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Competition in banking and the lending channel: Evidence from bank-level data in Asia and Latin America ☆

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ABSTRACT

This paper examines how banking competition affects the transmission of monetary policy through the bank lending channel. We apply a two-step estimation procedure using bank-level panel data for commercial banks in 10 Asian and 10 Latin American countries during the period from 1996 to 2006. In the first step we measure the degree of banking competition by applying the methodology proposed by Panzar and Rosse (1987). In the second step we estimate a loan growth equation where the explanatory variables include the Panzar–Rosse measure of banking competition. The estimation results provide consistent evidence that increased competition in the banking sector weakens the transmission of monetary policy through the bank lending channel. This is especially true for banks in Latin American countries and banks of small size, low liquidity, and low capitalization. We also discuss the policy implications of the main findings of this paper.

1. Introduction

In this paper we examine how competition in banking impacts the effectiveness of the monetary policy transmission mechanism in selected Asian and Latin American countries. We focus our analysis on the impact of banking competition on the lending channel, according to which banks with different characteristics and financial strength play a distinctive role in the transmission mechanism of monetary shocks. The bank lending channel focuses on the effects of monetary policy on the supply of bank loans. When banks that face a monetary policy tightening are not able to fully replace lost loanable funds, they need to curtail lending, which subsequently affects the real economy. This specific role of banks in the transmission of monetary policy through the bank lending channel has been extensively studied.[1]

In recent years the banking industry in Asia and Latin America has experienced significant changes in competitive conditions.[2] Factors that have contributed to these important changes in market structure include international financial integration, privatization, deregulation, a wave of mergers and acquisitions that raised market concentration, along with increased foreign bank penetration and financial reforms to bail out banks from crises including the recent 2008–9 global financial crisis.[3]

Changes in banking competition are expected to affect the transmission of monetary policy through the bank lending channel. Plausible channels include the following. First, if an increase in competition is caused by an increased market share held by larger banks, this should weaken the bank lending channel of monetary policy transmission. The idea is that competitive large banks typically enjoy better access to additional sources of funds (other than transaction and savings deposits such as CDs or inter-bank loans) with which they are able to counteract the decline in reserves caused by a monetary policy tightening. Accordingly, as the market share of large banks increases a given reduction in the supply of

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[1] Since the seminal work by Bernanke and Blinder (1988, 1992), there have been numerous papers on the bank lending channel as a monetary policy transmission mechanism. To name a few, Bernanke (1993), Kashyap, Stein, and Wilcox (1993), Bernanke and Gertler (1995), and Kashyap and Stein (1995, 2000).

[2] Recent changes in banking competition at a global scale have been well-documented in Bikker and Spierdijk (2008) and Bikker et al. (2009). They report that various Western and Eastern European economies experienced a decline in banking competition, while the banking industry in emerging markets became more competitive during the last decade.

[3] For the various factors contributing to changes in banking market structure and its implications on bank efficiency and stability in developing countries, see Ariss (2010).

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money has smaller effects on lending and hence on aggregate economic activity.

Second, increased competition can weaken the bank lending channel of monetary policy if the increase in competition is associated with a reduction in the informational asymmetries across banks over their borrowers' creditworthiness. These informational frictions and the fact that incumbent banks accumulate proprietary information about their customers typically make it costly for borrowers to switch from the incumbent bank (from which they have been borrowing for a period of time) to a new rival bank. These switching costs create a customer "lock-in" or "hold-up" effect. Thus, following a monetary policy tightening, small banks (who are typically more severely affected by the tightening) will shrink their loan supply. If borrowers cannot costlessly switch among lenders, the excess demand left by these small banks cannot be picked up by larger banks (who can better protect their loan supply). Therefore, our hypothesis is that at the aggregate level, the response of the total supply of credit to a change in monetary conditions should be increasing in the magnitude of these switching costs. When increased competition in banking markets lowers these costs, the impact of a given monetary policy shock should also diminish.

Third, competition in banking can impact the effectiveness of monetary policy through its effect on the sensitivity of bank loan rates to monetary policy shocks. Thus, an increase in competition (which makes a bank's prices more sensitive to changes in the marginal costs) can make monetary policy stronger if it implies that changes in the interest rates on deposits caused by a shock to reserves are more directly transmitted to the interest rates on loans.

In the first two cases, increased competition weakens the impact of monetary policy through the bank lending channel. In the last case, it strengthens the monetary policy transmission mechanism. Which of these effects dominates is not clear from the literature, and it ultimately remains as an empirical question. In this paper we aim to provide an answer to this question.

The issue of how the degree of competition in the market for bank credit impacts the effectiveness of monetary policy was first examined from a theoretical standpoint by Aftalion and White (1978) and VanHoose (1983, 1985). They show that the market structure of banking markets can have an important impact on the appropriate choice of monetary policy targets and instruments. Specifically, VanHoose (1983) shows that the federal funds rate becomes an ineffective monetary policy tool in a competitive banking system.

From an empirical standpoint, Adams and Amel (2005) use aggregate data for the United States from 1996 to 2002, and find that the effect of monetary policy on the bank lending channel is weaker in more concentrated rural banking markets than in less concentrated urban markets. Olivero, Li and Jeon (2009) use bank-level data to study the impact of consolidation on the effectiveness of monetary policy in Asian and Latin American countries. Being limited to concentration in banking, which is a somewhat narrow measure of market power in this sector, this literature has reached no consensus on how competition in the banking sector affects the effectiveness of monetary policy transmission through the bank lending channel.[4]

To examine the impact of banking competition on the bank lending channel in this study, we use bank-level balance sheet and income statement data for a sample of twenty countries in Asia and Latin America for the 1996–2006 period. We adopt a two-step estimation procedure: In the first step we measure the degree of banking competition applying the methodology proposed by Panzar and Rosse (1987). This technique measures the competitive behavior of banks by estimating the degree of deviation from competitive, marginal-cost pricing, but without explicitly using information on market structure. In the second step we estimate a loan growth equation where the Panzar–Rosse measure of banking competition (hereafter PRH statistic) is included as one of the explanatory variables along with other control variables.

We identify a threefold contribution of this paper to the existing literature. First, while previous work has focused on the effects of *concentration* in the market for bank credit, we take a more fundamental approach by using a *broader measure* of banking *competition*.[5] Doing so allows us to more accurately both explore the role of banking competition on the monetary policy transmission mechanism and compare our results with the mixed findings of the literature discussed above. To our knowledge, Gunji et al. (2009) is the only piece of research on the effects of this broader measure of banking competition on monetary policy at a global scale. However, they do not investigate the bank lending channel, and they focus mostly on developed countries. This contribution of focusing on a broader measure is especially relevant in the case of the banking industry for which, unlike other industries, it has been shown that the Structure–Conduct–Performance paradigm (which predicts an inverse relationship between concentration and competition) does not necessarily hold (see Northcott (2004) for a detailed discussion).

Second, we use bank-level balance sheet and income statement data which allows us to test one of the main propositions of the bank lending channel: i.e., that the response of banks to monetary policy shocks should be different depending on their individual characteristics that proxy for banks' financial constraints and/or strength of their balance sheets. In particular, using bank-level data, we can better identify the effects of the *supply-side* bank lending channel versus those of the *demand-side* interest rate channel, and to test for any systematic differences in the impact of competition in banking on monetary policy transmission across banks with different degrees of financial constraints.

Third, we take an international perspective and extend this topic to the context of emerging economies in Asia and Latin America. The banking industries in these countries provide a useful laboratory for studying the issue at hand since they have undergone important changes in the last decade. Their banking sectors have seen significant increases in consolidation through a boom of mergers and acquisitions, a large scale privatization of state-owned banks, and deregulation efforts. Since the early 1990s, they have also experienced significant increases in foreign bank penetration and the restructuring of domestic banking industries, and further, investment banks, mutual funds, and insurance companies have all begun to compete for the core business of commercial banks. These developments have raised concerns about the impact of banking competition on the effectiveness of monetary policy.[6]

[4] For examples of the mixed results regarding the impact of banking concentration on monetary policy transmission, see Cottarelli and Kourelis (1994) and Adams and Amel (2005) for the case of the US and English (2002) for the group of 10 countries case.

[5] Based on the results for industrialized countries by Bikker and Haaf (2002), increased market concentration is expected to reduce competition in banking. However, several counter-examples have been reported in the literature. For example, Dell'Ariccia (2001) develops a theoretical model to demonstrate the role played by informational asymmetries in shaping the market structure in banking. He shows that these informational asymmetries can make even highly concentrated banking markets very competitive. Northcott (2004) provides a detailed discussion of the role played by informational asymmetries between borrowers and lenders, switching costs for borrowers, and product differentiation in determining the relationship between concentration and competition in the banking industry. Using macro-level data on 69 countries for the period 1980–1997, Beck et al. (2006) find that both the concentration and the competitiveness of the banking system lower banking system fragility and the probability of a banking crisis, which implies a positive relationship between concentration and competition in the banking sector.

[6] For post-crisis reform measures towards enhancing competition in the banking sector, see Claessens and Laeven (2004) and Claessens (2009) for a global overview, Yildirim and Philippatos (2007) for Latin American countries, Bagliano et al. (2000), De Jonghe and Vander Vennet (2008), and Brissimis et al. (2008) for European countries, and Yokoi-Arai and Kawana (2007) for Asian countries.

Also, our estimates of the degree of banking competition in these economies complement those previously reported in the literature mostly for developed countries (e.g., Bikker and Haaf, 2002).

We present consistent evidence that increased competition in the banking sector weakens the monetary policy transmission mechanism through the bank lending channel. We also find that banks in Latin American and Asian economies operate in a monopolistically competitive environment, and that overall, banking competition in Latin America is higher than in Asia, resultantly making monetary policy transmission through the bank lending channel weaker in Latin America.

The remainder of the paper is structured as follows. In Section 2, we describe the data and research methodology. In Section 3, we report the estimation results and discuss their implications. In Section 4, we present the results of several robustness tests performed on our benchmark specification. In Section 5, we conclude.

2. Data and methodology

2.1. Data description

We use annual bank-level balance sheet and income statement data for the 1996–2006 period retrieved from the *BankScope* database. Our data set covers a total of 1062 banks (based on the availability of the loans data needed for our second step estimations) in 10 Asian countries (China, Hong Kong, India, Indonesia, Japan, Korea, Malaysia, the Philippines, Singapore, and Thailand) and 10 Latin American countries (Argentina, Bolivia, Brazil, Chile, Colombia, Mexico, Paraguay, Peru, Uruguay, and Venezuela).

Two sets of banks are considered outliers and dropped from our data set: First, banks for which lending activities are marginal (defined as those for which the ratio of loans to total assets is less than 20%); and second, banks that have potentially been involved in mergers, acquisitions or any other unusual business situations such as liquidation (defined as those for which total assets increase or decrease by more than 50% in a year). Our final data set consists of an unbalanced panel of 6707 bank-year observations covering 1062 banks over the period from 1996 to 2006. All data are presented in local currency and adjusted for inflation. We also collect short-term interest rates and GDP data for each of our sample economies. The main source for the macroeconomic data is the *International Financial Statistics* from the IMF. Tables A1 and A2 in Appendix A present the data summary statistics.

2.2. Methodology

Our empirical study is conducted in two steps. In the first step we estimate the degree of banking competition using the PRH statistic based on the Panzar and Rosse (1987) model. In the second step we investigate how banking competition affects the transmission of monetary policy through the bank lending channel.

In the first step we follow the methodology of Bikker and Haaf (2002), Bikker et al. (2009), and Goddard and Wilson (2009) to measure the degree of competition in the banking market. We calculate the PRH statistic, defined as the elasticity of revenue with respect to the marginal cost of the inputs used in the production of banking services. We do so by applying a fixed-effect (FE) estimation of Eq. (1a) using bank-level panel data for each country:

$$\ln(R_{i,t}) = \alpha_i + \beta_1 \ln(W_{1,i,t}) + \beta_2 \ln(W_{2,i,t}) + \beta_3 \ln(W_{3,i,t}) + x'_{i,t}\gamma + e_{i,t} \quad (1a)$$

where i indexes banks and t indexes time. $R_{i,t}$ is financial income as a measure of the revenue for bank i in year t; $W_{j,i,t}$ is the price of factor input j ($j = 1$ for financial expenses, $j = 2$ for administrative and operating expenses, and $j = 3$ for personnel expenses), all measured as the ratio of each type of expense to total assets. $x_{i,t}$ is a vector of exogenous control variables at the bank level, which includes the ratio of equity to total assets, the ratio of net loans to total assets, and the ratio of other income to total assets.[7] α_i is an individual bank effect, and $e_{i,t}$ is a random disturbance term. In Eq. (1a), the PRH statistic is given by the sum of the elasticities of revenue with respect to input prices, $(\beta_1 + \beta_2 + \beta_3)$. Under monopoly, PRH < 0; under perfect competition, PRH = 1; and under monopolistic competition, 0 < PRH < 1.[8] As in Vesala (1995) and Bikker and Haaf (2002), we interpret estimates of the PRH statistic as providing a continuous measure of the level of competition, with larger values indicating stronger competition.

The estimation of the PRH statistic using a static revenue equation as in (1a) has been criticized in the recent literature since it assumes that markets are always in their long-run equilibrium at each time period for which the data are observed, yielding statistics that are biased towards zero. Goddard and Wilson (2009) suggest applying a dynamic panel estimator to a dynamic model of the revenue equation. The idea is to allow for a partial adjustment towards the long-run equilibrium, with this adjustment being captured by the inclusion of a lagged dependent variable in the revenue equation. Following their suggestion, we apply Arellano and Bond's (1991) generalized method of moments (GMM) to our panel data to estimate Eq. (1b). The dynamic GMM estimation a la Arellano and Bond performs first-difference estimation to account for bank-level fixed effects and uses dynamic instruments in the GMM estimation.[9]

$$\Delta \ln(R_{i,t}) = \beta_0^G \Delta \ln(R_{i,t-1}) + \beta_1^G \Delta \ln(W_{1,i,t}) + \beta_2^G \Delta \ln(W_{2,i,t}) + \beta_3^G \Delta \ln(W_{3,i,t}) + \Delta x'_{i,t}\gamma + \Delta e_{i,t}. \quad (1b)$$

Doing so we obtain a dynamic PRH statistic given by $(\beta_1^G + \beta_2^G + \beta_3^G)/(1 - \beta_0^G)$.

In order to address the fact that the degree of competition might change over time, we also estimate time-varying PRH statistics by estimating Eq. (1a) for each of three 3-year panels in each country. We report these results as a robustness test in Section 4.

In the second step we address the following question: How does banking competition affect the transmission of monetary policy through the bank lending channel? To do so, we estimate a loan growth equation where the explanatory variables include the PRH measure of banking competition.

Following the standard practice in this literature, in our empirical model we assume that the real effects of monetary policy are derived from its effects of monetary policy on banks' marginal cost of loanable funds. Thus, based on Bernanke and Blinder (1988), we measure the stance of monetary policy through changes in the short-term interest rate, so that a monetary tightening (easing) is reflected in an increase (decrease) in interest rates. We use the Treasury bill (TB) rate for our sample of Asian and Latin American countries. When the TB rate is not available we use the money market rate or the discount rate. Short-term interest rates, the Treasury bill and money market rates have been used in much of previous research on monetary policy in global economies as a

[7] Bikker et al. (2009) caution that including a scale variable such as total assets or income in the control variable set in the revenue or price equations creates a significant upward bias and incorrect measures of the degree of competition.

[8] For derivations of these results, see Panzar and Rosse (1987).

[9] We follow the convention in Goddard and Wilson (2009) adding a superscript G to the regression coefficients to indicate that Eq. (1b) is estimated using GMM.

measure of the stance of monetary policy.[10] Although it can be argued that countries use indicators other than interest rate targets in their implementation of monetary policy, accounting for this possibility would not be feasible since these targets change over time and across countries. Therefore, accounting for this variety of targets would imply using different measures of monetary policy for different periods and different countries in the same regression.[11] In Section 4 we confirm the robustness of our results when using an alternative measure of monetary policy.

The bank lending channel model that we estimate is given by:

$$y_{i,j,t} = \alpha_i + \beta x_{j,t} + \rho_1 z1_{i,j,t} + \rho_2 z2_{i,j,t} + \rho_3 z3_{i,j,t} + \delta mp_{j,t} + \theta \mathrm{PRH}_{j,t} + \phi \mathrm{PRH}_{j,t} * mp_{j,t} + \lambda D_{j,t} + u_{i,j,t}, \quad (2)$$

where i indexes banks, j indexes countries where bank i operates, and t indexes time. This equation regresses the growth rate of loans (y) by bank i in country j at time t on an indicator of monetary policy (mp), the PRH measure of competition in banking (PRH), and an interaction term between the two. The interaction term is intended to capture the marginal impact of banking competition on the effects of monetary policy changes on loan growth. α_i is the constant which represents an individual bank-level effect. D is a crisis dummy which equals 1 for crisis years, and 0 otherwise. The crisis years are identified by looking at real GDP annual data, so that D takes a value of 1 when real GDP growth rates are less than −2%.[12]

We take the percentage change in the loan volume as the dependent variable since market size varies substantially across markets, such that the effect of a given change in interest rates would be increasing in market size otherwise.

The variable x is the growth rate of real GDP, and it is included to control for changes in the demand for loans, and to isolate the effects of monetary policy on the supply side of the market for loans. Therefore, the coefficient β on this variable x is expected to be positive.

Using bank-level balance sheet and income statement data to study the transmission mechanism of monetary policy allows us to better identify the *supply-side credit channels* of monetary policy transmission from the *demand-side interest rate* channels. Bank-level data help to identify the credit channel by investigating a specific empirical implication of the credit view, namely, that the response of loan supply to monetary policy shocks is expected to be different across banks with different characteristics and financial strength. To incorporate this idea into the model and to control for the effect of the financial strength in banks' balance sheets, we include the z variables in Eq. (2). Specifically, these variables measure bank-level characteristics that have been shown to exert a significant effect on loan growth. $z1$, $z2$ and $z3$ measure bank size, liquidity and capitalization, respectively.

Regarding bank size, the argument is that bigger banks face lower external finance premia and find it easier to isolate a shock to deposits by switching to alternative sources of funding. In this paper, we use a relative measure of size, calculated as the difference between the log of bank i's assets for period t and the average of the log of assets for all banks in that country during the same period. Therefore:

Table 1
The estimated Panzar and Rosse H (PRH) statistics, 1996–2006.

	Static PRH[a]	Dynamic PRH[b]
Asian countries		
China	0.115	−7.241
	(0.173)	(0.668)
Hong Kong	0.301	0.414
	(0.005)	(0.000)
India	−0.658	0.212
	(0.000)	(0.496)
Indonesia	0.055	0.351
	(0.665)	(0.001)
Japan	0.151	0.153
	(0.000)	(0.000)
Korea	−0.233	−0.012
	(0.077)	(0.891)
Malaysia	0.015	0.183
	(0.868)	(0.022)
Philippines	0.384	0.341
	(0.000)	(0.015)
Singapore	0.854	1.200
	(0.000)	(0.000)
Thailand	0.239	−0.280
	(0.000)	(0.272)
Average Asia	0.122	−0.468/0.284[c]
Latin American countries		
Argentina	0.368	0.302
	(0.000)	(0.000)
Bolivia	0.608	0.672
	(0.000)	(0.000)
Brazil	0.453	2.097
	(0.000)	(0.042)
Chile	0.305	0.280
	(0.000)	(0.000)
Colombia	0.118	0.175
	(0.024)	(0.001)
Mexico	0.720	1.503
	(0.000)	(0.015)
Paraguay	0.745	1.012
	(0.000)	(0.000)
Peru	−0.034	0.410
	(0.874)	(0.052)
Uruguay	1.002	0.952
	(0.003)	(0.000)
Venezuela	−0.492	−0.368
	(0.003)	(0.494)
Average Latin America	0.379	0.704

[a] The fixed effect (FE) estimation of the PRH statistic using the revenue equation is based on the static model specified in Eq. (1a). It is applied to the bank-year panel data for each country during the period of 1996–2006.

[b] We apply Arellano and Bond's (1991) generalized method of moments (GMM) procedure to our panel data to estimate Eq. (1b) and to obtain the dynamic PRH statistics. The dynamic GMM estimation a la Arellano and Bond performs first-difference estimation to account for bank-level fixed effects and uses dynamic instruments in the GMM estimation.

[c] Average values for all Asian countries/average values for Asian countries excluding China. The numbers in parentheses are p-values of the PRH statistics.

[10] See, for example, Shambaugh (2004) who takes the short-term interest rate as a measure of monetary policy in his study of the effect of exchanges rates on monetary policy for a total of 103 countries: Treasury bill rates for 56 countries and money market rates for 47 countries. Other measures of the monetary policy stance include money growth rates, including borrowed and non-borrowed reserves, and the VAR model-based monetary innovations and/or interest rate innovations. The former has been criticized for various deficiencies, such as the infrequent changes and different practical operations in different countries, while the latter VAR model-based approaches have been widely used in the literature. See our robustness tests section for more detailed information.

[11] According to the IMF, our sample countries take a variety of monetary policy operating targets: interest rates (Malaysia), monetary aggregate targets (China, Indonesia), inflation targeting (Peru, Thailand, Brazil, Chile, Colombia, Korea, Mexico, and Philippines), and monitoring various indicators in conducting monetary policy (India, Paraguay, Singapore, and Japan). [Source: Table. De Facto Exchange Rate Arrangements and Anchors of Monetary Policy as of December 31, 2004; http://www.imf.org/external/np/mfd/er/2004/eng/1204.htm#table.] These countries also adopt a variety of specific instruments of monetary policy. For example, Argentina uses the Cental Bank bill interest rate, reserve ratios, lending facilities up to 3 months, private sector loan control, repos, daily turnover as a percentage of total bank deposits, and collateralized lending. [Source: Information System for Instruments of Monetary Policy Database, IMF.]

[12] The crisis years that we identify are found to be consistent with alternative identifications of banking crisis episodes reported in the literature such as Caprio and Klingebiel (2003).

Table 2a
Estimation results of the loan growth equation using the whole sample.

Dependent variable: Δln(loans)	(1) Static PRH	(2) Dynamic PRH
mp	−0.914***	−0.854***
	(0.179)	(0.183)
mp ∗ PRH	0.703***	0.538***
	(0.225)	(0.204)
Δln(GDP)	125.3***	128.7***
	(17.94)	(17.73)
Size	−18.25***	−16.89***
	(2.711)	(2.833)
Liquidity	−0.327***	−0.329***
	(0.067)	(0.066)
Capitalization	3.034***	3.032***
	(0.318)	(0.316)
Crisis dummy	1.218	1.697
	(1.658)	(1.673)
Constant	24.54***	18.87**
	(7.173)	(7.665)
Observations	4170	4170

Notes: Two-stage least squares (TSLS) is used for estimation to address the possible endogeneity of bank characteristic variables. The results in column (1) use the PRH statistics estimated by applying the static FE estimator to Eq. (1a), and those in column (2) use the PRH statistics estimated by applying the dynamic GMM estimator to Eq. (1b). The numbers in parentheses denote standard errors of the coefficients.
* The statistical significance at the 10% level.
** The statistical significance at the 5% level.
*** The statistical significance at the 1% level.

Table 2b
Percentages change in lending as a result of a one percentage point increase in the stance of monetary policy.

(1) Static PRH		(2) Dynamic PRH	
PRH value	Changes in bank lending (%)	PRH value	Changes in bank lending (%)
Mean PRH = 0.212	−0.765	Mean PRH = 0.094	−0.803
25th percentile PRH = 0.054	−0.876	25th percentile PRH = 0.153	−0.772
50th percentile PRH = 0.151	−0.808	50th percentile PRH = 0.303	−0.691
75th percentile PRH = 0.458	−0.592	75th percentile PRH = 0.952	−0.342

Notes: Percentage changes in bank lending are calculated as $(\delta + \phi * \text{PRH})$, as specified in Eq. (2).

$$size_{i,t} = \ln(assets_{i,t}) - \frac{\sum_{i=1}^{n_t} \ln(assets_{i,t})}{n_t}, \quad (3)$$

where n denotes the number of banks in that country. The second measure of financial strength is bank liquidity. It is calculated as the ratio of liquid assets (the sum of cash and reserves) to total assets at the bank level. The idea is that banks with more liquid balance sheets may be better prepared to insulate their loan supply from unexpected shocks to deposits. The third measure of financial strength is bank capitalization, computed as the share of equity capital in total assets. Banks with high capitalization tend to pay lower risk premia for uninsured debt financing, and should therefore also be better prepared to insulate their loan supply from unexpected shocks to reserves caused by a monetary policy tightening.

There are possible endogeneity problems associated with the inclusion of these bank-level variables which might yield biased coefficient estimates. For bank size, a bank may become larger only because its loans grow rapidly. Regarding bank capitalization, a bank may become better capitalized because initially it faced a higher external finance premium. Therefore, it is not clear whether a highly capitalized bank is less liquidity-constrained. Also, bank capitalization could decrease with bank size, so that capitalization may not be a good indicator of liquidity constraints. Bank liquidity can also be a biased measure of financial constraints when a bank chooses to have more liquid assets only to compensate for stronger financing restrictions. To minimize the bias associated with these endogeneity concerns, we apply two-stage least squares (TSLS) in the estimation of the empirical model of Eq. (2). As instruments we use two lags of the instrumented variables.

We expect an increase in the interest rate to reduce the growth of bank lending, so that the coefficient of monetary policy δ is expected to have a negative sign. According to the arguments presented in Section 1, competition in banking could weaken or strengthen the monetary policy transmission mechanism through the bank lending channel, implying that the coefficient on the interaction term ϕ can be positive or negative. A positive (negative) sign for this coefficient implies that higher competition leads to a weaker (stronger) monetary policy transmission.

3. Empirical results

Applying a two-step estimation procedure, we first obtain the estimates of the PRH statistics for each country using Eqs. (1a) and (1b) as the measure of banking competition. We then introduce the estimated PRH statistics into the loan growth equation, Eq. (2), to examine the relationship between banking competition and the bank lending channel in Asian and Latin American countries.

Table 3a
Estimation results of the loan growth equation using Latin American and Asian subsamples.

Dependent variable: Δln(loans)	Latin America		Asia	
	(1) Static PRH	(2) Dynamic PRH	(3) Static PRH	(4) Dynamic PRH
mp	−0.990***	−0.987***	−1.401***	−1.225***
	(0.318)	(0.319)	(0.221)	(0.246)
mp ∗ PRH	0.636*	0.576*	2.984**	−0.311
	(0.371)	(0.337)	(1.478)	(0.489)
Δln(GDP)	93.45**	100.7***	151.6***	159.6***
	(38.20)	(36.83)	(15.83)	(15.49)
Size	−23.38***	−21.99***	−18.60***	−14.93***
	(4.660)	(4.986)	(3.625)	(2.890)
Liquidity	−0.176	−0.182	−0.492***	−0.495***
	(0.111)	(0.111)	(0.087)	(0.085)
Capitalization	3.422***	3.426***	1.745***	1.765***
	(0.549)	(0.549)	(0.346)	(0.335)
Crisis dummy	6.593*	7.915**	−1.981	−1.010
	(3.848)	(3.935)	(1.475)	(1.346)
Constant	1.074	−7.596	59.16***	46.15***
	(12.23)	(14.61)	(11.21)	(8.622)
Observations	1812	1812	2358	2358

Notes: TSLS is used for estimation. The results in columns (1) and (3) use the PRH statistics estimated by applying the static FE estimator to Eq. (1a), and those in columns (2) and (4) use the PRH statistics estimated by applying the dynamic GMM estimator to Eq. (1b). The numbers in parentheses denote standard errors of the coefficients.
* The statistical significance at the 10% level.
** The statistical significance at the 5% level.
*** The statistical significance at the 1% level.

Table 3b
Percentage changes in lending as a result of a one percentage point increase in the stance of monetary policy.

PRH value category	Latin America				Asia			
	(1) Static PRH		(2) Dynamic PRH		(1) Static PRH		(2) Dynamic PRH	
	PRH value	Change in bank lending (%)	PRH value	Change in bank lending (%)	PRH value	Change in bank lending (%)	PRH value	Change in bank lending (%)
Mean	0.365	−0.758	0.974	−0.426	0.076	−1.173	−0.684	*−1.012*
25th percentile	0.305	−0.796	0.303	−0.813	0.055	−1.238	0.153	*−1.272*
50th percentile	0.458	−0.699	0.952	−0.439	0.115	−1.059	0.183	*−1.282*
75th percentile	0.458	−0.699	2.093	0.219	0.151	−0.949	0.351	*−1.334*

Notes: Percentage changes in bank lending are calculated as $(\delta + \varphi * \text{PRH})$. The italicized numbers represent percent changes obtained by using the coefficients on the interaction term which are not statistically significant at the 10% level.

Table 1 reports the estimated PRH statistics.[13,14] The fact that most estimates are positive and less than 1 indicates that banks in Latin American and Asian countries seem to operate in a monopolistically competitive environment. Exceptions include India, Korea, and China from Asia and Venezuela from Latin America which are shown to have negative values of the PRH statistics. This implies a potential monopolistic environment or the presence of a structural disequilibrium in their banking markets.[15] China is shown to be an outlier.[16]

Our estimates show that banking industries in Latin America seem to be more competitive than those in Asia. While the sample mean of the PRH statistics estimated using the static revenue equation is 0.379 for Latin American banking, it is only 0.122 for Asian banking. Similarly, while the sample mean for the dynamic panel estimation is 0.704 for Latin America, it is only 0.284 for Asia. Using Monte Carlo simulations, Goddard and Wilson (2009) show that the PRH statistics obtained from a static model of the revenue equation are biased towards zero, while dynamic estimators of the revenue equation provide unbiased statistics. For some countries, like Singapore, Mexico, Paraguay and Uruguay, the PRH is particularly high.[17]

Our results are consistent with those reported by previous studies that have found banking competition in developing countries to be high, and sometimes higher than in some developed countries (see, for example, Gelós and Roldós, 2004; Yuan, 2006; Yildirim and Philippatos, 2007; Bikker and Spierdijk, 2008; Bikker et al., 2009).

In the second step we estimate the bank lending channel equation (2) using two-stage least squares (TSLS) to instrument the bank characteristics that might be endogenously determined with loan growth – namely banks' size, and their degrees of liquidity and capitalization. For the banking competition measure we use the two alternative estimates from step 1, the static FE estimator from Eq. (1a) and the dynamic GMM estimator from Eq. (1b). Table 2a reports these estimation results. Estimation results using the two alternative PRH statistics are consistent. The coefficient on the measure of the stance of monetary policy is negative as expected, which implies that the growth rate of loans falls when a country's central bank tightens its monetary policy. However, the coefficient on the interaction term of monetary policy and banking competition, $mp * \text{PRH}$, is positive and statistically significant, which suggests that banking market competition weakens the transmission of monetary policy through the bank lending channel.[18] The coefficients on the three variables measuring the strength of banks' balance sheets show that loan growth varies across banks of different sizes and different degrees of liquidity and capitalization. The growth rate of loans is larger for smaller and more highly capitalized banks. As expected, the coefficient on the GDP growth rate is positive and statistically significant, indicating that the growth rate of bank loans is larger in a growing economy where the demand for loans is rising.

We then compute the percentage point change in loan growth as a result of a one percentage point increase in the stance of monetary policy, under various alternative levels of banking competition as measured by the PRH statistics. This percentage point change is calculated as $(\delta + \phi * \text{PRH})$ and reported in Table 2b. These results show that an increase in interest rates always has a negative impact on bank lending, and that the real effects of monetary policy are diminished as competition in banking increases. Depending on the specification, we find that when the degree of competition in banking is at the sample mean level, the growth rate of bank lending falls by 0.765–0.803 percentage points after a one percentage point increase in the monetary policy indicator. Loan growth falls more, by 0.772–0.876 percentage points, in a less competitive banking system, where banking competition is at the lowest 25th percentile of the PRH distribution, while it falls by only 0.342–0.592 percentage points under a more competitive banking system as measured by the PRH at the highest 75th percentile. This provides evidence that stronger competition in the banking sector weakens the transmission of monetary policy through the bank lending channel.

[13] Due to the lack of available and reliable data on personnel expenses of individual banks in several countries, we estimate the PRH statistics as the sum of two elasticities, β_1 and β_2, and do not use β_3, the elasticity of revenue with respect to personnel expenses, for the whole sample. In fact, for many countries, β_3 is small and/or statistically insignificant. To maintain consistency across countries, we do not include β_3 in the PRH estimation even for the countries for which the personnel expense data are available. A good example for this is Japan. Accordingly, our estimated value of the PRH for Japan is significantly smaller than the PRH statistics reported in the literature. However, the banking market in Japan in earlier years was defined as perfect collusion with the PRH value close to 0 (Lloyd-Williams et al., 1991; Molyneux et al., 1996).

[14] Knowing that the confidence interval for each individual parameter in Eq. (1a) is different from that of the PRH statistic, which is a linear combination of the β parameters, we report both statistically significant and non-significant PRH statistics, and we use both in the second step estimations.

[15] Bikker et al. (2009) argue that a negative value of PRH statistic does not necessarily indicate monopoly by proving that when a revenue equation without a scale variable (i.e., total assets) in the explanatory variables set is used for estimation, even competitive firms can exhibit PRH < 0 if the market is in structural disequilibrium in the short run, i.e., if entry or exit is induced by current market conditions. Accordingly, additional information on long-run structural equilibrium and cost structure is needed in order to be able to discern the reasons for a negative value of the PRH statistic.

[16] In Section 4 we examine whether our main findings are affected by the exclusion of China from the sample.

[17] Uruguay has the largest PRH statistic value according to our static panel FE estimation. The highly competitive nature of the Uruguayan banking system is well known in the region. In fact, Uruguay has been dubbed the "Switzerland of Latin America" due to its highly competitive and stable banking sector. Thus, there are several reasons to expect a high value for the estimated PRH statistic: (1) even though Uruguay is a small country with a population of only around 3 million, there are more than 20 private banks; (2) most of these banks are branches of international banks, and can therefore draw upon support from large parent-banks abroad; (3) there is also a large number of brokers and financial services bureaus that compete with the commercial banks; (4) the banking sector is highly liquid; (5) off-shore banking has seen an increased importance lately; (6) risk aversion and liquidity considerations encourage banks to lend primarily within the financial sector; (7) most of the supply of bank loans is focused on short-maturity loans, which significantly limits the risk that these banks face; and (8) financial intermediation is highly dollarized in Uruguay (90% of deposits are foreign-currency denominated).

[18] The PRH term is not included in the regressions when the PRH statistics obtained from the panel FE and GMM are used as an independent variable. The reason is that in each country they are constant for the whole period and therefore, perfectly collinear with the country dummies.

Table 4a
Estimation results of the loan growth equation for heterogeneous bank types.

Dependent variable: Δln(loans)	Small banks		Low liquidity banks		Low capitalization banks	
	(1) Static PRH	(2) Dynamic PRH	(3) Static PRH	(4) Dynamic PRH	(5) Static PRH	(6) Dynamic PRH
mp	−0.930***	−0.898**	−0.801***	−1.099***	−0.825**	−0.833***
	(0.356)	(0.368)	(0.292)	(0.299)	(0.328)	(0.311)
mp ∗ PRH	0.928**	0.792*	−0.962**	−0.217	0.710*	0.617*
	(0.439)	(0.413)	(0.465)	(0.341)	(0.414)	(0.336)
Δln(GDP)	174.0***	177.8***	117.5***	106.6***	87.03***	89.80***
	(35.05)	(34.51)	(29.35)	(29.16)	(27.87)	(26.95)
Size	−30.40***	−28.41***	−23.10***	−24.29***	−21.26***	−20.06***
	(6.063)	(6.334)	(4.114)	(4.408)	(4.586)	(4.661)
Liquidity	−0.474***	−0.474***	−0.413**	−0.421**	−0.058	−0.055
	(0.129)	(0.127)	(0.203)	(0.204)	(0.110)	(0.108)
Capitalization	4.056***	4.038***	4.657***	4.638***	18.87***	18.33***
	(0.548)	(0.541)	(0.548)	(0.549)	(4.735)	(4.584)
Crisis dummy	−0.564	0.198	−0.100	−0.298	−0.061	0.561
	(3.171)	(3.216)	(2.689)	(2.771)	(2.450)	(2.430)
Constant	−8.025	−13.84	16.83	22.07*	−57.37*	−59.86**
	(10.68)	(11.41)	(12.00)	(13.09)	(30.60)	(30.36)
Observations	1977	1977	2001	2001	2047	2047

Notes: The whole sample is divided into two groups in each category by the median levels of size, liquidity, and capitalization in each country and year. TSLS is used for estimation. The results in columns (1), (3) and (5) use the PRH statistics estimated by applying the static FE estimator to Eq. (1a), and those in (2), (4) and (6) use the PRH statistics estimated by applying the dynamic GMM estimator to Eq. (1b). The numbers in parentheses denote standard errors of the coefficients.
* The statistical significance at the 10% level.
** The statistical significance at the 5% level.
*** The statistical significance at the 1% level.

Table 4b
Percentage changes in lending as a result of a one percentage point increase in the stance of monetary policy for banks of small size, low liquidity, and low capitalization.

	PRH values		Percentage changes in bank lending					
			Small banks (%)		Low liquidity banks (%)		Low capitalization banks (%)	
	Static PRH	Dynamic PRH	(1)	(2)	(3)	(4)	(5)	(6)
Mean value PRH	0.212	0.094	−0.734	−0.824	−1.005	*−1.119*	−0.675	−0.775
25th percentile PRH	0.055	0.153	−0.879	−0.777	−0.854	*−1.132*	−0.786	−0.739
50th percentile PRH	0.151	0.303	−0.789	−0.658	−0.947	*−1.165*	−0.717	−0.646
75th percentile PRH	0.458	0.952	−0.505	−0.144	−1.241	*−1.306*	−0.500	−0.246

Notes: 'Static PRH' contains the PRH statistics estimated by applying the static FE estimator to Eq. (1a), and 'Dynamic PRH' contains the PRH statistics estimated by applying the dynamic GMM estimator to Eq. (1b). The results in columns (1), (3) and (5) use the PRH statistic values of column 1, and those in (2), (4) and (6) use the PRH dynamic values of column 2. Alternative values of the PRH are taken from their distribution. Percentage changes in bank lending are calculated as $(\delta + \varphi * \text{PRH})$. The italicized numbers represent percent changes obtained by using the coefficients on the interaction term which are not statistically significant at the 10% level.

To examine whether the relationship between banking competition and the strength of monetary policy transmission varies across regions, we next divide the entire data set into two subsamples: Asia and Latin America. The results for these two subsamples are reported in Tables 3a and 3b. Most coefficients reported in Table 3a, especially those on monetary policy and the interaction term are shown to be statistically significant in Latin American countries. However, the coefficient on the interaction term for Asia shows mixed results. In Asia, the coefficient on the interaction term is positive and statistically significant when the static PRH is used, while it is not statistically significant when the dynamic PRH is used. We can infer that banking competition makes the monetary policy transmission mechanism weaker in Latin America, while yielding mixed results for Asia where competition in the banking industry seems to play a weaker role in the transmission mechanism of monetary policy.[19]

There are several possible reasons for these mixed results in the Asian sample. First, as evident from the results in Table 1, banking competition in Asia is lower than in Latin America during our sample period. Second, the cross-country variation in the degree of banking competition seems to be higher in Asia than in Latin America. Third, several Asian countries in our sample use a variety of monetary policy instruments, and operate several monetary policy targets other than interest rate targets.[20] Later we conduct robustness tests to examine whether a possible outlier effect of specific countries in Asia (namely, China and Japan), or the use of alternative measures of the monetary policy indicator affect our main results.

Table 3b shows that banks in Latin America curtail their lending in response to contractionary monetary policy shocks. When monetary policy is tightened through a one percentage point increase in the interest rate, the growth rate of lending for Latin American banks falls by 0.426–0.758 percentage points on average. In Latin America, more competition is shown to lead to a smaller reduction in lending in response to a monetary policy tightening.

[19] The lack of clear evidence for a significant relationship between competition in banking and the effectiveness of monetary policy in Asia is further confirmed in the various robustness tests later performed in Section 4.

[20] For more detailed information on monetary policy targets and instruments in the Asian countries, see Footnote 11 and De Facto Exchange Rate Arrangements and Anchors of Monetary Policy, which is available at http://www.imf.org/external/np/mfd/er/2004/eng/1204.htm#table, and Information System for Instruments of Monetary Policy Database, IMF.

To investigate whether the relationship between banking competition and the transmission of monetary policy changes across heterogeneous banks, we next split the data into two subsamples by each category of bank-specific characteristics, namely size, liquidity, and capitalization. We split the data for each category using their country median level, that is, banks of a size below the country's median are included in the small banks subsample; and banks with a degree of liquidity (capitalization) below their country's median are included in the low liquidity (capitalization) banks subsample. The subsample regression results reported in Table 4a show statistically significant coefficients on both the monetary policy indicator and the interaction variable for the groups of small and low capitalization banks. The interaction term for low liquidity banks is shown to have an unexpected negative or statistically insignificant coefficient.

As reported in Table 4b, overall, the monetary policy transmission mechanism is shown to be affected by the different characteristics of individual banks, which is an important property of the bank lending channel. These results show that as competition in the banking sector increases, monetary policy transmission through the bank lending channel decreases, and that this works particularly through the effects on smaller and less capitalized banks. This is consistent with the predictions of the bank lending channel – banks that are more financially constrained find it more difficult to fully substitute with alternative sources of funding the loanable funds lost due to a tightening of monetary policy. As a result, these banks need to cut their loan supply more than other types of banks in response to a monetary policy tightening.

4. Robustness tests

In this section we conduct various tests to examine whether our main findings are robust to the use of an alternative time-varying measure of the PRH statistic, an alternative indicator of the stance of monetary policy, and the removal of China or Japan from the Asian sample.

Our first robustness check involves using an alternative measure of the PRH statistic. We re-estimated the PRH statistics by allowing for the measure of competition to change over time.[21] To this end, we divide the overall sample period into three sub-periods – 1997–1999, 2000–2002, and 2003–2005.[22] Since some countries have a limited number of observations each year, the 3-year term estimation helps to alleviate concerns related to small sample bias, while introducing a time-varying property to the panel estimator of the PRH statistic.

Table 5 reports the estimated values of the PRH statistics using the static FE estimation for each country for each of the 3-year terms. Overall, these results seem to be consistent with the PRH statistics using the static panel FE estimation and dynamic panel GMM estimation which were reported and discussed earlier. The average value of the PRH statistics is higher for Latin American countries (0.537) than for Asian countries (0.361), implying that the level of banking competition is higher in Latin America than in Asia. We then re-estimate the loan growth equation using the time-varying, 3-year term estimation of the PRH statistics as a measure of banking competition. The estimation results are reported in Tables 6a and 6b. The coefficients on monetary policy are negative and statistically significant and those for the interaction term, with the exception of Asia, are positive and statistically significant. These results are consistent with those from our benchmark specification, reported in Tables 2 to 4. Our earlier finding that with the exception of Asia, increasing competition in the banking sector weakens the monetary policy transmission in all subsamples does not change when this alternative time-varying measure of banking competition is used. This is true, especially for banks of smaller size, lower liquidity, and lower capitalization. The negative and statistically significant coefficient on the PRH term reveals an interesting finding, i.e., that the more competitive the banking sector, the slower growth in bank lending.

Our next exercise is to study whether or not using an alternative monetary policy indicator affects our main findings. As discussed earlier, using changes in short-term interest rates (the Treasury bill rate and the money market rate) as an indicator of changes in the stance of monetary policy may be subject to two main limitations.

Table 5
An alternative measure of Panzar and Rosse H (PRH) statistics: the time-varying 3-year term estimation.*

	1997–1999	2000–2002	2003–2005	Average
Asian countries				
China	0.283	0.124	0.565	0.324
	(0.002)	(0.345)	(0.000)	
Hong Kong	0.631	0.423	0.471	0.508
	(0.056)	(0.053)	(0.000)	
India	−0.265	0.319	0.077	0.044
	(0.369)	(0.046)	(0.610)	
Indonesia	0.662	0.374	0.350	0.462
	(0.001)	(0.161)	(0.000)	
Japan	0.293	0.155	0.160	0.203
	(0.000)	(0.000)	(0.000)	
Korea	0.349	0.065	−0.423	−0.003
	(0.166)	(0.656)	(0.017)	
Malaysia	0.368	0.439	0.516	0.441
	(0.001)	(0.002)	(0.006)	
Philippines	0.522	0.310	1.010	0.614
	(0.001)	(0.209)	(0.001)	
Singapore	0.353	0.862	0.804	0.673
	(0.110)	(0.001)	(0.001)	
Thailand	0.718	0.198	0.130	0.349
	(0.000)	(0.176)	(0.483)	
Average Asia	0.391	0.327	0.366	0.361
Latin American countries				
Argentina	0.558	0.584	0.036	0.393
	(0.000)	(0.000)	(0.624)	
Bolivia	−1.077	0.667	0.877	0.156
	(0.385)	(0.015)	(0.002)	
Brazil	0.586	0.498	0.197	0.427
	(0.000)	(0.000)	(0.186)	
Chile	0.412	0.256	0.884	0.517
	(0.000)	(0.001)	(0.001)	
Colombia	0.860	0.200	0.045	0.368
	(0.000)	(0.222)	(0.943)	
Mexico	1.262	0.276	1.306	0.948
	(0.000)	(0.001)	(0.000)	
Paraguay	0.782	0.984	0.674	0.813
	(0.000)	(0.002)	(0.000)	
Peru	−0.085	0.358	0.040	0.104
	(0.834)	(0.060)	(0.937)	
Uruguay	1.068	0.914	0.931	0.971
	(0.049)	(0.000)	(0.002)	
Venezuela	1.219	0.388	0.412	0.673
	(0.000)	(0.015)	(0.033)	
Average Latin America	0.559	0.513	0.540	0.537

* The static FE estimator is applied to estimate the PRH statistic for each of the three 3-year terms. The numbers in parentheses are *p*-values of the PRH statistics.

[21] While introducing a time-varying property to the PRH measures, some disadvantages of this alternative measure of PRH statistics include possible small sample bias and a lack of full dynamic specification.

[22] This division of the whole sample period into three sub-periods takes into account the different timing of financial crises during our sample period. The first sub-period, 1997–1999, reflects the Asian financial crisis, while the second sub-period, 2000-2002, reflects the financial crises in several Latin American countries. The 2001–2002 crisis in Argentina severely hurt its neighboring countries including Paraguay, Uruguay, and Peru. We also estimate the PRH statistics for each year and country as well as for 2-year terms, subject to small sample bias limitations. The estimation results are available upon request. Yildirim and Philippatos (2007) estimate the PRH statistics in each year as well as for 4-year terms (1993–1996 and 1997–2000) for each of 11 Latin American countries.

Table 6a
Estimation results of the loan growth equation using the time-varying 3-year term PRH statistics as an alternative measure of competition in banking.

Dependent variable: Δln(loans)	Whole sample	Region		Bank characteristics		
		Latin America	Asia	Small banks	Low liquidity banks	Low capitalization banks
	(1)	(2)	(3)	(4)	(5)	(6)
mp	−1.513***	−1.679***	−1.157**	−1.189**	−2.985***	−1.825***
	(0.269)	(0.452)	(0.543)	(0.527)	(0.464)	(0.482)
PRH (time-varying)	−17.65***	−16.24**	−12.74*	−23.02***	−23.72***	−11.80*
	(4.096)	(7.410)	(6.716)	(8.091)	(7.655)	(6.843)
mp*PRH (time-varying)	1.379***	1.440***	−0.089	1.160*	2.496***	1.839***
	(0.321)	(0.521)	(0.910)	(0.621)	(0.583)	(0.565)
Δln(GDP)	127.4***	93.80**	156.1***	174.8***	106.9***	93.53***
	(17.42)	(36.62)	(15.41)	(34.16)	(28.72)	(26.98)
Size	−18.37***	−22.40***	−16.56***	−30.20***	−26.53***	−22.62***
	(2.802)	(4.799)	(3.646)	(6.234)	(4.336)	(4.850)
Liquidity	−0.341***	−0.203*	−0.456***	−0.493***	−0.430**	−0.021
	(0.067)	(0.114)	(0.085)	(0.127)	(0.202)	(0.114)
Capitalization	2.888***	3.318***	1.662***	3.908***	4.349***	18.78***
	(0.309)	(0.526)	(0.343)	(0.529)	(0.534)	(4.716)
Crisis dummy	2.246	7.438*	−0.262	0.857	1.533	0.681
	(1.666)	(3.825)	(1.361)	(3.187)	(2.713)	(2.481)
Constant	33.83***	12.10	53.42***	1.794	42.80***	−48.00
	(7.716)	(12.65)	(12.20)	(11.49)	(13.24)	(30.58)
Observations	4170	1812	2358	1977	2001	2047

Notes: In these estimations, the time-varying PRH statistics for 3-year terms (1997–1999, 2000–2002, 2003–2005) reported in Table 5 are used as an alternative indicator of banking competition. TSLS is used for estimation. For the results presented in columns (4), (5) and (6), the whole sample is divided into two groups in each category by the median levels of size, liquidity, and capitalization in each country and year. The numbers in parentheses denote standard errors of the coefficients.
* The statistical significance at the 10% level.
** The statistical significance at the 5% level.
*** The statistical significance at the 1% level.

Table 6b
Percentage changes in lending as a result of a one percentage point increase in the stance of monetary policy when competition is measured by a time-varying PRH statistic.

	PRH values			Whole sample (%)	Region		Bank characteristics		
	Whole sample	Latin America	Asia		Latin America (%)	Asia (%)	Small banks (%)	Low liquidity banks (%)	Low capitalization banks (%)
				(1)	(2)	(3)	(4)	(5)	(6)
Mean value PRH	0.415	0.521	0.321	−0.941	−0.928	*−1.186*	−0.708	−1.950	−1.062
25th percentile PRH	0.197	0.200	0.156	−1.241	−1.390	*−1.171*	−0.960	−2.493	−1.463
50th percentile PRH	0.374	0.499	0.310	−0.997	−0.961	*−1.185*	−0.755	−2.051	−1.137
75th percentile PRH	0.584	0.667	0.439	−0.707	−0.719	*−1.196*	−0.511	−1.527	−0.750

Notes: Alternative values for the PRH are taken from their distribution. Percentage changes in bank lending are calculated as $(\delta + \varphi * \text{PRH})$. The italicized numbers represent percent changes obtained by using the coefficients on monetary policy and its interaction with PRH which are not statistically significant at the 10% level.

First, if interest rates are influenced by changes in other macroeconomic variables, including the rate of GDP growth, then the effects of monetary policy may be overestimated by approximating the measure of the stance of monetary policy with short-term interest rates. Second, various different forms of monetary policy targeting and instruments are used across countries and years (see Footnote 11). To address these concerns, we follow Gunji et al. (2009) and, instead of using short-term interest rates, we use a modified measure of monetary policy by eliminating the variation in other macroeconomic variables from changes in the nominal interest rate. The measure of the stance of monetary policy is the residuals of the interest rate equation in a vector autoregressive (VAR) model. [23] This approach allows us to obtain a more accurate measure of monetary policy since it only keeps the changes in interest rates that are driven by exogenous monetary policy shocks. This VAR model-based monetary policy shock is expected to reflect changes in the monetary policy stance in a country where non-interest rate targets are used in the design of monetary policy.

Following the methodology in Gunji et al. (2009), for each country in our sample, we build a 6-variable VAR model which consists of the short-term interest rate, the log of bank lending, the log of the monetary base, the log of the price level, the log of aggregate output and the rate of exchange rate depreciation.[24] We follow the assumption adopted in Gunji et al. that the monetary authority adjusts the interest rate, based on contemporaneous output and prices.[25] We use quarterly data for the period 1996–2006 obtained from the *International Financial Statistics* of the IMF. We sum the residuals of the interest rate equation for the four quarters in each year and use them as an alternative annual indicator of monetary policy shocks. We report the results of this exercise in Tables 7a and 7b. These results are consistent with those reported and discussed earlier. Our main finding that increasing competition in the banking sector weakens monetary policy transmission is robust to the use of this alternative VAR-based measure of monetary policy.

[23] Empirical studies using this VAR methodology to obtain a measure of the stance of monetary policy for countries other than the US include Sims (1992), Bernanke and Mihov (1998), Kim (1999), and Gunji et al. (2009), among others.

[24] The variables are specified in levels following the findings in Sims et al. (1990) that even if some variables in a VAR have unit roots, the estimates are still consistent.

[25] We use four lags in the VAR model which is consistent with the quarterly frequency of the data. Additional lags do not add much information.

Table 7a
Estimation results of the loan growth equation using the VAR model-based, alternative indicator of the stance of monetary policy.

Dependent variable: Δln(loans)	Whole sample	Region		Bank characteristics		
		Latin America	Asia	Small banks	Low liquidity banks	Low capitalization banks
	(1)	(2)	(3)	(4)	(5)	(6)
mp (VAR model-based)	−0.731***	−0.826***	0.268	−0.713**	−0.872***	−1.230***
	(0.156)	(0.228)	(0.564)	(0.297)	(0.227)	(0.262)
mp (VAR)∗PRH	0.598***	0.663***	−3.335	0.824***	0.574**	0.597**
	(0.147)	(0.215)	(2.082)	(0.312)	(0.235)	(0.243)
Δln(GDP)	165.1***	165.0***	174.5***	215.4***	170.7***	104.4***
	(16.57)	(32.79)	(14.95)	(32.32)	(27.22)	(25.16)
Size	−15.13***	−19.84***	−10.73***	−27.77***	−18.04***	−19.43***
	(2.948)	(4.804)	(3.374)	(6.797)	(4.572)	(4.637)
Liquidity	−0.337***	−0.240**	−0.402***	−0.513***	−0.441**	−0.0683
	(0.064)	(0.106)	(0.082)	(0.125)	(0.203)	(0.101)
Capitalization	3.055***	3.448***	1.688***	4.065***	4.778***	16.74***
	(0.318)	(0.541)	(0.332)	(0.549)	(0.555)	(4.328)
Crisis dummy	1.220	5.924	−1.347	−0.682	0.414	0.424
	(1.654)	(3.835)	(1.333)	(3.163)	(2.699)	(2.318)
Constant	9.589	−15.70	27.49***	−17.18	−6.760	−54.37*
	(8.037)	(13.61)	(9.553)	(11.91)	(13.93)	(28.78)
Observations	4140	1812	2328	1973	2001	2041

Notes: TSLS is used for estimation. '*mp* (VAR model-based)' denotes the monetary policy indicator which is measured as the residuals in the interest rate equation of a VAR model. The PRH measure used in this case is the dynamic GMM estimator a la Arellano and Bond (1991). For the results in columns (4), (5) and (6), the whole sample is divided into two groups in each category by the median levels of size, liquidity, and capitalization in each country and year. The numbers in parentheses denote standard errors of the coefficients.

* The statistical significance at the 10% level.

** The statistical significance at the 5% level.

*** The statistical significance at the 1% level.

Table 7b
Percentage changes in lending as a result of a one percentage point increase in the stance of monetary policy measured using the VAR model-based, alternative indicator.

	PRH values			Whole sample (%)	Region		Bank characteristics		
	Whole sample	Latin America	Asia		Latin America (%)	Asia (%)	Small banks (%)	Low liquidity banks (%)	Low capitalization banks (%)
				(1)	(2)	(3)	(4)	(5)	(6)
Mean value PRH	0.094	0.974	−0.684	−0.675	−0.180	*2.549*	−0.636	−0.818	−1.174
25th percentile PRH	0.153	0.303	0.153	−0.640	−0.625	*−0.242*	−0.587	−0.784	−1.139
50th percentile PRH	0.303	0.952	0.183	−0.550	−0.195	*−0.342*	−0.463	−0.698	−1.049
75th percentile PRH	0.952	2.093	0.351	−0.162	0.562	*−0.903*	0.071	−0.326	−0.662

Notes: Alternative values of PRH are taken from their distribution. Percentage changes in bank lending are calculated as $(\delta + \varphi * \text{PRH})$. The italicized numbers represent percent changes obtained using the coefficients on monetary policy and its interaction with PRH which are not statistically significant at the 10% level.

Finally, our last robustness exercise is to check the consistency of our results to the inclusion in the sample of China, with the well-known particular competitive structure of its banking sector.[26] We also examine a subsample excluding Japan.[27] Japanese banks account for about 37% of the sample of Asian banks, and Japan's per capita income is high, relative to the other countries in our sample. The monetary authority in Japan conducted an aggressive expansionary policy by maintaining the interest rate at the zero lower bound during our entire sample period. The estimation results by excluding China or Japan from the analysis show that the "China factor" or the "Japan factor" does not change the main findings of our paper, namely that competition in banking makes the monetary policy transmission mechanism through the bank lending channel weaker, and that this result is stronger in Latin America than in Asia.[28] This is true especially for banks smaller in size, and of low liquidity and low capitalization.

[26] Notice that we were not able to get a significant estimate of the static PRH for China, the estimate for the dynamic PRH is well below 0 (see Table 1), and the time-varying 3-year term estimates are significantly volatile (see Table 5).

[27] We thank the referee for the suggestion to examine a possible "Japan factor".

[28] The estimation results without China or Japan are not reported here to save space. They are available from the authors upon request.

5. Conclusion

In this paper we use bank-level balance sheet and income statement data to assess how changes in competition in the banking industry affect the transmission of monetary policy through the bank lending channel in twenty Latin American and Asian countries during the period from 1996 to 2006. We apply a two-step estimation procedure: In the first step we estimate PRH statistics to measure the degree of competition in banking; in the second step we estimate a loan growth equation where the estimated PRH statistics and their interaction with the monetary policy indicator are used as explanatory variables.

With a specific focus on the bank lending channel, we find consistent evidence that banking competition is inversely related to the effectiveness of monetary policy. This is especially true for banks of smaller size, lower liquidity, and lower capitalization. The validity of these main findings is assured based on various robustness checks. We also find that the banking sectors in Latin America and Asia are characterized as monopolistically competitive, and that overall, banking competition is higher in Latin America than in Asia. An increased level of competition in Latin American banking sectors is shown to reduce the effectiveness of

monetary policy transmission in the region. While banking competition can have positive implications for the banking sector, our results do show that it also has negative implications for the effectiveness of monetary policy transmission through the bank lending channel.

An important contribution of our work is that we focus on the relationship between the effectiveness of the monetary policy transmission mechanism and a broad measure of competition in banking, with a specific focus on the bank lending channel in emerging economies in Asia and Latin America. Doing so, we contribute to the previous literature that has focused only on the effects of market concentration, a rather narrow measure of competition. This contribution of focusing on a broader measure, which is obtained using correct specifications, is especially relevant in the case of the banking industry for which, unlike other industries, it has been shown that the relationship between concentration and competition is ambiguous.

From a policy perspective, our results present a pressing need for a closer monitoring of developments regarding competition and market structure in the banking sectors of emerging markets. Specific developments in the emerging market banking industry in recent years include increased financial integration and internationalization, an important wave of mergers and acquisitions that has significantly increased consolidation, privatization efforts, the increased presence of foreign banks, the removal of entry barriers, and widespread financial and banking reforms among others. These developments have directly affected the competitive structure of the industry. Therefore, based on our results, we expect an important impact of changes in banking competition on the monetary policy transmission mechanism. In particular, our results unveil the importance of the need for proper regulatory measures that can offset the negative effects of further increases in banking competition on the effectiveness of the monetary policy transmission mechanism in the global banking sector. This is particularly true in the context of the recent world financial turmoil and coordinated international efforts towards financial and banking reform.

Appendix A

See Tables A1 and A2.

Table A2
Data summary statistics. Source: *BankScope* from *Bureau van Dijk* and *IBCA* and *International Financial Statistics* of the IMF.

Variable	Obs.	Mean	Std. dev.	Min.	Max.
Data for step 1: Estimation of PRH statistics					
Interest income/total assets	5802	0.124	0.189	0.000	0.831
Interest expenses/total assets	5770	0.077	0.173	0.000	0.500
(administrative + operating expenses)/total assets	3219	0.027	0.041	0.000	0.278
Capitalization (equity/total assets, %)	5954	13.429	14.801	1.160	99.030
Net loans/total assets (%)	5878	51.803	19.843	0.000	99.970
Data for step 2: Estimation of loan growth equation					
Δln(loans)	5973	5.738	44.062	−538.442	396.648
mp	220	10.024	9.832	0.100	86.098
Δln(GDP)	220	0.036	0.049	−0.130	0.232
Size (relative size measure, Eq. (3))	5935	2.077	2.125	−3.180	9.847
Liquidity (liquid assets/total assets, %)	5933	34.255	24.469	0.227	98.312

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Table A1
Number of bank-year observations in each country: based on bank loans data. Source: *BankScope* from *Bureau van Dijk* and *IBCA*.

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Total
Argentina	82	70	65	65	60	62	46	59	50	49	43	651
Bolivia	13	8	11	8	10	9	9	8	8	8	6	98
Brazil	110	84	104	93	90	89	93	77	71	61	53	925
Chile	27	25	24	24	24	23	19	19	19	19	21	244
China	14	11	16	19	23	19	22	37	39	48	50	298
Colombia	26	26	18	18	18	20	22	24	22	16	12	222
Hong Kong	28	15	17	21	16	17	17	15	25	8	6	185
India	53	51	50	53	53	50	52	48	51	50	41	552
Indonesia	63	37	21	36	38	35	37	33	34	38	33	405
Japan	123	115	125	131	130	127	122	120	118	115	116	1342
Korea	28	26	12	20	18	16	15	12	14	14	14	189
Malaysia	33	30	25	26	18	23	23	23	20	21	19	261
Mexico	29	22	26	32	28	25	26	22	23	10	8	251
Paraguay	10	3	6	9	7	26	11	8	8	4	2	94
Peru	20	9	10	16	22	21	16	16	14	9	6	159
Philippines	19	11	10	16	8	9	11	12	23	12	6	137
Singapore	12	8	7	6	9	5	4	3	7	6	2	69
Thailand	18	12	13	16	16	17	17	16	17	16	17	175
Uruguay	10	3	9	5	8	29	42	36	38	13	6	199
Venezuela	17	15	20	21	33	29	26	27	27	19	17	251
Total	735	581	589	635	629	651	630	615	628	536	478	6707

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