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of macroprudential policy?

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What do we know about the effects of macroprudential policy?*

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Abstract

The literature on the effectiveness of macroprudential policy tools is still in its infancy and has so far provided only limited guidance for policy decisions. In recent years, however, increasing efforts have been made to fill this gap. Progress has been made in embedding macroprudential policy in theoretical models. There is increasing empirical work on the effect of some macroprudential tools on a range of target variables, such as quantities and prices of credit, asset prices, and on the amplitude of the financial cycle and financial stability. In this paper we review recent progress in theoretical and empirical research on the effectiveness of macroprudential instruments.

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“The application of these so-called macroprudential policies is still very much at the developmental stage. When the Bank gained operational responsibility for monetary policy in 1997, there was a long history of practical experience, together with a vast theoretical and empirical literature for us to draw on. That didn't make setting monetary policy easy, but it certainly helped. By comparison, we are still in the Stone Age in respect of deploying macroprudential policies. There is lots of scope for academia to help us out here, on both the theoretical and empirical fronts.” (Bean, 2012)

1. Introduction

The global financial crisis has highlighted the need to go beyond a purely micro-based approach to financial regulation and supervision. With the benefit of hindsight, there has been a fundamental lack of understanding of system-wide risk.

There is a growing consensus among policymakers that a macroprudential approach to regulation and supervision should be adopted. Policymakers around the globe are currently working on implementing macroprudential policy tools and frameworks. These efforts involve coordination among central banks, governments and regulatory authorities (which may also be the central bank). At the same time, analysis is still needed about the appropriate macroprudential tools, their transmission mechanism and their effects.

Theoretical models of macroprudential policy are still in their infancy and therefore provide only limited guidance on how to think about its impact. However, major efforts have been undertaken over the past years to pursue this line of research. Empirical evidence on the effects of macroprudential instruments is still scarce, given that they have become standard policy tools only in recent years. In advanced countries, the experience with macroprudential policy is fairly recent, although some measures to support the domestic financial system and to influence the supply of credit taken in the 1930s and 1950s have been viewed as macroprudential tools (Haldane, 2011). By contrast, central banks in emerging market countries have been regular practitioners of macroprudential policy, without calling it by this name (McCauley, 2009).

This paper aims to tie together theoretical and empirical contributions to the literature on macroprudential policy. The aim is to provide guidance on how to think about the effectiveness of macroprudential tools and how they are transmitted to financial intermediation and macroeconomic activity. In our analysis we distinguish two forms of effectiveness – in achieving stated intermediary goals of macroprudential policy (e.g. credit growth), and in achieving its ultimate goal of supporting financial stability and thereby macroeconomic stability.

The remainder of the paper is organized as follows. Section 2 discusses the perimeter and taxonomies of macroprudential instruments. Section 3 provides an overview of their usage, including an overview of the historical experience. Section 4 review alternative approaches to conceptualize the effectiveness and transmission mechanism of macroprudential tools. It goes on to discuss the evidence on the effectiveness of macroprudential tools. Section 5 discusses issues affecting the effectiveness of macroprudential instruments, and section 6 concludes.

2. What are macroprudential instruments?

Macroprudential policy can best be understood by contrasting it with the traditional microprudential perspective on regulation. The micro and macroprudential perspectives differ in terms of their objectives and understanding on the nature of risk (Borio, 2003). The former aims at enhancing the safety and soundness of individual financial institutions. The latter instead focuses on the stability of the financial system as a whole, with a view to limiting macroeconomic costs from financial distress (Crockett, 2000). Another key difference is that risk is taken as exogenous under the microprudential perspective, while the macroprudential perspective emphasizes the endogenous nature of systemic risk. Macroprudential policy therefore focuses on the procyclical behavior of the financial system, and the interconnectedness of individual financial institutions and markets, as well as their common exposure to economic risk factors.

In contrast to the literature on monetary policy with its clear-cut consensus on the role of different instruments, the literature on macroprudential policy has looked at a wide range of possible tools without a primary instrument emerging. It has only recently been converging towards a common understanding of its perimeter and a common taxonomy of instruments.

In terms of the perimeter of macroprudential policy, macroprudential instruments are commonly viewed as distinct from other macroeconomic tools that can support financial stability, such as monetary and fiscal policy (Blanchard et al, 2010; Borio, 2009; Caruana, 2010). A combination of these tools is seen as necessary to address systemic risk in all its complexity (Caruana, 2010).

We follow IMF (2011a) and define the macroprudential toolbox as comprising two types of instruments. One is specifically tailored to mitigating systemic risk, and includes countercyclical capital buffers or systemic capital charges. The other is instruments not originally developed with systemic risk in mind but that can be modified to become part of the macroprudential toolkit. Time-varying loan-to-value (LTV), loan-to-income (LTI) or debt-to-income (DTI) ratios belong to this category. IMF (2011a) argues that for these to be macroprudential tools, two conditions need to hold. First, they should target explicitly and specifically systemic risk. Second, the chosen institutional framework is underpinned by the necessary governance arrangements to ensure there is no slippage in their use.

While precise in theory, the delimitation of the perimeter of macroprudential policy is not clear-cut in practice. Recent surveys conducted among central banks reveal that there are grey areas in regard to what counts as a macroprudential instrument (CGFS, 2010). Most notably, there is no agreement on whether capital controls should be considered as part of the macroprudential arsenal. The FSB and BIS for example do not include capital controls among macroprudential policy tools, since they are applied only to non-residents, whereas some countries' policymakers consider them to be macroprudential instruments. Following IMF (2011b), capital controls could be macroprudential instruments if they are geared towards systemic risk and are underpinned by strict governance arrangements. Given the historical experience of build-ups of financial imbalances accompanied by a growing share of net foreign-currency financing (Borio and Shim, 2007), especially for emerging market economies, the macroprudential toolkit could also include measures to limit system-wide currency mismatches in an effort to stem the domestic financial consequences of capital inflows. Examples of such measures include limits on open foreign exchange positions and constraints on the type of foreign currency assets (Turner, 2009).

Another grey area is measures geared towards strengthening the resilience of the infrastructure of the financial system. It is now common to include these in the macroprudential toolkit (e.g. Group of Thirty, 2010; BIS-FSB-IMF, 2011; Schoenmaker and Wiertz, 2011).

A third grey area is crisis resolution. While this policy area also focuses on systemic risk it involves more reactive rather than preventative policy and thus typically is not included in the macroprudential toolkit (see e.g. IMF, 2013; Osiński et al., 2013).

In the policy debate and the research literature, it is possible to identify two main taxonomies of macroprudential tools, which help in understanding how they affect the financial system and the macroeconomy.¹

Nature of risk and intermediate objectives

The first organizes tools in terms of the nature of systemic risk they address and what specific objectives they are geared towards. In terms of the nature of systemic risk, the main and by now common distinction is between tools geared towards addressing the time dimension and those focusing

¹ Distinctions along other dimensions have also been used, including rules (built-in stabilizers) versus discretion in calibrating the tools of macroprudential policy (e.g. Borio and Shim, 2007); tools based on quantity or on price restrictions (e.g. Perotti and Suarez, 2011); and instruments used in industrial or emerging market countries (McCauley, 2009).

Table 1 Macroprudential tools across different risk dimensions and intermediate objectives

Intermediate objectives/ functions	Risk dimensions	
	Time-series	Cross-sectional
Leverage/credit/asset price booms	Countercyclical capital buffers	
	Through-the-cycle valuation of margins or haircuts for collateral used in securitized funding markets (like repos)	
	Countercyclical change in risk weights for exposure to certain sectors	
	<i>Time-varying LTV, Debt-To-Income (DTI) and Loan-To-Income (LTI) caps</i>	
	<i>Time-varying caps and limits on credit or credit growth</i>	
	<i>Dynamic provisioning</i>	
	<i>Rescaling risk-weights by incorporating recessionary conditions in the probability of default assumptions (PDs)</i>	
Liquidity/market risk	Time-varying systemic liquidity surcharges	<i>Capital charge on derivative payables</i>
	Levy on non-core liabilities	Levy on non-core liabilities
	<i>Time-varying limits in currency mismatch or exposure (e.g. real estate)</i>	
	<i>Time-varying limits on loan-to-deposit ratio</i>	
	<i>Stressed VaR to build additional capital buffer against market risk during a boom</i>	
Interconnectedness/ market structure/financial infrastructure		Higher capital charges for trades not cleared through CCPs
		Systemic capital surcharges
		Systemic liquidity surcharges
		<i>Powers to break up financial firms on systemic risk concerns</i>
		<i>Deposit insurance risk premia sensitive to systemic risk</i>
		<i>Restrictions on permissible activities (e.g. ban on proprietary trading for systemically important banks)</i>

Sources: IMF (2011a; 2013). Entries include a) instruments developed specifically to mitigate systemic risk and b) instruments not originally aimed at systemic risk but modified to be part of macroprudential toolkit (in italics). The classification in terms of intermediate objectives is taken from Schoenmaker and Wierts (2011) and Houben et al. (2012).

on the cross-sectional dimension of systemic risk.² The former address the procyclicality in the financial system. The latter focus on how risk is distributed at a point in time within the financial system and on contributions to systemic risk of individual institutions.

Within each dimension of systemic risk, it is then possible to identify intermediate objectives to which macroprudential tools are assigned and specific functions for each tool.³ In terms of specific functions or intermediate objectives to which macroprudential tools are assigned, the policy debate seems to converge to distinguishing three types of tools (Table 1).⁴

The first type of tools focuses on the time dimension of systemic risk, and comprises tools geared towards credit, leverage and asset price booms. The second is also geared towards the time dimension, and addresses liquidity or market risk. The third type of tools addresses vulnerabilities that arise from either market structure – i.e. vulnerabilities related to interconnectedness, size, position in the market – and those originating in the financial infrastructure (e.g. related to central counterparty clearing and real time gross settlement systems).⁵ These structural vulnerabilities pertain mainly to the cross-section dimension of systemic risk.

Note that tools that address the time dimension and the cyclical nature of systemic risk need not be time-varying. Examples of time-invariant instruments of this type include fixed caps on cyclical variables such as LTV limits or loan-to-deposit (LTD) ceilings. On the other hand, tools that address the cross-sectional dimension of systemic risk may not be time-invariant (see BCBS, 2011).

Macroprudential tools geared towards market failures

An alternative taxonomy focuses on the market failures that macroprudential policy addresses. As De Nicolò et al. (2012) stress, addressing the time and the cross-section dimensions of systemic risk *per se* does not provide a justification for regulatory intervention. Rather, macroprudential regulation should be viewed as addressing market failures that create systemic risk. These market failures include risk externalities across financial institutions, and between the financial sector and the real economy.

The literature distinguishes three main drivers of such risk externalities (De Nicolò et al., 2012): strategic complementarities, i.e. strategic interactions of financial institutions that cause the build-up of vulnerabilities during the expansionary phase of the financial cycle (herding); fire sales, i.e. a generalized sell-off of financial assets, which cause a decline in asset prices and a deterioration of the balance sheets of financial intermediaries; and interconnectedness, i.e. the risk of contagion caused by the propagation of shocks from systemic institutions or through financial networks. As noted by De Nicolò et al. (2012) externalities driven by interconnectedness are particularly strong for SIFIs.

An influential example of research along these lines is Hanson et al (2011), which characterizes the macroprudential approach to capital regulation as an effort to control the social costs associated with excessive balance-sheet shrinkage on the part of multiple financial institutions hit with a common shock. To achieve this, there are only two options: raising new capital to replace that which was lost;

² This distinction was first introduced by Borio and Crockett (2000).

³ The concept of intermediate objectives – which is commonly employed in the monetary policy literature – has been introduced in the literature on macroprudential policy by Schoenmaker and Wierts (2011).

⁴ This distinction is elaborated in IMF, 2011a,b; FSB-BIS-IMF, 2011b; CGFS, 2010; Bank of England, 2011; ESRB, 2011; Houben et al., 2012. A similar taxonomy is provided by CGFS (2010), which groups macroprudential tools depending on the vulnerability they address – leverage, liquidity or market risk, interconnectedness – and on the financial sector component they are geared to (bank or deposit-taker, non-bank investor, securities market or financial infrastructure). IMF (2011a,b) also highlight those associated with capital flows and those related to foreign currency risk.

⁵ ESRB (2011) refines this third set of tools by differentiating instruments that address risk arising from (direct and indirect) exposures, risk related to expectations of a bailout, and risk linked to “soft” infrastructure (such as accounting practices or risk management standards) and “hard” infrastructure (e.g. netting requirements in settlement systems).

or letting the ratio of capital to assets decline. The tools that Hanson et al. discuss are different mechanisms for facilitating adjustment on one of these two margins.⁶

Macroprudential instruments can then be classified according to the externalities they can address. Table 2, taken from De Nicolò et al. (2012), provides such a classification and indicates that alternative policy tools are often complementary. This suggests that there is no one-to-one mapping between externality and instrument, and that a combination of tools is likely to be more effective in tackling a market failure. It also suggests that among all macroprudential instruments, capital surcharges are effective in dealing with all of the externalities.

Table 2 Macroprudential tools across different types of market failures/externalities

Externalities	Instruments			
	Capital requirements (surcharges)	Liquidity requirements	Restrictions on activities, assets, or liabilities	Taxation
Strategic complementarities	x		x	
Fire sales	x	x		X
Interconnectedness	x		x	X

Source: De Nicolò, Favara and Ratnovski (2012).

This approach has been followed also in practice. A notable example is the European Systemic Risk Board (ESRB), which is tasked with macroprudential oversight of the financial system within the European Union. The ESRB maps market failures – including externalities such as those related to fire sales and interconnectedness – into intermediate objectives for macroprudential policy (ESRB, 2014a, 2014b).

3. Experiences with macroprudential instruments

Since the outbreak of the global financial crisis, macroprudential policy has come to play a key role in the policy debate but the experience with macroprudential instruments goes back as far as the 1930s. Some of the tools which are currently being used or proposed as part of the macroprudential toolset were originally used with microprudential objectives. Others were seen as monetary policy instruments to influence the supply of credit and growth (Bank of England, 2009), often focused on macroeconomic stabilization in the presence of large capital flows and a volatile exchange rate (Cordella et al., 2014).

In discussing experiences with macroprudential policy, it is useful to distinguish these historical experiences further in the past from recent experiences. Haldane (2011) identifies a first phase in the 1930s, when policymakers adopted a variety of measures to support the domestic financial system and to influence the supply of credit. According to Haldane (2011), macroprudential policy was used as early as 1938 in the United States, in a successful effort by Roosevelt to boost lending and growth, as the country was facing a double-dip recession, with banks being criticized for not lending more to the real economy. These measures took the form of a relaxation of prudential and valuation standards for US banks in the Uniform Agreement on Bank Supervisory Procedures, whose explicit goal was to support lending and activity in the real economy, “the activist goal of liberalizing bank examinations

⁶ These tools are grouped in six sets that comprise time varying capital requirements; higher quality capital; prompt corrective action targeted at dollars of capital, not capital ratios; contingent capital; regulation of debt maturity and asset liquidity; regulating the shadow banking system.

to make them dynamically adjustable to current economic policies” (Simonson and Hempel, 1993, as cited in Haldane, 2011).

Following this interpretation, one could view restrictions introduced on both the asset side and the liability side of US banks’ balance sheets in the 1930s and in the following decades – in an effort to support the domestic banking system – as macroprudential measures. In the United State, these include interest rate ceilings, interstate banking restrictions, and the Glass-Steagall separation of commercial and investment banking. They also include selective credit controls introduced in the 1950s with the aim of influencing the housing cycle (Grebler, 1960) and used throughout the 1970s (Schreft, 1990). Elliott et al. (2013) provide a detailed review of the historical usage of and provide a qualitative assessment of the costs and benefits of countercyclical macroprudential tools used in the United States since the First World War. They suggest that many of these tools appear to have succeeded in their short-term goals, for example in limiting specific types of bank credit or liability and affecting lending terms, while it was less obvious that they improved financial stability.

Similar measures were taken in the 1960s and 1970s in other countries.⁷ Well-known examples are the direct credit ceilings and the special deposit scheme known as “the corset” introduced in the United Kingdom in an effort to counter the rapid growth in domestic banks’ exposures and its destabilizing effect. Similar policies were also present in the Netherlands between the 1960s and 1980s, where different forms of instruments were employed to contain credit creation by banks (de Greef et al., 1996). Another example is Sweden, where the Swedish Riksbank introduced domestic credit controls in the 1950s, which were supported by exchange controls (Jonung, 1993). It has been argued that these policies helped prevent financial crises (Englund, 1999). Most of these measures were phased out in the 1980s and 1990s, as deregulation and globalization changed the global financial landscape, reflecting policymakers’ concerns over the viability of traditional banking in the face of pressure from non-bank financial institutions (Hellwig, 1994, 1995).

Since the 1970s, policy makers in emerging markets facing large capital flows have used reserve requirements in an effort to stabilize the domestic economy by stabilizing the exchange rate and the credit cycle. As argued by Cordella et al. (2014), the distinction between this “business-cycle driven use” of macroprudential policy and the “systemic risk-driven” use is not clear-cut, since the use of macroprudential instruments to deal with the business cycle supports financial stability by preventing excessive fluctuations in capital flows and hence reduces the probability of systemic risk.

Recent experiences

In the second phase, which took place in more recent years, macroprudential tools were (re-)adopted – mostly in emerging market countries – to strengthen the resilience of the domestic financial system. Recent surveys conducted among central banks provide an overview of central banks’ experience with macroprudential policy (CGFS, 2010; IMF, 2011b,c).⁸ They show that the use of macroprudential policy instruments – whether or not they were called by their name – has been most widespread in emerging market countries in Asia and Latin America. In these countries, central banks have applied macroprudential policies at least since the aftermath of the 1997 Asian financial crisis and the 1998 Russian financial crisis, in an effort to strengthen the resilience of their domestic financial system.

The most commonly used tools include measures to limit credit supply to specific sectors that are prone to excessive credit growth (e.g. caps on LTV ratios or debt/income ratios aimed at restricting mortgage lending), and limits on net open currency positions and measures to prevent the build-up of domestic imbalances arising from cross-border capital flows (for example via reserve requirements). The former were most widely used in Asia, whereas the latter could be found mostly in Latin American countries (Moreno, 2011; Montoro and Moreno, 2011).

⁷ Hodgman (1973) provides a survey of the use of credit control in European countries. Shu et al. (2008) draw parallels with credit controls used by the People’s Bank of China in the 2000s.

⁸ IMF (2011b) surveyed central banks from 63 countries and the European Central Bank about the use of macroprudential tools in the second half of the 2000s. CGFS (2010) conducted a survey at end-2009 of 33 central banks.

Before the global financial crisis, macroprudential tools have not been much applied on a system-wide basis to banks' balance sheets in advanced countries. An important exception is dynamic provisioning in Spain, which arguably did not prevent a major bubble in the domestic housing market but made the banking system more resilient to shocks by increasing its shock-absorption capacity (Saurina, 2009a,b). However, some observers highlighted that these tools were not sufficient to prevent the large problems in the Spanish banking sector which emerged following the unwinding of the domestic real estate boom in 2007 (e.g. Mahapatra, 2012).

In recent years, measures that target the size or the composition of bank balance sheets – e.g. LTD ceilings, institution-specific capital add-ons or time-varying capital charges – have gained in importance.⁹

4. Alternative approaches to investigate the effectiveness of macroprudential policy and its transmission mechanism

It has been argued that the transmission mechanism through which macroprudential policy and monetary policy work is similar to the extent that both work through the bank lending and balance sheet channels, and both are geared towards modifying private agents' behavior (Beau et al., 2012). In fact, the literature on the monetary transmission mechanism can also offer insights on how macroprudential tools can work. In contrast to the monetary policy literature, however, the effectiveness and the transmission mechanism of macroprudential policy tools are not yet well understood. From a theoretical point of view, a main reason is that there is no agreed modeling framework of the interaction between the financial system and the macroeconomy (see Galati and Moessner, 2013). From an empirical perspective, macroprudential tools have to a large extent been introduced only in response to the recent crisis, which makes it difficult to assess their effectiveness and transmission channels empirically and guide the design of macroprudential tools going forward (see Turner, 2010).

Complicating the analysis is that macroprudential measures have typically not been taken in isolation, but in combination with other policies. Moreover, as emphasized in CGFS (2010), the transmission mechanism is likely to change over time as the result of changes in financial intermediation practices and in the structure of the financial system. In particular, there is uncertainty about how financial innovation, consolidation in the financial sector and changes in the balance between institution- and market-based credit affect systemic risk over time.

For all these reasons, the literature on the effectiveness and the transmission mechanism of macroprudential policy is still in its infancy and has so far provided only limited guidance for policy decisions. In recent years, however, much effort has been made to fill this gap. Progress has been made in embedding macroprudential policy in different types of theoretical models. There is increasing empirical work on the effect of some macroprudential tools on a range of intermediate target variables, such as quantities and prices of credit, asset prices, output growth, and on the amplitude of the financial cycle.

In this section, we review recent progress along three lines of research on the effectiveness and transmission mechanism of macroprudential instruments. The first consists of alternative theoretical frameworks for modeling macroprudential policy and its impact on financial and real variables. These include banking/finance models and macroeconomic models.¹⁰ The second comprises stylised presentations of how changes in individual macroprudential instruments are expected to contribute to the objectives of macroprudential policy. This analysis is typically narrative and conducted through so-called “transmission maps”. The third line of research uses different strategies to empirically assess the effectiveness of macroprudential policy tools.

⁹ LTD ceilings have been introduced in China, Korea and the United States (see Federal Reserve Board, 2012; Lim et al., 2011; and van den End, 2013 for details). SIFI buffers are the most common institution-specific capital add-ons.

¹⁰ For an overview of models of macroeconomic implications of financial frictions, see Brunnermeier et al. (2013).

a. Theoretical approaches

There exists by now a large body of research on the interaction between the macroeconomy and financial stability, which can offer insights on the possible impact of macroprudential policy. Many contributions have been reviewed elsewhere (e.g. Brunnermeier et al., 2013; Benigno, 2013; Galati and Moessner, 2013; Beck et al., 2014). Therefore, rather than providing a detailed discussion of these contributions, this section describes examples of theoretical approaches that offer insights on the impact and transmission mechanism of macroprudential tools, to give an overview of where the literature is heading. For the ease of exposition, these approaches can be grouped into three types of models: banking/finance models; three-period banking or dynamic stochastic general equilibrium (DSGE) macro models; and infinite horizon general equilibrium macro models.

Banking/finance models

Banking/finance models capture the state-dependent nature of assets and contracts (e.g. Diamond and Dybvig 1983; Diamond and Rajan, 2001). In these models, financial contracts are affected by informational asymmetries, commitment and incentives problems which can result in default. Financial instability can then result from self-fulfilling equilibria generated by exogenous shocks or from idiosyncratic or systematic shocks that propagate through the financial system through informational and balance sheet linkages.

One important advantage of these models is that they can explain the complex interaction between borrowers and lenders. They have therefore offered important insights on the impact of macroprudential policy tools that address the cross-sectional dimension of systemic risk. One important example is the paper by Perotti and Suarez (2011), which compares price-based and quantity-based regulation of systemic externalities originating in banks' short-term funding. This distinction between price- and quantity based tools plays a key role in the current policy debate.¹¹ The paper shows that a combination of a Pigouvian tax on short-term funding with a net stable funding ratio or a liquidity coverage ratio might be optimal for regulators, depending on the nature of heterogeneity across banks.

At the same time, these models have two important shortcomings. First, to be tractable these models typically neglect the role of time and the business cycle, which makes it more difficult to study macroprudential tools geared towards the procyclicality of the financial system. Second, they are mostly partial equilibrium models, and recent research suggests that the effect of macroprudential tools is different in a general equilibrium setting (Al-Darwish et al., 2011; Jaffee and Walden, 2011).

Three-period general equilibrium models

Recent research has addressed these issues by developing stylized three-period general equilibrium models to study the interaction between asset prices and financial distress in the corporate and financial sector. These papers analyze the risk-taking behavior of heterogeneous agents in an economy that is vulnerable to systemic risk and in which default can occur.

One type of such models have the key feature that financial amplification during credit booms and busts involves externalities (e.g. Lorenzoni, 2008; Tsomocos, 2013; Goodhart et al., 2012; Gersbach and Rochet, 2012a, 2012b). These externalities arise because individual agents take financial decisions without taking into account the general equilibrium effect of their actions. During times of stress, agents neglect the effect of their asset sales on aggregate prices. As a result, agents take on socially excessive exposure to risk and over-borrow, eventually creating feedback loops of falling asset prices, tightening financial constraints and fire sales. Although these models are highly stylized, they can be used to study the impact of macroprudential tools geared towards preventing fire sales and credit crunches, which are found to be critical for increasing financial stability and improving the welfare of savers and borrowers (Goodhart et al., 2013). These include loan to value ratios, capital requirements for banks, liquidity coverage ratios for banks, dynamic loan loss provisioning for banks, and margin requirements on repurchase agreements used by shadow banks.

¹¹ For more details, see Galati and Moessner (2011).

Another type of three-period general equilibrium models captures the different roles that banks play in the economy – providing liquidity insurance for savers, improving the risk sharing opportunities for savers, increasing the amount of funding available to borrowers (Kashyap et al., 2014). These models can be used to analyze alternative causes of the global financial crisis – excessive risk-taking by under-capitalized banks which were exploiting taxpayer support; funding vulnerabilities in the financial system and bank runs – and regulatory tools that can help prevent future crises.

This research highlights how the introduction of new regulation will induce banks and savers to endogenously alter their other portfolio choices. As a result, different regulatory tools can have a very different impact on financial stability. In particular, prudential tools that moderate the risk of a run can exacerbate problems caused by limited liability. One important issue highlighted by recent research based on three-period general equilibrium models is the possibility of disturbing “interactions” between countercyclical macroprudential tools and instruments that focus on the cross-section dimension. In particular, Horváth and Wagner (2013) show that countercyclical bank regulation might increase cross-sectional risk, while policies that reduce cross-sectional risk reduce procyclicality.

Infinite horizon macroeconomic models with financial factors

Infinite horizon DSGE models augmented with financial frictions, which build on the financial accelerator mechanism of Bernanke et al. (1999), have the potential to investigate the effects of macroprudential tools that focus on the time dimension of systemic risk. Their general equilibrium nature makes them attractive for policy analysis. Frictions related to financial intermediaries and the role of bank capital in the monetary transmission mechanism have been studied with DSGE models (e.g. Goodfriend and McCallum, 2007). Moreover, they are particularly suitable for simulations, which makes them useful to study the impact of new policy instruments.

Until a few years ago, macroeconomic models of this type suffered from several important drawbacks, which limited their use in studying the effectiveness and transmission mechanism of macroprudential instruments. First, being traditionally solved by linearization, these infinite horizons models were not well suited to incorporate state-contingency in a meaningful way and hence to analyze systemic crises or the impact of changes in regulation. Second, with very few recent exceptions, these models generally assumed complete markets and implicitly assumed that defaults either do not occur or are exogenous (see e.g. Cúrdia and Woodford, 2010). Third, as argued forcefully by Geanakoplos (2011), they ignored endogenous leverage. By construction, therefore, these types of DSGE models with financial frictions describe financial crises as big negative shocks that are amplified. They cannot capture the fact that crises are rare events resulting from “credit booms gone wrong” that are followed by deep and long recessions (Boissay et al., 2013).

Since the global financial crisis, however, much effort has been undertaken to extend infinite horizon DSGE models to include a richer characterization of real-financial linkages. Compared to standard DSGE models, these models have multiple equilibria, and are used to analyze non-linearity and externalities. They feature more elaborate amplification mechanisms. These types of model can provide a framework to evaluate macroprudential (or monetary) policies which can be used during a credit boom to reduce the expected costs of a financial crisis.

One line of research that promises insights on the impact of macroprudential policy relies on infinite-horizon DSGE models with borrowers (households or firms) facing occasionally binding endogenous constraints.¹² These models have been used to explain the mechanism of financial amplification in terms of the interaction of falling asset prices, declining net worth, tightening financial constraints and macroeconomic contraction. These models can be used to examine macroprudential policies over booms and busts and determine the optimal magnitude of specific instruments.

This line of research has been termed “Neo-Fisherian”, since the financial amplification it describes captures features of Fisher’s (1933) debt-deflation spiral. The borrowing constraint is occasionally binding, depending on private agents’ and policymakers’ choices, which determine the state of the economy (Bianchi and Mendoza, 2010; Jeanne and Korinek, 2012; Benigno et al., 2013). In crisis

¹² See Benigno (2013) for a detailed discussion of the modelling elements of this line of research.

times the constraint is binding, whereas in tranquil states it is not. The borrowing constraint is endogenous and depends on asset prices such as the price of land.

Another class of models studies global dynamics in models with financial frictions in a continuous time setting (He and Krishnamurthy, 2012, 2013; Brunnermeier and Sannikov, 2014; Adrian and Boyarchenko, 2012). In this research line, macroeconomic factors and the financial system are integrated in an analysis that is not confined around the steady state, which provides important insights on the mechanisms that can lead to financial crises.

In the seminal paper by Brunnermeier and Sannikov (2014), the financial sector does not internalize all the costs associated with excessive risk taking. This results in excessive leverage and maturity mismatch. While securitization allows the financial sector to offload some of the risk, it exacerbates excessive risk-taking. In this model, systemic risk and volatility dynamics are endogenous due to adverse feedback loops between financial and real factors. The model thus portrays an economy with low volatility and “reasonable” growth around the steady state but with high volatility and large output losses away from the steady state. The economy is inherently unstable because leverage and risk-taking are endogenous. An important feature of this model is the so-called “volatility paradox”: as aggregate risk declines, equilibrium leverage goes up and amplification becomes more severe. The model embeds key nonlinearities: small shocks keep the economy near the stable steady state but large shocks lead to an unstable crisis regime characterized by liquidity spirals.

The classes of models with incomplete asset markets, aggregate shocks, heterogeneous agents facing occasionally binding constraints and endogenous systemic risk are challenging from a computational point of view. They rely on non-linear global solution methods to evaluate short- and long-run effects of financial frictions. These solution methods cannot be easily implemented for large models. The analysis is therefore mostly restricted to a limited set of shocks and states.

While these papers have mostly provided qualitative insights, recent research has been able to match quantitatively the nonlinearities that can be found in macroeconomic and financial data, and in particular the different dynamics across tranquil times, periods of stress and systemic crises (He and Krishnamurthy, 2014).

In recent research, Benes et al. (2014a, 2014b) propose an alternative approach to include financial intermediaries’ balance sheets into DSGE models to yield highly nonlinear feedback effects between bank balance sheets, borrower balance sheets and the real economy during financial crises. The MAPMOD model they introduce is a simulation model whose parameters are calibrated to match basic stylized facts of financial cycles.

This model provides a flexible tool to simulate the impact of specific macroprudential policy decisions, such as changes in countercyclical capital requirements, and a wide range of scenarios affecting the financial sector. It shares the problem faced by DSGE models with occasionally binding constraints that it cannot be estimated because of global nonlinearities and changing financial sector policies, which would require unrealistically large samples.

Main insights on macroprudential policy

While still in their infancy, the different strands that incorporate real-financial linkages into macroeconomic or banking models offer several insights to the policy debate on macroprudential instruments.

First, one main contribution of modern versions of DSGE models with financial-real linkages has consisted in explaining mechanisms through which real and financial factors interact, and how this interaction can generate systemic crises. In particular, the combination of a macroeconomic boom, a credit boom and low interest rates is conducive to a crisis when the credit boom turns supply-driven, as illustrated by Boissay et al. (2013). This research highlights the role of consumption smoothing and precautionary savings in the build-up of financial imbalances.

Second, calibrations of these models improve our understanding of the role of regulation in reducing the incidence of financial crises. Based on a quantitative analysis of their model calibrated to US data,

for example, Bianchi and Mendoza (2010) show that in the absence of regulation, financial crises are significantly more frequent and more severe.

Third, state-contingent taxes can play an important role in supporting financial stability. In Bianchi and Mendoza (2010), a regulator can replicate exactly its equilibrium allocations as a decentralized equilibrium, and thus neutralize the credit externality on which these models hinge, by imposing state-contingent taxes on debt and dividends of about 1 and -0.5 percent on average respectively. This tax is higher during periods when leverage is building up and the economy is becoming vulnerable to a financial crisis. The idea is that such a tax induces agents to value more the accumulation of precautionary savings with respect to the competitive equilibrium without taxes.

Fourth, externalities that underpin endogenous systemic risk can be addressed by Pigouvian taxes. Jeanne and Korinek (2010) for example show that a Pigouvian tax on borrowing may induce borrowers to internalize these externalities and increase welfare. More generally, these types of models allow characterizing the optimal mix of ex-ante macroprudential policy and ex-post policy (i.e. bailouts) in response to financial crises.

b. Stylized presentations

In recent years, several studies have followed an alternative, narrative approach to studying the transmission mechanism and effectiveness of macroprudential tools. An influential report by the CGFS (2012a) provides a conceptual discussion of the transmission mechanism of a range of macroprudential instruments, aiming to provide guidance on how the efficiency and effectiveness of these instruments could be judged in practice. The report presents so-called “transmission maps” for the impact on the credit cycle and on the resilience of the financial sector of stress tests, as well as tools such as capital or provisioning requirements, sectoral capital requirements, liquidity requirements and asset-side instruments. Where possible, the narrative analysis is supplemented with empirical evidence to provide some indications of the effectiveness and efficiency of different tools.

This type of analysis provides several important results. First, in terms of monitoring the build-up of financial imbalances and predicting crisis, CGFS (2012a) documents how the credit-to-GDP gap, the debt service ratio, the growth in residential property prices and their gap turn out to have been useful indicators in signaling past crises. By contrast, the predictive content of variables involving consumer credit appears to be limited.

Second, the transmission map analysis points to capital- and liquidity based macroprudential tools as playing an important role in increasing the resilience of the financial sector and smoothing the credit cycle. At the same time, these policies imply potential costs that affect their efficiency.

Third, raising capital or liquidity requirements enhances the resilience of the banking system through both direct and indirect channels. These measures also influence the shape of the credit cycle, as banks will tend to respond to a rise in generic liquidity requirements by adjusting the profile of their assets and liabilities.

Fourth, asset-side tools can play an important role in increasing the resilience of the banking system directly through decreasing both the probability of default (PD) and loss-given-default (LGD) of loans. Moreover, they have potentially significant dampening effects on the credit cycle. In particular, tighter LTV and DTI ratio caps can restrain the quantity of credit by limiting the funding available for certain borrowers, reducing housing demand and by increasing savings. These tools would tend to ease house prices, thereby reducing households’ ability to obtain credit and withdrawing equity more generally. As a result, these tools will likely lead to a broad decline in the demand for credit.

Finally, this type of stylized analysis highlights the interaction between different macroprudential instruments, and between macroprudential policy and other forms of policy, such as monetary and fiscal policy.

c. Empirical approaches

Empirical analysis on macroprudential instruments is difficult because of the lack of established models of the interaction between the financial system and the macroeconomy, as well as by the

scarcity of data needed to conduct empirical tests.¹³ As discussed in Galati and Moessner (2013), until a few years ago, little analysis was available on data needs for macroprudential policy purposes. In recent years, however, much effort has been undertaken in identifying data requirements. Examples of recent proposals on data collection and requirements include Lo (2009), Sibert (2010) and Brunnermeier et al. (2014).

At the international policy level, a broad picture of data needs is emerging (see eg. Borio, 2010; Cecchetti et al., 2010; Eichner et al., 2010). Planned enhancements to the BIS international banking statistics include more granular data collected to better measure the size and volatility of cross-border borrowing by the resident non-financial private sector from non-resident banks, and how it compares with borrowing from resident banks, which would be useful for decisions on the use of macroprudential policy tools (CGFS (2012b)). There have also been efforts to build a reporting framework for systemically important banks, which provides insights on the network connections among these banks (BCBS, 2013a). The G20 Data Gaps Initiative is a broad thrust towards collecting data that are needed for policy analysis (e.g. FSB-IMF, 2013).

In terms of information on the usage of macroprudential tools, the IMF conducted a survey of country authorities on macroprudential policy actions (IMF (2011b)). Claessens and Ghosh (2012) use data on macroprudential policy actions from this survey, and supplement it with data from an internal IMF survey of country desk economists. Lim et al. (2013) combine this type of information in a so-called macroprudential index. Recent progress on data collection include Shim et al. (2013), who put together a database on policy actions related to the housing markets globally and made this publicly available. Vandebussche et al. (2012) collected information on macroprudential policy measures related to house prices in a database for 16 countries in Central, Eastern, and South-Eastern Europe at a quarterly frequency. Federico et al. (2012a) constructed a quarterly dataset on legal reserve requirements for 52 countries, of which 15 are industrial and 37 developing countries, focussing on legal rather than actual reserve requirements, for 1970-2011. Using this dataset, they describe stylized facts regarding the use of reserve requirements as a macroeconomic stabilization tool.

A main problem of empirical work on macroprudential policy is how to identify its impact on macroeconomic and financial variables, i.e. how to distinguish correlation and causation. The literature has broadly followed six approaches in dealing with this issue: event studies; assessments of authorities or outside observers; reduced-form regression analysis, typically conducted using cross-country panel regressions; macro stress tests; counterfactual analysis; analysis based on micro data.

One very common approach relies on event studies, typically carried out at central banks (e.g. CGFS, 2010), the IMF (e.g. Hilbers et al, 2005, 2007; Crowe et al, 2011a, b) or the BIS (e.g. Borio and Shim, 2007; Montoro and Moreno, 2011), and covering different cross-section of countries. To give an example, Table 3, taken from Crowe et al (2011a), organizes events studies on the impact of macroprudential measures aimed at dealing with real estate booms.¹⁴

Using descriptive case studies, Se (2013) suggests that in the aftermath of the Asian crisis, several Asian emerging countries have successfully applied the loan-to-value tool to slow down increases of house prices. Considering country experiences using a mainly descriptive approach, and based on the literature, Terrier et al. (2011) review the use of policy tools to lean against the wind in Latin America, considering microprudential tools, which could be used for macroprudential purposes if calibrated appropriately over the cycle, and macroprudential tools.

¹³ CGFS (2012a) discusses the literature on the empirical evidence for the strength of their proposed transmission channels of macroprudential tools, namely for the impact of stress tests, capital or provisioning requirements, sectoral capital requirements, liquidity requirements and asset-side macroprudential instruments on the credit cycle, on resilience and on output.

¹⁴ Borio et al (2001) provide a discussion of the interaction between practices concerning the valuation of collateral and loan-to-value ratios and an overview of the regulators' experience with LTV ratios.

Table 3 Stylised facts of effect of macroprudential policy responses to real estate booms

Measure	To address	Used in countries	Impact
Higher/differentiated capital requirements or risk weights by loan type	Rapid credit growth and/or real estate boom	Bulgaria, Croatia, India, Poland, Norway	Not always effective, some side-effects of shifting the risk elsewhere in the system
Tighter/differentiated loan classification and provisioning requirements	Rapid credit growth and/or real estate boom	Bulgaria, Croatia, Greece, Israel, Ukraine	Limited effect
Dynamic provisioning	Resilience to cyclical downturn/bust	China, Colombia, India, Spain, Uruguay	So far so good
Tightening eligibility requirements, e.g. limits on loan-to-value ratios	Real estate boom	China, Hong Kong SAR, Korea, Malaysia, Singapore, Sweden	Short-lived effect on prices and mortgage activity
Source: Crowe et al. (2011a), Table 2.			

A second approach relies on compiling the assessments of authorities and outside observers on the effectiveness of macroprudential tools (Borio and Shim, 2007). Authorities' assessments provide direct evidence on specific tools. At the same time, they suffer from two main drawbacks. First, they may be subjective assessments of authorities, rather than being based on independent empirical evaluations. Moreover, for individual country experiences there is a problem of the counterfactual – it is not clear what would have happened in the absence of macroprudential measures. In fact, Borio and Shim (2007) note that judging the overall effectiveness of macroprudential tools is hard, and that a more definite answer would need to be based on a more systematic analysis of the different episodes.

A third approach consists of studies that use reduced-form regression analysis. Compared to event studies, this line of research allows more formal tests of the impact of macroprudential tools. However, it suffers from two main drawbacks. First, reduced-form models do not capture well the interaction between macroeconomic, financial and policy variables. Furthermore, since in most cases macroprudential tools have been introduced only in recent years in policymakers' toolkit, there is not much data to assess their effectiveness and transmission channels empirically. Moreover, macroprudential tools have mostly been used in conjunction with other policies, such as monetary policy, so that it is difficult to isolate their effects.

Using cross-country data over the past three decades in panel regressions, Kuttner and Shim (2012) analyse the degree to which macroprudential policy tools have been effective in mitigating housing price and credit cycles, after controlling for country-specific structural factors and macroeconomic variables. They find that decreases in loan-to-value ratios are associated with lower house price growth, and that limiting debt-service-to-income ratios and increasing loan loss provisioning requirements attenuate housing credit growth. Using panel data regressions, Vandebussche et al. (2012) find that changes in the minimum capital adequacy ratio and non-standard liquidity measures, namely marginal reserve requirements on foreign funding and marginal reserve requirements linked to credit growth, had some impact on house price inflation in Central, Eastern, and South-Eastern European countries, whereas some other macroprudential measures had no impact. Using panel regressions for data from a 2010 IMF survey of the cross-country use of macroprudential policies, Ahuja and Nabar (2011) find that LTV caps decelerate property price growth, that both LTV and DTI caps slow property lending growth, and that LTV caps also affect a broader range of financial stability indicators in economies with pegged exchange rates and currency boards. Wong et al. (2011) find based on panel regressions with data from 13 economies that maximum LTV ratios are effective in

reducing systemic risk stemming from the boom-and-bust cycle of property markets, with the effect on household leverage being more apparent than the effect on property market activity.

Claessens and Ghosh (2012) use a panel data set of credit-, liquidity and capital-related macroprudential measures and relate these to the pro-cyclicality of three banking variables, namely leverage growth, asset growth, and noncore-to-core liabilities growth. They use a sample of 4673 banks in 170 countries, of which 30 countries implemented at least one macroprudential policy instrument during the period 2000-2010. They consider caps on loan-to-value, caps on debt-to-income, limits on credit growth, reserve requirements, dynamic provisioning, and limits on foreign lending. They find that caps on debt-to-income ratios are relatively effective in emerging economies for a broad range of build-up in financial sector vulnerabilities.

Bruno and Shin (2013) use panel data analysis to study the impact on capital flows of macroprudential policies introduced by Korea in 2010 in comparison with 48 other countries. They find that the sensitivity of capital flows to Korea to global financial conditions decreased following the introduction of macroprudential policies, compared with other countries.

Also using cross-country empirical analysis in panel data regressions, Lim et al. (2011)'s results suggest that macroprudential policy may dampen procyclicality, mainly through credit-related measures (e.g. LTV caps) or liquidity-related measures (e.g. reserve requirements). Also using cross-country data in panel regressions, and consistent with Lim et al. (2011), Dell'Ariccia et al. (2012) find that macroprudential policy tools can reduce the incidence of credit booms and decrease the likelihood that booms end up badly. Using panel fixed-effects models, Wang and Sun (2013) analyse annual data for 171 banks in China from 2010-11, and conclude that some macroprudential policy tools, such as the reserve requirement ratio and housing-related policies, are useful, but cannot guarantee protection against systemic risk; they also suggest that better-targeted macroprudential policies have greater potential to contain systemic risk.

Using cross-country data for Latin American economies in panel regressions, Tovar et al. (2012) tentatively find that reserve requirements had a moderate temporary effect of slowing the pace of credit growth. Using VAR analysis, Federico et al. (2012b) study the macroeconomic effects of changes in legal reserve requirements in Argentina, Brazil, Colombia, and Uruguay. They find that output falls in response to exogenous changes in reserve requirements. Using VAR analysis for Brazil, Glocker and Towbin (2012) find that a discretionary tightening of reserve requirements leads to a decline in domestic credit.

The fourth approach consists of macro stress tests, which can be used to trace the response of the financial system to unusually large exogenous shocks (Sorge, 2004 and Drehmann, 2009).¹⁵ Macro stress tests are by nature forward-looking and highlight the transmission of shocks within the system. They rely explicitly on an underlying view of the forces that can drive financial distress. Similarly to other methodological approaches, however, these models generally fail to capture feedback effects between the financial system and the macroeconomy. They also fail to capture the key aspect of financial distress that small shocks can have very large effects (Borio and Drehmann, 2009).

Recently promising efforts have been undertaken to overcome these shortcomings. Aikman et al (2009) present a Risk Assessment Model for Systemic Institutions (RAMSI) that also includes feedback effects resulting from liquidity risk and embodies an element of procyclicality, which they deem suitable for counterfactual simulations in which regulatory changes – such as varying capital and liquidity buffers – can affect systemic risk. The Bank of Canada's macro stress testing model (Macro-Financial Risk Assessment Framework, MFRAF) estimates systemic risks based on interbank spillover effects at major Canadian banks, linking solvency, market, and funding liquidity risks, and using detailed data on Canadian banks' balance sheets (Gauthier et al. (2010, 2012)). Van den End (2012)'s macro stress-testing model for liquidity risks of banks in the Netherlands incorporates proposed Basel 3 liquidity regulation and second-round feedback effects of shocks, and suggests that Basel 3 liquidity regulation limits liquidity tail risk. Van den End and Kruidhof (2013) use a liquidity

¹⁵ BCBS (2013b, 2013c) provide a survey of the macro stress testing literature for liquidity risk; they conclude that liquidity risk modelling still remains in its infancy, especially in macro stress tests.

stress-testing model to simulate the systemic implications of the Basel 3 Liquidity Coverage Ratio (LCR), taking into account the impact of bank reactions on second round feedback effects. They find that a flexible approach to the LCR is a useful macroprudential instrument to mitigate its adverse side-effects during times of stress; but that at extreme stress levels the instrument becomes ineffective and the lender of last resort has to underpin the stability of the system.

A fifth approach conducts counterfactual analysis. Several papers have studied whether macroprudential policy, if it had been applied ahead of the recent financial crisis, could have affected developments positively. Recent unpublished work by the Committee on the Global Financial System (CGFS) of case studies in some major economies finds that, given the knowledge available at the time, macroprudential policy, e.g. via capital or liquidity requirements, could have had positive effects regarding some identified risks in the run-up to the crisis, but not regarding some other risks, e.g. the dependence on cross-currency funding and the growth of the shadow banking system (see FSB/IMF/BIS, 2011a)

Antipa et al. (2010) use a DSGE model estimated for the United States, the euro area and the United Kingdom over the period 1985-2010 to perform counterfactual simulations of macroprudential policies, in the form of an augmented Taylor rule where the short-term interest rate responds to credit growth, and where the authority can increase the cost of credit independently from the short-term interest rate. They find within their model that such macroprudential policy would have been effective in smoothing the last credit cycle and in reducing the depth of the Great Recession. Catte et al. (2010) perform counterfactual simulations within the National Institute of Economic and Social Research's large-scale global macroeconomic model (NiGEM) for the United States for the period 2002-7. They assume that the policymaker has access to an instrument that affects mortgage credit spreads directly, since the model does not allow to specify the nature of macroprudential tools explicitly, with banks not explicitly modelled, for example. They find that use of this instrument would have had a significant effect in reducing real house prices and thereby dampening the housing boom. Barrell et al. (2010) study how macroprudential surveillance could have been better undertaken, using a crisis-prediction model for 14 OECD countries estimated over the period 1980-1997. They suggest that countercyclical macroprudential policy would best be calibrated on house prices and current accounts rather than GDP and credit, since they find that credit growth does not have a statistical impact on crisis risk. Izquierdo, Loo-Kung, and Rojas-Suarez (2013) perform simulations for the path of the stock of loan-loss reserves in El Salvador, assuming that the dynamic provisioning rules of Peru or Bolivia had been followed. They suggest that if either of these rules had been followed, Salvadoran banks would have accumulated more provisions during the pre-Lehman period, which could have been used during the financial crisis to support credit.

A sixth empirical approach consists in using micro data, either on individual banks' balance sheet items or on household borrowing. Igan and Kang (2011) for example use data from a survey of mortgages and housing demand by Korean households to examine the impact of LTV and DTI limits on house price dynamics and household leverage in Korea.

There has been particularly limited empirical work on the effects of macroprudential policy tools addressing the cross-sectional dimension, with data limitations being one reason for this. Using data on individual banks' loan books, risk exposures, and on interbank linkages including OTC derivatives for the Canadian banking system, Gauthier et al. (2012) find that macroprudential capital allocation mechanisms reduce default probabilities of individual banks as well as the probability of a systemic crisis by about 25%, suggesting that macroprudential capital buffers can substantially improve financial stability.

BCBS (2013a) provides estimates of the impact of additional capital requirements for globally systemically important banks on growth, based on results from studies by Macroeconomic Assessment Group (2010, 2011). They find that a one percentage point increase in capital for globally systemically important banks would dampen growth on average by an additional 0.07 basis points per year for an eight year implementation period, and by an additional 1.1 basis point per year for a four year implementation period, on average over the transition. Note that the simulated costs refer to the transition to higher capital standards, while the Macroeconomic Assessment Group emphasizes that

benefits in terms of reduced systemic crises are reaped in the steady state. This difference is important. Based on results from BCBS (2010), Macroeconomic Assessment Group estimated that additional capital requirements for globally systemically important banks should provide an annual benefit of about 40–50 basis points of GDP, reflecting the reduced probability of a systemic financial crisis (see BCBS (2013a)).

Miles et al. (2012) provide estimates of socially optimal bank capital, considering overall economic (or social) costs. They calibrate how much increases in bank capital ratios reduce the probability of banking crises and the expected future costs of banking crises. They find that the amount of equity capital which is likely to be desirable for banks is much larger than banks have used in recent years and also higher than targets agreed under the Basel 3 framework, concluding that socially optimal bank capital should be about 20% of risk weighted assets.

The effect of communication about financial stability issues via the publication of Financial Stability Reports and through speeches and interviews over the past 14 years, has been studied in Born et al. (2011). They find that Financial Stability Reports had a significant effect on stock market returns and tended to reduce market volatility. By contrast, speeches and interviews had little effect on market returns and did not reduce volatility during tranquil times, but had a substantial effect during the 2007–10 financial crisis.

5. Issues affecting the effectiveness of macroprudential instruments

For macroprudential policy, one main problem is that regulatory arbitrage, for example through lending via foreign branches or direct cross-border lending, erodes the effectiveness of macroprudential instruments, as discussed for example in Borio and Shim (2007) and Hilbers et al. (2005) based on individual country experiences. For the Eurosystem, this is a particularly relevant issue, which has driven much of the discussions on the European Systemic Risk Board.

Macroprudential policy could also become less effective if risk taking and exposures move outside the regulated banking sector, while remaining systemically important, which calls for coordination with other policy areas. Some historical examples of leakages in regulation are provided in Bank of England (2009), and Hilbers et al. (2005) considered this to be a relevant factor for the recent experience of some CEE economies. Aiyar et al. (2012) find evidence of some leakage associated with foreign bank branches. They find that during 1998–2007, when regulators imposed time-varying bank-specific minimum capital requirements on banks in the United Kingdom, UK-regulated banks reduced lending in response to tighter capital requirements, but non UK-regulated banks (resident foreign branches) increased lending compared with a reference group of regulated banks. Jiménez et al. (2013) find that while countercyclical dynamic provisioning in Spain smoothed cycles in the supply of credit and in bad times upheld firm financing and performance, it did little to stop the credit boom to firms in good times as firms switched to less affected banks.

A lack of coordination of macroprudential policy with monetary policy could also make the former less effective. The literature on the interaction between macroprudential policy and monetary policy is in its infancy, including for example papers of Bean et al. (2010), Angeloni and Faia (2009), Beau et al. (2012), Kannan et al. (2012), and is discussed in Galati and Moessner (2013). Angelini et al. (2012) review the recent literature on the interaction between macroprudential policy and monetary policy. Within a macro stress testing model using data for Dutch banks, van den End (2012) studies the interaction of banks' reactions to Basel 3 liquidity standards with extended refinancing operations and asset purchases by the central bank as part of its unconventional monetary policy, and finds that central banks' asset purchases have more influence on banks relative to refinancing operations due to banks' increased bond holdings. Using panel regressions, Maddaloni and Peydro (2013) find for euro area banks that the impact of low monetary policy rates on the softening of lending standards is reduced by more stringent prudential policy on either bank capital or the loan-to-value ratio for mortgage loans applied in different countries. Federico et al. (2012b) find that reserve requirement policy acted as a substitute for monetary policy rather than a complement. For example, reserve requirements fell in bad times to stimulate output while interest rates increased to prevent a rapid depreciation of the domestic currency. Glocker and Towbin (2012) find that a positive reserve

requirement shock leads to an exchange rate depreciation and an improvement in the current account, and to an increase in prices. Their results suggest that reserve requirement policy can complement interest rate policy in pursuing a financial stability objective, but cannot be its substitute with regards to a price stability objective. Tovar et al. (2012)'s results suggest that the effects of changes in policy interest rates and macroprudential policy in the form of reserve requirements have reinforced each other in Latin American economies.

6. Conclusions

The literature on the effectiveness of macroprudential policy tools is still in its infancy and has so far provided only limited guidance for policy decisions. In recent years, however, increasing efforts have been made to fill this gap. Progress has been made in embedding macroprudential policy in theoretical models. There is increasing empirical work on the effect of some macroprudential tools on a range of target variables, such as quantities and prices of credit, asset prices, and on the amplitude of the financial cycle and financial stability. Since empirical evidence on the effectiveness of macroprudential policy tools is still limited, the use of macroprudential policy tools is likely to involve some experimentation, from which authorities setting these instruments can learn over time and which they can use to improve their mix of macroprudential policy tools.

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