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Mortgage Lending and Financial Stability in Asia

Peter J. Morgan and
Yan Zhang

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Peter Morgan is Senior Consultant for Research at the Asian Development Bank Institute (ADBI). Yan Zhang is a research associate at ADBI.

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Please contact the authors for information about this paper.

E-mail: pmorgan@adbi.org, yanzhang@adbi.org

Asian Development Bank Institute
Kasumigaseki Building 8F
3-2-5 Kasumigaseki, Chiyoda-ku
Tokyo 100-6008, Japan

Tel: +81-3-3593-5500
Fax: +81-3-3593-5571
URL: www.adbi.org
E-mail: info@adbi.org

Abstract

We estimated the effect of the share of mortgage lending by individual banks (together with some control variables) on two measures of financial stability—the bank Z-score and the nonperforming loan ratio—for a sample of 212 banks in 19 emerging Asian economies for 2007–2013 from the Bankscope database. We find some evidence that an increased share of mortgage lending is positive for financial stability, specifically by lowering the probability of default by financial institutions and reducing the nonperforming loan ratio, at least in noncrisis periods, for levels of mortgage shares up to 30%–40%. For higher levels of mortgage lending shares, the impact on financial stability turns negative. We also find that the share of mortgage lending can be a useful measure of both financial development and financial inclusion.

This finding most likely reflects the effect of a higher share of mortgage lending in diversifying the mix of banks' assets and, thereby, reducing overall risk. However, if the share of mortgage lending is too high, then the diversification effect diminishes. Therefore, the challenge is to balance the expected improvement in financial stability due to asset diversification against negative impacts that might result from easier lending standards or overly rapid increases in mortgage lending that could trigger a bubble in the housing market. This highlights the need for prudent monetary policy and macroprudential policy measures to forestall the development of such bubbles.

JEL Classification: G21, O16, R3

Contents

1. INTRODUCTION

Domestic banking crises often originate in the real estate sector, as shown, among others, by Reinhart and Rogoff (2009) and Bordo and Jeanne (2012). Therefore, one might conclude that mortgage lending is negative for financial stability. However, in normal (noncrisis) periods, mortgage lending may actually contribute to financial stability. This is because mortgage loans have different risk properties from other bank assets, e.g., commercial loans, so having some share of mortgage loans in a bank's portfolio tends to diversify the risk of that portfolio. Also, because individual mortgage loans are small, they do not contribute much to systemic risk, except in periods of real estate bubbles (IMF 2006). In addition, increased mortgage lending can be considered a form of financial inclusion, in the sense that a greater number of mortgage loans reflects greater access by households to the formal financial system. For example, Morgan and Pontines (2014) have found some evidence from a cross-country panel data set that an increased share of lending to small and medium-sized enterprises (SMEs) can be positive for some measures of financial stability. An increased share of lending for mortgages may operate in a similar way. Thus, mortgage lending could be an important mechanism for increasing financial development, financial stability, and financial inclusion in emerging economies at the same time, providing that the development of housing price bubbles can be avoided.

In this paper, we estimate the effect of the share of mortgage lending in total loans by individual banks (together with some control variables) on two measures of financial stability—the bank Z-score and the nonperforming loan (NPL) ratio. Our sample comprises 212 banks in 19 emerging Asian economies. We focus on mortgage lending for two reasons: its importance in overall household credit (averaging about 54% of total household credit in major Asian emerging economies, according to IMF [2011]); and the fact that it is the only variable in the Bankscope database on banks that is related to financial inclusion. We find some evidence that an increased share of mortgage lending aids financial stability, mainly by lowering the probability of default by financial institutions and reducing the NPL ratio, at least for mortgage lending shares up to 30%–40% of the total. The main contribution of our paper is that few studies have examined the relationship between the mortgage lending share and financial stability, despite the importance of real estate lending in many financial systems. Even fewer studies have examined this relationship at the bank level.

Section 2 of this paper examines the definitions of financial stability and describes possible channels for interactions between mortgage lending and financial stability. Section 3 surveys the previous literature in this area. Section 4 describes the data on financial stability and mortgage lending that are used in this study, together with some stylized facts on the relationship between financial stability and mortgage lending. Section 5 describes the econometric model that is used in this paper, followed by the empirical results. Section 6 briefly explains our robustness checks on the results obtained. Section 7 concludes.

2. FINANCIAL STABILITY AND MORTGAGE LENDING

This section provides some definitions of financial stability and discusses the channels by which increases in mortgage lending might affect financial stability.

2.1 Definitions of Financial Stability

The global financial crisis of 2007–2009 heightened awareness of financial stability and the need for a macroprudential dimension to financial surveillance and regulation. Nonetheless, there is no generally agreed definition of financial stability, because financial systems are complex with multiple dimensions, institutions, products, and markets. Indeed, it is easier to describe financial instability than stability. The European Central Bank (ECB) website defines financial stability as:

> … a condition in which the financial system—comprising of financial intermediaries, markets and market infrastructures—is capable of withstanding shocks, thereby reducing the likelihood of disruptions in the financial intermediation process which are severe enough to significantly impair the allocation of savings to profitable investment opportunities. (ECB 2012)

Further, the ECB defines three particular conditions associated with financial stability:

1. The financial system should be able to efficiently and smoothly transfer resources from savers to investors.
2. Financial risks should be assessed and priced reasonably accurately and should also be relatively well managed.
3. The financial system should be in such a condition that it can comfortably absorb financial and real economic surprises and shocks. (ECB 2012)

Perhaps the third condition is the most important, because the inability to absorb shocks can lead to a downward spiral whereby they are propagated through the system and become self-reinforcing, leading to a general financial crisis and broadly disrupting the financial intermediation mechanism. In this study, we focus on two measures of bank-level stability—the bank Z-score and the NPL ratio. As is described in more detail below, both of these measures provide information on the potential resilience of banks in the face of a financial crisis or other shock.

2.2 Interactions between Mortgage Lending and Financial Stability

We focus on the train of causality from mortgage lending to financial stability. In other words, does an increase in the mortgage loan ratio tend to enhance financial stability? Alternatively, one could ask if an increase in financial stability leads to an increase in the mortgage loan ratio. It is unlikely that an increase in financial stability would lead to a decrease in mortgage lending.

Evidence from the advanced economies suggests that household loans have lower default rates compared with larger corporate loans. Also, relative to losses from corporate loans, those incurred from household loans tend to be smaller and more predictable. Thus, the risk that individual household loans pose to financial stability is lower compared with that of corporate loans. Moreover, a balanced portfolio of household and corporate loans would increase the risk diversification of bank portfolios (IMF 2006). Of course, housing booms (and subsequent busts), and the associated movements in house prices, can lead to financial crises and economic downturns. In such periods, the risk of individual mortgage loans becomes highly correlated with each other, and, hence, entails much greater risk for financial stability.

3. LITERATURE REVIEW

Research on the impacts of housing prices and mortgage lending growth on financial stability has been extensive. Reinhart and Rogoff (2009) show that the six major historical episodes of banking crises in advanced economies since the mid-1970s were all associated with housing price busts. Bordo and Jeanne (2002) find that financial crises are generally triggered when house prices have peaked, or just after they have started falling. Claessens, Kose, and Terrones (2008) have found evidence that recessions associated with credit crunches and house price busts tend to be deeper and longer than other recessions, although their paper uses total credit to the private sector, rather than mortgage credit, in their analysis. Calabria (2013) argues that the uniquely high levels of "dual" leverage in the mortgage finance system in the United States (US) were the primary drivers of the high levels of losses to both households and financial institutions. Gerlach (2012) notes that a sharp fall in property prices can lead to financial instability in many ways, including economic weakness as housing construction slows, triggering financial strains and defaults among property developers, construction companies, and real estate firms; rising unemployment leading to NPLs and defaults among households; and overall weakness leading to a sharp worsening of banks' balance sheets.

The experience of the subprime crisis in the US in 2007–2009 shows the perils to financial stability of increasing financial inclusion by relaxing lending standards and lending terms at the same time. Dell'Ariccia, Igan, and Laeven (2008) have found evidence that lending standards in the US declined more where credit booms were larger, and that there was a mutually reinforcing interaction between housing prices, lending standards, and credit growth. Mian and Sufi (2009) find that the increase in mortgage defaults in the US in 2007 was disproportionately large in districts with a relatively large share of subprime borrowers, and those districts experienced an unprecedented relative growth in mortgage credit.

The IMF (2011) has analyzed the relationship between housing finance and financial stability using a panel data set of 36 advanced and emerging economies from 2004 to 2009. They estimated a two-equation model of inflation-adjusted home price changes and the change in the proportion of NPLs. They find that a 1-percentage-point increase in the ratio of mortgage credit to gross domestic product (GDP) in 2004–2007 was associated with a 0.15-percentage-point increase in NPLs during the global financial crisis period of 2007–2009. However, the overall effect of the change in the mortgage loan ratio on NPLs during 2004–2009 was negative and insignificant. These results suggest that mortgage loans have a negative impact on financial stability during a financial crisis, but the impact for the period as a whole was ambiguous and highlights the importance of distinguishing the effects of mortgage lending in crisis and noncrisis periods. In contrast to our paper, the IMF (2011) uses macro-level data.

However, research on the impacts of the share of mortgage finance in total lending is much scarcer and less conclusive. Cacnio (2014) describes a research project by the South East Asian Central Banks (SEACEN) Research and Training Centre based on 13 country case studies in South Asia and Southeast Asia. Most of the results show that the level of mortgage loans does not pose a risk to financial stability of banks in this region. For example, the study of India (Kumar 2014) uses micro-level data from Indian banks to estimate a regression model of determinants of NPLs as a measure of financial stability. He finds that the change in the share of housing loans in total credit is negatively related with changes in NPLs. The study of Taipei,China (Hsu and Yu 2014) estimates a vector error correction model of the mortgage NPL ratio using quarterly macro-level data, with independent variables including real GDP, real

mortgage loan growth, real housing price, and real interest rate. In the long-term cointegration equation, the coefficient of mortgage loans is positive, but not significant. In the short-run error-correction model, the coefficient for mortgage loan growth is negative and significant, implying that a short-term increase in mortgage loan growth is positive for financial stability.

As mentioned earlier, the risk characteristics of housing loans may be similar to those of SMEs (at least in noncrisis periods), because both are small-scale. In a study of Chilean banks, Adasme, Majnoni, and Uribe (2006) find that the NPLs of small firms have quasi-normal loss distributions, whereas those of large firms have fat-tailed distributions. They note that the quasi-normality of small loans' loss curves means that the occurrence of large and infrequent losses is not a major concern, and therefore that lending processes to this class can be greatly simplified. This implies that the systemic risk of the former group is lower than that of the latter, so that increased loans to SMEs (or mortgage loans) should reduce the overall riskiness of banks' lending portfolios.

4. DATA AND STYLIZED FACTS

4.1 Data

Our data set covers 19 emerging economies in Asia (Bangladesh; People's Republic of China (PRC); Hong Kong, China; Indonesia; India; Kyrgyz Republic; Republic of Korea; Kazakhstan; Sri Lanka; Malaysia; Nepal; Philippines; Pakistan; Singapore; Thailand; Tajikistan; Taipei,China; Uzbekistan; and Viet Nam) and 212 individual banks. The measure of financial inclusion used in the analysis is the share of mortgage loans in total outstanding loans (*mtgr*). The two measures of financial stability in the regression models are the bank Z-score (*z*) and the NPL ratio (*npl*). The data are annual, and the unbalanced panel sample covers the period 2007–2013. Bank-level data were obtained from the Bankscope database.[1] We believe that none of the economies in the sample had housing bubbles or financial crises in this period, so the data sample corresponds to a normal (noncrisis) period. The results may differ if crisis periods are included.

The first measure, bank Z-score, is a widely used indicator of financial stability (e.g., World Bank 2013). It is defined as:

$$(\mathrm{ROA} + \mathrm{equity/assets})/\mathrm{sd}(\mathrm{ROA}), \quad (1)$$

where ROA is average annual return on year-end assets, assets are total year-end assets, and sd(ROA) is the standard deviation of ROA (World Bank 2013:23). The numerator of the Z-score is the total available equity in a given period, i.e., the equity already on the balance sheet plus the current year's profits. Therefore, the Z-score indicates the number of standard deviations that a bank's rate of return on assets can fall in one period before it becomes insolvent, i.e., the size of an annual loss that would be needed to wipe out all existing equity (Roy 1952). Therefore, a higher Z-score signals a lower probability of bank insolvency, because the loss would have to be a higher number of standard deviations to trigger insolvency, and hence implies greater financial stability. We calculated this measure for each bank in our sample set using data obtained from the Bankscope database. The second measure, *npl*, is the ratio of NPLs to total loans. Bank NPLs represent future potential capital losses, so a higher

[1] Bureau van Dijk. Bankscope Database. https://bankscope.bvdinfo.com/version-2015325/home.serv?product=scope2006 (accessed 15 March 2015).

NPL ratio implies potentially lower financial stability. Bank NPLs also come from the Bankscope database.

Bank-level control variables—ratio of liquid assets to the total deposits and short-term funding (*liq*), total assets (*lgast*), ratio of debt to total assets (*la*), and the ratio of operating cost to total income (*ci*)—are taken from the Bankscope database. Income diversity (*ind*) is calculated as 1 minus the absolute value of the ratio of interest income to total operating income. Interest income and total operating income are also from the Bankscope database. Economy-level control variables—real GDP growth rate and the CPI—are from the World Bank's World Development Indicators database.[2]

Table 1 reports the descriptive statistics for all the variables used in the empirical analysis, respectively. As a benchmark, the normal distribution is characterized by a skewness of 0 (symmetry) and kurtosis of 3 (not very fat tails). Against these criteria, *z*, *npl*, *mtgr*, *liq*, and *ci* all show significant signs of both skewness and kurtosis, which suggests that the presence of outliers could be a significant issue in our sample. In these circumstances, the traditional ordinary least squares (OLS) estimator could be biased and inefficient. The correlations among the explanatory variables are quite low, which suggests that multicollinearity is not likely to be an issue in our empirical analysis.

Table 1: Descriptive Statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max	Skewness	Kurtosis
z	1,573	35.74	30.69	–77.16	230.69	2.27	11.24
npl	1,359	4.02	8.45	0.00	89.99	5.23	36.12
mtgr	1,574	17.68	18.43	0.01	100.00	2.21	8.71
liq	1,562	28.84	34.56	0.39	993.07	16.02	406.02
lgast	1,574	16.31	1.93	10.78	21.85	–0.07	3.06
la	1,574	58.33	17.32	0.59	179.88	0.54	7.47
ci	1,566	50.13	26.21	4.93	523.99	7.56	116.79
ind	1,764	36.24	31.29	0.00	99.80	0.26	1.75
gdp	1,331	6.93	3.52	–2.46	15.24	–0.61	3.37
cpi	1,325	5.14	3.50	–0.85	23.12	1.00	4.94

Note: Number of observations is different for each variable because of different number of missing data for each variable.

Source: Authors' calculations.

To test the time series properties of the main variables in our model, we have conducted unit root tests on our three main variables. There are six types of unit root tests often used in panel data analysis literature: (i) Levin–Lin–Chu test (Levin, Lin, and Chu 2002), (ii) Harris–Tzavalis test (Harris and Tzavalis 1999), (iii) Breitung test (Breitung 1999), (iv) Hadri Lagrange multiplier (LM) stationarity test (Hadri 2000), (v) Im–Pesaran–Shin test (Im, Pesaran, and Shin 2003), and (vi) Fisher-type tests (Maddala and Wu 1999). However, the first four types of tests require the data to be strongly balanced and the Im–Pesaran–Shin test requires strongly balanced data or a time dimension of longer than nine periods. Unfortunately, our data set is not balanced and only spans 7 years at most. Therefore, we test for unit roots using two kinds of Fisher-type methods, which are based on the Augmented Dickey–Fuller (ADF) test (Dickey and Fuller 1979) and the Phillips–Perron (PP) test (Phillips and Perron 1988).

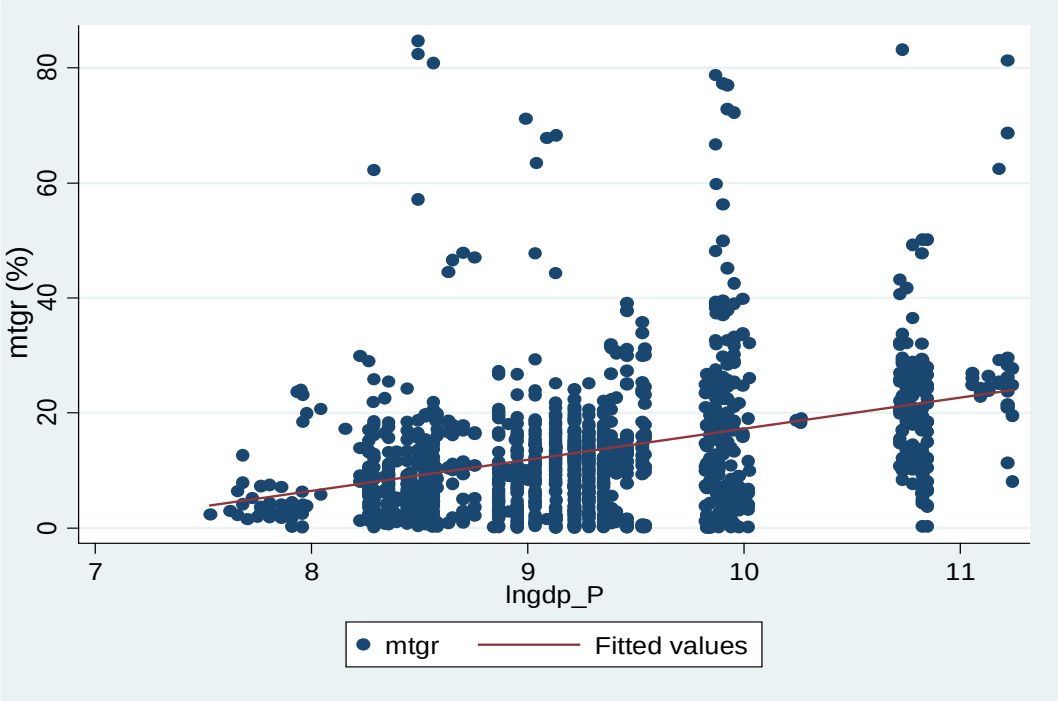
[2] World Bank. World Development Indicators. http://databank.worldbank.org/data/views/variableselection/selectvariables.aspx?source=world-development-indicators (accessed 12 February 2015).

The null hypotheses for the Fisher-type tests are that the time series data follow a unit root process. All the tests for our main variables strongly reject the null hypothesis that there are unit roots in these data.

4.2 Mortgage Lending Ratio as a Measure of Financial Inclusion and Financial Development

This subsection provides some simple comparisons of the relationship between the mortgage loan ratio, per capita GDP, and the two measures of financial stability—the Z-score and the NPL ratio—described in the previous subsection. The first point is that the mortgage loan ratio increases significantly in line with per capita GDP (Figure 1).[3] This is consistent with the behavior of other measures of financial development and financial inclusion, and suggests that the share of mortgage lending can be considered an indicator of both financial development and financial inclusion. To be sure, the rising mortgage loan ratio could simply reflect a higher loan value per individual without any increase in the number of individuals receiving loans. However, given that the value of non-mortgage loans is likely to rise at least partly in line with property prices as well, it seems unlikely that such a substantial increase in the mortgage loan ratio would be achieved without an increase in financial inclusion, i.e., increased number of borrowers.

Figure 1: Mortgage Loan Ratio versus Per Capita GDP



GDP = gross domestic product, lngdp_P = per capita GDP in nominal US dollars in log terms, mtgr = mortgage loan ratio.

Sources: World Bank. Global Financial Inclusion Database. http://datatopics.worldbank.org/financialinclusion/ (accessed 13 February 2015); Bureau van Dijk. Bankscope Database. https://bankscope.bvdinfo.com/version-2015325/home.serv?product=scope2006 (accessed 15 March 2015); authors' estimates.

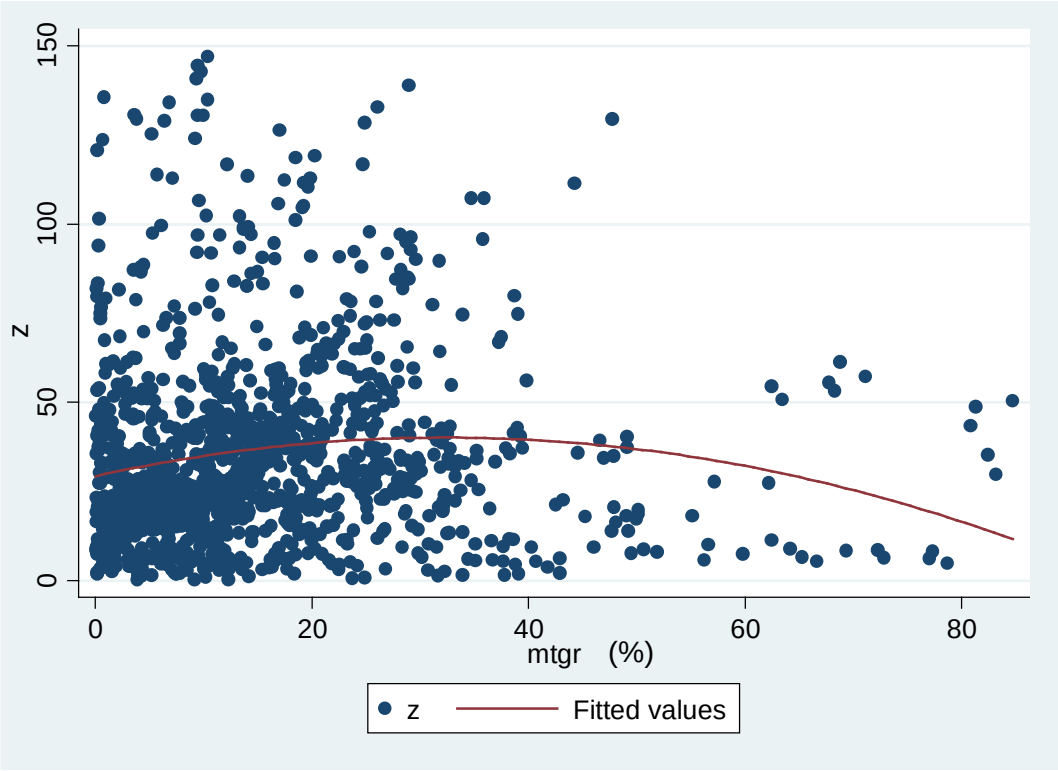
[3] Per capita GDP here is shown in nominal US dollar terms, but the picture is very similar for per capita GDP in purchasing power parity (PPP] terms.

Second, Figures 2 and 3 show the fitted lines for simple quadratic regressions of the mortgage loan ratio on *z* and *npl*, respectively. They show evidence of an inverted U-shape relation between the mortgage loan ratio and the Z-score, and a U-shape relationship between the mortgage loan ratio and the NPL ratio, respectively. For mortgage loan shares up to about 30%–40%, a rising mortgage share tends to be associated with higher financial stability in both cases. However, above around 40%, the relationship turns negative and positive for *z* and *npl*, respectively, suggesting that higher mortgage loan ratios may be negative for financial stability. This is consistent with the expectation that the advantages of asset diversification will diminish if a bank's loan portfolio is excessively concentrated in mortgage loans. It should be noted that the trend lines were estimated by eliminating outliers from the sample according to the following rules (the 1% criteria follows Hesse and Cihák [2007], 85% is the cutoff value for the mortgage loan ratio):

- Mortgage loan ratio: Dropping lowest 1% and those with ratio >85%
- Z-score: Dropping highest 1% and lowest 1%
- NPLs: Dropping highest 1% and lowest 1%.

These rules were also followed in the regression estimates described in Section 5.

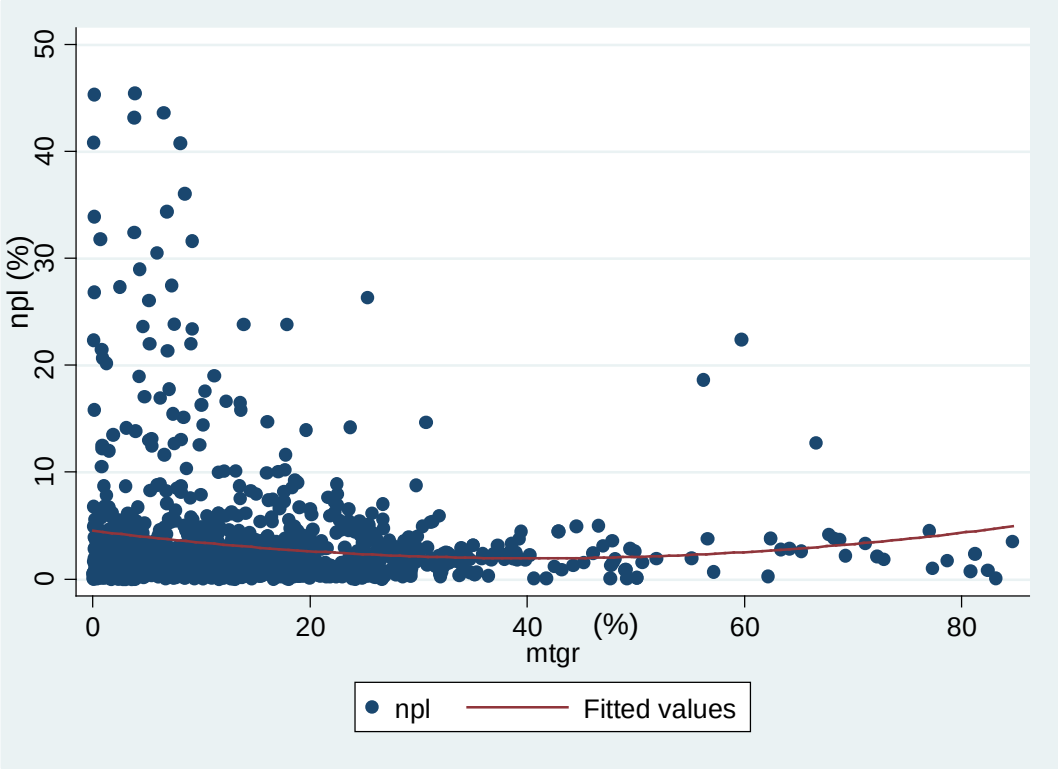
Figure 2: Mortgage Loan Ratio versus Bank Z-Score



z = Z-score; mtgr = mortgage loan ratio, simple regression of z on mtgr and mtgr^2

Source: Bureau van Dijk. Bankscope Database. https://bankscope.bvdinfo.com/version-2015325/home.serv?product=scope2006 (accessed 15 March 2015); authors' estimates.

Figure 3: Mortgage Loan Ratio versus Bank NPL Ratio



npl = nonperforming loan ratio; mtgr = mortgage loan ratio, simple regression of npl on mtgr and mtgr^2

Sources: Bureau van Dijk. Bankscope Database. https://bankscope.bvdinfo.com/version-2015325/home.serv?product=scope2006 (accessed 15 March 2015); authors' estimates.

5. MODEL AND RESULTS

5.1 Regression Model

To verify the relationship between financial stability and financial inclusion, we estimate the following model with our panel data:

$$finstab_{i,j,t} = \alpha + \beta mtgr_{i,j,t} + \gamma mtgr_{i,j,t}^{2} + \theta X_{i,j,t} + \lambda C_{j,t} + \eta_t + \nu_i + \varepsilon_{i,j,t}, \qquad (2)$$

where *finstab* is the measure of financial stability and *mtgr* is the share of mortgage loans to total loans of each bank. We also include a quadratic term of the mortgage loan share to test its potential nonlinear relationship with financial stability. Based on previous research on the effects of other bank-related variables on financial stability (Hesse and Cihák 2007; Cihák and Hesse 2008), we include a group of control variables for both bank-level and macro-level factors that may affect financial stability. The vector *X* contains bank-specific control variables, including ratio of liquidity to total deposits (*liq*), logarithm of total assets (*lgast*), ratio of debt to total assets (*la*), ratio of operating cost to total income (*ci*), and income diversity (*ind*). The vector *C* contains macroeconomic control variables, including year-on-year percent change of real GDP (*gdp*) and year-on-year percent change of the consumer price index (*cpi*). Further, η_t and v_i are vectors of economy- and year-dummy variables. The error terms $\varepsilon_{i,j,t}$, where $i = 1,\ldots, N$ represents the bank, $j = 1, \ldots, M$ represents the economy, and $t = 1, \ldots, T$ represents the year of observation, are assumed to be normally and independently

distributed. Finally, β and γ are the coefficients of interest that measure the effects of the mortgage loan ratio on financial stability, θ is the vector of coefficients of the bank-specific variables, and λ is the vector of coefficients of the economy-specific variables.

5.2 Regression Methods

We estimate the parameters of equation (2) using two regression methods, which are OLS, controlling for economy levels and fixed year effects, and the system generalized method-of-moments (GMM) dynamic panel. Two aspects of equation (2) are worth noting. First, the financial stability of each bank may depend on its historical trend and may be slow to adjust substantially in the short run. Second, there is a potential endogeneity problem of regressing financial stability measures on mortgage loans in the same year, because the financial stability measure may also affect the mortgage loans ratio. If we use contemporaneous regressors, the possible mutual causality might lead to bias in our estimates.

To check on the robustness of our results, we use two methods to deal with these two potential problems. First, lagged independent variables are included in the OLS regressions. With the explanatory variable (*mtgr*) and all control variables lagged 1 year, the estimation results can capture the possible past effects of these variables on the banks' stability. Moreover, the potential reverse causality effect from financial stability to mortgage loans in the same year is eliminated by using mortgage loans lagged 1 year which are exogenous. This method was also applied in previous studies of the effects of other variables on financial stability (e.g., Hesse and Cihák 2007; Cihák and Hesse 2008).

Second, we employ the system-GMM method to analyze a dynamic panel, which includes the lagged dependent variable in the regression model. System-GMM is based on a system composed of first differences instrumented on lagged levels and of levels instrumented on lagged first differences. In addition to providing a rigorous remedy for endogeneity bias, dynamic panel GMM estimation holds two further attractions. First, it is more robust to measurement error than cross-section regressions. Second, dynamic panel GMM estimates remain consistent even if the explanatory variables are endogenous if the instrumental variables are sufficiently lagged. Therefore, the system-GMM estimation method is suitable to alleviate the endogeneity bias and explore the dynamic structure of financial stability.

5.3 Results

Table 2 presents the empirical results of the OLS regressions. Columns (1) and (3) report results with only fixed year effects, whereas columns (2) and (4) include fixed economy effects. In column 1, the mortgage loan share ($mtgr_{-1}$) enters positively and is significant at the 1% level. More interestingly, the quadratic term of the mortgage loan share ($mtgr^2_{-1}$) is significantly negative. The positive coefficient of the linear term and the negative coefficient of the quadratic term imply an inverse U-shape relationship between mortgage loans and financial stability. That is, when the mortgage loan ratio is lower than a critical level, a higher share of mortgage lending leads to a higher Z-score (lower probability of insolvency); and when the mortgage loan ratio exceeds that point, a higher mortgage loan share leads to a lower Z-score (higher probability of insolvency). Based on the estimated coefficients, one can calculate the critical point of the mortgage loan share when the Z-score reaches its highest value. Column (1) of Table 3 shows that the critical point is 38.8% in this case.

In column (3) of Table 2, the coefficient of $mtgr_{-1}$ is significantly negative and the coefficient of the quadratic term $mtgr^2_{-1}$ is significantly positive, which implies a U-shape relationship with regard to bank NPLs. As shown in column (3) of Table 3, when the mortgage loan ratio is lower than 37.3%, a higher share of mortgage lending leads to a lower level of NPLs, which is positive for bank stability, and the level increases when mortgage loan ratio is over 37.3%, which is negative for bank stability. Therefore, results from both of our financial stability measures imply that, up to a certain point, increasing the share of mortgage loans of a bank increases its financial stability, which stresses the role of mortgage loans as a means of asset diversification. However, if a bank's share of mortgage loans rises above the range of 30%–40%, the diversification effect turns negative and insolvency risks increase. Columns (2) and (4) in Tables 2 and 4 show similar empirical results for mortgage loans, even after controlling for fixed economy effects, although the coefficient magnitudes are significantly smaller. Table 3 shows that the critical point estimates are somewhat lower but similar to those of models reported in columns (1) and (3).

Table 2: OLS Estimation Results

	Z-Score		NPL	
Variable	**(1)**	**(2)**	**(3)**	**(4)**
$mtgr_{-1}$	0.73***	0.70***	–0.104***	–0.092**
	(0.19)	(0.19)	(0.038)	(0.038)
$mtgr^2_{-1}$	–0.0094***	–0.0116***	0.00143**	0.00136**
	(0.0029)	(0.0028)	(0.00058)	(0.00059)
liq_{-1}	–0.294***	–0.098	0.077***	0.008
	(0.070)	(0.072)	(0.020)	(0.017)
$lgast_{-1}$	2.84***	1.98***	–0.04	0.39***
	(0.61)	(0.67)	(0.12)	(0.13)
la_{-1}	–0.130	–0.006	0.134***	0.018
	(0.085)	(0.092)	(0.029)	(0.027)
ci_{-1}	–0.237***	–0.293***	0.002	–0.008
	(0.045)	(0.051)	(0.018)	(0.017)
ind_{-1}	–0.103***	–0.122***	–0.0112	–0.0287***
	(0.029)	(0.029)	(0.0070)	(0.0090)
gdp_{-1}	0.35	0.3	–0.288***	0.066
	(0.30)	(0.41)	(0.058)	(0.067)
cpi_{-1}	–0.66**	0.16	0.436***	–0.21*
	(0.28)	(0.41)	(0.068)	(0.13)
Cons	13.85	0.93	–3.64	4.08
	(13.99)	(14.11)	(3.3)	(3.43)
N	825	825	825	825
Year dummy	Yes	Yes	Yes	Yes
Economy dummy	No	Yes	No	Yes
Adjusted R^2	0.185	0.247	0.197	0.427

NPL = nonperforming loan, OLS = ordinary least squares.

Notes: Robust standard errors are reported in parentheses.

* Significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level.

The coefficients of year and economy dummies are not reported.

Source: Authors' calculations.

Regarding the control variables, Table 2 shows that the share of liquid assets has a negative effect on financial stability, i.e., the Z-score tends to be lower and NPLs higher. Banks that have higher total assets tend to be more stable, which suggests that

the size of total assets could be an indicator showing the financial strength of a bank. The cost–income ratio is found to be negatively related with banks' Z-scores, but with little effect on the NPL ratio. This result is consistent with those in Hesse and Cihák (2007) and Cihák and Hesse (2008), which show that banks with higher cost–income ratios might have greater difficulty in covering their costs when facing financial risks, which implies a higher likelihood of financial instability. Also in line with Hesse and Cihák (2007), higher income diversity negatively affects the Z-scores, although it reduces NPLs. Finally, we find GDP growth has a positive effect on financial stability, which implies that economies with high growth rates are less prone to financial instability. There was no consistent effect of the CPI on financial stability. However, the coefficients of CPI in columns (1) and (3) were found to be significant at the 5% level, which implies that higher inflation is negative for financial stability in both cases.

Table 3: Critical Points Based on OLS Regression Results

	Z-Score		NPLs	
	(1)	(2)	(3)	(4)
β	0.7293	0.7084	–0.1043	–0.0923
γ	–0.0094	–0.0116	0.0014	0.0014
Critical values of mortgage loans ($f(x)'=0$, $x=-\beta/2\gamma$)	38.7926	30.5345	37.2500	32.9643

Note: β and γ are coefficients from equation (2) and their estimates are from Table 2.

Source: Authors' calculations.

The results of the system-GMM regressions are reported in Table 4. In columns (1) and (3), we include year dummies to control for year-dependent effects, and in columns (2) and (4), we include economy-specific dummies as well. The results are very similar to those in Table 2. The estimated coefficients of the lagged Z-score (z) and NPLs (npl) are significant and positive, which suggests that financial stability depends highly on history. The coefficients of mortgage loans are positive and significant at the 1% level in columns (1) and (2), whereas they are negative and significant at the 1% level in columns (3) and (4). The coefficients of the quadratic terms are negative and significant at the 5% level in columns (1) and (2), whereas they are positive and significant at the 1% level in columns (3) and (4). These results are consistent with those of the OLS estimates in Table 2, and again imply that, up to some critical level, banks with a higher mortgage loan ratio tend to have higher Z-scores and lower NPLs, but this relationship reverses if the mortgage loan share exceeds that level, i.e., mortgage loans have an inverse U-shape effect on banks' financial stability.

The standard diagnostic tests of the four regressions presented in Table 4 suggest no misspecification problems with the AR2 test failing to reject the null hypothesis of no second-order residual autocorrelation, whereas the Hansen test for overidentifying restrictions also fails to reject the null hypothesis that the instruments are valid, although the results of the Sargan test fail to reject it only for equations (1) and (2).

Table 4: Dynamic Panel Estimation Results

Variable	Z-Score		NPL	
	(1)	(2)	(3)	(4)
z_{-1}	0.819***	0.817***		
	(0.018)	(0.036)		
npl_{-1}			0.75262***	0.6603***
			(0.00065)	(0.0046)
mtgr	0.190***	0.43***	–0.0324***	–0.095***
	(0.048)	(0.11)	(0.0014)	(0.013)
$mtgr^2$	–0.00169**	–0.0040***	0.000312***	0.00117***
	(0.00067)	(0.0011)	(0.000022)	(0.00017)
liq	–0.049***	–0.020	0.04732***	0.0419***
	(0.015)	(0.052)	(0.00044)	(0.0036)
lgast	1.38***	–0.32	–0.1188***	0.698***
	(0.21)	(0.63)	(0.0086)	(0.074)
la	–0.029	0.031	0.04790***	0.0162***
	(0.024)	(0.079)	(0.00064)	(0.0059)
ci	0.021	–0.216***	0.01228***	0.0114***
	(0.018)	(0.053)	(0.00038)	(0.0032)
ind	–0.0233***	–0.013	–0.00461***	–0.0297***
	(0.0069)	(0.015)	(0.00014)	(0.0015)
gdp	–0.223***	0.035	–0.09643***	–0.1002***
	(0.035)	(0.092)	(0.00078)	(0.0081)
cpi	0.299***	0.37**	0.1959***	0.062***
	(0.056)	(0.18)	(0.0020)	(0.012)
Cons	–15.75***	19.97	–1.51***	1.46
	(4.34)	(12.92)	(0.18)	(1.95)
N	827	827	827	827
Year dummy	yes	yes	yes	yes
Economy dummy	no	yes	no	yes
No. of instruments	119	85	234	156
AB test AR2	0.739	0.906	0.987	0.920
Sargan test	0.637	0.206	0.000	0.000
Hansen test	0.275	0.487	0.792	0.527

NPL = nonperforming loan.

Notes: Estimated system generalized method-of-moments (GMM) results are based on two-step standard errors based on Windmeijer (2005) finite sample correction. Standard errors are reported in parentheses.

AB test AR2: *p*-value of the Arellano-Bond test that average auto covariance in residuals of order 2 is 0. The *p*-values of the Hansen *J* test for overidentifying restrictions, which is asymptotically distributed as χ^2 under the null of instrument validity.

* Significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level.

The coefficients of year and economy dummies are not reported.

Source: Authors' calculations.

Similar to the findings in Table 2, Table 4 shows that banks with higher asset liquidity, a higher cost–income ratio, and higher income diversity tend to have lower Z-scores and higher NPL ratios. In line with Hesse and Cihák (2007) and Hesse and Cihák (2008), the ratio of loans to assets is negatively related with financial stability, which shows that including more debt could pose more financial risk to the banks. Finally, there were no consistent results for total assets and the two macro-level control variables.

6. ROBUSTNESS CHECK

The bank-specific information in our sample varies widely, resulting in a quite heterogeneous sample with a large proportion of outliers. In our main analysis, our strategy to deal with the outliers is presented in Section 4.2. However, one concern is whether our results are robust to different detection methods for outliers. To test the robustness of our results, a robust regression model is used as an alternative to OLS. Robust regression is often employed when data are contaminated with outliers or influential observations. The results from the robust regression estimation are reported in Table 5. Columns (1)–(2) and (3)–(4) show the different estimations with the Z-scores and the NPL ratios as dependent variables, respectively. Consistent with our earlier results, the share of mortgage loans has an inverse U-shape effect on banks' Z-scores and a U-shaped effect on banks' NPL ratios, although not all of the coefficients are statistically significant.

Table 5: Robust Regression Estimation Results

	Z-Score		NPL	
Variable	**(1)**	**(2)**	**(3)**	**(4)**
$mtgr_{-1}$	0.50***	0.66***	–0.0190***	–0.0045
	(0.12)	(0.10)	(0.0065)	(0.0044)
$mtgr^2_{-1}$	–0.0016	–0.0053***	0.000067	–0.000064
	(0.0014)	(0.0012)	(0.000081)	(0.000053)
liq_{-1}	–0.008	0.017	–0.0014	0.00009
	(0.017)	(0.014)	(0.0018)	(0.00060)
$lgast_{-1}$	2.58***	0.95***	0.090***	0.055***
	(0.42)	(0.37)	(0.023)	(0.015)
la_{-1}	–0.169***	–0.105***	0.0068***	–0.0046***
	(0.042)	(0.039)	(0.0025)	(0.0017)
ci_{-1}	–0.092***	–0.148***	0.0133***	–0.0041***
	(0.028)	(0.023)	(0.0018)	(0.0011)
ind_{-1}	0.011	0.014	–0.0084***	0.00170*
	(0.023)	(0.023)	(0.0012)	(0.00092)
gdp_{-1}	0.61***	–0.02	–0.226***	0.015
	(0.21)	(0.27)	(0.011)	(0.011)
cpi_{-1}	–0.51**	–0.20	0.174***	–0.043***
	(0.22)	(0.31)	(0.012)	(0.013)
Cons	–6.37	7.52	1.53***	5.26***
	(8.10)	(8.12)	(0.48)	(0.34)
N	971	970	922	922
Year dummy	Yes	Yes	Yes	Yes
Economy dummy	No	Yes	No	Yes
Adjusted R^2	0.202	0.317	0.482	0.973

NPL = nonperforming loan.

Notes: Standard errors are reported in parentheses.

* Significant at the 10% level, ** significant at the 5% level, *** significant at the 1% level.

To save space, the coefficients of year and economy dummies are not reported.

Source: Authors' calculations.

7. CONCLUSIONS

The main contribution of our paper is to find a relationship between the share of mortgage lending and measures of financial stability, an area which has been little studied. Most related studies have looked instead at the effects of mortgage lending growth and general credit growth on the risk of financial crises. Even fewer studies have examined this relationship using bank-level data. Also, it is notable that the share of mortgage lending tends to rise with per capita GDP, which suggests that it can serve as an indicator of both financial development and financial inclusion. This is significant, both because of the importance of mortgage lending in overall household credit, and because it is the only variable related to financial inclusion in the Bankscope database.

We estimated the effect of the share of mortgage lending by individual banks (together with some control variables) on two measures of financial stability. We find some evidence that, up to a critical level of 30%–40% of total loans, an increased share of mortgage lending is positive for a bank's financial stability, specifically by lowering the probability of default by financial institutions and reducing the ratio of nonperforming loans. However, if the mortgage share exceeds that level, the impact on financial stability becomes negative. This result is consistent with the notion that asset diversification increases stability, whereas asset concentration is negative for stability. It should be noted that none of the economies in the sample had housing bubbles or financial crises in the estimation period, so the data sample corresponds to a normal (noncrisis) period. The results may differ if crisis periods are included.

These results are confirmed with the OLS and GMM regressions. These show that mortgage lending can make a positive contribution to financial stability up to a certain point, at least during periods not characterized by real estate bubbles or financial crises. This diversification effect is similar to that found for SME lending described in Morgan and Pontines (2014).[4] Therefore, the challenge is to balance the expected improvement in financial stability due to asset diversification against negative impacts that might result from easier lending standards or too rapid an increase in mortgage lending that could trigger a price bubble in the housing market. This highlights the need for prudent monetary policy and macroprudential policy measures such as loan-to-value ratios to forestall the development of such bubbles.[5] Further work in this area is needed.

Future work could also consider the effects of the mortgage loan ratio on other measures of financial stability, such as the volatility of GDP growth, bank loans, and bank deposits, or the presence of financial crises. Also, as mentioned, the effect of the mortgage loan ratio may differ substantially between noncrisis and crisis periods, indicating some kind of regime switching mechanism.

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[5] Morgan, Regis, and Salike (2015) show that loan-to-value ratios can be effective in reducing the growth rate of mortgage loans in a panel of Asian economies.

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