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Macro-prudential policies to mitigate financial system vulnerabilities☆

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A B S T R A C T

Macro-prudential policies aimed at mitigating systemic financial risks have become part of the policy toolkit in many emerging markets and some advanced countries. Their effectiveness and efficacy are not well-known, however. Using panel data regressions, we analyze how changes in balance sheets of some 2800 banks in 48 countries over 2000–2010 respond to specific policies. Controlling for endogeneity, we find that measures aimed at borrowers – caps on debt-to-income and loan-to-value ratios, and limits on credit growth and foreign currency lending – are effective in reducing leverage, asset and noncore to core liabilities growth during boom times. While countercyclical buffers (such as reserve requirements, limits on profit distribution, and dynamic provisioning) also help mitigate increases in bank leverage and assets, few policies help stop declines in adverse times, consistent with the ex-ante nature of macro-prudential tools.

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1. Introduction

This paper analyzes the use of macro-prudential policies aimed at reducing vulnerabilities in banking systems, with a special focus on their use in and for emerging markets.[1] Recent events have highlighted the high costs of financial crises. More generally, the potential for economic costs arising from the way financial system operates – whether from excessive financial cycles or spillovers through interconnectedness – has been increasingly recognized recently. Due also to early policy and research efforts (e.g., Borio and White, 2003; White, 2006, Brunnermeier et al., 2009), this has led to greater acknowledgement for the potential value of macro-prudential policies (see Bank of England, 2009; Hanson et al., 2011; De Nicolò et al., 2012 for reviews). These policies aim to contain (the buildup of) systemic risks and achieve greater financial stability, and in that way reduce the adverse consequences of financial volatility – including through crises – for the real economy. They are meant to complement micro-prudential regulations and traditional macroeconomic management tools, notably monetary and fiscal policies (IMF, 2011, 2012b).

While some of the recognition in recent years has been motivated by the (ongoing) crises in advanced countries, emerging markets have had much greater experiences with macro-prudential policies, in part as they have had more pronounced business and financial cycles. This greater cyclicality is in part due to their greater exposures to international capital flow volatility, commodity price shocks, and other risks, and external and internal transmission channels that operate more adversely. In this context, there is much to learn for advanced countries from emerging markets, and lessons for emerging markets themselves, on the effectiveness of macro-prudential policies. More generally, there is a recognition that macro-prudential policies need to be properly designed and calibrated to country characteristics and circumstances, for which cross-country analysis can help.

To help guide the use of macro-prudential policies, this paper asks the following three questions. What macro-prudential policies are available in principle and what policies have countries actually used? What is the evidence to date on the effectiveness of these different policies? And what are the specific experiences with policies in terms of reducing banking systems' vulnerabilities? On the basis of the new analysis and other experiences, the paper concludes with thoughts on which macro-prudential policies countries can best use given their situations, and makes suggestions for further research.

We are not the first to study the use and effectiveness of macro-prudential policies. Most studies, however, take an aggregate perspective, that is, they investigate the effects of policies at the overall economic or financial sector level – e.g., credit or asset price growth, the occurrence of a financial crisis – or at the subsector level – e.g., real estate credit, house or other asset prices. We extend this work by investigating how policies may affect certain channels by which vulnerabilities and externalities can arise at the more micro-economic level. Specifically, we analyze the role of macro-prudential policies in limiting vulnerabilities in individual banks (and thereby overall banking systems). Besides being able to study specific channels and control for more variables, one advantage of individual bank data is that there is less concern for endogeneity (as policies are less likely to be adopted in response to individual bank behavior). To explore the role of differences in country circumstances and conditions, we use a large sample of countries, including both advanced countries and emerging markets, and relatively open and closed capital account economies. And we differentiate by type of policies and by phase of the country's financial cycle, i.e., whether overall credit extended to the private sector is in an upswing or downswing.

We find that macro-prudential policies aimed at the borrowers – caps on debt-to-income (DTI) and loan-to-value (LTV) ratios – are quite effective in (indirectly) reducing banking system vulnerabilities. Also limits on foreign currency lending are effective in reducing vulnerabilities during boom times. While countercyclical buffers (such as reserve requirements, profit distribution, and dynamic provisioning) also help mitigate increases in bank leverage and asset, few macro-prudential policies help stop declines in bank variables in more adverse times. We interpret the fact that demand oriented measures aimed at the real estate markets are consistently effective in addressing financial sector vulnerabilities as indicative of two facts: one, real estate cycles are important aspect of the overall financial cycles,

[1] While we use here the distinction emerging markets vs. advanced countries, in the empirical applications we also consider other country characteristics, such as being relatively open or closed on the capital account.

triggering often major concerns about systemic banking system risks, and making these measures thus important; and two, addressing demand for credit directly can be effective – to reduce banking system vulnerabilities – as it faces fewer problems of implementation, including circumventions.

Together, this suggests that macro-prudential policies are best most used as ex-ante tools, i.e., for reducing the buildup in bank risks in boom periods, rather than for mitigating declines when the cycle turns. While macro-prudential policies can help lessen a systemic crunch by providing buffers so that banks do not (need to) reduce leverage, assets, and noncore liabilities as much during bad times, in practice these effects are absent or not very strong. We also conjecture that some macro-prudential policies aimed at mitigating the buildup of financial vulnerabilities, including caps on LTV and DTI, can work perversely during financial downturns when not sufficiently lowered as they make adjustments more difficult. As such, macro-prudential policies need to be properly calibrated and adjusted.

We conclude that macro-prudential policies can be important elements of the policy toolkit aimed at overall systemic risk mitigation, especially for countries exposed to international shocks. As they affect resource allocations, however, macro-prudential policies imply also some costs, including possibly limiting (efficient) financial sector development. And poorly designed or wrongly implemented tools can be circumvented, imply further distortions, and possibly even work perversely. We therefore conclude that to provide the most benefits policies need to be properly chosen, carefully calibrated depending on country and financial system characteristics, including capital account openness, and adjusted by circumstances.

The paper itself is structured as follows. Section 2 provides a short overview of the various macro-prudential policies available in principle. It then reviews the actual use of policies and the evidence to date on the effectiveness of different policies in reducing measures of systemic risks. Section 3 presents the data used and the regression results of the new empirical analysis on the effectiveness of macro-prudential policies in mitigating banking system vulnerabilities. Section 4 concludes, also with reference to countries' current situations, prospects and vulnerabilities, on whether and how macro-prudential policies can best be used. It also provides some suggestions for further research.

2. Review of macro-prudential policies used and their effectiveness

This section first reviews the macro-prudential policies toolkit available in principle. It then reviews the actual use of macro-prudential policies for a large sample of countries. It next reviews the existing literature on the effectiveness of macro-prudential policies. The next section then evaluates for these countries using new data and panel regressions the effectiveness of various tools and approaches to reduce vulnerabilities in banking systems.

2.1. The toolkit available

The macro-prudential policies toolkit available in principle is quite large, in part as it includes existing micro-prudential tools as well as new instruments. To mitigate causes of systemic risk and to reduce those externalities that contribute to adverse financial sector dynamics, a number of instruments have been proposed and some have been used, even before the recent global crisis.[2] Table 1 categorizes these measures in a 3-by-5 matrix (for other classifications, see Bank of England, 2011; Schoenmaker and Wierts, 2011; IMF, 2011). The matrix covers along the vertical axes the goals of various types of policies, while along the horizontal axes the (intermediate) targets and methods are covered.

In reviewing the goals of various types of macro-prudential policies, it is useful to classify measures in three groups (rows, along the vertical axis). The first two groups are aimed at reducing the occurrence and consequences of cyclical financial risks, by respectively either dampening the expansionary phase of the cycle, or reinforcing the resilience of the financial sector to the adverse phases of the cycle. The third group is aimed at risks arising from interconnectedness and tries to ensure the internalization of spillovers.

[2] Note that many of these instruments can also serve some other policy objectives, including, besides micro-prudential objectives, assuring consumer protection or fostering greater competition.

Table 1
The macro-prudential toolkit.

	Policy Tool				
	Restrictions related to borrower, instrument, or activity	**Capital requirements, provisioning, surcharges**	**Restrictions on financial sector balance sheet (assets, liabilities)**	**Taxation, levies**	**Other (including institutional infrastructure)**
Expansionary phase	Time varying caps/limits/rules on: - DTI, LTI, LTV - margins, hair-cuts - lending to sectors - credit growth	Countercyclical capital requirements, leverage restrictions, general (dynamic) provisioning	Time varying caps/limits on: - mismatches (FX, interest - reserve requirements	Levy/tax on specific assets and/or liabilities	- Accounting (e.g., varying rules on mark to market) -Changes to compensation, market discipline,
Contractionary phase: fire-sales, credit crunch	Adjustment to specific loan-loss provisioning, margins or hair-cuts (e.g., through the cycle, dynamic)	Countercyclical capital requirements, general (dynamic) provisioning	Liquidity limits (e.g., Net Stable Funding Ratio, Liquidity Coverage Ratio)	Levy/tax (e.g., on non-core liabilities)	-Standardized products -OTC vs. on exchange -Safety net (Central Bank/Treasury liquidity, fiscal support)
Contagion, or shock propagation from SIFIs or networks	Varying restrictions on asset composition, activities (e.g., Volcker, Vickers)	Capital surcharges linked to systemic risk	Institution-specific limits on (bilateral) financial exposures, other balance sheet measures	Tax/levy varying by externality (size, network)	- Institutional infrastructure (e.g., CCPs) - Resolution (e.g., living wills) - Varying information, disclosure
		Enhancing resilience			
		Dampening the cycle			
		Dispelling gestation of cycle			

Observers also tend to classify policies by intended target and method. Table 1 does this in five groups (columns, along the horizontal axis), namely: a) quantitative restrictions on borrowers, instruments or activities; b) capital and provisioning requirements; c) other quantitative restrictions on financial institutions' balance sheets; d) taxation/levies on activities or balance sheet composition; and e) other, more institutional-oriented measures, such as accounting changes, changes to compensation, etc. Except for category a), these can all be seen as affecting the supply side of financing, while category a) aims to affect demand for financing. And while this overlap is less precise, tools in category b) are more aimed at enhancing resilience, while categories c) and d) are more aimed at dampening the cycle.

Specific measures under each of the 15 (3 * 5) combinations include those correcting or compensating for fundamental factors that can give rise to externalities and market failures and those that compensate for policy factors that can contribute to adverse financial dynamics (such as the Procyclicality introduced by micro-prudential capital requirements). The measures in the first four columns are meant to be time-, institution-, or state-varying, while the ones in the fifth column are meant to be more structural. And some measures fall into more than one combination depending on how they are used. As noted, many of the measures are tools traditionally used for micro-prudential objectives; however, by making them vary by time, institution, or state of the world, they can be used to achieve macro-prudential objectives, such as dampening the amplitude of the cycle.

2.2. Preferred use of macro-prudential policies

The preferred use of macro-prudential policies will vary depending on the specific country's exposure to shocks and risks, and its structural, institutional and financial market characteristics that affect the amplification of financial and real sector cycles and the effectiveness of (specific) policies. For one, the country's financial structure, that is, the importance of banks versus capital markets in external financing, is likely an important factor in the choice of policy. For example, financial institution-based measures are likely of greater importance when much of the external financing comes from the regulated financial system.[3] Such financial structures can differ vastly across countries, including the ones being studied here. The industrial organization of the financial system may also matter. State-owned banks, for example, may on one hand be more likely to comply with macro-prudential policies (as they are more easily directed). On the other hand, state-owned banks might be formally exempted from some policies. They also have been shown to suffer from greater forbearance and be subject to political pressures, resulting in poor allocation of resources. Depending on the relative strength of these effects, this could make macro-prudential policies more or less effective with large state-owned bank presence. The degree of international financial integration will matter as well, not only for the type of policy (and capital flow management) tools that can (best) be used, but also the effectiveness of policies. For example, in a country with a very open capital account and a large foreign bank presence, it will be harder to prevent the circumvention of (some) macro-prudential policies.

The use and effectiveness of policies could also vary depending on the availability and effectiveness of fiscal, monetary, and micro-prudential policies. For example, some countries can use monetary policy to affect the financial cycle, but for others, such as those in a currency union and having a pegged exchange rate, this is not available (even when available, the effectiveness of monetary policy is not clear). Other may have high debt and less room to conduct countercyclical fiscal policy. And, the degree of financial openness will matter for the choice of policies, because of it affects the degree to which some policies can be implemented and more generally determines exposures (for example, there are strong links between behavior of capital flows and bank vulnerabilities; see further Hahm et al., 2011; Claessens and Ghosh, 2013).

Preferred use could also vary depending on other elements of the broader policy toolkit available to mitigate systemic risks. Although only employed recently, some countries (e.g., US, EU) have been

[3] For instance, reserve requirements are more effective when as many deposit-like claims as possible are subject to it. Especially in advanced economies, however, many deposit-like claims are not directly regulated, or at least not like bank deposits, creating scope for avoidance. Of related importance is the development of the shadow banking system, since that is (by definition) less subject to macro-prudential policies. At the same time, the use of macro-prudential policies in the formal banking system could increase the shadow banking system.

using stress tests to help identify financial system vulnerabilities (and identify remedial actions). Such stress tests are more forward-looking than macro-prudential policies that are static or not adjusted in a timely manner. They can also be less coarse in their applications (by having for example very granular asset categories for risk scenarios). More generally, they can be more tailored to (emerging) macro-economic and financial vulnerabilities than macro-prudential policies can be, especially if the macro-prudential policies are not properly designed to (changing) country circumstances. As such, stress tests could to some degree complement or substitute for the use of macro-prudential policies.[4]

Institutional environment constraints (e.g., lack of data, know-how and skills in supervisory agencies), political economy, and other factors may also lead countries to adopt macro-prudential policies in specific ways, possibly differently from what is otherwise preferable. Furthermore, financial reforms are proceeding in a number of ways, both internationally coordinated (e.g., the new liquidity requirements announced early 2013) and country-specific (e.g., Vickers and Volcker rules), making the overall institutional environment itself in flux. And, a major issue is that little is known on the actual effectiveness of various macro-prudential policies, meaning usage often has proceeded on an ad-hoc or experimental basis.

2.3. Actual use of macro-prudential policies

Data on the actual use of macro-prudential policies in recent years have been collected through a survey of country authorities as well as from an internal IMF survey of country desk economists for a sample of some 48 countries, both advanced countries and emerging markets (see further Lim et al., 2011 for the exact coverage and definitions). The use is coded in the form of a dummy variable for each instrument that takes the value of 1 for countries and years in which that instrument is used or zero otherwise. The nine specific instruments covered are (Table 2): caps on loan-to-value (LTV) and debt-to-income (DTI) ratios, limits on credit growth (CG), limits on foreign lending (FC), reserve requirements (RR), dynamic provisioning (DP), countercyclical requirements (CTC), limits on profit redistribution (PRD), and a residual category (Other).[5] Only for some of the macro-prudential policies is the level also known: caps on LTV and DTI ratios, which vary from 0 to 1 and 0 to 0.5 respectively. To be consistent with the other macro-prudential policies, however, we use dummies to indicate the use of caps on LTV and DTI ratios. Table 2 organizes these measures along the categories of Table 1: those aimed at borrowers (caps on LTV and DTI ratios); those aimed at financial institutions' assets (CG and FC); those aimed at financial institutions' liabilities (RR); those aimed at building buffers (DP, CTC, PRD); and the remaining category Other.

In our sample a total of 35 countries – of which 25 are emerging markets and 10 are advanced countries – have implemented at least one of these instruments once during the period 2000–2010 and 13 countries have never used any of these instruments during this period (Table 2 provides the details, including when the tool was in use, although not necessarily continuously). Most usage of macro-prudential policies over this period is by emerging markets. This pattern is consistent with the greater needs in emerging markets, both for being more exposed to external shocks and for having more "imperfect" financial markets, and hence more frequent necessity to tackle market failures.[6] It is also consistent though with their generally less liberalized financial systems. We also differentiate between open and closed capital account countries on the basis of the country having a Chinn and Ito

[4] Stress tests, however, have some drawbacks. Typically they cover a subset of financial intermediation (mainly the major banks) and may therefore not capture all systemic risks. They are also less ex-ante in that actions to reduce systemic risks (e.g., need for recapitalization) would follow in a more discretionary way from the test.

[5] Note that RR can also fulfill monetary policy functions (see Federico et al., 2012). The category Other contains some macro-prudential policies not yet classified as well as some macro-prudential policies which observance was coded independently, with the latter possibly overlapping to some degree with the other policies already classified.

[6] There are also many possible interactions between macro-prudential policies and capital flow management tools. This is in part because some macro-prudential policies operate in such a way that they can be considered a capital flows management tool (e.g., limitations on foreign currency exposures for banks that end up affecting mostly non-residents, see Ostry et al., 2011; IMF, 2012a). In addition, macro-prudential policies can also affect the need for capital flows management tools. For example, by reducing the demand for loans, LTV caps can reduce the demand of banks for (whole-sale) funding, some of which may be in foreign exchange. Consequently, an LTV cap can indirectly reduce the need for capital flows management tools to be used.

Table 2
Details on use of macro-prudential instruments by country/year.

Measures	Characteristics	Country	Classification[a]		Period
Aimed at borrowers					
Loan-to-value caps	Reduce vulnerability, arising from highly geared borrowings	Brazil	Closed	Emerging	2000–2010
		Bulgaria	Closed	Emerging	2010
		Canada	Open	Advanced	2000–2010
		Chile	Open	Emerging	2000–2010
		China	Closed	Emerging	2000–2010
		Colombia	Closed	Emerging	2000–2010
		Croatia	Open	Emerging	2000–2010
		France	Open	Advanced	2000–2010
		Hong Kong	Open	Advanced	2000–2010
		Hungary	Open	Emerging	2010
		India	Closed	Emerging	2000–2010
		Italy	Open	Advanced	2000–2010
		South Korea	Closed	Advanced	2002–2010
		Malaysia	Closed	Emerging	2000–2010
		Mexico	Open	Emerging	2000–2010
		Norway	Open	Advanced	2010
		Philippines	Closed	Emerging	2000–2010
		Poland	Closed	Emerging	2000–2010
		Romania	Open	Emerging	2004–2007
		Singapore	Open	Advanced	2000–2010
		Spain	Open	Advanced	2000–2010
		Sweden	Open	Advanced	2010
		Thailand	Closed	Emerging	2003–2010
		Turkey	Closed	Emerging	2010
Debt-to-income caps	Reduces vulnerability arising from highly geared borrowings	China	Closed	Emerging	2000–2010
		Colombia	Closed	Emerging	2000–2010
		Hong Kong	Open	Advanced	2005–2010
		Poland	Closed	Emerging	2010
		Romania	Open	Emerging	2004–2008
		Serbia	Open	Emerging	2010
		South Korea	Closed	Advanced	2006–2010
Aimed at financial institutions (addressing asset side)					
Credit growth caps	Reduces credit growth directly	China	Closed	Emerging	2000–2010
		Colombia	Closed	Emerging	2000–2010
		Malaysia	Closed	Emerging	2000–2010
		Nigeria	Closed	Emerging	2010
		Serbia	Open	Emerging	2008–2010
		Singapore	Open	Advanced	2010
		Argentina	Closed	Emerging	2003–2010
		Austria	Open	Advanced	2008–2010
Foreign currency lending limits	Reduces vulnerability to ft risks; Reduces credit growth directly	Brazil	Closed	Emerging	2000–2010
		Hungary	Open	Emerging	2010
		Poland	Closed	Emerging	2006–2010
		Romania	Open	Emerging	2005–2010
		Serbia	Open	Emerging	2008–2010
		Turkey	Closed	Emerging	2009–2010
Aimed at financial institutions (addressing liabilities side)					
Reserve requirements	Reduces vulnerability to funding risks; Reduces credit growth indirectly	Brazil	Closed	Emerging	2008–2010
		Bulgaria	Closed	Emerging	2007–2010
		China	Closed	Emerging	2004–2010
		Colombia	Closed	Emerging	2007–2010
		Russia	Closed	Emerging	2004–2009
Aimed at financial institutions (addressing bank buffers)					
Dynamic loan-loss provisioning	Increases resilience and reduces credit growth indirectly;	Brazil	Closed	Emerging	2005–2010
		Bulgaria	Closed	Emerging	2005–2010
		Colombia	Closed	Emerging	2007–2010
		India	Closed	Emerging	2010
		Mongolia	Open	Emerging	2010
		Peru	Open	Emerging	2008–2010
		Russia	Closed	Emerging	2010
		Spain	Open	Advanced	2000–2010
		Uruguay	Open	Emerging	2001–2010

(*continued on next page*)

Table 2 (*continued*)

Measures	Characteristics	Country	Classification[a]		Period
Countercyclical capital requirements	Increases resilience and reduces credit growth indirectly;	Brazil	Closed	Emerging	2007–2010
		India	Closed	Emerging	2003–2010
		Argentina	Closed	Emerging	2010
Profit distribution restrictions	Limit dividend payments in good times to help buildup capital buffers in bad times	Colombia	Closed	Emerging	2008–2010
		Poland	Closed	Emerging	2009–2010
		Romania	Open	Emerging	2009–2010
		Slovakia	Open	Emerging	2008–2010
		Turkey	Closed	Emerging	2008–2010
Institutional infrastructure					
Moving of derivatives to organized	Increases transparency				
Volcker/Vickers types rules	Reduces (counterpart) risks in capital				
Increase disclosure at system level	Reduces risks of intra-sector spillovers				
Market structure measures	Enhance market discipline				
Other					
Other macro-prudential measures (countercyclical provisioning, countercyclical capital, restrictions on profit distribution, restrictions on treatment of profits in regulatory capital)	Decrease leverage growth	Brazil	Closed	Emerging	2007–2010
		Colombia	Closed	Emerging	2000–2010
		Croatia	Open	Emerging	2007–2010
		Hungary	Open	Emerging	2010
		Indonesia	Open	Emerging	2005–2010
		Malaysia	Closed	Emerging	2000–2010
		Norway	Open	Advanced	2010
		Serbia	Open	Emerging	2008–2010
		Slovakia	Open	Emerging	2008–2010
		South Africa	Closed	Emerging	2008–2010
		South Korea	Closed	Advanced	2008–2010
		Thailand	Closed	Emerging	2008–2010
		Uruguay	Open	Emerging	2008–2010

[a] The classification variable divides the sample into emerging versus advanced economy countries (source: IMF), and open versus closed capital account countries (source: Chinn–Ito Index 2008). We define a country as having an open capital account country if its Chinn–Ito index is larger than the global median in 2005, and as a closed capital account country if its Chinn–Ito index is smaller than the global median in 2005.

(2008) index of financial openness in 2005 above (33 countries) or below (15 countries) the median global index.[7] The capital account dimension is an analytically useful distinction as it indicates what risks are (more) important and affects the consequences that may need to be managed. On this measure, as expected, all advanced countries have open capital accounts, while in the case of emerging markets, some have relatively open capital accounts, but others like China and India, are relatively closed. In turns out that macro-prudential policies have been used more in closed capital account countries, reflecting perhaps these countries' generally less liberalized financial systems.

The usage statistics presented so far do not consider the length of time over which the specific policies have been used. Fig. 1 provides the percentage of countries that have used any policy in a given year. As noted, there is a growing recognition of the value of macro-prudential policies. This is reflected in the strong trend of increased usage of macro-prudential policies since the 1990s, with emerging markets in particular using macro-prudential policies more, both before and after the recent crisis. On average, macro-prudential policies were four times more likely to be used by emerging markets than by advanced countries in the period right before the crisis (with this ratio declining to 3.3 after the crisis as advanced countries started to introduce macro-prudential policies). Differentiating between open and closed capital account countries leads to less sharp, but qualitatively similar differences.

[7] Note that we use the global median Chinn–Ito index, that is, the median within the whole Chinn–Ito dataset, not the median within this sample, which is why we have more open than closed countries. Also, as it is binary split, the closed account group still includes countries such as Brazil, Colombia, Russia and Turkey, for which capital flows are still very important from overall economic management and financial stability point of views. While we do not have Chinn–Ito data for Serbia, we classify it in the open capital account group, since by all accounts it has an open capital account.

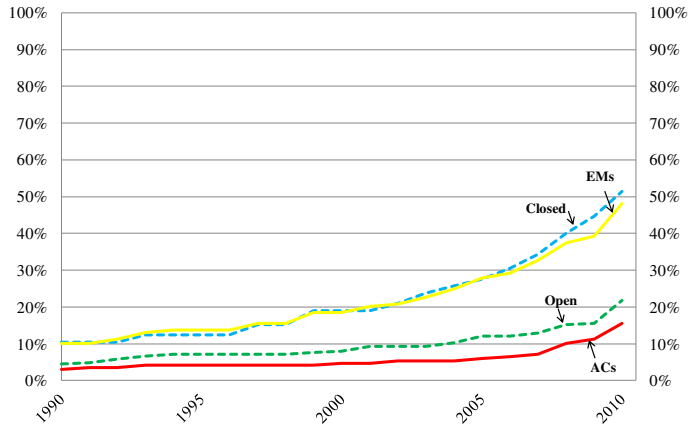

Fig. 1. Use of macro-prudential policies: advanced countries vs. emerging markets and open vs. closed capital account.* *Index of *MaPP* usage in emerging markets (EMs), advanced countries (ACs), open capital account economies (Open) and closed capital account economies (Closed). The index represents the percentage of countries in our samples that have used macro-prudential policies. Source: Lim et al. (2011); Fund staff calculations.

Overall, countries use LTVs the most (Table 3, column 1): 24 countries used it at least in one year during this period. This is followed by dynamic provisioning (DP, 9 countries), foreign currency (FC, i.e., lending limits, 8 countries), debt-to-income (DTI, 7 countries), and credit growth (CG) caps and profit distribution restrictions (PRD), both used by 6 countries. These are followed by reserve requirements (RR, 5 countries) and finally countercyclical capital (CTC, 2 countries).

Weighting by the length of time over which the macro-prudential policies are used (column 2 in Table 3), the most often used policy in the whole sample of countries is by far the loan-to-value (LTV): in about 44% of the country-year combinations when a policy was used, it was an LTV. Next, besides the category Other, are four categories used about equally frequently: debt-to-income (DTI) and credit growth (CG) caps, foreign currency (FC) lending limits, and dynamic provisioning (DP), all used about 8% of the cases each. These are followed by reserve requirements (RR), 5%, profit distribution restrictions

Table 3
Overall use of macro-prudential instruments.

Type of instrument	Total countries	Frequency of use (%)	Emerging markets	Advanced countries	Closed capital	Open capital account	Frequency of EMs-year (%)	Frequency of ACs-year (%)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
LTV	24	44	15	9	11	13	35	74
DTI	7	9	5	2	4	3	8	11
CG	6	8	5	1	4	2	10	1
FC	8	8	7	1	4	4	10	3
RR	5	5	5	0	5	0	7	0
DP	9	9	8	1	5	4	9	11
CTC	2	1	2	0	2	0	2	0
PRD	6	3	6	0	4	2	4	0
Other	13	12	12	1	6	7	15	1
Total by classification	35 (only)	100	25 (only)	10 (only)	15 (only)	20 (only)	100	100

There are in total 35 countries using a macro-prudential policy at any point during the period 2000–2010. Countries are classified into emerging versus advanced economy countries (source: IMF), and open versus closed capital account countries (source: Chinn–Ito Index 2008). A country is defined as an open capital account country if its Chinn–Ito Index is larger than the global mean in 2005, and a closed capital account country if its Chinn–Ito Index is smaller than the global mean in 2005. The frequency of use is the ratio of country-pairs using a particular instrument to the total number of country-year pairs using a macro-prudential policy (e.g., 44% of the time during 2000–2010, countries were using LTV ratios compared to only 9% of the time using DTI ceilings).

(PRD), 3%, and finally countercyclical capital (CTC), 1%. Note that some countries used more than one policy at a time, making these comparisons relative to the overall use of macro-prudential policies.

Use of a specific policy can also be expected to vary between advanced countries and emerging markets and between open vs. closed capital account countries in part as the sources of systemic risks vary. In advanced countries, LTVs are used the most (Table 3, columns 3 and 4), with countries using LTVs over this period: Canada, France, Hong Kong, Italy, South Korea, Norway, Singapore, Spain and Sweden. Usage of other macro-prudential policies by advanced countries is rarer: just Hong Kong and South Korea use DTI, Singapore uses credit growth limits, Austria foreign exchange limits, Spain dynamic loan-loss provisioning, and Norway and South Korea Other tools. While LTV caps and foreign currency limits are used almost equally in both open and closed economies, reserve requirements are only used in relatively closed capital account countries (Table 3, columns 5 and 6). This likely reflects differences in both risk exposures and financial system structures, and possibly the degree of financial liberalization. Otherwise, the differences in use between open and closed economies are not as stark as those between emerging markets and advanced countries.

Differences between emerging markets and advanced countries' use of specific policies are starker when considering the length of time over which the policies are used (columns 7 and 8 of Table 3, which report usage percentages by country-year observations for each group). Emerging markets use a much broader set of policies over a longer period than advanced countries do. Because emerging markets tend to be more concerned with large and volatile capital inflows and with related systemic liquidity risk, they tend to favor relatively more capital flow- and liquidity-related policies (FC, RR). But they also use limits on credit growth more often, possibly in part because they tend to have less liberalized financial systems. They also tend to rely somewhat more on limits on profit distributions. On the other hand, as noted, advanced countries tend to mainly prefer the demand for credit related measure LTVs (74% of their usage by country-year observations). They also use DTI and dynamic provisioning Marginally more than emerging markets do. This suggests that advanced countries are more concerned with risks arising from excessive leverage, and the consequent de-leveraging.

2.4. *Effectiveness of macro-prudential policies: existing studies*

Some existing papers have analyzed the effects of macro-prudential policies on various measures of financial vulnerability and stability (see further IMF (2012b) for a recent review of studies). Lim et al. (2011) explore the role of macro-prudential policies and document evidence of some macro-prudential policies being effective in reducing the procyclicality of credit and leverage. Specifically, using cross-country regressions, they find that tools such as LTV and DTI caps, ceilings on credit growth, reserve requirements, and dynamic provisioning rules, can mitigate the "procyclicality" of credit.

IMF (2012b) also investigates in a cross-country context the effectiveness of (changes in) macro-prudential policies on financial vulnerabilities (credit growth, house prices, and portfolio capital inflows) and any effects on the real economy (output growth, and sectoral allocation, i.e., the share of residential investment), considering also whether the effects of policies are symmetric between tightening and loosening. Overall, they find that both (time-varying) capital requirements and RRs have statistically significant effects on credit growth for, that limits on LTV ratios and capital requirements (but not RRs) have strong effects on house price appreciation rates, and that RRs reduce portfolio inflows in emerging markets with floating exchange rates. They cannot reject the hypothesis that the effect of policies is symmetric, rather than asymmetric. Their evidence also suggests that limits on LTV impact output growth, may be working through reducing construction investment, but other policies show little evidence of directly affecting output.

Crowe et al. (2011) explore the effects of policies like LTVs on real estate booms and busts. They find that policies such as maximum LTV linked to the real estate cycle appear to have the best chance to curb a boom. They argue that the narrower focus of such tools reduces their costs. And, for measures aimed at strengthening the banking system (such as dynamic provisioning), even when failing to stop a boom, they argue that such tools may still help to cope with the bust. Vandenbussche et al. (2012) investigate whether macro-prudential policies had any impact on house price inflation in Central, Eastern and Southeastern European countries. Their evidence suggests that measures like capital ratio

requirements and non-standard liquidity measures (marginal reserve requirements on foreign funding or linked to credit growth) helped slow down house price inflation.

Dell'Ariccia et al. (2012) conduct an empirical investigation of the use of macro-prudential policies in mitigating general credit booms and busts. Their results suggest that macro-prudential policies can reduce the incidence of credit booms and decrease the probability that booms end up badly.[8] Consistent with the focus of macro-prudential policies on financial vulnerabilities, they find a reduction in the probability of a bad boom, primarily for those booms that end up in a financial crisis, although the effect on the probability of economic underperformance is not very different. They conclude that macro-prudential policies can reduce the risk of a bust, while simultaneously reducing the vulnerability of the rest of the economy to troubles in the financial system.

Besides these more aggregate, cross-country studies, there are also some case studies, often focused on specific risks or market segments, and using micro data. Jiménez et al. (2012), for example, find for the case of Spain that countercyclical macro-prudential policies, such as dynamic provisioning, are useful in taming credit supply cycles. More importantly, they find that during bad times, dynamic provisioning helps smooth the downturn, upholding firm credit availability and performance during recessions. Igan and Kang (2011) find evidence of effects of LTV and DTI limits on mortgage credit growth in Korea. And for the case of the UK over the period 1998–2007, Aiyar et al. (2012, 2013) show that bank-specific higher capital adequacy requirements dampen lending by individual banks (whereas tighter monetary policy does not affect the supply of lending).

3. Analysis of effects of macro-prudential policies on banking system vulnerabilities

This section provides a new analysis on the effectiveness of macro-prudential policies for mitigating banking system vulnerabilities. It first describes the data used and then analyzes the effectiveness of the various policies countries have used.

3.1. Data used for analysis

We perform our analysis using the panel dataset of macro-prudential policies actually used (described above) and relate these to measures of banking system vulnerabilities, in particular annual changes in three variables: leverage (a bank's total assets to total equity ratio), asset, and noncore to core liabilities.[9] Our main data source for the bank balance sheet data is the Bankscope database, which standardizes balance sheet statements to adjust for variations in accounting and auditing conventions so that they are (reasonably) comparable. The sample of banks is chosen so that for each country, we cover the top 100 banks based on total assets (or less if only fewer banks exist). This way we avoid the sample being dominated by advanced countries where there are many banks, such as the US, Germany and Japan. We use unconsolidated data, so that we also cover individual subsidiaries of foreign banks.

All financial statement data are annual and in US dollars. To remove the effect of outliers, we winsorize all observations, discarding bank balance sheet ratios above (or below) the five percent level in both tails of the distributions. We end up with some 18,000 observations on approximately 2820 banks in 48 countries over the period 2000–2010, of which approximately 1650 are in 24 advanced countries and 1170 in 24 emerging markets. Since 35 countries have adopted at least one macro-prudential policy tool and 13 have adopted none at any time during 2000–2010, we have both good sized treatment and control groups.

Table 4A provides summary statistics of the dependent and independent variables used. It shows the large variation in these measures across individual banks, even with the removal of outliers. Growth in leverage is on average very small, but varies greatly, between 386% up and down. Asset

[8] When estimating regressions using the subcomponents of their macro-prudential index, they find that credit and interest controls and open foreign exchange position limits enter significantly in most regressions, although their significance is sensitive to the specific combination of variables included.

[9] Since we are limited to annual bank balance sheets data, we cannot study the effects of intra-year changes in macro-prudential policies (some countries, like Korea, have altered macro-prudential policies within a single year, see Igan and Kang, 2011). However, since such changes are rare and more general macro-prudential policies are not meant as short-term risk management tools, we do not expect our results to be affected.

Table 4A
Summary statistics of regression variables.

Variable		All sample					AC					EM				
		Obs.	Mean	Std. dev.	Min	Max	Obs.	Mean	Std. dev.	Min	Max	Obs.	Mean	Std. dev.	Min	Max
Banks		2821 (unique)					1651 (unique)					1170 (unique)				
Years		2000–2010					2000–2010					2000–2010				
Countries		48 (unique)					24 (unique					24 (unique)				
Bank level	Leverage growth (YoY) (%)	18,082	0.16	41.93	−386.13	386.13	10,496	−0.43	36.59	−386.13	386.13	7586	0.97	48.35	−386.13	386.13
	Asset growth (YoY) (%)	18,092	13.32	28.4	−37.55	77.05	10,506	10.42	25.59	−37.55	77.05	7586	17.35	31.45	−37.55	77.05
	Noncore to core liab. growth (YoY) (%)	15,630	−1.14	58.53	−663.23	647.81	8923	−1.25	51.74	−663.23	592.09	6707	−0.99	66.5	−408.4	647.81
	Leverage ratio	21,225	14.23	12.34	1.07	51.06	12,272	17.56	13.65	1.07	51.06	8953	9.66	8.36	1.07	51.06
	Noncore-to-core liability ratio	18,421	2.77	6.14	0.03	25.59	10,472	3.36	6.99	0.03	25.59	7949	2	4.71	0.03	25.59
	Assets (USD $M)	21,234	58030.4	211,517	0.01	3,914,824	12,281	88741.1	260,026	0.01	3,807,892	8953	15903.9	101,480	0.03	3,914,824
Country level	Real GDP growth (%)	11,700	5.67	10.81	−15.38	21.41	16,474	5.29	10.62	−15.38	21.41	11,700	5.67	10.81	−15.38	21.41
	Interest rate change	10,926	−5.16	19.3	−53.19	27.63	11,851	−6.53	18.81	−53.19	27.63	10,926	−5.16	19.3	−53.19	27.63
	Exchange rate classification	12,869	2.44	0.92	1	6	18,161	2.18	1.18	1	4	12,869	2.44	0.92	1	6
	Debt to GDP (%)	30,713	56.66	25.66	16.19	114.49	18,112	62.87	25.86	16.19	114.49	12,601	47.74	22.57	16.19	114.49
	Foreign reserves/GDP (%)	29,113	13.16	17.04	0.28	121.27	10,328	0.07	0.49	−2.02	4.11	11,414	19.32	12.05	3.73	67.61
	Systemic financial crisis	31,031	0.05	0.21	0	1	18,161	0.06	0.24	0	1	12,870	0.02	0.15	0	1
	Capital account openness (Chinn–Ito)	30,668	1.42	1.35	−1.16	2.46	18,161	2.33	0.48	−0.11	2.46	12,507	0.1	1.09	−1.16	2.46
	Capital account flow/GDP (%)	27,556	0.05	0.44	−2.02	4.11	17,699	9.18	18.54	0.28	121.27	17,228	0.04	0.41	−1.42	2.16
	Bank assets/stock market cap (%)	26,602	97.58	94.1	4.96	357.47	16,210	131.66	96.36	4.96	357.47	10,392	44.43	59.55	4.96	320.48
	Foreign share of bank assets (%)	15,263	23.09	26.19	0.3	85.1	9065	16.84	22.09	0.3	85.1	6198	32.24	28.9	0.3	85.1
	LTV	31,031	0.42	0.49	0	1	18,161	0.31	0.46	0	1	12,870	0.57	0.5	0	1
	DTI	31,031	0.07	0.25	0	1	18,161	0.03	0.16	0	1	12,870	0.13	0.33	0	1
	CG	31,031	0.08	0.27	0	1	18,161	0	0.06	0	1	12,870	0.19	0.39	0	1
	FC	31,031	0.08	0.27	0	1	18,161	0.02	0.13	0	1	12,870	0.16	0.37	0	1
	RR	31,031	0.06	0.23	0	1	18,161	0	0	0	0	12,870	0.14	0.34	0	1
	DP	31,031	0.08	0.27	0	1	18,161	0.06	0.24	0	1	12,870	0.11	0.31	0	1
	CTC	31,031	0.02	0.15	0	1	18,161	0	0	0	0	12,870	0.05	0.22	0	1
	PR	31,031	0.02	0.13	0	1	18,161	0	0.05	0	1	12,870	0.04	0.19	0	1
	Other *MaPP*	31,031	0.09	0.28	0	1	18,161	0.01	0.11	0	1	12,870	0.19	0.39	0	1

growth is on average 13% per year, but varies also greatly among banks, from −38% to 77%, as does the growth in the reliance on noncore to core liabilities, between −663% and 648%. As we cover many countries, some with small banking systems, the banks included vary greatly in size, from $10 million to the largest being $3.9 trillion. While the average leverage is 14, some banks are very lowly weakly leveraged, having a debt-to-equity ratio of just 1, whereas the highest leveraged bank has a ratio of 51. Also, while the average noncore to core liabilities ratio is 2.8 and many banks do not rely on noncore liabilities at all, for some banks, noncore liabilities can reach up to 26 times core liabilities.

Differences between the groups of advanced countries and emerging markets are as expected, with the average growth rates in leverage, asset and noncore to core liabilities higher in emerging markets than in advanced countries. This reflects the general financial cycles in these two groups of countries, with advanced countries also experiencing more downturns over this period. Banks are typically smaller in emerging markets, less leveraged, and less dependent on noncore to core liabilities than in advanced countries. Since we winsorize the data, extreme values can be the same (and thus be identical between the various groups).

We differentiate between boom and bust years depending on whether overall real credit in the specific country increases or decreases in that year (note that some countries did not experience any decline in credit over this period). Table 4Bb makes clear that the boom and bust parts of the cycles are different in terms of banks' balance sheets behavior. It also shows that booms and busts vary between countries, with those in emerging markets (open) varying from those in advanced countries (closed capital account countries). For example, the typical expansionary phase is stronger in emerging markets than in advanced countries, with larger asset growth and higher leverage growth. The typical contractionary phase is less severe though in terms of bank variables in emerging markets than in advanced countries, except for the decline in the noncore to core liabilities. Some differences reflect that over this period advanced countries faced more periods with declines in overall credit. Overall though booms and busts tend to be more intense in emerging markets (see Claessens and Ghosh, 2013).

Closed differ from open capital account economies in many ways similar as emerging markets differ from advanced countries, with closed countries having higher asset growth and generally more volatility in financial variables between booms and busts. This could be because capital account restrictions are adopted by those countries more exposed to systemic risks, including due to global shocks. Or it could be that more closed countries are less well-developed financially and institutionally, which make them more prone to (external) shocks.

Importantly, there are differences between those countries that have used macro-prudential policies and those that have not, in that the median increases in bank leverage and assets are larger for those countries that have used macro-prudential policies. This suggests that those countries experiencing larger increases in financial risks have a greater willingness to adopt macro-prudential policies. These aspects confirm the need to control for some endogeneity in the adoption of macro-prudential policies.

Given other country differences, it will be important to include country controls in the regressions. In robustness regressions, we therefore include various time-varying country controls, with annual data obtained from the IMF's International Financial Statistics (IFS) and other sources. One set of variables includes the real GDP growth rate to proxy for the state of the country's business cycle, as that will affect whether banks are more likely to expand or contract their balance sheets. We include the change in interest rates to control for the monetary policy stance, which can be expected to affect the country's financial cycle, including the degree of risk-taking, and the effectiveness of policies. We also control for the country's exchange rate arrangement, with a measure varying from 0 for a completely fixed (i.e., a de-facto peg or membership of a currency zone) to 6 for a free-float regime.[10]

[10] Exchange rate arrangements can matter in two ways for vulnerabilities. A more fixed exchange rate arrangement can limit monetary policy as an instrument to mitigate cycles and it may thus mean more booms (and busts). It may also mean some moral hazard as the fixed rate implies a more explicit form of public insurance for the banking system. At the same time, the exchange rate arrangement can affect our measures of banking system vulnerabilities since these are recorded in US dollars. This means that, depending on the local vs. foreign currency composition of banks' balance sheets, fluctuations in the dollar-local currency rate can get more reflected in our measures if the exchange rate is (more) flexible.

Table 4B
Summary statistics of banking variables by country.

Country	Number of banks	Country	Classification	Number of observations	Use of *MaPP* 2000–2010	Leverage	Assets	NCC	Leverage	Assets	NCC	Leverage	Assets	NCC
						2000–2010			Expansionary phase			Contractionary phase		
Argentina	59	Closed	Emerging	649	Yes	0.68	9.1	−5.9	8.6	18	−6.8	−13	−5.6	−4.4
Australia	53	Open	Advanced	583	No	−3.5	12	4.7	−3.5	12	4.7			
Austria	100	Open	Advanced	1100	Yes	−0.19	12	−0.8	−0.43	14	−0.65	1.5	−3.5	−1.8
Belgium	67	Open	Advanced	737	No	−2.9	9.1	3.4	−2.4	10	5	−3.8	7.5	0.81
Brazil	100	Closed	Emerging	1100	Yes	3.1	22	−0.56	3.3	19	2.7	2.8	30	−8.9
Bulgaria	27	Closed	Emerging	297	Yes	5.1	24	−1.7	8.4	32	−0.41	−3.5	4.7	−5.1
Canada	86	Open	Advanced	946	Yes	−2	12	−3.2	1.1	21	−2.3	−2	−2.7	−3.7
Chile	27	Open	Emerging	297	Yes	1.9	16	−20	7.5	12	−17	−8.3	24	−23
China	100	Closed	Emerging	1100	Yes	−0.89	25	−3	−0.89	25	−3			
Colombia	28	Closed	Emerging	308	Yes	−2.4	13	1.4	−2.4	13	1.4			
Croatia	36	Open	Emerging	396	Yes	2.7	15	−1.3	3	16	−1.7	−0.11	6.8	2.2
Czech Republic	34	Open	Advanced	374	No	−1.5	17	−6	0.15	16	−2.6	−6	17	−15
Finland	22	Open	Advanced	242	No	2.9	11	2.6	2.9	11	2.6			
France	100	Open	Advanced	1100	Yes	−0.11	12	1.1	0.35	13	2.3	−1.8	8.7	−3.4
Germany	100	Open	Advanced	1100	No	−1.1	7.2	−7	1.6	13	−7.4	−2.8	3.5	−6.8
Hong Kong	49	Open	Advanced	539	Yes	−0.88	9.5	−1.2	−0.88	9.5	−1.2			
Hungary	28	Open	Emerging	308	Yes	0.93	15	2.8	0.95	15	5.4	0.81	11	−15
India	91	Closed	Emerging	1001	Yes	−1.8	16	−0.92	−1.8	16	−0.92			
Indonesia	51	Open	Emerging	561	Yes	−3	17	−2.8	−3	14	−4.3	−2.9	41	10
Ireland	38	Open	Advanced	418	No	−1.8	4.3	0.64	6.1	13	1.4	−18	−13	−1.1
Italy	100	Open	Advanced	1100	Yes	0.75	10	−1	0.75	10	−1			
Japan	100	Open	Advanced	1100	No	−1.6	4.1	−0.39	−2.9	6.9	−4.5	−0.97	2.8	1.5
Malaysia	81	Closed	Emerging	891	Yes	1.4	12	3.4	2.1	10	7.7	−0.66	16	−9.5
Mexico	73	Open	Emerging	803	Yes	3.4	16	6.8	−0.62	14	−4.2	12	21	28
Mongolia	6	Open	Emerging	66	Yes	4.3	34	−1.1	2.1	34	3.5	23	30	−39
Netherlands	57	Open	Advanced	627	No	−3.2	8	−3.2	−2.4	11	−3.4	−6.8	−3	−2.6
New Zealand	17	Open	Advanced	187	No	−1.1	4	−2.3	−1	9.5	−1.8	−1.3	−9.5	−3.5
Nigeria	28	Closed	Emerging	308	Yes	−8.1	17	−7.5	−12	19	−8	13	8.3	−4.3
Norway	100	Open	Advanced	1100	Yes	5	14	5.7	8	29	14			
Peru	25	Open	Emerging	275	Yes	−0.45	17	−5	4.4	18	2.1	−4.4	15	−10
Philippines	39	Closed	Emerging	429	Yes	4.5	16	−7.8	3.9	17	−8.6	9.9	15	−0.88
Poland	46	Closed	Emerging	506	Yes	2.5	15	−6.7	2.5	15	−6.7			
Portugal	39	Open	Advanced	429	No	0.65	11	7.6	0.81	11	8.5	−6.3	23	−30
Romania	27	Open	Emerging	297	Yes	6.9	20	4.5	11	28	9.8	−4.1	−1.4	−12
Russia	100	Closed	Emerging	1100	Yes	4.2	26	−0.6	4.2	26	−0.6			
Serbia	33	Open	Emerging	363	Yes	2.9	21	9.6	4.4	21	10	−14	30	−1.1
Singapore	29	Open	Advanced	319	Yes	1	12	−0.36	0.93	13	−0.018	2	7.9	−4.5
Slovakia	18	Open	Advanced	198	Yes	5.2	14	−0.31	2.7	20	24	13	19	−58

South Africa	49	Closed	Emerging	539	Yes	−1.3	12	−2.4	−2.2	12	−3.4	0.19	12	−0.79
South Korea	42	Closed	Advanced	462	Yes	0.94	15	−4	−0.5	14	−4.4	3.7	15	−3.5
Spain	100	Open	Advanced	1100	Yes	0.68	8.4	6.4	0.68	8.4	6.4			
Sweden	100	Open	Advanced	1100	Yes	0.45	13	−4.3	0.45	13	−4.3			
Switzerland	100	Open	Advanced	1100	No	−0.064	12	−6.7	−0.55	9.6	−4.9	1.2	18	−11
Thailand	34	Closed	Emerging	374	Yes	−0.55	12	5.6	0.18	11	3.8	−4	18	14
Turkey	59	Closed	Emerging	649	Yes	−1.1	14	−2.8	0.093	15	0.5	−39	−30	−82
United Kingdom	100	Open	Advanced	1100	No	0.8	10	0.73	4	14	4.3	−5.5	2	−5.8
United States	100	Open	Advanced	1100	No	−2.4	10	−2.2	−2.8	9	−2	−0.8	15	−3.3
Uruguay	23	Open	Emerging	253	Yes	−3.4	7.4	−9.6	−4.2	4.1	4.8	−2.3	12	−29
Average (24 emerging countries)						0.9	17.15	−1.9	1.65	17.67	−0.58	−1.82	13.57	−10.04
Average (24 advanced countries)						−0.17	10.48	−0.42	0.55	12.95	1.36	−2.04	6.34	−8.92
Average (15 closed capital account countries)						−0.05	15.74	−2.33	0.41	16.73	−1.91	−2.91	7.6	−10.4
Average (33 open capital account countries)						0.34	12.58	−0.67	1.19	14.33	1.38	−1.49	10.85	−9.12
Average (13 non-*MaPP* countries)						1.14	9.21	−0.62	0	11.23	−0.01	−4.64	5.75	−6.98
Average (35 *MaPP* countries)						0.92	15.53	−1.36	1.5	16.83	0.54	−0.73	12.09	−10.63

In another robustness test we include, in addition to the first set, the public debt-to-GDP ratio, since that may affect the ability and willingness of the country to conduct countercyclical fiscal policy. We also include the annual change in foreign exchange reserves, as a ratio to GDP, since that influences the degree to which international factors affect and possibly aggravate domestic financial cycles, as well to proxy for changes in the country's creditworthiness. Here macroeconomic management will matter. For example, depending on the degree to which capital inflows are sterilized, a buildup in reserves in response to capital inflows can mitigate a credit boom. And since policies may work less well when a country faces a financial crisis, we include a crisis dummy from Laeven and Valencia (2012).

A country's openness can affect its vulnerability, since the degree to which domestic financial cycles can occur (and be of systemic concern) can depend on international factors, especially for emerging markets. Openness also affects the degree to which macro-prudential policies may be subject to circumvention. In an additional set of robustness regressions, we therefore include, again in addition to the base macroeconomic variables, the country's degree of de-jure openness (as measured by the Chinn–Ito index). We also include de-facto financial openness, proxied by capital flows as a percent of GDP. To avoid endogeneity, we lag all of these country measures by one year.

Besides the time-varying country controls, we include in other set of robustness regressions a number of variables to capture key country characteristics. The degree to which macro-prudential policies can be applied and be effective depends in part on the degree to which financial intermediation occurs through the banking system or other, less regulated forms. For example, it is more challenging to use some types of macro-prudential policies for financing intermediated through capital markets or the shadow banking system. We therefore include in a robustness test a measure for the country's financial structure, specifically, the ratio of bank to market financing (from the World Bank financial structure database). In addition, as macro-prudential policies may be less effective for some classes of banks, we include information on the ownership structure of the banking system, specifically the fraction owned by foreign banks. To avoid endogeneity, we date the structural country measures as of 2000. Note that, since we do not have these variables for all countries and all years, the number of observations is less for these robustness tests.

Raw statistics for these country variables, including the use of macro-prudential policies, are presented in Table 4A. In terms of real GDP growth, emerging markets tend to outperform advanced countries, 5.7% vs. 5.3%. In terms of the central bank policy rate, while emerging markets have higher rates than advanced countries do over the period 2000–2010, they have moderated their rates less than advanced countries did since 2000. And debt levels vary greatly, from 16% to 114% of GDP, with advanced countries generally having higher debt levels than emerging markets, on average 63% vs. 48%. A few countries experienced a systemic banking crisis, in the group of emerging markets some 2% of country-year observations were crisis years, whereas for advanced countries it was 6%.

Countries differ also widely in structural characteristics. For example, exchange rate arrangements vary from belonging to a currency union (e.g., Spain, Germany) to being freely floating (e.g., US, Australia, Japan). In terms of de-jure and de-facto capital account openness, there are large differences among countries as well, varying from China being nearly closed de-jure, to Norway and Singapore being fully open. And some financial systems are dominated by banks, while others are more balanced between bank and market forms of external financing: the ratio of the size of the banking system relative to capital markets varies from less than 5% to more than 350% for Switzerland. Also, foreign bank presence varies widely in the sample, with market shares less than 0.4% for China to over 85% for Croatia, Czech Republic, Hong Kong, Romania, the Slovak Republic, and Uruguay.

3.2. Empirical model

We want to assess the effects of the nine macro-prudential policies on our three risk variables, comparing the use of each instrument with an alternate scenario where the instrument is not used. The empirical model we use is Generalized Method of Moments (GMM) panel regressions. The GMM model is advantageous because it corrects to some degree for the biases introduced by endogeneity problems (e.g., countries that use a policy may do so in response to concerns about systemic risk, captured in part

by our dependent variables).[11] We test for every regression that the GMM system estimator satisfies the orthogonality hypothesis between the lagged endogenous variables. The lagged dependent variables, also including credit growth, and time and country fixed effects are used as instruments and are weighted such as to minimize the asymptotic variance of the estimator.

We define the base regression model as follows:

$$\Delta Y_{i,c,t} = \alpha + \lambda * \Delta Y_{i,c,t-1} + \beta * MaPP_{j,c,t} + \varphi * MaPP_{j,c,t} * \Delta Y_{i,c,t-1} + \theta * X_{c,t-1} + \mu * Z_{i,c,t-1} + \varepsilon_{i,c,t}^{MaPP} \quad (1)$$

For each bank i in country c in year t, $Y_{i,c,t}$ represents the change in respective bank risk variable. In terms of right-hand side variables, all regressions include a lagged dependent variable, to allow for natural convergence. We control for individual bank conditions by including a vector $Z_{i,t-1}$ which consists of a bank's leverage and liquidity (ratio of noncore to core funding) positions in the previous year. To control for macroeconomic developments and policies as well as country-level time-invariant circumstances, we include in robustness tests various vectors $X_{c,t-1}$ of (lagged) variables. In all regressions, we include year fixed effects, to control for any (remaining) time-varying effects, such as changes in global economic or financial conditions (as well as inflation in US dollars), and individual country fixed effects, to control for any time-invariant country effects.

In terms of the policy variables of interest, in the base regression the matrix $MaPP_{j,c,t}$ is our set of dummy variables that take the value of 1 during years in which instrument j is used in country c and zero otherwise. Countries that never use any instrument are thus included, with values of zero for all instruments. We run these regressions first with each of the nine macro-prudential policies individually. We further investigate whether the effects of specific policies vary by the intensity of the changes in the bank risk variable. We do this by including $MaPP_{j,c,t}$ * $\Delta Y_{i,c,t-1}$, i.e., the interaction between the specific policy and the respective lagged bank risk variable, calculated as a matrix. Significant coefficients would indicate that the policies are more effective when the financial cycle is more intense.

As noted, we want to investigate whether there are differences between the effects of policies during expansionary and contractionary financial phases. While macro-prudential policies are mainly aimed at reducing the buildup of vulnerabilities, and as such should be most effective during an expansionary period, they may also help mitigate the decline in financial intermediation during contractionary periods. Note that this means that the sign of a policy could change: negative in expansionary periods when a policy lowers the buildup of bank vulnerabilities, and positive in contractionary periods when it mitigate declines. Some macro-prudential policies may also more effective than others in term of mitigating expansions. As discussed (see also Fig. 1), LTV, DTI, CG, and FC are typically seen to mitigate externalities arising in upswings. And policies such as RR, DP, CTC, and PRD are seen as building buffers that can be draw-down in the adverse part of the cycle, and thereby mitigate contractions. To investigate whether any tools are particularly effective in mitigating a (larger) expansion or reducing the adverse impacts of a (larger) correction, we conduct regressions differentiating expansions from contractions on the basis of aggregate credit.

We next explore specific combinations of macro-prudential policies (using the four-way classification of Tables 1 and 2): 1. borrower-based (caps on LTV and DTI ratios); 2. financial institutions' asset-based (CG and FC); 3. financial institutions' liabilities-based (RR); 4. financial institutions' buffer-based (DP, CTC, PRD); and a residual 5th category (Other). We group this way as there may be interactions within a group. For example, DTI and LTV can be substitute, in that both can lower the amounts of loans that can be extended. Or they can be complements, as when, if borrowers obtain loans beyond those limited by the LTV cap (including on the same house), a cap on the DTI would still limit overall debt (service) obligations. Besides including these groups one-by-one in regressions, we also include all

[11] Note that since we study the behavior of individual banks, there is much less risk of endogeneity compared to country studies. In country-based studies, the risks that macro-prudential policies are adopted in response to the behavior of the credit, leverage or other financial system variables is considerable, which means a possible bias when studying the effects of macro-prudential policies on these aggregate variables. In our case, feedback from individual banks risk variables to the adoption (or removal) of policy is much less likely as each bank represents only a (small) part of overall financial intermediation. Nevertheless, using GMM should help with removing any residual endogeneity.

groups together in one regression, as there may be complementarities and other interactions across the groups. Financial institutions' liabilities-based macro-prudential policies for example could be less or more effective when at the same time the country also has limits on credit growth, an asset-based policy. Or when having buffer types of policies in place, tools like borrower-based LTV and DTI may be less needed and effective.

We also investigate if results vary between advanced countries and emerging markets and between closed and open capital account countries by including interaction dummies in the base and phases regressions (note, we do not need to use a separate dummy on whether the country falls in the group of emerging markets vs. advanced countries, or open vs. closed economies, since we always use country fixed effects). We further explore robustness of the main results by including variables to capture time-varying country changes. And while we already use country fixed effects, thus controlling in general for time-invariant differences between countries, we also explore the role of country characteristics directly.

3.3. Regression results

Table 5 reports the base results for the three risk variables. While the full sample consists of 2800 banks in 48 countries, because some of the bank variables are not always available (notably noncore funding), we use a sample of some 2300 banks and 13,000 observations in the base regressions. Columns (1), (4) and (7) present the results of regressing the risk variables only on lagged independent variables and standard bank-specific control variables. The coefficients on the lagged dependent variables are consistently negative, indicating that there are some natural mitigating forces making risks not increase or decrease unboundedly. For example, when leverage growth is high this period, it can be expected to increase less next period since there are limits on banks' balance sheets expansions, like capital adequacy requirements, and market discipline may act as a mitigating force on individual institutions.

The coefficients on the bank-specific variables are largely as expected in sign when significant. Specifically, banks with high leverage positions already, tend to have lower growth in leverage. Such banks are, however, more likely to see their assets grow faster, a phenomenon first noted by Adrian and Shin (2010). The signs for the degree to which the bank relies on noncore vs. core funding are less clear a priori, in part since funding can adjust faster than capital positions. This ambiguity is reflected in the fact that the coefficient on noncore to core funding is significantly positive for leverage growth and significantly negative for asset growth. For the growth in noncore to core liabilities, the coefficient is significantly negative, as expected since banks with already high noncore to core funding can grow their noncore funding less.

Next, columns (2), (5), and (8) of Table 5 present the results of the effectiveness of specific instruments in terms of reducing bank risks, while the effectiveness of policies also considering the intensity of the cycle is investigated in columns (3), (6) and (9). We only show the coefficients for the policies, but all regressions have the usual country fixed effects and control for key bank-level variables.

Regressions show that many policies help in controlling banking system vulnerabilities, as many coefficients are significantly negative. Specific results can be summarized as follows:

- *Measures aimed at borrowers*: For all three bank risk variables, the coefficients on both LTV and DTI are always statistically significant and with the expected negative sign in levels. The regression results suggest that LTV caps reduce leverage growth by some 0.75 percentage points, asset growth by 0.49 percentage points, and noncore to core liabilities growth by 1.1 percentage points. Limits on DTI generally have a much greater impact on bank risks. When introduced, DTI limits reduce leverage growth by 1.1 percentage points, asset growth by 2 percentage points, and noncore to core liabilities growth by 2.3 percentage points. These two policies are also effective in curbing the severity of the cycles in leverage and noncore to core liabilities as the coefficients on the LTV and DTI interacted with these lagged dependent variables are negative and significant. For asset growth, we find no such effects (both are actually significantly positive). Overall these two instruments thus reduce individual bank leverage, asset, and noncore to core liabilities growth, especially so when there is more change in leverage and noncore to core liabilities.

Table 5
Base regression results of effects of macro-prudential policies: 2000–2010.

Explanatory variables	Leverage growth			Asset growth			NCC growth		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Lag dependent variable	−0.079*** [0.020]	Yes	Yes	−0.529***	Yes	Yes	−0.074***	Yes	Yes
		Yes	Yes	[0.011]	Yes	Yes	[0.024]	Yes	Yes
Lag leverage ratio	−0.001*** [0.000]	Yes	Yes	0.001***	Yes	Yes	−0.000	Yes	Yes
		Yes	Yes	[0.000]	Yes	Yes	[0.000]	Yes	Yes
Lag noncore/core ratio	0.001*** [0.000]	Yes	Yes	−0.001***	Yes	Yes	−0.003***	Yes	Yes
		Yes	Yes	[0.000]	Yes	Yes	[0.000]	Yes	Yes
LTV		−0.748***	−0.703***		−0.490***	−0.367***		−1.092**	−0.953**
		[0.199]	[0.216]		[0.073]	[0.071]		[0.500]	[0.434]
LTV × lag dependent var			−0.915***			1.542***			−0.721***
			[0.140]			[0.062]			[0.206]
DTI		−1.139***	−1.327***		−2.046***	−1.806***		−2.277***	−1.442*
		[0.346]	[0.412]		[0.225]	[0.293]		[0.744]	[0.775]
DTI × lag dependent var			−0.880**			8.154***			−1.807***
			[0.343]			[0.620]			[0.506]
CG		−0.510	−0.591		−0.647**	−1.689***		−0.265	−0.498
		[0.325]	[0.376]		[0.278]	[0.418]		[0.795]	[0.822]
CG × lag dependent var			−0.647**			9.223***			−1.177***
			[0.270]			[0.840]			[0.392]
FC		−0.906***	−0.909***		−0.536***	−0.669***		−2.415***	−2.348***
		[0.209]	[0.208]		[0.122]	[0.170]		[0.543]	[0.552]
FC × lag dependent var			−0.055			2.702***			0.187
			[0.175]			[0.187]			[0.285]
RR		−0.108	0.085		−0.552***	−1.448***		0.775**	1.022***
		[0.174]	[0.201]		[0.088]	[0.128]		[0.339]	[0.368]
RR × lag dependent var			−1.044***			4.290***			−0.771***
			[0.237]			[0.226]			[0.229]
DP		−0.747***	−0.736***		−1.246***	−1.408***		−1.227***	−1.112***
		[0.157]	[0.156]		[0.100]	[0.118]		[0.357]	[0.378]
DP × lag dependent var			−0.165			3.090***			−0.203
			[0.340]			[0.220]			[0.322]
CTC		−0.584***	−0.539**		−1.682***	−1.774***		−0.562	−0.734
		[0.206]	[0.219]		[0.209]	[0.219]		[0.498]	[0.466]
CTC × lag dependent var			−1.021*			1.298***			−1.591***
			[0.607]			[0.258]			[0.449]
PRD		−1.103***	−1.087***		−0.060	−0.406**		−0.255	−0.176
		[0.217]	[0.218]		[0.093]	[0.176]		[0.294]	[0.308]
PRD × lag dependent var			−0.209			4.291***			1.058**
			[0.178]			[1.091]			[0.455]

(*continued on next page*)

Table 5 (*continued*)

Explanatory variables	Leverage growth			Asset growth			NCC growth		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Other		−0.462***	−0.410***		−1.270***	−1.729***		−0.290	−0.311
		[0.110]	[0.120]		[0.136]	[0.138]		[0.222]	[0.207]
Other × lag dependent var			−0.516**			3.571***			−0.625***
			[0.242]			[0.277]			[0.185]
Constant	0.619***	Yes	Yes	−0.523***	Yes	Yes		Yes	Yes
	[0.116]			[0.101]					
Observations	13,052	13,052	13,052	13,056	13,056	13,056	12,848	12,848	12,848
Number of banks	2305	2305	2305	2305	2305	2305	2265	2265	2265

Notes: The dependent variable is the bank leverage growth (in (1)–(3)), the total asset growth (in (4)–(6)), and the noncore liabilities growth (in (7)–(9)). We control for the first lag of the dependent variable, for the lagged bank leverage ratio and noncore-to-core liability ratio. The macro-prudential policy measures used are: LTV (caps on loan-to-value), DTI (caps on debt-to-income), CG (limits on credit growth), FC (limits on foreign lending), RR (reserve requirements), DP (dynamic provisioning), CTC (countercyclical provisioning and countercyclical capital), PRD (restrictions on profit distribution), and other (including, among others, countercyclical provisioning, countercyclical capital, restrictions on profit distribution, and restrictions on the treatment of profits in regulatory capital). Although regressed one at a time, *MaPP*s are shown in one column in (2), (3), (5), (6), (8), (9) to save space. These are all GMM regressions which use lagged differences, the lagged real credit growth, and a time trend (fixed effect) as instrumental variables for the dependent variable. The regressions control for individual trends (country fixed effects). GMM standard errors are in brackets. ***, **, and * represent significance at the 1, 5, and 10 percent levels respectively.

- *Measures aimed at financial institutions (addressing asset side)*: Limits on credit growth – CG – help reduce asset growth, with the introduction of limits on credit growth to decrease asset growth by 0.6 percentage points. Coefficients are statistically insignificant for the leverage and noncore to core liabilities risk measures, but they are significantly negative when interacting with the intensity of these cycles. Foreign currency lending limits – FC – are also effective, with statistically negative signs for all three bank risk variables. But, contrary to expectations, FC limits are not that much more useful when the cycles are more intense (and for the asset cycle, it actually has a positive sign, like CG).
- *Measures aimed at financial institutions (addressing liability side)*: Reserve requirements (RR) significantly reduce asset growth in levels, but not more so when the intensity of the asset cycle is greater. Reserve requirements do not affect the leverage cycle. Neither do they reduce noncore to core liabilities growth, rather the opposite. The latter may be because higher reserve requirements make the bank seek additional funds to finance the reserve requirements, which at the margin means more noncore liabilities. When the cycle is more intense though, reserve requirements help more to reduce the leverage and noncore to core liabilities growth measures.
- *Measures addressing bank buffers*: Dynamic provisioning (DP) appears to be a robust instrument in reducing level growth in all three measures. In terms of intensity of the cycle, however, there appears to be no additional mitigating effect. Countercyclical requirements are quite effective for reducing growth in leverage and assets, and have some effects in reducing the intensity of the leverage and noncore to core liabilities risk measures, but not that of assets. Restrictions on profit redistribution (PRD) seem to be effective in reducing leverage and assets growth, but not in reducing growth in noncore to core liabilities. It also shows some perverse effects as the cycle becomes more intense since the coefficients for the interacted variables are significantly positive for asset and noncore to core liabilities growth. This may be due to a very limited sample though, since only a handful of countries adopted this measure since 2008.
- *Other measures*: This category of macro-prudential policies, which cannot be classified otherwise, reduces growth in leverage and assets, but not in the noncore to core vulnerability measure. It does help though with the reducing the intensity of the growth in noncore to core liabilities (and leverage) variables. When we interact this measure with the strength of the asset growth cycle, however, the level effect remains statistically significant negative, yet the intensity effect becomes positive.

Next, we repeat the same regressions, except differentiating expansionary from contractionary periods, where we use the general credit cycle in the country to determine the phase (note that the dependent variable, individual bank risk, may be in a phase different from the general country credit cycle).[12] Table 6 reports the regression results. As over this period credit is generally expanding, the number of observations in expansionary periods (some 10,000) is larger than in contractionary periods (some 2600). Regressions are again run with one policy at a time, so that each row of results refer to that policy only, and the coefficients for the bank control variables refer to the regressions without any policy.

Results show that macro-prudential policies are much more effective in booms than they are in busts, with many coefficients statistically significant in expansionary periods and much fewer so in contractionary periods. Specifically, we find that in booms LTV, DTI, FC, DP, PRD, and Other help limit leverage growth; all macro-prudential policies except for CG and PRD (i.e., LTV, DTI, FC, RR, DP, CTC and Other) help limit asset growth; and FC and DP help limit noncore to core liabilities growth.

In principle, tools such as reserve requirements could help provide liquidity cushions, while dynamic provisioning could help build capital buffer during upturns, supporting lending during

[12] Using overall credit to differentiate phases rather than individual banks' risk variables themselves is consistent with the notion that policymakers adopt macro-prudential policies in response to concerns about overall financial developments, as opposed to concerns about individual bank's risks which should trigger micro-prudential measures. It also avoids possible data sampling biases – since we do not always cover the universe of banks within a given country – and further reduces the risks that selecting the phases using information from the dependent variables themselves biases our results.

Table 6
Effectiveness of macro-prudential policies by phase of the cycle.

Explanatory variables	Leverage growth		Asset growth		NCC growth	
	Good times (expansionary phase) (1)	Bad times (contractionary phase) (2)	Good times (expansionary phase) (3)	Bad times (contractionary phase) (4)	Good times (expansionary phase) (5)	Bad times (contractionary phase) (6)
Lag dependent variable	−0.059**	−0.044	−0.564***	−0.478***	−0.043	−0.154***
	[0.028]	[0.032]	[0.010]	[0.018]	[0.029]	[0.037]
Lag leverage ratio	−0.001***	−0.001***	0.000***	0.000***	−0.001*	0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Lag noncore/ core ratio	0.001***	0.000	0.000**	−0.000**	−0.004***	−0.001***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
LTV	−0.572**	−0.368	−0.163***	−1.457***	0.090	−1.715***
	[0.226]	[0.365]	[0.053]	[0.321]	[0.460]	[0.615]
DTI	−0.725**	1.529**	−1.958***	0.074	0.095	4.861***
	[0.307]	[0.722]	[0.251]	[0.251]	[0.583]	[1.074]
CG	−0.090	0.237	0.842***	−1.002***	−0.129	−0.994
	[0.388]	[0.290]	[0.241]	[0.255]	[0.972]	[0.616]
FC	−0.586**	−0.088	−0.963***	1.364***	−1.104**	−5.481***
	[0.231]	[0.350]	[0.126]	[0.315]	[0.550]	[1.176]
RR	0.148	0.000	−0.312***	0.000	0.465	0.000
	[0.173]	[0.000]	[0.060]	[0.000]	[0.349]	[0.000]
DP	−0.506***	0.000	−1.108***	0.000	−0.575*	0.000
	[0.168]	[0.000]	[0.069]	[0.000]	[0.306]	[0.000]
CTC	−0.186	0.000	−1.478***	0.000	−0.355	0.000
	[0.237]	[0.000]	[0.174]	[0.000]	[0.484]	[0.000]
PRD	−0.580***		−0.090		0.196	
	[0.216]		[0.094]		[0.323]	
Other	−0.233*	−1.354**	−1.474***	1.554***	−0.220	−4.290***
	[0.133]	[0.586]	[0.125]	[0.327]	[0.264]	[0.872]
Observations	10,402	2650	10,404	2652	10,240	2608
Number of banks	2253	1284	2253	1285	2217	1265

Notes: The dependent variable is the bank leverage growth (in (1) and (2)), the total asset growth (in (3) and (4)), and the noncore liabilities growth (in (5) and (6)). We control for the first lag of the dependent variable, for the lagged bank leverage ratio and noncore-to-core liability ratio. The macro-prudential policy measures used are: LTV (caps on loan-to-value), DTI (caps on debt-to-income), CG (limits on credit growth), FC (limits on foreign lending), RR (reserve requirements), DP (dynamic provisioning), CTC (countercyclical provisioning and countercyclical capital), PRD (restrictions on profit distribution), and other (including, among others, countercyclical provisioning, countercyclical capital, restrictions on profit distribution, and restrictions on the treatment of profits in regulatory capital). Although regressed one at a time, *MaPP*s are shown in one column to save space. These are all GMM regressions which use lagged differences, the lagged real credit growth, and a time trend (fixed effect) as instrumental variables for the dependent variable. The regressions control for individual trends (country fixed effects). GMM standard errors are in brackets. ***, **, and * represent significance at the 1, 5, and 10 percent levels respectively.

downturns. Other tools such as limits on profit redistribution could also have countercyclical, buffer effects, helping banks' willingness to maintain (or reduce less) their balance sheets in bad times. In our regressions, however, very few policies affect in a statistically significant way the speed of decline when the credit cycle reverses. The only ones that are significant and positive are DTI, which helps maintain overall leverage growth during downturns; FC and Other, which help maintain overall bank asset growth; and DTI, which helps to limit the decline in noncore to core liabilities. And there are actually some negative signs, meaning that having a policy in place worsens the declines. Specifically, Other reduces leverage growth, LTV and CG appear to lower asset growth during downturns, and LTV, FC and Other seem to worsen declines in noncore to core liabilities.

That macro-prudential policies are mostly effective in expansionary times may not surprise, as most macro-prudential policies are not designed to mitigate contractions as such. It could even be that tools like LTV limits actually act perversely during periods of credit contractions and asset price declines. As borrowers' net worth and income declines, for example, strict LTV limits make it even harder for lenders to extend loans, possibly leading to further declines in house prices, and setting of a perverse

Table 7
Using fewer macro-prudential policy groupings.

Explanatory variables	Leverage growth				Asset growth				NCC growth			
	All		Expansionary phase	Contractionary phase	All		Expansionary phase	Contractionary phase	All		Expansionary phase	Contractionary phase
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Lag dependent variable	−0.079*** [0.020]	−0.043 [0.034]	−0.059** [0.028]	−0.044 [0.032]	−0.529*** [0.011]	−0.524*** [0.020]	−0.564*** [0.010]	−0.478*** [0.018]	−0.074*** [0.024]	−0.031 [0.035]	−0.043 [0.029]	−0.154*** [0.037]
Lag leverage ratio	−0.001*** [0.000]	−0.001*** [0.000]	−0.001*** [0.000]	−0.001*** [0.000]	0.001*** [0.000]	0.000** [0.000]	0.000*** [0.000]	0.000*** [0.000]	−0.000 [0.000]	−0.001 [0.000]	−0.001* [0.000]	0.000 [0.000]
Lag noncore/core ratio	0.001*** [0.000]	0.001* [0.000]	0.001*** [0.000]	0.000 [0.000]	−0.001*** [0.000]	−0.001** [0.000]	0.000** [0.000]	−0.000** [0.000]	−0.003*** [0.000]	−0.004*** [0.000]	−0.004*** [0.001]	−0.001*** [0.000]
MaPP aimed at borrowers	−0.464*** [0.153]	−0.311 [0.436]	−0.333** [0.160]	0.151 [0.368]	−0.624*** [0.071]	−0.371*** [0.143]	−0.340*** [0.051]	−1.158*** [0.216]	−0.930** [0.439]	1.660* [0.855]	0.145 [0.365]	−0.196 [0.506]
MaPP aimed at FI (asset side)	−0.565*** [0.143]	0.193 [0.526]	−0.502*** [0.193]	0.087 [0.213]	−0.470*** [0.098]	0.820*** [0.200]	−0.668*** [0.109]	0.005 [0.132]	−1.501*** [0.401]	−3.211*** [1.118]	−0.721 [0.440]	−2.017*** [0.506]
MaPP aimed at FI (liabilities side)	−0.108 [0.174]	0.537 [0.421]	0.148 [0.173]	0.000 [0.000]	−0.552*** [0.088]	0.602*** [0.155]	−0.312*** [0.060]	0.000 [0.000]	0.775** [0.339]	0.478 [0.684]	0.465 [0.349]	0.000 [0.000]
MaPP aimed at FI (buffers)	−0.443*** [0.095]	−0.114 [0.297]	−0.272*** [0.101]	−1.529** [0.722]	−0.448*** [0.055]	0.279** [0.112]	−0.626*** [0.055]	−0.074 [0.251]	−0.568*** [0.213]	−0.016 [0.503]	−0.191 [0.199]	−4.861*** [1.074]
Other	−0.462*** [0.110]	−0.451 [0.382]	−0.233* [0.133]	−1.354** [0.586]	−1.270*** [0.136]	−1.937*** [0.228]	−1.474*** [0.125]	1.554*** [0.327]	−0.290 [0.222]	0.559 [0.591]	−0.220 [0.264]	−4.290*** [0.872]
Constant		1.187*** [0.249]				0.163 [0.238]				1.791** [0.803]		
Observations	13,052	13,052	10,402	2650	13,056	13,056	10,404	2652	12,848	12,848	10,240	2608
Number of banks	2305	2305	2253	1284	2305	2305	2253	1285	2265	2265	2217	1265

Notes: The dependent variable is the bank leverage growth (in (1)–(4)), the total asset growth (in (5)–(8)), and the noncore liabilities growth (in (9)–(12)). We control for the first lag of the dependent variable, for the lagged bank leverage ratio and noncore liability ratio. The macro-prudential policy measures used are: *MaPP* aimed at borrowers (caps on loan-to-value and caps on debt-to-income), *MaPP* aimed at financial institutions, asset side (limits on credit growth, limits on foreign lending), *MaPP* aimed institutions, liabilities side (reserve requirements), *MaPP* aimed at financial Institutions as buffers (dynamic provisioning, countercyclical provisioning and countercyclical capital, restrictions on profit distribution), and Other (including, among others, countercyclical provisioning, countercyclical capital, restrictions on profit distribution, and restrictions on the treatment of profits in regulatory capital). Although regressed one at a time, *MaPP*s are shown in one column in (1), (3), (4), (5), (7), (8), (9), (11), (12) to save space regressions in (2), (6), and (10) include all variables simultaneously. These are all GMM regressions which use lagged differences, the lagged real credit growth, and a time trend (fixed effect) as instrumental variables for the dependent variable. The regression individual trends (country fixed effects). GMM standard errors are in brackets. ***, **, and * represent significance at the 1, 5, and 10 percent levels respectively.

cycle of even tighter LTV ratios. Unless the limits are adjusted quickly in a rightly calibrated manner, that is, without unduly increasing systemic risks, their effects may be perverse.

Since theory suggests that the impacts of policies vary not only by phase of the financial cycle but also by type of policies, we next group the policies in our five broad categories. Results (Table 7, columns 1, 5, 9) confirm that policies aimed at borrowers' demand, financial institutions' asset side, and building buffers are effective in reducing all three risk measures over the whole financial cycle. Liability side-oriented measures help with reducing asset growth, but perhaps surprisingly, there is no evidence that these measures are effective to stem the growth of noncore to core liabilities. Possibly more direct measures, such as the levy on noncore liabilities suggested by Shin (2010), are more effective. The evidence is that Other helps with reducing leverage and asset growth, but not with growth in noncore to core liabilities. These effects are somewhat confirmed when regressions are run using all groups at the same time (columns 2, 6, 10). Results are much less statistically significant, however, given multicollinearity (as countries tend to use more than one group at the same time). Nevertheless, there is again some evidence that those policies that seek to directly affect borrower demand and asset side help reduce growth in asset and noncore to core liabilities.

When we split by phase, we find again that policies are most effective in the expansionary phase of the financial cycle (columns 3, 7, 11) and much less so in contractionary phase (columns 4, 8, 12). During booms, all policies, except those that seek to directly affect financial institutions' liabilities, work to reduce growth in leverage. And all groups of policies reduce asset growth in boom times. None of the macro-prudential policies, when classified in groups, however, help to reduce growth in noncore to core liabilities during expansionary times. In the contraction phase, the groups of buffer-oriented and Other actually worsen the decline in leverage, while policies directly aimed at borrowers make the decline in assets worse. Only Other seems to help maintain growth in assets. And the groups of asset-based, buffer-based and Other macro-prudential policies also make the decline in noncore to core liabilities worse. This suggests that macro-prudential policies may be ineffective in fostering a restoration of financial intermediation during adverse conditions.

To investigate whether there are differences between the effectiveness of macro-prudential policies depending on country characteristics, we run regressions interacting policies with group dummies. Table 8 provides the results, where coefficients without interactions refer to the general effects and coefficients for the interactions to the additional effects for emerging markets and open economies. It shows that only a few policies affect risks in the groups differently as a limited number of interaction coefficients are statistically significant. This is in large part because policies tend to be used more, and for some exclusively, by emerging markets and closed economies, making direct comparisons limited.

For those policies used by both advanced countries and emerging markets, the results suggest that LTVs are less effective in reducing asset growth in open economies and DTIs are less effective in reducing leverage growth in emerging markets and open economies. The CG measure affects asset growth more for closed than open economies and FC limits help reduce asset growth somewhat more in emerging markets and open economies, and noncore to core growth in open economies. DP seem to work better for controlling leverage and asset growth in closed economies and Other limits seem of more value for reducing leverage and asset growth in emerging markets and closed economies. Otherwise, results suggest no significant differences between instruments in limiting some of the risk buildups in emerging markets' (or closed countries') banking systems vs. in advanced countries' (or open countries').

We lastly explore as robustness tests whether differences between countries may drive results. We add to the base regressions country characteristics in four groups, three time-varying and one time-invariant (we still use country fixed effects to account for any residual differences): a. the country's annual GDP growth, the change in its policy interest rate, and the flexibility of its exchange rate arrangement; b. its sovereign debt to GDP, the ratio of foreign exchange reserves to GDP, and the presence of a systemic banking system crisis; c. the degree of financial openness (proxied by the Chinn–Ito index), and de-facto financial integration (proxied by capital flows as a share of GDP); and d. financial structure (the ratio of the banking system size to the stock market capitalization), and banking ownership structure (the share of foreign banks in the country).

When we add the first groups of country variables (Table 9), we find that lagged real GDP growth has the expected positive sign for leverage, but is not significant, and has negative and significant

Table 8
Emerging markets vs. advanced countries and open vs. closed countries.

Explanatory variables	Leverage growth		Asset growth		NCC growth	
	(1) EM vs. AC	(2) Open vs. closed	(3) EM vs. AC	(4) Open vs. closed	(5) EM vs. AC	(6) Open vs. closed
Lag dependent variable	−0.079***	−0.079***	−0.529***	−0.529***	−0.074***	−0.074***
	[0.020]	[0.020]	[0.011]	[0.011]	[0.024]	[0.024]
Lag leverage ratio	−0.001***	−0.001***	0.001***	0.001***	−0.000	−0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Lag noncore/core ratio	0.001***	0.001***	−0.001***	−0.001***	−0.003***	−0.003***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
LTV	−0.154	−1.595**	0.159	−2.855***	0.074	1.450
	[0.481]	[0.772]	[0.121]	[0.595]	[0.880]	[1.315]
LTV × indicator	−1.461	1.178	−2.159***	2.960***	−2.577*	−4.036**
	[0.975]	[1.097]	[0.291]	[0.663]	[1.476]	[2.005]
DTI	−3.981**	−3.258***	−0.589	−1.603***	0.321	−0.916
	[1.702]	[0.850]	[1.375]	[0.578]	[2.131]	[1.294]
DTI × indicator	2.866*	3.748***	−1.444	0.754	−2.637	−3.810
	[1.678]	[1.177]	[1.380]	[0.703]	[2.231]	[2.950]
CG	−3.053	0.184	−3.183	−4.265***	1.814	−0.965
	[3.081]	[0.623]	[2.846]	[0.852]	[4.499]	[1.606]
CG × indicator	3.262	−0.761	1.416	5.229***	−2.327	0.967
	[3.281]	[0.783]	[3.134]	[0.916]	[5.557]	[1.908]
FC	−2.619***	−1.096*	0.437**	0.843***	−3.336*	3.697*
	[0.915]	[0.582]	[0.175]	[0.245]	[1.919]	[2.133]
FC × indicator	3.136**	0.292	−2.630***	−2.019***	1.784	−9.238***
	[1.226]	[0.857]	[0.361]	[0.302]	[2.794]	[2.988]
RR	−0.108	−0.108	−0.552***	−0.552***	0.775**	0.775**
	[0.174]	[0.174]	[0.088]	0.088]	[0.339]	[0.339]
RR × indicator						
DP	−0.747***	−0.884***	−1.246***	−1.463***	−1.227***	−1.591***
	[0.157]	[0.179]	[0.100]	[0.117]	[0.357]	[0.419]
DP × indicator		1.803*		4.686***	0.000	2.922
		[0.932]		[0.905]	[0.000]	[2.111]
CTC	−0.584***	−0.584***	−1.682***	−1.682***	−0.562	−0.562
	[0.206]	[0.206]	[0.209]	[0.209]	[0.498]	[0.498]
CTC × indicator						
PRD	1.201	−0.985***	−0.451	−0.038	−0.513	−0.366
	[1.555]	[0.257]	[1.235]	[0.082]	[1.532]	[0.378]
PRD × indicator	−2.534	−0.467	0.282	−0.932*	0.275	0.724
	[1.652]	[0.933]	[1.252]	[0.509]	[1.692]	[1.262]
Other	1.405	−0.010	4.334***	−2.009***	0.991	−0.076
	[1.274]	[0.389]	[1.061]	[0.212]	[1.378]	[0.479]
Other × indicator	−2.063	−0.962	−6.479***	2.023***	−1.478	−0.380
	[1.405]	[0.791]	[1.161]	[0.389]	[1.540]	[0.741]
Observations	13,052	13,052	13,056	13,056	12,848	12,848
Number of banks	2305	2305	2305	2305	2265	2265

Notes: The dependent variable is the bank leverage growth (in (1) and (2)), the total asset growth (in (3) and (4)), and the noncore liabilities growth (in (5) and (6)). We control for the first lag of the dependent variable, for the lagged bank leverage ratio and noncore-to-core liability ratio. The macro-prudential policy measures used are: LTV (caps on loan-to-value), DTI (caps on debt-to-income), CG (limits on credit growth), FC (limits on foreign lending), RR (reserve requirements), DP (dynamic provisioning), CTC (countercyclical provisioning and countercyclical capital), PRD (restrictions on profit distribution), and other (including, among others, countercyclical provisioning, countercyclical capital, restrictions on profit distribution, and restrictions on the treatment of profits in regulatory capital). Although regressed one at a time, *MaPPs* are shown in one column to save space. For regressions (1), (3), and (5), the indicator variable is 1 for emerging markets and 0 for advanced economies. For regressions (2), (4), and (6), the indicator variable is 1 for open economies, and 0 for closed economies. These are all GMM regressions which use lagged differences, the lagged real credit growth, and a time trend (fixed effect) as instrumental variables for the dependent variable. The regressions control for individual trends (country fixed effects). GMM standard errors are in brackets. ***, **, and * represent significance at the 1, 5, and 10 percent levels respectively.

coefficients for asset and noncore to core growth. That the state of the real business cycle does not positively affect asset and noncore to core liabilities growth may be due in part because we already control for financial cycles using the lagged dependent variable. Monetary policy seems to play no role

Table 9
Including macroeconomic variables.

Explanatory variables	Leverage growth			Asset growth			NCC growth		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Lag dependent	−0.080***	Yes	Yes	−0.551***	Yes	Yes	−0.059*	Yes	Yes
variable	[0.019]	Yes	Yes	[0.013]	Yes	Yes	[0.035]	Yes	Yes
Lag real GDP	0.385	Yes	Yes	−0.384***	Yes	Yes	−1.583***	Yes	Yes
growth	[0.239]	Yes	Yes	[0.046]	Yes	Yes	[0.490]	Yes	Yes
Lag IR growth	0.477***	Yes	Yes	−0.028	Yes	Yes	0.299	Yes	Yes
	[0.114]	Yes	Yes	[0.035]	Yes	Yes	[0.233]	Yes	Yes
FX rate	−0.456*	Yes	Yes	−0.575***	Yes	Yes	0.810	Yes	Yes
arrangement	[0.254]	Yes	Yes	[0.204]	Yes	Yes	[1.026]	Yes	Yes
Lag leverage	−0.001***	Yes	Yes	0.000***	Yes	Yes	−0.001**	Yes	Yes
ratio	[0.000]	Yes	Yes	[0.000]	Yes	Yes	[0.000]	Yes	Yes
Lag noncore/core	0.001***	Yes	Yes	−0.000**	Yes	Yes	−0.004***	Yes	Yes
ratio	[0.000]	Yes	Yes	[0.000]	Yes	Yes	[0.000]	Yes	Yes
LTV		−2.625***	−2.031*		−0.803***	−0.426***		−4.922***	−4.483**
		[0.880]	[1.078]		[0.147]	[0.130]		[1.826]	[1.821]
LTV × lag			−0.494***			1.406***			−0.328
dependent var			[0.163]			[0.058]			[0.273]
DTI		0.676	1.175**		−1.046***	−0.645*		−0.943	−0.553
		[0.512]	[0.547]		[0.334]	[0.332]		[1.655]	[1.860]
DTI × lag			−1.424***			6.646***			−1.122**
dependent var			[0.387]			[0.529]			[0.445]
CG		0.433	0.052		−2.076***	−2.431***		−1.642	−1.854
		[0.408]	[0.444]		[0.377]	[0.446]		[1.379]	[1.357]
CG × lag			−1.177***			8.320***			−0.383
dependent var			[0.224]			[0.708]			[0.347]
FC		2.617**	2.419*		−2.196***	−0.602		−4.761***	−4.838***
		[1.191]	[1.254]		[0.306]	[0.390]		[1.482]	[1.504]
FC × lag			0.363			2.256***			−0.045
dependent var			[0.318]			[0.167]			[0.247]
RR		−0.008	0.218		−0.455***	−1.180***		0.623	1.060**
		[0.244]	[0.245]		[0.070]	[0.103]		[0.494]	[0.516]
RR × lag			−1.541***			3.739***			−0.582**
dependent var			[0.225]			[0.193]			[0.237]
DP		−0.693***	−0.523*		−1.709***	−1.718***		−1.241***	−1.191**
		[0.242]	[0.279]		[0.110]	[0.136]		[0.457]	[0.490]
DP × lag			0.103			2.398***			−0.279
dependent var			[0.420]			[0.214]			[0.351]
CTC		0.322	0.456		−1.807***	−1.790***		−1.213	−1.938**
		[0.454]	[0.476]		[0.183]	[0.190]		[0.768]	[0.809]

CTC × lag dependent var			−1.211** [0.481]			1.278*** [0.227]			−1.525*** [0.430]
PRD		−0.527* [0.320]	−0.380 [0.316]		−0.553*** [0.174]	−2.247*** [0.533]		0.536 [0.411]	0.422 [0.439]
PRD × lag dependent var			−1.504** [0.656]			9.512*** [2.698]			1.866** [0.870]
Other		−0.286 [0.184]	0.054 [0.217]		−1.479*** [0.123]	−1.580*** [0.119]		−0.554* [0.322]	−0.540* [0.309]
Other × lag dependent var			−0.752*** [0.161]			2.964*** [0.244]			−0.521*** [0.173]
Constant	1.899*** [0.629]	Yes	Yes	1.280** [0.505]	Yes	Yes	−0.246 [2.376]	Yes	Yes
Observations	10,339	10,339	10,339	10,342	10,342	10,342	10,173	10,173	10,173
Number of banks	1892	1892	1892	1892	1892	1892	1857	1857	1857

Notes: The dependent variable is the bank leverage growth (in (1)–(3)), the total asset growth (in (4)–(6)), and the noncore liabilities growth (in (7)–(9)). We control for the first lag of the dependent variable, the lagged bank leverage ratio and noncore-to-core liability ratio, and country-level macro-variables (lagged real GDP growth, lagged interest rate growth, and the foreign exchange arrangement). The macro-prudential policy measures used are: LTV (caps on loan-to-value), DTI (caps on debt-to-income), CG (limits on credit growth), FC (limits on foreign lending), RR (reserve requirements), DP (dynamic provisioning), CTC (countercyclical provisioning and countercyclical capital), PRD (restrictions on profit distribution), and other (including, among others, countercyclical provisioning, countercyclical capital, restrictions on profit distribution, and restrictions on the treatment of profits in regulatory capital). Although regressed one at a time, *MaPP*s are shown in one column in (2), (3), (5), (6), (8), (9) to save space. These are all GMM regressions which use lagged differences, the lagged real credit growth, and a time trend (fixed effect) as instrumental variables for the dependent variable. The regressions control for individual trends (country fixed effects). GMM standard errors are in brackets. ***, **, and * represent significance at the 1, 5, and 10 percent levels respectively.

Table 10
Additional robustness tests.

Explanatory variables	Leverage growth			Asset growth			NCC growth		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Lag dependent variable	−0.029 [0.024]	−0.026 [0.026]	−0.154*** [0.038]	−0.685*** [0.029]	−0.467*** [0.018]	−0.794*** [0.014]	−0.044 [0.046]	−1.634*** [0.557]	−0.135*** [0.046]
Lag real GDP growth	0.440** [0.208]	0.370* [0.199]	−0.692 [0.430]	−0.226** [0.097]	−0.551*** [0.067]	−1.199*** [0.064]	−2.248*** [0.770]	0.568** [0.243]	−2.683*** [0.866]
Lag IR growth	0.256* [0.141]	0.196** [0.077]	0.353 [0.295]	−0.541*** [0.081]	0.038 [0.048]	0.285*** [0.064]	0.378 [0.297]	−0.800 [0.980]	0.294 [0.964]
FX rate arrangement	−0.041 [0.151]	−0.074 [0.125]	2.583 [2.164]	−0.969*** [0.219]	−0.684*** [0.182]	2.247*** [0.666]	−1.597 [1.495]	−0.001** [0.000]	1.319 [5.519]
Lag leverage ratio	−0.001*** [0.000]	−0.001*** [0.000]	−0.001*** [0.000]	−0.001*** [0.000]	−0.000*** [0.000]	0.000 [0.000]	−0.001** [0.000]	−0.004*** [0.001]	−0.000 [0.000]
Lag noncore/core ratio	0.000* [0.000]	0.000* [0.000]	0.001*** [0.000]	−0.000 [0.000]	0.001*** [0.000]	−0.000 [0.000]	−0.004*** [0.001]		−0.003*** [0.000]
Lag debt GDP	0.229 [0.469]			−0.039 [0.372]			1.148 [0.905]		
Lag foreign reserves	−0.057 [0.648]			−7.195*** [0.481]			−3.714 [2.335]		
Systemic financial crisis	−0.068 [0.097]			0.045 [0.092]			−0.483 [0.443]		
Lag capital account openness		0.895*** [0.203]			1.550*** [0.344]			2.888 [1.879]	
Lag capital account flow		−29.729** [12.749]			−7.230 [5.924]			40.318 [29.625]	
Lag bank assets/stock market cap			−0.225 [0.179]			−0.381*** [0.052]			−0.645** [0.314]
Lag foreign share of bank assets			−0.017 [0.017]			−0.052*** [0.006]			0.009 [0.024]
LTV	−0.122 [0.490]	−0.433 [0.401]	0.376 [0.768]	2.998*** [0.585]	−1.246*** [0.255]	0.250 [0.289]	−2.787 [2.942]	−3.699* [1.910]	−2.004 [1.445]
DTI	0.477 [0.638]	−0.695 [0.948]	0.987 [0.606]	4.371*** [0.763]	2.387*** [0.658]	−0.285 [0.410]	0.555 [2.717]	−2.833 [2.214]	0.577 [2.062]
CG	0.162 [0.362]	0.893 [0.744]	0.264 [0.606]	−0.757 [0.472]	−12.014*** [1.883]	0.475 [0.490]	2.275 [2.069]	2.202 [2.472]	0.881 [1.400]
FC	0.130 [1.091]	−0.264 [0.800]	1.402 [0.974]	−0.208 [0.506]	−0.409 [0.314]	−0.870*** [0.329]	−2.458 [2.045]	−4.240** [1.696]	−2.851** [1.442]
RR	0.477** [0.201]	0.192 [0.176]	0.381 [0.277]	0.343** [0.150]	0.111 [0.070]	−0.566*** [0.094]	0.920 [0.636]	1.652*** [0.615]	1.645*** [0.483]
DP	−1.397*** [0.414]	−0.318* [0.165]	−0.671 [0.515]	−0.742*** [0.126]	−1.421*** [0.080]	−1.235*** [0.141]	−1.180 [0.806]	−1.086** [0.480]	−1.525** [0.744]

CTC	0.232 [0.274]	−0.368 [0.274]	0.757 [0.491]	−1.364*** [0.169]	−2.170*** [0.178]	−1.321*** [0.172]	−0.155 [1.070]	0.661 [1.058]	0.786 [0.714]
PRD	0.264 [0.232]	0.389** [0.184]	−0.037 [0.364]	−0.810*** [0.265]	−0.166 [0.140]	−0.115 [0.141]	1.149* [0.605]	0.314 [0.413]	1.059*** [0.406]
Other	−0.287 [0.182]	−0.199 [0.161]	−0.030 [0.249]	−1.218*** [0.166]	−1.587*** [0.135]	−1.050*** [0.126]	0.530 [0.667]	−0.343 [0.422]	0.576 [0.366]
Observations	9432	8844	6920	9479	8888	6920	9324	8740	6790
Number of banks	1763	1713	1696	1769	1717	1696	1736	1685	1657

Notes: The dependent variable is the bank leverage growth (in (1)–(3)), the total asset growth (in (4)–(6)), and the noncore liabilities growth (in (7)–(9)). We control for the first lag of the dependent variable, the lagged bank leverage ratio and noncore-to-core liability ratio, and country-level macro variables (lagged real GDP growth, lagged interest rate growth, and the foreign exchange arrangement) in all regressions. The macro-prudential policy measures used are: LTV (caps on loan-to-value), DTI (caps on debt-to-income), CG (limits on credit growth), FC (limits on foreign lending), RR (reserve requirements), DP (dynamic provisioning), CTC (countercyclical provisioning and countercyclical capital), PRD (restrictions on profit distribution), and other (including, among others, countercyclical provisioning, countercyclical capital, restrictions on profit distribution, and restrictions on the treatment of profits in regulatory capital). Although regressed one at a time, *MaPPs* are shown in one column to save space. These are all GMM regressions which use lagged differences, the lagged real credit growth, and a time trend (fixed effect) as instrumental variables for the dependent variable. The regressions control for individual trends (country fixed effects). GMM standard errors are in brackets. ***, **, and * represent significance at the 1, 5, and 10 percent levels respectively.

in curbing banks' risks, and is actually significantly positive for leverage growth, insignificantly negative for asset growth, and positive but insignificant for noncore to core liabilities growth. The lack of effects is consistent with the general literature that finds that large increases in interest rate are needed to stop credit boom and prick asset prices bubbles.[13] The type of exchange rate regime does importantly determine the growth in leverage and asset liabilities, with growth lower with more floating exchange rate regimes. This may be because such countries have less volatile financial cycles, in part as the exchange rate absorb some of the capital flow pressures.

In terms of effects of macro-prudential policies, the base regression results do not change qualitatively when adding this group of country variables. In terms of leverage growth, LTV, DP and PRD are effective, for asset growth all policies are effective, and for noncore to core growth LTV, FC, DP and Other. There is slightly less significance for some policies when adding the intensity of these variables, but the signs remain the same for most of those that were significant in the base regressions. As such we conclude that regression results are robust.

We next add (lagged) debt and foreign exchange reserves to GDP, and a systemic crisis dummy, keeping the other macroeconomic variables. We find (Table 10, columns 1, 4, 7) that the country's debt burden does not show a consistent pattern with the changes in bank risks. The cyclicality in the asset growth risk measure is partly related to changes in lagged foreign exchange reserves, which exerts some dampening influence, may be as capital flows are sterilized. Systemic financial crises are not related in a significant way (they are only associated with greater declines in leverage during downturns, not reported).

Regression results do not differ qualitatively from the base regression results when adding this group of controls. Coefficients for individual policies are most significant for asset growth regressions, with similar policies significant as those in the base regressions (DP, CTC, PRD, and Other). Leverage growth is lower when using DP. While LTV, FC, DP and CTC help reduce growth in noncore to core liabilities, these are not statistically significant. When adding these variables, some coefficients become positive significant, such as those for LTV and DTI for asset growth. And PRD is significantly associated with increases in noncore to core liabilities. When splitting by phase (not reported), we find again less effects of policies for the bad times sample, with some perverse results.

Similarly, the addition of the two financial openness variables does not change the core regression results (Table 10, columns 2, 5, 8). As expected, de-jure financially more open economies have higher growth in the three risk variables, with coefficients for leverage and asset growth significant. Being de-facto financially more open reduces leverage growth. In terms of policies, the regression results shows that DP reduce leverage growth and confirm that LTV, CG, DP, CTC, and Other affect asset growth negatively, and that LTV, FC and DP reduce noncore to core liabilities growth. Surprisingly, PRD is significantly associated with increases in leverage and DTI with increases in assets, while RR is again significantly associated with increases in noncore to core liabilities.

When adding the financial system structure and the share of foreign banks (Table 10, columns 3, 6, 9), the sample is reduced (even more) as these variables are not available for all countries and all periods. The ratio of bank asset to stock markets is associated with reduced asset and noncore to core liabilities growth, possibly indicating that in already very bank-oriented systems there is less scope for rapid growth in bank lending. Foreign bank presence is associated with lower asset growth, possibly due to foreign banks engaging in some cherry picking, lowering overall credit extension (Detragiache et al. (2008) show that the presence of foreign banks in low-income countries is associated with less credit).

Regression results for leverage are most affected as now no policy is statistically significant. For asset growth though, many macro-prudential policies remain statistically significant negative (FC, RR, DP, CTC and Other), while FC are again found to reduce and RR to increase noncore to core liabilities growth. In addition, DP seems to reduce noncore to core liabilities growth. And while PRD is

[13] Crowe et al. (2011), for example, find for real estate booms that a 100 basis point hike in the policy rate would reduce house price appreciation by only 1 percentage point, compared to a historical average of 5 percentage increase per year, but it would also lead to a decline in GDP growth of some 0.3 percentage points.

significantly positive in explaining noncore to core liabilities growth, as noted, this tool has been used by few countries only. Overall, regression results are thus again largely robust.

4. Conclusions

Recent theoretical advances support a role for macro-prudential policies in safe-guarding financial stability. Such policies can reduce the buildup of vulnerabilities and can help mitigate the impact of adverse cycles by encouraging a greater buildup of buffers. Our analysis confirms that countries stand to benefit from greater use of macro-prudential policies to reduce the risk arising in their banking systems. Using a large panel dataset of individual bank balance sheets, we find that many macro-prudential policies reduce the growth in key variables: leverage, assets, and the non-core to core liabilities ratio. We find in particular caps on debt-to-income and loan-to-value ratios to be effective. There is also evidence that the effectiveness of these tools varies by the intensity of the cycle, with a relatively greater impact of many macro-prudential policies when financial vulnerabilities increase more.

Some macro-prudential policies are more suited to reducing the buildup of vulnerabilities, while others are more geared towards building up buffers. When we differentiate those policies thought to be more effective in reducing vulnerabilities, we find that these help reduce risks during upswings. In contraction phases, however, some of these tools seem to prevent a rebound in financial variables, suggesting that they may be ineffective in fostering a restoration of financial intermediation during adverse conditions. On the other hand, those tools which help build buffers in good times generally reduce the level and the growth of bank risk measures during upswings, but also help provide cushions that alleviate more severe crunches during downswings. As such, these tools may be more promising.

There are large differences across countries in the usage of macro-prudential policies, with emerging markets and closed capital account countries using these policies relatively more than advanced countries and open capital account countries. We find evidence that across a broad range of changes in banking system vulnerabilities policies are somewhat more effective at curbing risks in emerging markets. This ought not to surprise, given both the more frequent use in these countries and the fact that their financial systems are often simpler, making it more likely that macro-prudential policies are effective. We also find that the effects of macro-prudential policies to be quantitatively greater in open capital account countries, even though they are used relatively less in these economies. We also conjecture that there could be both complementary and substitution relationships between macro-prudential policies and capital flow management tools.

As documented, emerging markets have been at the forefront of using macro-prudential policies. The ongoing financial crises in advanced countries and their weak economic performance in contrast to emerging markets' stable financial systems and continued solid performance, however, may perhaps make one question the view that emerging markets are more exposed to risks and in need of such policies. In principle, all types of countries can experience the externalities and market failures that macro-prudential policies try to address. In practice, the choice of what policies (if any) to use will be country- and circumstance-specific as our findings suggest. While in some respects, systemic risks concerns in emerging markets are becoming similar to those of advanced countries, emerging markets likely need to use a different and broader set of policies, including macro-prudential tools besides monetary, fiscal, and micro-prudential policies. At the same time, their general pragmatic approaches to date can benefit from further research on what are the most effective and efficient approaches given specific conditions (see also Acharya, 2011, and Shin, 2011 on how to adapt policies, especially to emerging markets and developing countries).

Our work comes with caveats and (related) suggestions for future research. Residual selection, endogeneity and omitted variables problems can still drive our results. Propensity scoring could be used to control to some degree for country selection issues. Techniques such as matching banks from different macro-prudential policy regimes could address another type of selection problem. Another way to control for bank characteristics would be to study how subsidiaries of the same foreign bank behave in countries with different macro-prudential policies. While this would reduce the number of observations significantly, as few global banks have operations in many countries, it would control for otherwise difficult to capture bank-specific aspects, such as the quality of its risk management.

A major issue is how to account for circumventions and risk transfers to other, possibly less regulated parts of the financial system. Our regression results indicate that (some) macro-prudential policies are more effective in reducing vulnerabilities in banks. It could be, however, that these same macro-prudential policies are also more easily avoided by channeling financing through less regulated parts of the financial system (note that this does not apply to those macro-prudential policies aimed directly at borrowers as those are less likely to be avoided). As such, using macro-prudential policies need not be associated with less overall systemic risks or reduced financial cycles.

One way to investigate for this possibility is to use more aggregate financial measures, as has been done in some studies using overall credit development. This has its own (econometric) caveats, however, including greater concerns for endogeneity. Another way is to investigate how complementary, market-based measures, such as asset prices (including credit spreads) and systemic risk rankings (e.g., those based on Marginal Expected Shortfall Measures as developed in Acharya et al. (2010) or CoVaR, as developed in Adrian and Brunnermeier (2011) respond to various macro-prudential policies. By being less institutions' specific and possibly more comprehensive, such measures may suffer less from issues of circumvention. These and other extensions are left for future research, in part as many of these measures and underlying data are not (yet) available for a large sample of countries and a long time-period.

Finally, while our results suggest that macro-prudential policies can be important elements of the toolkit aimed at overall systemic risk mitigation — especially for countries exposed to international shocks — the adoption of such policies may also entail some costs. In particular, in as much as macro-prudential policies affect resource allocations, they may affect economic activity and growth and/or possibly limit (efficient) financial sector development.

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