Financial development and the effectiveness of macroprudential measures[1]

Yusuf Soner Başkaya[2], Turalay Kenç[3], Ilhyock Shim[4] and Philip Turner[5]

1. Introduction

Over the past two decades or so, many countries have used various types of macroprudential policy to maintain financial stability. The first wave of such measures was taken by several Asian economies just before the Asian financial crisis of 1997-98. The second was adopted during the boom years in the early to mid-2000s mainly by emerging market economies (EMEs).

After the global financial crisis of 2007-09, central banks and regulators around the world have agreed on the importance of macroprudential policies in securing both global and domestic financial stability.[6] Since then, significant progress has been made in implementing macroprudential policies. Many jurisdictions have established macroprudential policy authorities mostly in the form of collective decision making bodies such as councils or forums. Over the past several years, more and more countries, including not only EMEs but also advanced economies (AEs), have introduced macroprudential policy measures to slow down strong growth in housing credit and capital inflows as well as other aspects of financial stability.

The popularity of macroprudential policy has led policymakers and academics to conduct research on their use and effectiveness. Most of the papers in this relatively recent literature have focused on assessing the effectiveness of macroprudential policies either based on their legal types (ie monetary, prudential and fiscal), on their target groups (borrowers, lenders, home buyers and sellers) and their scope (general credit policies, narrow credit policies (such as housing or consumer credit)).

[1] We thank Ahmet Murat Alper, Koray Alper, Sebnem Kalemli-Ozcan, Fatma Pinar Erdem Kucukbicakci and the participants of the CBRT-BIS-IMF conference on "Macroprudential Policy: Effectiveness and Implementation Challenges" held in İstanbul on 26–27 October 2015 for their helpful comments and suggestions. We also thank Jimmy Shek for his excellent research assistance. The views expressed are those of the authors and not necessarily those of the Central Bank of the Republic of Turkey or the Bank for International Settlements.

[2] Central Bank of the Republic of Turkey, İstiklal Cad. 10 06100 Ulus-ANKARA, Republic of Turkey. E-mail: soner.baskaya@tcmb.gov.tr.

[3] E-mail: turalaykenc@gmail.com.

[4] Bank for International Settlements, Representative Office for Asia and the Pacific, 78th floor, Two International Finance Centre, 8 Finance Street, Central, Hong Kong SAR, China. E-mail: ilhyock.shim@bis.org.

[5] Bank for International Settlements, Centralbahnplatz 2, CH-4002 Basel, Switzerland. E-mail: philip.turner@bis.org.

[6] For example, in October 2010, the Group of Twenty (G20) finance ministers and central bank governors agreed to work further on macroprudential policy frameworks, including tools to mitigate the impact of excessive capital flows.

But few researchers have sought to assess the effectiveness of different macroprudential policy tools on credit growth in different countries. However, this is an important aspect to understand because the scope of individual tools differs and because the transmission channels can be so different. In particular, much will depend on how developed is a country's financial market. The challenge for a researcher is to simplify the enormous heterogeneity not only of tools but also of countries.

The research strategy adopted by this paper is to divide the main tools into quantity-based measures and price-based measures. The presumption is that bank-based financial systems tend to rely on quantity-based tools, while in those where capital market or external financing has a large weight, general price-based tools may work better.

This paper tries to answer the following two questions: (1) what type of macroprudential policy tool works best on credit growth? That is, are price-based or quantity-based tools more effective? (2) How does the effectiveness of price-based and quantity-based tools vary with the level of financial development? The simplifying schema guiding this research is summarised in Table 1 in section 3 below. The word "simplifying" deserves emphasis. A very prohibitive price imposed by a price-based tool could be equivalent to a quantity-based tool. Nor is there a hard-and-fast boundary between monetary and macroprudential measures. Nevertheless, this schema does help us reach some interesting conclusions.

A simple schema of types of macroprudential policies Table 1

	Price-based	Quantity-based
Non-interest rate monetary policy measures	Reserve requirements (RR) Liquidity requirements (Liq)	Credit growth limits (CRg)
Prudential policy measures	Risk weights on housing loans (RW)	Maximum loan-to-value ratio (Ltv)
	Provisioning rules (Prov)	Maximum debt-service-to-income ratio and other lending criteria (Dstilc) Exposure limits to the property sector (Expo)

The main results of this study are the following. First, we find that quantity-based domestic macroprudential measures taken by a country are effective in slowing its total credit growth. In particular, we show that quantity-based measures slow total credit growth on almost the entire distribution of the level of financial development, including relatively low levels of financial development. However, the differential effect of the financial development on the effectiveness of quantity-based measures is not statistically different from zero. These results are in line with the findings of many recent papers consistently showing that the maximum debt-service-to-income ratios and the maximum loan-to-value ratios were effective in slowing the growth of housing credit and general bank credit, since these two types of policy are the most important part of quantity-based measures considered in this study.

In contrast, we show that the price-based measures effectively slow credit growth only when the level of financial development is relatively high above the median of the distribution. We also find that the more financially developed a country is, the more effective the price-based measures are. The results for price-based measures,

together with those for quantity-based measures, confirm that financially developed countries benefit more from using price-based measures, while countries with low levels of financial development can achieve the desired outcome with quantity-based measures.

Finally, we show that the differential effects of financial development on the effectiveness of quantity-based and price-based macroprudential policies are robust when we use alternative composite indexes for financial development or alternative sample periods.

This article is organised as follows. Section 2 provides a literature review. Section 3 describes data and empirical approaches. In section 4, we provide empirical results. Section 5 concludes.

2. Literature review

This paper is related to three underexplored themes in the literature on the macroprudential policies, which is by itself relatively at its early stage of development: (1) the effectiveness of various types of macroprudential policy on the growth of credit; (2) price-based vs quantity-based tools; and (3) financial development and macroprudential policies.

First, many papers considered the effectiveness of macroprudential measures on domestic bank credit growth, using a large cross-country sample. In particular, Borio and Shim (2007) conduct an event-study analysis on macroprudential policy actions taken by 18 Asian and European economies, and find that such actions reduce domestic bank credit growth in the years after their introduction. Lim et al (2011) consider 40 economies that took macroprudential measures. Using a panel regression analysis, they find that reserve requirements and dynamic provisioning are effective in reducing private sector real credit growth during booms, and that maximum loan-to-value (LTV) and debt-service-to-income (DSTI) ratios, dynamic provisioning and reserve requirements reduce the procyclicality of credit growth. Kuttner and Shim (2013) consider 57 economies that have taken macroprudential policy actions affecting housing markets, and find that a typical tightening of DSTI limits slows real housing credit growth by 5–6 percentage points over the subsequent year. Claessens et al (2014) show that macroprudential policy measures such as maximum LTV and DSTI ratios and limits on foreign currency lending are effective in reducing the growth in bank-level leverage and assets during booms. Finally, Cerutti et al (2016) find that macroprudential policies overall are effective in reducing real domestic bank credit growth and that borrower-based measures such as LTV and DSTI limits are very effective through their effects on household credit.[7]

Second, regarding the desirability of price-based vs quantity-based tools, Shin (2012) points out that a levy on wholesale/FX-denominated liabilities has the advantage of being price-based, but a leverage cap has the drawback of being not price-based and open to circumvention. To our knowledge, very few papers have

[7] In a historical perspective, Elliott et al (2013) consider macroprudential tools the Federal Reserve and other US agencies have used since the First World War, and find that macroprudential policies designed to tighten credit availability, especially tools such as underwriting standards, have a significant effect, but that macroprudential policies designed to ease credit availability have little effect on credit.

looked into the issue of relative effectiveness of price-based and quantity-based measures. For example, Cizel et al (2016) find that quantity-based macroprudential measures have stronger cross-sector substitution effects (from bank to non-bank credit) in advanced economies.

Finally, a small number of papers explicitly considered the relationship between a country's level of financial development and the choice/effectiveness of macroprudential policies using a large cross-country sample. Lim et al (2011) point out that the stage of economic/financial development affects the choice of macroprudential policy instruments, and consider dummies for exchange rate regime and country/year effects in their regression analyses. In a cross-country study, Sheng (2015) finds that FX-related prudential measures are more effective when the ratio of private bank credit to GDP is higher. Finally, Cerutti et al (2016) consider institutional variables such as the exchange rate regime, de facto financial openness, the log of per capita GDP (as a proxy for the level of economic development), the level of credit relative to GDP, and the International Country Risk Guide (ICRG) index of institutional quality. They find that (1) macroprudential policies are more effective for a sample of relatively (de facto financially) closed economies than for relatively open economies; (2) macroprudential policies are less effective in countries with more flexible exchange rates; (3) the level of economic development and the quality of institutions do not explain the effectiveness of macroprudential measures; and (4) economies with a higher credit-to-GDP ratio have more difficulty in lowering credit growth through macroprudential measures when they consider a sample of low-income developing economies or a sample of relatively (de facto financially) closed economies.

3. Data and empirical approaches

We use quarterly data on total credit, GDP, domestic macroprudential policy measures, financial development indicators, macroeconomic variables, and financial crisis dummies for 37 economies over the sample period of 1996Q1 to 2011Q4. The 37 economies include 20 AEs and 17 EMEs, with ten economies from Asia-Pacific, five from central and eastern Europe, one from Africa, three from Latin America, 16 from western Europe and two from North America. Table 2 provides the list of 37 economies.

Data on total credit to the private non-financial sector are from the BIS database on credit to the non-financial sector publicly available. Since we use the credit-to-GDP ratio as the dependent variable in our empirical analysis, we divide the quarterly credit series by quarterly GDP data from national sources.

Domestic macroprudential measures are obtained from the database in Shim et al (2013). In the database, each tightening action is assigned value +1, each loosening action value –1, and no action value zero. The eight types of policy action recorded in the database can be classified into price-based and quantity-based measures. In particular, reserve requirements (RR), liquidity requirements (Liq), risk weights (RW) and provisioning requirements (Prov) are price-based measures, while credit growth limits (CRg), LTV limits (Ltv), DSTI limits and other lending criteria (Dstilc) and exposure limits (Expo) are quantity-based measures (Table 1).

Price-based and quantity-based macroprudential measures

Number of distinct policy actions, Q1 1990–Q2 2012

Table 2

Region	Country	All price-based measures					All quantity-based measures					Total
		Sum	Tighten	Loosen	Monetary	Prudential	Sum	Tighten	Loosen	Monetary	Prudential	
Asia and the Pacific	AU	2	2	-	-	2	-	-	-	-	-	2
	CN	44	35	9	43	1	23	21	2	1	22	67
	HK	-	-	-	-	-	16	10	6	1	15	16
	IN	42	25	17	35	11	2	2	-	-	2	44
	ID	4	3	1	4	-	1	1	-	-	1	5
	JP	1	-	1	1	-	2	1	1	2	-	3
	KR	10	7	3	5	5	21	15	6	-	21	31
	MY	21	14	7	19	2	8	4	4	-	8	29
	SG	-	-	-	-	-	9	7	2	-	9	9
	TH	6	4	2	3	3	2	1	1	-	2	8
Central and eastern Europe	CZ	8	2	6	8	-	-	-	-	-	-	8
	HU	4	-	4	4	-	4	3	1	-	4	8
	PL	5	3	2	2	3	3	3	-	-	3	8
	RU	22	15	7	22	-	-	-	-	-	-	22
	TR	19	11	8	15	4	3	3	-	-	3	22
Latin America	AR	11	3	8	11	2	-	-	-	-	-	11
	BR	39	17	22	37	2	-	-	-	-	-	39
	MX	1	1	-	-	1	-	-	-	-	-	1
Africa	ZA	1	1	-	-	1	-	-	-	-	-	1
Western Europe	AT	2	-	2	2	-	-	-	-	-	-	2
	BE	2	-	2	2	-	-	-	-	-	-	2
	CH	1	1	-	-	1	1	1	-	-	1	2
	DE	6	-	6	6	-	-	-	-	-	-	6
	DK	-	-	-	-	-	4	2	2	-	4	4
	ES	5	2	3	2	3	3	1	2	-	3	8
	FI	5	-	5	5	-	-	-	-	-	-	5
	FR	10	3	7	8	2	-	-	-	-	-	10
	GB	2	-	2	2	-	-	-	-	-	-	2
	GR	3	-	3	2	1	4	3	1	3	1	7
	IE	7	1	6	6	1	1	1	-	-	1	8
	IT	10	2	8	9	1	1	-	1	-	1	11
	NL	2	-	2	2	-	3	3	-	-	3	5
	NO	8	2	6	4	4	3	3	-	-	3	11
	PT	3	-	3	3	-	2	1	1	-	2	5
	SE	-	-	-	-	-	2	2	-	-	2	2
North America	CA	5	-	5	5	-	6	6	-	-	6	11
	US	2	-	2	2	-	-	-	-	-	-	2
Total (37)		313	154	159	269	50	124	94	30	7	117	437

AU: Australia; CN: China; HK: Hong Kong SAR; ID: Indonesia; IN: India; JP: Japan; KR: Korea; MY: Malaysia; SG: Singapore; TH: Thailand; CZ: Czech Republic; HU: Hungary; PL: Poland; RU: Russia; TR: Turkey; AR: Argentina; BR: Brazil; MX: Mexico; ZA: South Africa; AT: Austria; BE: Belgium; CH: Switzerland; DE: Germany; DK: Denmark; ES: Spain; FI: Finland; FR: France; GB: United Kingdom; GR: Greece; IE: Ireland; IT: Italy; NL: Netherlands; NO: Norway; PT: Portugal; SE: Sweden; CA: Canada; US: United States. The figure in brackets is the total number of economies.

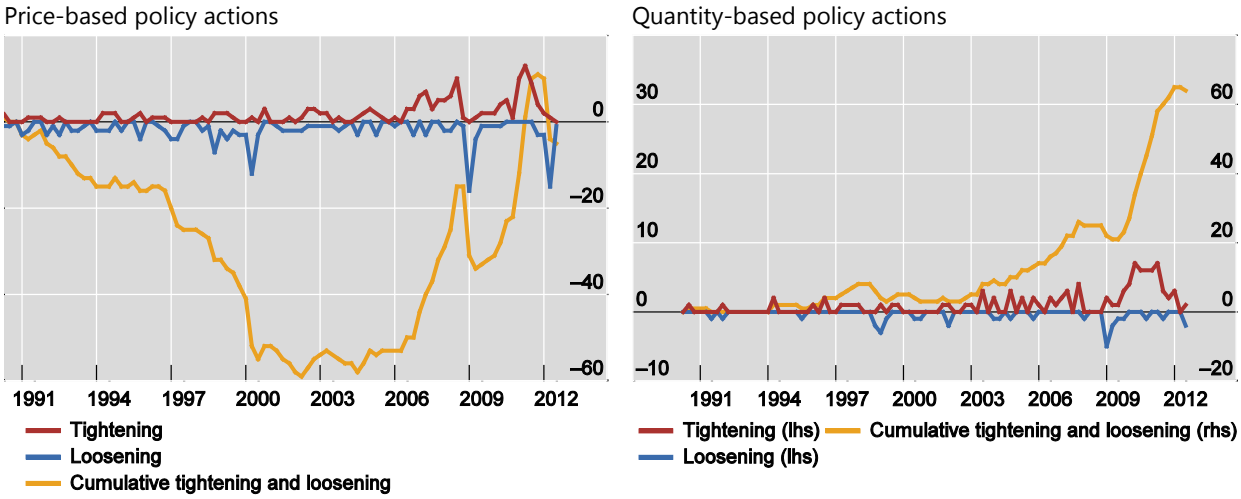
Source: Shim et al (2013); authors' calculation.

We can combine these individual policy indicators into various aggregate measures. In particular, we can define an indicator for monetary price-based measures (MonPrice) as the sum of the indicators for RR and Liq, an indicator for prudential price-based measures (PruPrice) as the sum of the indicators for RW and Prov, an indicator for monetary quantity-based measures (MonQuant) as the indicator for CRg, and an indicator for prudential quantity-based (PruQuant) as the sum of the indicators for Ltv, Dstilc and Expo. Finally, we can define an indicator for all price-based measures (AllPrice) as the sum of the indicators for MonPrice and PruPrice, and an indicator for all quantity-based measures (AllQuant) as the sum of the indicators for MonQuant and PruQuant. Table 2 shows the number of policy actions for the aggregate indicators as well as the number of tightening and loosening policy actions.

Figure 1 shows how price-based and quantity-based measures were used over time by the 37 economies. Generally speaking, these economies had more often loosened price-based measures than tightened from 1990 to around 2002 (Figure 1, left-hand panel). Between 2003 and 2008, there were more tightenings of price-based measures than loosenings. After a sharp increase in loosening actions during the peak of the global financial crisis, these economies overall took more tightening actions involving price-based tools than loosening ones after 2009. In contrast, the 37 economies overall had more often tightened quantity-based measures than loosened them from 1990 to 2012, except two brief periods of more loosening actions immediately after the Asian financial crisis of 1997 and during the peak of the global financial crisis of 2007–09 (Figure 1, right-hand panel).

Use of macroprudential measures

Number of policy actions in a quarter — Figure 1



The yellow lines denote the cumulative sum of tightening actions (each +1) and loosening actions (each –1) starting from Q1 1990.

Source: Shim et al (2013); authors' calculation.

It should be noted that the correlation of all price-based measure indicators (+1, 0, –1) and all quantity-based measure indicators (+1, 0, –1) over 1990–2012 is 0.15, and the correlation of cumulative indicators of all price-based measures and cumulative indicators of all quantity-based measures is 0.44. Also, the two measures were used at the same time during 1990–2012 in 17 out of 2782 country-quarter observations, in particular, at the same time in the same direction in 4 (loosen) and

13 (tighten) country-quarters. That is, we have no observation with two types of policy action taken in the opposition directions.

Composite index of financial development

Normalised and rescaled index

Table 3

Country	Average[1]
Argentina	1.19
Russia	1.33
Turkey	1.78
Hungary	1.83
Mexico	1.97
Poland	1.99
Indonesia	2.04
Brazil	2.29
India	2.34
Greece	3.36
Czech Republic	3.36
Norway	4.01
Italy	4.04
Finland	4.40
Korea	4.60
Belgium	4.75
Australia	4.83
Sweden	4.95
France	5.07
China	5.19
South Africa	5.22
Austria	5.29
Denmark	5.34
Ireland	5.47
Portugal	5.56
Germany	5.63
Thailand	5.71
United States	5.94
Canada	6.02
Spain	6.24
Singapore	6.28
Malaysia	6.58
Netherlands	6.97
United Kingdom	8.39
Switzerland	9.01
Japan	9.36
Hong Kong SAR	15.25
Median	5.07
Average	4.96

Note: [1] We first normalise 13 World Bank Financial Development indicators by subtracting mean and dividing by the standard deviation. Second, we take first principal components. Third, we subtract the minimum value to all normalised index values, so that the rescaled minimum value of the index becomes zero. Finally, for each economy, we calculate the average value of the index over the period of 1989 to 2011.

Source: World Bank Financial Development Indicators; authors' calculation.

To measure a country's level of financial development in a comprehensive way, we construct our own composite financial development indicators. In particular, we first normalise 13 World Bank Financial Development indicators by subtracting mean and dividing by the standard deviation, and then take first principal components. We consider the following ten ratios capturing the depth of a country's financial system: (i) (private credit by banks)/GDP, (ii) (bank assets)/GDP, (iii) (bank assets)/(bank assets and central bank assets), (iv) (liquid liabilities)/GDP, (v) (central bank assets)/GDP, (vi) (financial system deposits)/GDP, (vii) (private credit by banks and other financial institutions)/GDP, (viii) (domestic credit to private sector)/GDP, (ix) (stock market cap)/GDP, and (x) (stock market total value traded)/GDP. We also include the following two ratios proxying the efficiency of a financial system: (i) (credit to government and state-owned enterprises)/GDP, and (ii) stock market turnover ratio. Finally, we use the ratio of bank credit to bank deposits as a measure of the stability of a financial system. We consider all three categories of depth, efficiency and stability, and construct a composite variable for the level of financial development (*FinDev*).[8] Table 3 provides the average value of the composite index over the period of 1989 to 2011 for the 37 economies in the ascending order. However, it is worth noting that, while our composite index is a comprehensive measure capturing the common variation in a wide range of indicators for a country, it does not intend to measure the institutional or legal aspect of financial development.

We use standard macroeconomic variables as controls. In particular, we use short-term interest rates, real GDP growth, per capita GDP, CPI inflation and the ratio of current account to GDP. Finally, we also consider two crisis dummies, one for banking crises and the other for currency crises, in Laeven and Valencia (2012).

Using the data described so far, we conduct cross-country panel OLS regressions with time fixed effects and country fixed effects, denoted by μ_t and μ_i, respectively. In our regressions, we also consider country-specific linear trends in the credit-to-GDP ratio, ie, $\mu_i \cdot t$. All explanatory variables are lagged by one quarter. We consider four lags of policy variables, *P_MaPP* and *Q_MaPP*, denoting price-based and quantity-based measures, respectively, to capture the policy effect over one year after implementation. Specifically, we use the following econometric specification:

$$\begin{aligned}\Delta(credit/GDP)_{i,t} = {} & \beta_1 \Delta(credit/GDP)_{i,t-1} + \beta_2 \Delta(credit/GDP)_{i,t-1} \\ & + \sum_{j=1}^{4} \beta_{3j} (P\_MaPP)_{i,t-j} + \sum_{j=1}^{4} \beta_{4j} (Q\_MaPP)_{i,t-j} \\ & + \sum_{j=1}^{4} \beta_{5j} (FinDev)_{i,t} \cdot (P\_MaPP)_{i,t-j} + \sum_{j=1}^{4} \beta_{6j} (FinDev)_{i,t} \cdot (Q\_MaPP)_{i,t-j} \\ & + \beta_7 Controls_{i,t-1} + \mu_i + \mu_t + \mu_i \cdot t + \varepsilon_{i,t} \end{aligned} \quad (1)$$

It should be noted that interest rate policy is also a typical price-based measure for general credit and beyond ("gets in all the cracks in the economy"). This is because loose interest rate policy (ie lower interest rates) encourages greater borrowing by

[8] In addition to using the principal component method to construct a composite index for the level of financial development, we also calculated the simple average of the 13 indicators after normalising each of them. We also calculated the average level for each of the three categories and then calculated the average over the three categories. These two indexes have relatively high levels of correlation with the composite index from the principal component method (0.6 and 0.8. respectively).

households to bring spending forward from the future to the present (Bruno et al (2016)). Increased household borrowing will increase demand for housing, other things being equal.

The effect of price-based and quantity-based macroprudential policies on credit growth

Table 4

Dependent variable: Quarterly percentage point change in the credit-to-GDP ratio			
	(1)	(2)	(3)
Quarterly percentage point change in the credit-to-GDP ratio at t-1		0.227**	0.186*
		(0.104)	(0.107)
Quantity-based MaPP (t-1)	-0.001	-0.002**	-0.003
	(0.000)	(0.001)	(0.000)
Quantity-based MaPP (t-2)	-0.004	-0.004	-0.005
	(0.004)	(0.004)	(0.004)
Quantity-based MaPP (t-3)	-0.009***	-0.008***	-0.009***
	(0.002)	(0.002)	(0.002)
Quantity-based MaPP (t-4)	-0.004***	-0.002	-0.004
	(0.001)	(0.002)	(0.003)
Price-based MaPP (t-1)	0.003*	0.003	0.002
	(0.002)	(0.002)	(0.001)
Price-based MaPP (t-2)	0.002	0.002	0.002
	(0.002)	(0.001)	(0.001)
Price-based MaPP (t-3)	-0.002	-0.003	-0.003
	(0.002)	(0.002)	(0.002)
Price-based MaPP (t-4)	-0.003**	-0.003	-0.004*
	(0.001)	(0.002)	(0.002)
Crisis controls	Yes	Yes	Yes
Macroeconomic controls	Yes	Yes	Yes
p-value for H_o: $\sum_{j=1}^{4} \beta_{3j} = 0$	0.922	0.899	0.521
p-value for H_o: $\sum_{j=1}^{4} \beta_{4j} = 0$	0.000	0.000	0.000
Country fixed effects	Yes	Yes	Yes
Time fixed effects	Yes	Yes	Yes
Country linear trends	No	No	Yes
Observations	1600	1600	1600
R-squared	0.241	0.280	0.314

Note: We use robust standard errors clustered for country and time. *, ** and *** denote significance at 10, 5 and 1% levels, respectively. Macroeconomic controls include GDP growth rate, GDP per capita, current account to GDP ratio, annual inflation rate and the short-term interest rate. Crises controls include binary indicators for banking crises and currency crises.

4. Empirical results

In this section, we apply the econometric methods detailed in the previous section to analyse the effects of price-based and quantity-based macroprudential measures on credit growth, and then the differential impact of price-based and quantity-based measures depending on the level of financial development.

4.1 Effectiveness of macroprudential measures

We start our analysis by investigating the effectiveness of the price-based and quantity-based measures without differentiating their effects with respect to the level of financial development. In terms of Equation (1), this corresponds to $\beta_{5j} = \beta_{6j} = 0$ for all values of *j*. Column (1) of Table 4 compares the relative effectiveness of these measures in a specification with no control for the lagged dependent variable, proxying for latent time-varying persistent dynamic effects. When we consider the dynamic structure of our specification, the overall effects of the price-based and quantity-based tools are measured by $\sum_{j=1}^{4}\beta_{3j}$ *and* $\sum_{j=1}^{4}\beta_{4j}$, respectively. Table 4 shows that we cannot reject the hypothesis that the effect of price-based tools is equal to zero. In contrast, we find that the tightening of quantity-based tools is effective in slowing total credit growth, as we reject $\sum_{j=1}^{4}\beta_{4j} = 0$ at the 1% level. Controlling for the lagged dependent variable in column (2), and for the country specific linear trends for the credit-to-GDP ratio in column (3) does not change this result, suggesting that the results of the effectiveness of the quantity-based tools and ineffectiveness of the price-based tools hold under different conditions.

4.2 Effectiveness of price-based vs quantity-based measures

We next analyse our key question, ie whether the degree of financial development matters for the effectiveness of price-based and quantity-based tools. In Equation (1), the overall effect of price-based and quantity-based measures deployed at time *t-j* can be stated, respectively, as:

$$\frac{\partial\Delta(credit/GDP)_{i,t}}{\partial(P\_MaPP)_{i,t-j}} = \sum_{j=1}^{4}\beta_{3j} + \sum_{j=1}^{4}\beta_{5j}(FinDev)_{it} \quad (2)$$

$$\frac{\partial\Delta(credit/GDP)_{i,t}}{\partial(Q\_MaPP)_{i,t-j}} = \sum_{j=1}^{4}\beta_{4j} + \sum_{j=1}^{4}\beta_{6j}(FinDev)_{it} \quad (3)$$

In this specification, $\sum_{j=1}^{4}\beta_{3j}$ and $\sum_{j=1}^{4}\beta_{4j}$correspond to the effect of price-based and quantity-based measures, respectively, when the financial development measure is equal to zero, which is the minimum possible value of the financial development variable in our sample. Regarding the differential effects, $\sum_{j=1}^{4}\beta_{5j} \neq 0$ in Equation (2) implies that the effect of the price-based macroprudential tools vary with the level of financial development. Similarly, $\sum_{j=1}^{4}\beta_{6j} \neq 0$ in Equation (3) corresponds to the effect of quantity-based tools varying with the financial development. In particular, $\sum_{j=1}^{4}\beta_{5j} < 0$ and $\sum_{j=1}^{4}\beta_{6j} < 0$ imply that the macroprudential tightening becomes more effective in slowing credit growth for higher levels of financial development.

The estimation results for Equation (1) are presented in Table 5. Since the overall effect of the policy measures shown in Equations (2) and (3) differs at different levels of financial development, it is convenient to present the key results with a figure rather than a table. The left-hand panel of Figure 2 shows the quarterly percentage point change in the credit-to-GDP ratio in response to a tightening of price-based macroprudential tools, as well as the upper and lower bounds of the 90 percent confidence interval to assess the significance of the effect. We find that, at low levels of financial development, ie when the financial development index is around 2.5 or at

The effect of financial development and price-based and quantity-based macroprudential polices on credit growth

Table 5

Dependent variable: Quarterly percentage point change in the credit-to-GDP ratio	
Quarterly percentage point change	0.188*
in the credit-to-GDP ratio at t-1	(0.109)
Financial development (FinDev)	0.002**
	(0.001)
Quantity-based MaPP (t-1)	-0.004
	(0.004)
Quantity-based MaPP (t-2)	0.004
	(0.004)
Quantity-based MaPP (t-3)	-0.008
	(0.006)
Quantity-based MaPP (t-4)	-0.003
	(0.002)
Price-based MaPP (t-1)	0.004
	(0.003)
Price-based MaPP (t-2)	0.003
	(0.004)
Price-based MaPP (t-3)	0.001
	(0.004)
Price-based MaPP (t-4)	0.001
	(0.004)
FinDev x Quantity-based MaPP (t-1)	0.000
	(0.001)
FinDev x Quantity-based MaPP (t-2)	-0.001***
	(0.000)
FinDev x Quantity-based MaPP (t-3)	0.000
	(0.001)
FinDev x Quantity-based MaPP (t-4)	0.000
	(0.000)
FinDev x Price-based MaPP (t-1)	-0.001*
	(0.000)
FinDev x Price-based MaPP (t-2)	-0.001
	(0.001)
FinDev x Price-based MaPP (t-3)	-0.001
	(0.001)
FinDev x Price-based MaPP (t-4)	-0.001*
	(0.001)
Macroeconomic controls	Yes
Crisis controls	Yes
p-value for H_o: $\sum_{j=1}^{4} \beta_{5j} = 0$	0.073
p-value for H_o: $\sum_{j=1}^{4} \beta_{6j} = 0$	0.250
Country fixed effects	Yes
Time fixed effects	Yes
Country linear trends	Yes
Observations	1600
R-squared	0.317

We use robust standard errors clustered for country and time. *, ** and *** denote significance at 10%, 5% and 1% levels, respectively. Macroeconomic controls include GDP growth rate, GDP per capita, current account to GDP ratio, annual inflation rate and the short-term interest rate. Crises controls include binary indicators for banking crises and currency crises.

the 20th percentile of the financial development distribution, the value of the overall effect of a tightening of price-based tools is positive but insignificant. This effect of a tightening of price-based macroprudential tools on credit growth becomes significant and negative as the financial development index exceeds 5.5, which approximately corresponds to the 60th percentile of the financial development distribution.

As for the effect of the quantity-based macroprudential measures, the right-hand panel of Figure 2 shows that the negative effect on tightening on the credit growth is insignificant at very low levels of financial development. When the financial development index is above 1.59, corresponding to the 9th percentile of the financial development distribution, the effect of quantity-based macroprudential policies become statistically significant. This implies that a tightening of quantity-based macroprudential policies effectively slow credit growth when a country's level of financial development is above the very low threshold.

Financial development and the effects of macroprudential measures Figure 2

Note: The horizontal axis shows the normalised and rescaled composite index of financial development described in section three.

One important result in Table 5 that deserves emphasis is that the hypothesis $\sum_{j=1}^{4} \beta_{5j} = 0$ is rejected at 7 percent significance level. In contrast, we find no evidence that the level of financial development plays a statistically significant role in the magnitude of the effect of the quantity-based macroprudential tools on credit growth. This partly explains why the effect of price-based measures is insignificant at low levels but significant at high levels of financial development.

We believe that it is important to document the difference between the effectiveness of the price-based and quantity-based macroprudential tools, and how their effectiveness changes with the level of financial development. One possible channel that may drive the role of financial development in the effectiveness of price-based and quantity-based tools is difference in the price sensitivity of loan demand with respect to financial development. In particular, in an economy where the credit market is less developed and the agents have relatively limited access to credit, one may expect that the credit demand may be insensitive to the variations in the price of credit. That is, the availability of credit may matter more for the credit market outcomes in this economy, than its price, compared to other economies with higher financial development. Therefore, in such an economy, one may expect the

policies aiming at affecting the price of borrowing to be less effective in slowing credit growth than those directly targeting the quantity of borrowing.

5. Concluding remarks

Using a cross section of 37 countries, we evaluate in this paper whether quantity-based and price-based macroprudential measures differ from each other in terms of smoothing the variations in total credit. While this question by itself is a relatively less explored one, we further analyse how the level of financial development of an economy matters for the relative effectiveness of these two sets of tools.

This paper provides novel findings on the effects of macroprudential policies. When we do not consider the differential effect of financial development, we find that the quantity-based tools can effectively smooth the variations in total credit, whereas the price-based tools are ineffective. However, our results highlight the fact that these effects are not independent from the degree of financial development, particularly for the price-based tools. While the quantity-based tools are effective in moderating credit cycles almost irrespective of the level of financial development, the price-based tools effectively curb excess variations in total credit in relatively more developed financial markets. This finding is robust to different empirical specifications as well as to different composite measures of financial development.

While this study does not provide a detailed analysis on the channels leading to different performance of price-based and quantity-based macroprudential tools, one possible channel is that the price elasticity of the credit demand is low in countries with low levels of financial development. As a result, policy tools aiming at making credit more expensive may not be effective in deterring the credit demand in those countries. However, when a country's level of financial development is sufficiently high, the price of credit may start becoming as relevant as its availability, and thus the policies focusing on the cost of borrowing (ie price-based tools) may become effective as well in smoothing credit cycles.

References

Borio, C and I Shim (2007): "What can (macro-)prudential policy do to support monetary policy?" *BIS Working Paper*, no 242.

Bruno, V, I Shim and H S Shin (2016): "Comparative assessment of macroprudential policies", *Journal of Financial Stability*, forthcoming.

Cerutti, E, S Claessens and L Laeven (2016): "The use and effectiveness of macroprudential policies: new evidence", *Journal of Financial Stability*, forthcoming.

Cizel, J, J Frost, A Houben and P Wierts (2016): "Effective macroprudential policy: cross-sector substitution from price and quantity measures", *DNB Working Paper*, no 498.

Claessens, S, S Ghosh and R Mihet (2014): "Macro-prudential policies to mitigate financial system vulnerabilities", *IMF Working Paper* 14/155, August.

Douglas, E, J Feldberg, and A Lehnert (2013): "The history of cyclical macroprudential policy in the United States", Federal Reserve Board, *Finance and Economics Discussion Series* 2013-39.

Kenneth, K, and I Shim (2013): "Can non-interest rate policies stabilise housing markets? Evidence from a panel of 57 economies", *BIS Working Paper*, no 433.

Laeven, L and F Valencia (2012): "Systemic banking crises database: an update", *IMF Working Paper*, 12/163.

Lim, C H, F Columba, A Costa, P Kongsamut, A Otani, M Saiyid, T Wezel, and X Wu (2011): "Macroprudential policy: what instruments and how to use them? Lessons from country experiences", *IMF Working Paper* 11/238.

Sheng, W (2015): "Macroprudential policies and capital controls, financial development and the interaction effects on external debt liabilities", unpublished results, September.

Shim, I, B Bogdanova, J Shek and A Subelyte (2013): "Database for policy actions on housing markets", *BIS Quarterly Review*, September, pp 83–95.

Shin, H S (2012): "Adapting macroprudential policies to global liquidity conditions", *Central Bank of Chile Working Papers* no 671, July.