely returned to late 1990s/ early 2000s levels when tighter leverage requirements were in place (Figure 21).

[61] Shadow banking can be seen to include products associated with securitization (MBS, ABS, and other GSE liabilities), as well as short-term money market transactions that are not backstopped by deposit insurance, including repo and commercial paper.

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