# House Prices and Bank Profitability

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## Abstract

This article examines whether housing prices affect bank profitability. Pooled OLS, fixed-effects, random-effects models, and dynamic panel system GMM are used. We use panel data for 190 commercial banks from 1993 to 2015 across 22 countries in our empirical analysis. We find that housing price movements affect bank profitability positively. Furthermore the effect of the hosing price on the ROA turn out to be two times bigger in market-based financial system than in bank-based financial system. The effect of the house price growth on the ROA is four times bigger in the USA than in non-USA group. Especially in the USA the effect of house-price decrease on the ROA proves to be around six times as big as the effect of house-price increase on the ROA. This explains why the global financial crises were most severe in the USA in 2007 and 2008. The policy implication is that especially when a country moves into a more market-based financial system, stabilizing housing prices is very important to ensuring financial stability and that macroeconomic prudential supervision policy extends to housing-industry policy.

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## 1. Introduction

As the financial market has developed into a more market-based system, housing finance has also changed from a bank basis to a market basis (ECB, 2009). Many researchers have already noted that stability in the real estate market is very vulnerable to rapid changes in a financial system (Acharya et al., 2011; Sá et al., 2014; Choi and Park, 2018).

When real estate prices rose, their rise was accelerated by increasing liquidity due to a boom in the asset-securitization market. As the real estate bubble burst, mortgage-backed securities lost their quality allure. This caused an additional fall in real estate prices (Coleman et al., 2008; Shin, 2009). Thus, the adjustment speed and strength of the housing-price movement tends to expand in a market-based financial system (Herring and Wachter, 1999; Jimenez et al., 2006).

The recent global financial crisis placed housing-price movements in the spotlight of academic and political discussions. In those discussions, many researchers note that housing-price movements affect the business cycle and monetary-policy transmission (Green and Wachter, 2007; Leamer, 2007; Mishkin, 2007; Taylor, 2007; IMF, 2008; Ume, 2018; Yunus, 2018). Movements in housing prices have affected not only the macro level, such as business cycles and monetary-policy transmission mechanisms, but also the micro level such as mortgage loans and bank performance.

Housing-price movements can affect bank performance in several ways: First, house-price growth can improve the quality of mortgage loan. Mortgage lending is by far the largest category of bank asset (ECB, 2005, 2010), so mortgage loans and bank performance are dependent on housing-price movements. Increases in housing prices could reduce mortgage-loan default risk, which reduces the loan loss provisions.

Consequently, a boom in the residential-property market should improve bank performance with lower loan loss provision and a bust should worsen the bank performance.

Second, house-price growth can also increase the quantity of collateral assets. Banks' exposure to the residential real estate sector is enhanced due to lending to property development and construction and also the use of properties as collateral for other loans. Whenever housing prices rise, the value of collateral assets will increase and banks will be able to make more loans with lower loan-loss provisions. Therefore the bank performance will increase when the house-price increases. This could happen especially in a country with a more market based financial system. Dell'Ariccia et al. (2012) showed that areas with higher mortgage securitization rates experienced higher credit booms and house price increases. When housing prices decline, banks' profits decrease because the value of collateral assets and mortgage securitization rates will decrease which reduce the volume of mortgage loan and increase loan-loss provisions than when housing prices were higher (Davis and Zhu, 2009; Niinimaki, 2009).

Many papers cover the determinants of bank performance. In most studies, such variables as bank size, risk, ownership, age, capital ratio, and operational efficiency are used as internal determinants (Berger et al., 1987; Bourke, 1989; Demirguc-Kunt and Huizinga, 1999; Micco et al., 2007; Beck et al., 2005; Goddard and Wilson, 2009). On the other hand, such variables as central bank interest rate, inflation, GDP development, securitization, taxation, and legal and institutional characteristics of the country or the recent financial turmoil are used as external determinants of bank performance (Bourke, 1989; Albertazzi and Gambacorta, 2009; Demirguc-Kunt and Huizinga, 1999; Beltratti and Stulz, 2009; Casu et al., 2013).

However, researchers have offered very limited empirical evidence on how housing-price movements relate to bank performance. Arpa et al. (2001) look into the performance of Austrian banks in the 1990s. They find that an increase in real estate prices is associated with greater bank profitability. Martins et al. (2015) estimate the influence of residential mortgage loans on bank profitability and risk. Using data on 555 banks in the EU-15 from 1995 to 2008, their results suggest that greater exposure to residential mortgage loans on the balance sheet seems to improve banks' performance in both profitability and credit risk in precrisis times. Davis and Zhu (2009) try to find the relationship between commercial-property prices and the performance of individual banks in various industrialized economies. They include all types of bank and bank-like institutions except central banks, the government and multilateral institutions. Their sample includes 904 banks with a total of 6,162 bank–year observations during the sample period (1989–2002). In their paper, they find that commercial-property price tends to be positively associated with bank lending and bank profitability.

Unlike Davis and Zhu (2009), our study is designed to find the relationship between residential-property price and bank profitability only for commercial banks. We selected panel data from 190 commercial banks in 22 countries with a total of 2,487 observations selected by 2014 bank-asset size from 1993 to 2015 and analyze the impact of housing-price movements on bank profits. For this purpose, we also added conventional explanatory variables such as macro factors and bank- and country-specific variables. Furthermore we are going to see if the securitization or financial system influences the effect of house price growth on the bank performance.

The rest of the paper is organized as follows. Section 2 describes the model and the data. Section 3 presents the results of the empirical analysis. Finally, Section 4 summarizes and offers policy implications.

## 2. Model and data

We examine the effect of housing-price growth on return on assets (ROA) using the following models.

$$ROA_{it} = \beta_0 + \beta_1 HPG_{jt} + \beta_2 MARKET_j + \beta_3 GDPR_{jt} + \beta_4 NPL_{it} + \beta_5 CAR_{it} + \beta_6 NIM_{it} + \varepsilon_{it} \quad (1)$$

$$ROA_{it} = \beta_0 + \beta_1 HPG_{jt} + \beta_2 MARKET_j + \beta_3 GDPR_{jt} + \beta_4 NPL_{it} + \beta_5 CAR_{it} + \beta_6 NIM_{it} + \mu_i + \varepsilon_{it} \quad (2)$$

where the dependent variable, $ROA_{it}$, is the ROA in bank *i* at time *t*. Here *j* indicates the country where the bank *i* is located. $HPG_{jt}$, $MARKET_j$ and $GDPR_{jt}$, represents the nominal housing-price growth rate, market-based financial system dummy of country *j* and the GDP growth rate in country *j* at time *t*, respectively. A dummy variable, MARKET, is used, which is 1 if a country is classified as a market-based financial system, or, 0, as a bank-based financial system. *NPL*, *CAR*, and *NIM* stand for the ratio of nonperforming loans to gross loans, the capital-adequacy ratio, and the net interest margin, respectively. Equation (1) will be estimated by pooled ordinary least squares. The error term, $\varepsilon_{it}$, is assumed to have mean 0 and to be uncorrelated with each of the regressors in the pooled OLS. Equation (2) is estimated by fixed- and random-effects methods. The error term is composed of the unobserved bank-specific effect, $\mu_i$, and an idiosyncratic error, $\varepsilon_{it}$. Heteroscedasticity and autocorrelation are assumed in the fixed- and random-effects models: $\mu_i \sim \left(0, \sigma^2_{\mu_i}\right)$, $\varepsilon_{it} \sim \left(0, \sigma^2_{\varepsilon_{it}}\right)$, and $E(\varepsilon_{it}\varepsilon_{is}) \neq 0$. The fixed-effects model allows $\mu_i$ to be correlated with the independent variables, $X_i$ = (*MARKET*, *HPG*, *GDPR*, *NPL*, *CAR*, *NIM*)′: $E(\mu_i X_{it}) \neq 0$, while we assume $E(\mu_i X_{it}) = 0$ in the random effects model.

$$ROA_{it} = \beta_0 + \rho \mathrm{ROA}_{it-1} + \beta_1 \mathrm{HPG}_{jt} + \beta_2 \mathrm{MARKET}_j + \beta_3 \mathrm{GDPR}_{jt} + \beta_4 \mathrm{NPL}_{it} + \beta_5 \mathrm{CAR}_{it} + \beta_6 NIM_{it} + \mu_i + \varepsilon_{it}, \quad (3)$$

where Equation (3) is a dynamic model as it includes the one-year lagged dependent variable, $ROA_{it-1}$, as an explanatory variable in the right-hand side. This model assumes that last year's bank profitability influences the current-period bank profitability. Arellano and Bond (1991) used a generalized method of moments (GMM) estimator to Equation (3) in first differences as follows. Explanatory variables except lagged dependent variable, $\mathrm{ROA}_{t-1}$, are assumed to be exogenous.

$$\Delta ROA_{it} = \rho \Delta \mathrm{ROA}_{it-1} + \beta_1 \Delta \mathrm{HPG}_{jt} + \beta_3 \Delta \mathrm{GDPR}_{jt} + \beta_4 \Delta \mathrm{NPL}_{it} + \beta_5 \Delta \mathrm{CAR}_{it} + \beta_6 \Delta NIM_{it} + \Delta \varepsilon_{it}, \quad (4)$$

where Equation (4) is a first difference formation of Equation (3). Time-invariant variable, $\mathrm{MARKET}_j$, and unobserved bank-specific effect, $\mu_i$, have disappeared. The lagged levels of dependent variables in Arellano and Bond (1991) turn out to be poor instruments in a differenced equation, especially when the dependent variable follows random walk process. Thus Arellano and Bover (1995), and Blundell and Bond (1998) proposed a system GMM estimator by using lagged difference variables as instruments in a level equation in addition to lagged level variables in a difference equation. Accordingly system GMM offers a more efficient estimation as it uses a system of two equations: a differenced equation and a level equation. The moment conditions of difference equation are $\mathrm{E}\left[ROA_{i,t-s}\Delta\varepsilon_{it}\right]=0$, and $\mathrm{E}\left[X_{i,t-s}\Delta\varepsilon_{it}\right]=0$, $s\geq 2$. Additional moment conditions of level equation are $\mathrm{E}[\Delta ROA_{i,t-s}(\mu_i+\varepsilon_{it})]=0$, and $\mathrm{E}[\Delta X_{i,t-s}(\mu_i+\varepsilon_{it})]=0$, $s\geq 2$. X is a vector of exogenous variables in the right hand side of the equation.

The ROA data, the ratio of nonperforming loans to gross loans (NPL), the capital-adequacy ratio (CAR; defined as the ratio of equity to total assets), and the net interest margin (NIM) are from Bankscope. Nominal residential housing-price data are from the International House Price Database of the Federal Reserve Bank of Dallas (Mack and Martínez-García, 2011). The GDP growth rate (GDPR) is from the World Bank's World Development Indicator. The classification of bank-based and market-based financial system is based on Demirgüç-Kunt and Huizinga (1999, p54) except Luxembourg. Luxembourg is classified as a market-based financial system using similar criteria. Table 1 presents summary statistics for the variables used in our empirical analysis.

Table 2 shows the number of banks and observations by country. The total number of banks and observations are 190 and 2,487, respectively. The number of banks in the US, Japan, and the UK are 38, 41, and 18, respectively. In the last column financial system of a country is listed. Table 3 lists the composition of observations by year and by USA group and Non-USA group. As this is an unbalanced panel data set, 1993 has just four observations and number of banks continued to increase to 187 in 2015.[1] USA data range from 1993 to 2015, and Non-USA data range from 1996 to 2015. The number of observations increases with time.

[1] As this is an unbalanced panel data, the maximum number of banks by year, 187, does not exactly match the number of banks used, 190.

Insert Table 1, 2, & 3.

From Figure 1 to 3 lines represent the mean of the variables and short bars show the upper bound and lower bound of 95% confidence interval assuming *t*-distribution of the variable. Data in the graphs range from 1993 to 2015. Figure 1 shows housing-price growth of the whole period. It decreased from 2006 to 2009 and rose from 2010. Housing-price growth continued to increase to 2015. House price growth decreased from 1996 and rose again after 2004. In Figure 1-1 the whole data is classified into USA and non-USA groups according to the affiliation of the banks. The thick dotted line depicts the trend of housing price growth of non-USA group. House price growth decreased from 1996 to 2003 experiencing the 1997 East Asian financial crisis and rose very abruptly after 2003 due to global expansionary monetary policy. The thick line shows the trend of housing-price growth of USA. In the USA house price growth continued increase from 1993 to 2005 even though the East Asian economic crisis attacked the East Asian countries. The Fed started to increase the federal fund rate in 2004 and housing-price growth started to decline in 2006 and continued to decline until 2008, resulting in the global financial and economic crisis in 2008. Global expansionary monetary policy began in late 2008 to cope with the crisis and housing-price growth again rose through the end of the period.

Figure 2 represents the ROA movement. On the whole the ROA dropped after 1997 East Asian economic crisis. And again the ROA dropped after 2007 global financial crisis and continued to increase thereafter. Compared with house price growth we can see that ROA moves rather similarly with housing price growth in Figure 1 except during the East Asian financial crisis in 1997–1998. Figure 2-1 we can see the separate movements of ROA in the USA and non-USA group. The thick dotted line shows the movement of ROA in non-USA countries. ROA decreased seriously in 1998 and gradually recovered except the 2008 global economic crisis. The thick line shows the movement of ROA in the USA. On average the ROA in the USA is higher than non-USA group through the whole period.  However, from 2007 to 2009 the ROA in the USA decreased significantly because of global financial crisis originated in the USA in 2007. Figure 3 shows the trend of average GDP growth rates. Very low growth rates in 1997, 2002–2003, and 2009 are attributed to the East Asian financial crisis, the burst of the Dot-com bubble, and global financial crisis, respectively.

Insert Figure 1, 1-1, 2, 2-1 and 3.

## 3. Empirical results

Before we undertake the panel data analysis, we will draw very simple regression lines between ROA and housing price growth. Figure 4 shows a simple scatter diagram and fitted line between housing-price growth and ROA, showing a very significant relationship between the two. The simple regression result shows that the estimated slope coefficient is 0.06 at the 1% significance level.

Insert Figure 4.

In Figure 5, the whole data are classified into market-based financial system and bank-based financial system according to the affiliation of banks. Two regression lines between ROA and house-price growth are drawn. The data for the thick line and dotted line are from market-based country and bank-based country, respectively. Both lines are positively sloped but the thick line looks steeper than the dotted line.

Insert Figure 5.

In Figure 6 the data are classified into USA and non-USA group. Thick regression line and dotted line show the regression lines between ROA and housing growth rate for the USA group and non-USA group, respectively. Thick line for USA group looks much steeper than non-USA group.

Insert Figure 6.

In Figure 7 USA group data are again classified into house-price increasing and decreasing period. The slope is asymmetric between house-price decreasing and increasing period. The thick line represents the regression line during house-price decreasing period and thin line shows the regression line during increasing period. Here we can find that thick line looks much steeper than the thin dotted line for the house-price increasing period.

Insert Figure 7.

Table 4 lists the estimation results for the benchmark ROA equation. Column (1) is pooled OLS estimation result with robust standard errors (Huber, 1967; White, 1980). The estimation results from fixed- and random-effects models with heteroscedasticity- and autocorrelation-consistent Rogers or clustered standard errors (Rogers, 1993) are in Columns (2) and (3). Column (4) lists the estimation results of dynamic system GMM.

Insert Table 4.

According to the Breusch-Pagan / Cook-Weisberg test for heteroscedasticity, the null of homoscedasticity is rejected at the 1% significance level ($p = 0.000<0.1$).

We found that heteroscedasticity exists, and we used a Huber/White/Sandwich estimator of variance in the OLS in Table 4 Column (1).

After running the random effects model, we ran Breusch-Pagan Lagrange multiplier test for random effects. The null hypothesis that random effects is not appropriate is rejected at the 1 % significance level ($p$=0.000<0.01). This means that variances are significantly different across banks. Therefore random effects are preferred to OLS model.

We test whether a fixed- or random-effects model is appropriate using a Hausman test. The finding ($p = 0.000 < 0.01$) shows strong evidence to reject the null hypothesis that the estimators are consistent, but the random-effects model is asymptotically more efficient. Therefore, the fixed-effects model in Column (2) is preferred in our study. Furthermore modified Wald Test for bankwise heteroscedasticity in fixed effect model is performed. The null hypothesis of homoscedasticity is rejected at the 1% significance level ($p$=0.000). We found that there exists a heteroscedasticity. We also performed a Wooldridge test for autocorrelation in the idiosyncratic errors on panel data.[2] The null hypothesis of no first autocorrelation is rejected at the 1% significance level (p value = 0.0037< 0.01). Therefore we estimated a dynamic model by twostep system GMM estimation using Windmeijer’s (2005) finite-sample correction for the two-step covariance matrix in Column (4).

The estimated coefficients of housing-price growth are positive and statistically significant at the 1% level in Columns (1)–(4). This means that an increase in housing-price growth leads to an increase in ROA. The coefficients of housing-price growth (HPG) are 0.029, 0.023, 0.026, and 0.025 in Columns (1)–(4),

[2] Wooldridge (2002).

respectively. When housing prices increase (decrease) by 1%, ROA increases (decreases) by 0.026% on average. The estimated coefficients of a market-based financial system dummy variable (MARKET) are -0.218 at the 1% significance level in Column (1), -0.186 at the 5% significance level in Column (3) and -0.226 in Column (4) at the 1% significance level, respectively. The ROA of bank in the market-based financial system turn out to be lower than in the bank-based financial system. The reason is that banking industry is under more competitive environment in the market-based financial system than in the bank-based financial system. It is conjectured that it is easier for banks to earn more profit under underdeveloped and regulated financial market system rather than under developed and liberalized financial system.

The estimated coefficients of the GDP growth rate (GDPR) are 0.033, 0.052, 0.044, and 0.031 at the 1% significance level in Columns (1)–(4), respectively. The increase in the GDP growth rate turned out to improve ROA. The estimated coefficients of the ratio of nonperforming loans to gross loans (NPL) are negative and significant at the 1% level in Columns (1)–(4). As the NPL increases, the ROA decreases. The estimated coefficients of the capital-adequacy ratio (CAR) are positive and significant at the 10% level in Column (1) and 5% level in Column (2) and (4), and 1% level in Column (3). As the CAR increases, the ROA increases. The estimated coefficients of the net interest margin (NIM) are positive and significant at the 1% level in Columns (1)–(4). An increase in NIM proved to increase ROA.

Based on the dynamic panel system GMM in Column (4), we reject the null hypothesis of no autocorrelation of order 1 at the 5% significance level, $p = 0.002 < 0.05$, but could not reject the null hypothesis of no autocorrelation of order 2 at the 5% significance level, $p = 0.134 > 0.05$. This shows that our dynamic panel model is properly specified. The standard covariance matrix used in two-step estimation is robust to panel-specific heteroscedasticity and autocorrelation. All the explanatory variables except the lagged dependent variable are treated as exogenous. Both the differenced equation and level equation are used in the twostep system GMM estimation. The *p*-value of Hansen's overidentification test for joint validity of instruments is 0.213, implying that the instruments are valid. The estimated coefficient of the one-year lagged ROA is 0.223 at the 5% significance level, supporting dynamic stability of the model. This means that one-year lagged ROA positively influences ROA in the current period.

Insert Table 5.

Table 5 lists results of expanded model in the sense that several dummy variables are augmented to the twostep GMM estimation from Table 4. USA, UK and JAPAN are 1 if a bank belongs to USA, UK, and JAPAN, or 0, otherwise, respectively. NEG is defined as 1 when housing growth rate is negative, or 0, otherwise. Market, USA, UK, JAPAN and NEG dummies are employed to see if there is a difference in the effect of house price growth on ROA. First to see whether the effect of the HPG on ROA is related to the classification of financial system, Market*HPG is added. Secondly USA*HPG is added to the model instead of Market*HPG to see whether the effect of HPG on ROA is influenced by whether the bank's affiliation is USA or not. Thirdly NEG*HPG is added to see if the effect of HPG on ROA is affected by the sign of HPG. Last country dummy variables such as USA, UK, and JAPAN are used in the creation of cross-product terms with NEG*HPG, respectively. Similar instrument variables are used as in Column (4) in Table 1.

The null hypothesis of no autocorrelation of order 1 at the 5% significance level are all rejected at the 5% significance level and the null hypothesis of no autocorrelation of order 2 could not be rejected at the 5% significance level. This means that the dynamic panel model is well specified. The *p*-values of Hansen's overidentification test for joint validity of instruments are all bigger than 0.1, implying that the instruments are valid. In Column (1), the estimated coefficient of Market*HPG is 0.02 at the 5% significance level. The partial derivative of ROA with respect to HPG is 0.016+0.020*Market. The effect of HPG on ROA is 0.036 when a bank belongs to a market-based financial system. However in the bank-based financial system the effect of HPG on ROA is 0.016. We could conclude that the impact of HPG on ROA is almost more than two times bigger in a market-based financial system than in a bank-based financial system.

$$\frac{\partial ROA}{\partial HPG} = 0.016 + 0.020 * Market$$

$$\left.\frac{\partial ROA}{\partial HPG}\right|_{Market=1} = 0.016 + 0.020 * 1 = 0.036$$

In Column (2), we replaced Market dummy by USA dummy in order to see the effect of house price growth on ROA in the case of USA. The total estimated coefficients of first derivative of ROA with respect to HPG in the USA is 0.048. However, the effect of HPG on ROA is 0.012 in non-USA group. The impact of HPG on ROA is almost four times bigger in the USA than in non-USA group. In comparison with Column (1), the dummy effect of USA is much stronger in Column (2) than Market dummy in Column (1). It is also noticeable that the USA intercept dummy of USA in Column (2) is -0.395 and Market intercept dummy is -0.258 in Column (1).

$$\frac{\partial ROA}{\partial HPG} = 0.012 + 0.036 * USA$$

$$\left.\frac{\partial ROA}{\partial HPG}\right|_{USA=0} = 0.012$$

$$\left.\frac{\partial ROA}{\partial HPG}\right|_{USA=1} = 0.012 + 0.036 * 1 = 0.048$$

In Column (3), we used NEG dummy to see if there exists an asymmetry in the effect of HPG on ROA depending on whether house price increases or decreases. However, the estimated coefficient of cross-product of NEG and HPG dummy turned out to be insignificant. The effect of HPG on ROA turned out to be unaffected by whether house price increases or decreases. In Column (4), however, we augmented the estimation model by adding variables such as USA*NEG*HPG, UK*NEG*HPG, and JAPAN*NEG*HPG to see whether asymmetry exists in the effect of HPG on ROA in the US, UK and Japan, respectively. The estimated coefficient of USA*NEG*HPG is 0.084 at the 1% significance level, but those of UK*NEG*HPG and JAPAN*NEG*HPG are insignificant. When we take the partial derivative of ROA with respect to HPG, we get the following result from estimated model in Column (4).

$$\frac{\partial ROA}{\partial HPG} = 0.018 + 0.007 * NEG + 0.084 * USA * NEG$$

$$\left.\frac{\partial ROA}{\partial HPG}\right|_{NEG=0\ \&\ USA=1} = 0.018$$

$$\left.\frac{\partial ROA}{\partial HPG}\right|_{NEG=1\ \&\ USA=1} = 0.018 + 0.007 * 1 + 0.084 * 1 * 1 = 0.109$$

The estimated coefficient of HPG on ROA is 0.018 when the house price growth is positive in the USA (NEG=0 & USA=1). Nevertheless the estimated coefficient of HPG on ROA is 0.109 and significant at 1% level by Wald test[3] when the house price growth is negative in the USA (NEG=1 & USA=1). The estimated coefficient of HPG with NEG=1 and USA=1, 0.109, turns out to be almost 6 times bigger than that of HPG, 0.018. For example, when the housing price increases by 10% point in the USA, the ROA increases by 0.18% point. On the contrary the ROA decreases by 1.09% point when the housing prices decreases by 10% point in the USA. The asymmetric effect of HPG on ROA is very significant especially in the USA. This can explain why the fall in the housing price in the USA led to a serious financial crisis. We can presume that the fall in the housing prices in the USA during 2007-2008 led to a serious deterioration in ROA in US banks. However it is interesting that the asymmetric effect of HPG on ROA is not shown in other countries such as UK and Japan.

We try to explore again the reason why the effect of HPG on ROA turned out to be the strongest in the USA during the house-price decreasing period. Figure 8 depicts the trend of the mortgage backed securities (MBS) outstanding in the USA and Europe. The thick line indicates the USA and thick dotted line, Europe. Compared with the Europe, we could find that the level of MBS is extraordinarily higher in the USA than in Europe from Figure 8. Both lines kept increasing up to 2008 and recorded the highest level around 2008. In the U.S. the outstanding volume of mortgage-backed securities reached $9.3 trillion in 2008. In Europe, the

[3] The null hypothesis of the sum of estimated coefficients of HPG, NEG*HPG, and USA*NEG*HPG is zero, is rejected by Wald test with *p*=0.0001.

outstanding volume of mortgage-backed securities reached about $2 trillion in 2008 (Casu et al. 2013, p. 1620). From this Figure 8 the level of securitization was the most active in the USA. The high level of securitization in the USA may be one of the reasons why the effect of house-price growth on ROA was the strongest.

Figure 9 shows the trend of US MBS outstanding is classified into agency and non-agency. Here agency includes government agencies or sponsored agencies such as Federal Home Loan Mortgage Corporation (FHLMC), The Federal National Mortgage Association (FNMA), The Government National Mortgage Association (GNMA), the National Credit Union Administration (NCUA), and the Federal Deposit Insurance Corporation (FDIC). It is noticeable that the MBS outstanding of agency kept increasing after 2007, however, it started to decrease after 2007. In comparison of agency which is influenced by government policy, the movement of MBS of non-agency is relatively sensitive to the market sentiment and this may have caused the abrupt deterioration of bank profit when house price decreases.

## 4. Summary and policy implications

We observe that before and after the 2008 global financial crisis, housing prices went up and down significantly. During the same period, banks' ROA moved in tandem with housing prices. Using global bank panel data, we find empirically that housing prices affect the ROA very significantly. We used an extensive bank-level panel data of 4,287 observations from 190 banks from 1993 to 2015 in 22 countries and pooled OLS, fixed- and random-effects models, and dynamic panel data analysis. From our empirical results, we conclude that an increase in housing prices improves bank profitability. When hosing prices keep increasing, ROA improves due to the increase in the mortgage lending etc. Similarly, a rapid decline in housing prices results in a deterioration of ROA; this may have been an important cause of the financial crises.

Furthermore the effect of the hosing price on the ROA turn out to be two times bigger in market-based financial system than in bank-based financial system. The effect of the house price growth on the ROA is four times bigger in the USA group than in non-USA group. Especially in the USA the effect of housing price on the ROA prove to be around six times during house-price decreasing period as big as during house-price growth increasing period. This explains why the global financial crises were most severe in the USA in 2007 and 2008.

Therefore, the policy implication is that especially when a country moves into a more market-based financial system, stabilizing housing prices is very important to ensuring financial stability and that macroeconomic prudential supervision policy extends to housing-industry policy.

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## References

Acharya, V., Richardson, M., Van Nieuwerburgh, S., and White, L. 2011. *Guaranteed to Fail: Fannie Mae, Freddie Mac and the Debacle of Mortgage Finance.* Princeton, NJ: Princeton University Press.

Albertazzi, U., and Gambacorta, L. 2009. "Bank profitability and the business cycle." *Journal of Financial Stability* 5(4), 393–409.

Arellano, M., and Bond, S. R. 1991. Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. *Review of Economic Studies.* 58(2), 277–297.

Arellano, M., and Bover, O. 1995. "Another look at the instrumental variable estimation of error-components models." *Journal of Econometrics* 68(1), 29–51.

Arpa, M., Giulini, I., Ittner, A., and Pauer, F. 2001. "The influence of macroeconomic developments on Austrian banks: implications for banking supervision." BIS Papers No 1 (part 3), March.

Beck, T., Cull, R., and Jerome, A. 2005. "Bank privatization and performance: Empirical evidence from Nigeria." *Journal of Banking and Finance* 29, 2355–2379.

Beltratti, A., and Stulz, R.M. 2009. "Why did some banks perform better during the credit crisis? A cross-country study of the impact of governance and regulation." NBER Working Paper 15180.

Berger, A.N., Hanweck, G.A., and Humphrey, D.B. 1987. "Competitive viability in banking: Scale, scope and product mix economies." *Journal of Monetary Economics* 20, 501–520.

Blundell, R., and Bond, S. 1998. "Initial conditions and moment restrictions in dynamic panel data models." *Journal of Econometrics* 87(1), 115–143.

Bourke, P. 1989. "Concentration and other determinants of bank profitability in Europe, North America and Australia." *Journal of Banking and Finance* 13, 65–79.

Casu, B., Clare, A., Sarkisyan, A. and Thomas, S. 2013. "Securitization and Bank Performance." *Journal of Money, Credit and Banking* 45(8), 1617-1658.

Choi, C., and Park, K. 2018. "Financial System and Housing Price." *Emerging Markets Finance and Trade* 54(2), 328–335. doi:10.1080/1540496X.2017.1344832

Coleman IV, M., LaCour-Little, M., and Vandell, K. D. 2008. "Subprime lending and the housing bubble: Tail wags dog?" *Journal of Housing Economics* 17(4), 272–290.

Davis, E.P., and Zhu, H. 2009. "Commercial property prices and bank performance." *Quarterly Review of Economics and Finance* 49(4), 1341–1359.

Dell'Ariccia, G., Igan, D., and Laeven, L. 2012. "Credit Booms and Lending Standards: Evidence from the Subprime Mortgage Market." *Journal of Money, Credit and Banking*, 44(2-3), 367–384.

Demirgüç-Kunt, A., and Huizinga, H. 1999. "Determinants of commercial bank interest margins and profitability: Some international evidence." *The World Bank Economic Review* 13, 379–408.

Demirgüç-Kunt, A., and Levine, R. 1999. "Bank-based and market-based financial systems: Cross-country comparisons." *Policy Research Working Paper* 2143, The World Bank.

ECB. 2005. "EU banking structures." ECB, October 2005.

ECB. 2009. "Housing Finance in the EURO Area." Occasional Paper Series No. 101, March.

ECB. 2010. "Structural indicators for the EU banking sector." ECB, January 2010.

Goddard, J., and Wilson, J.O.S. 2009. "Competition in banking: A disequilibrium approach." *Journal of Banking and Finance* 33(12), 2282–2292.

Green, R.K., and Wachter, S.M. 2007. "The housing finance revolution." Paper presented at the federal Reserve Bank of Kansas City 31st Economic Policy Symposium, "Housing, Housing Finance and Monetary Policy," Jackson Hole, Wyoming, August 31–September 1: 21–66.

Herring, R., and Wachter, S.M. 1999. "Real estate booms and banking busts: An international perspective." Occasional Papers Group of Thirty 58.

Huber, P. 1967. "The behavior of maximum likelihood estimates under nonstandard conditions." *Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics and Probability.* Berkeley, CA: University of California Press: 221–233.

IMF. 2008. "The changing housing cycle and its implications for monetary policy." IMF World Economic Outlook, April, 103–130.

Jimenez, G., Salas, V., and Saurina, J. 2006. "Determinants of Collateral." *Journal of Financial Economics* 81(2), 255–281.

Leamer, E. 2007. "Housing is the business cycle." Paper presented at the Federal Reserve Bank of Kansas City 31st Economic Policy Symposium, "Housing, Housing Finance and Monetary Policy," Jackson Hole, Wyoming, August 31–September 1: 149–233.

Mack, A., and Martínez-García, E. 2011. "A cross-country quarterly database of real house prices: A methodological note." Federal Reserve Bank of Dallas, Working Paper No. 99.

Martins, A.M., Serra, A.P., Martins, F.V., and Stevenson, S. 2015. "Residential property loans and bank performance during property price booms: Evidence from Europe." Working Papers in Real Estate & Planning 05/14, University of Reading.

Micco, A., Panizza, U., and Yanez, M. 2007. "Bank ownership and performance. Does politics matter?" *Journal of Banking and Finance* 31(1), 219–241.

Mishkin, F.S. 2007. "Housing and the monetary transmission mechanism." Paper presented at the Federal Reserve Bank of Kansas City 31st Economic Policy Symposium, "Housing, Housing Finance and Monetary Policy," Jackson Hole, Wyoming, August 31–September 1: 359–413.

Niinimaki, J.-P. 2009. "Does collateral fuel moral hazard in banking?" *Journal of Banking and Finance* 33(3), 514–521.

Rogers, W. 1993. "Regression standard errors in clustered samples." *Stata Technical Bulletin* 13, 19–23. In *Stata Technical Bulletin* Reprints 3. College Station, TX: Stata Press: 88–94.

Roodman, D. 2009a. "How to do xtabond2: An introduction to difference and system GMM in Stata." *Stata Journal* 9(1), 86–136.

Sá, F., Towbin, P., and Wieladek, T. 2014. "Capital inflows, financial structure and housing booms." *Journal of the European Economic Association* 12(2), 522–546.

Shin, H. S. 2009. "Securitisation and financial stability." *The Economic Journal* 119, 309–332.

Taylor, J.B. 2007. "Housing and monetary policy." Paper presented at the Federal Reserve Bank of Kansas City 31st Economic Policy Symposium, "Housing, Housing Finance and Monetary Policy," Jackson Hole, Wyoming, August 31–September 1: 463–476.

Ume, E. 2018. "The impact of monetary policy on housing market activity: An assessment using sign restrictions." *Economic Modelling* 68, 23–31.

White, H. 1980. "A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity." *Econometrica* 48, 817–830.

Windmeijer, F. 2005. "A finite sample correction for the variance of linear efficient two-step GMM estimators." *Journal of Econometrics* 126(1), 25–51.

Wooldridge, J. M. 2002. *Econometric Analysis of Cross Section and Panel Data*. Cambridge, Massachusetts: The MIT Press.

Yunus, N. 2018. "Transmission of shocks across global real estate and equity markets: An examination of the 2007–2008 housing crisis." *Applied Economics* 50(36), 3899–3922. doi:10.1080/00036846.2018.1430343

**Data**

Bankscope, https://www.bvdinfo.com/en-us/our-products/company-information/international-products/bankscope.

Federal Reserve Bank of Dallas, International House Price Database, https://www.dallasfed.org/en/institute/houseprice.aspx.

Securities Industry and Financial Markets Association, https://www.sifma.org/, 2019

World Bank, World Development Indicator, http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators.

Figure 1 Trend of average house price growth

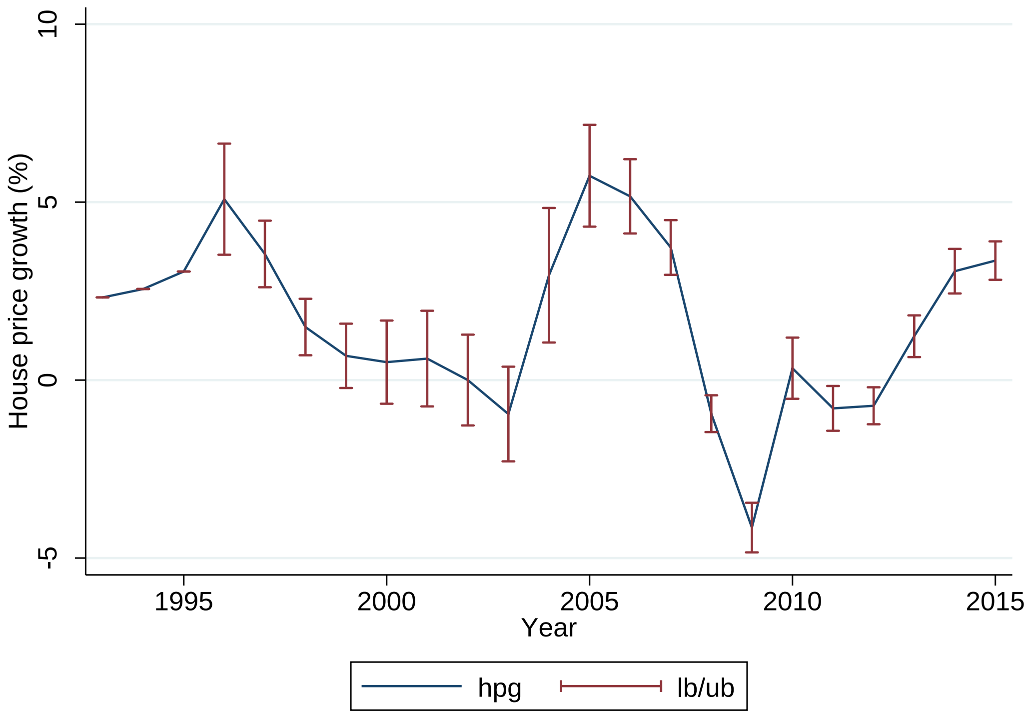



Figure 1-1 Trend of average house price growth by USA and non-USA group

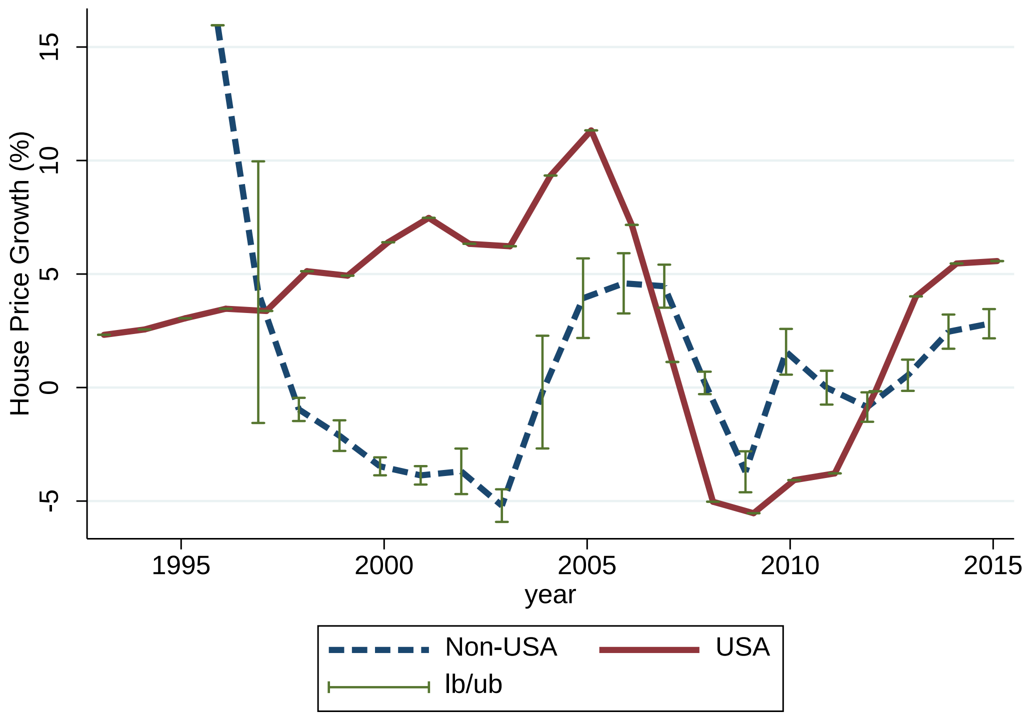


Figure 2 Trend of average ROA

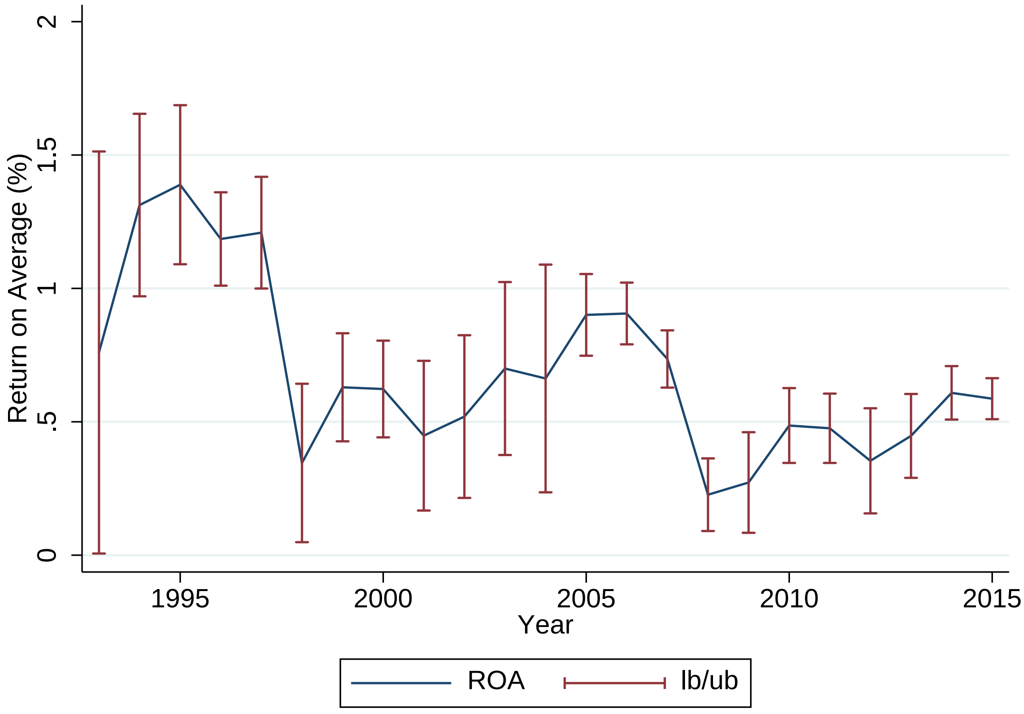



Figure 2-1 Trend of average ROA by USA and non-USA

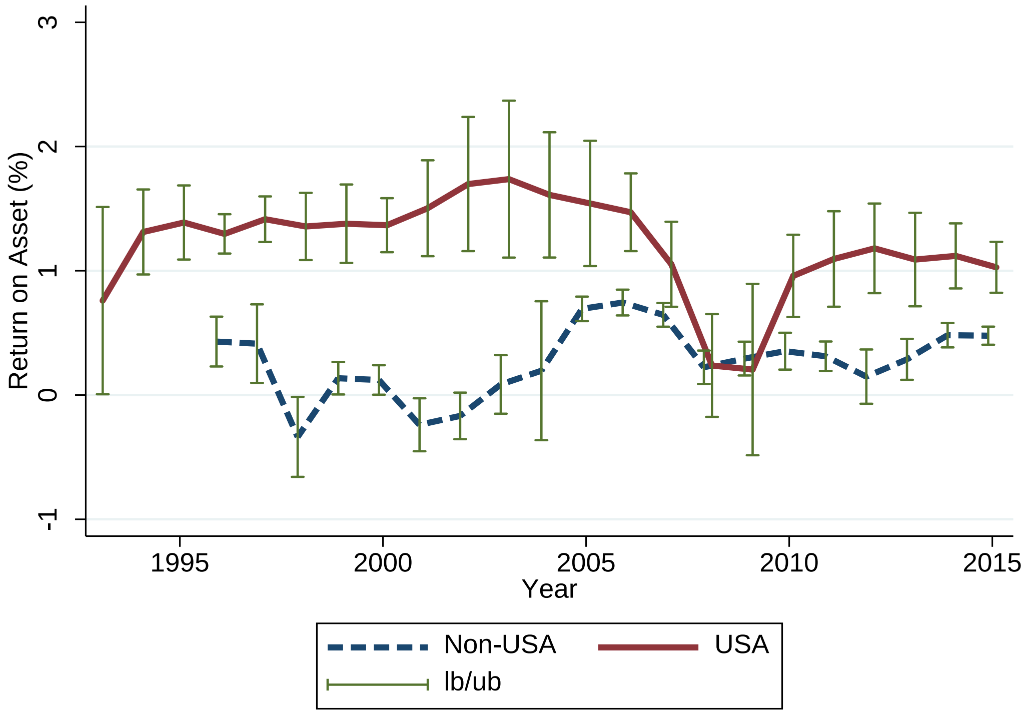


Figure 3 Trend of average GDP growth rate

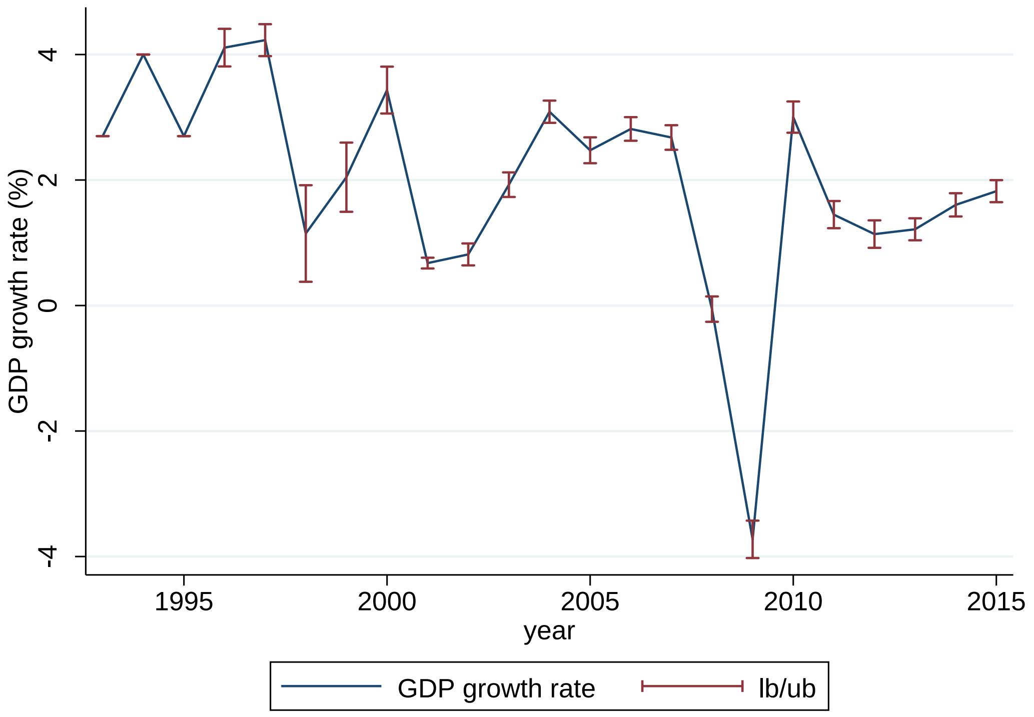
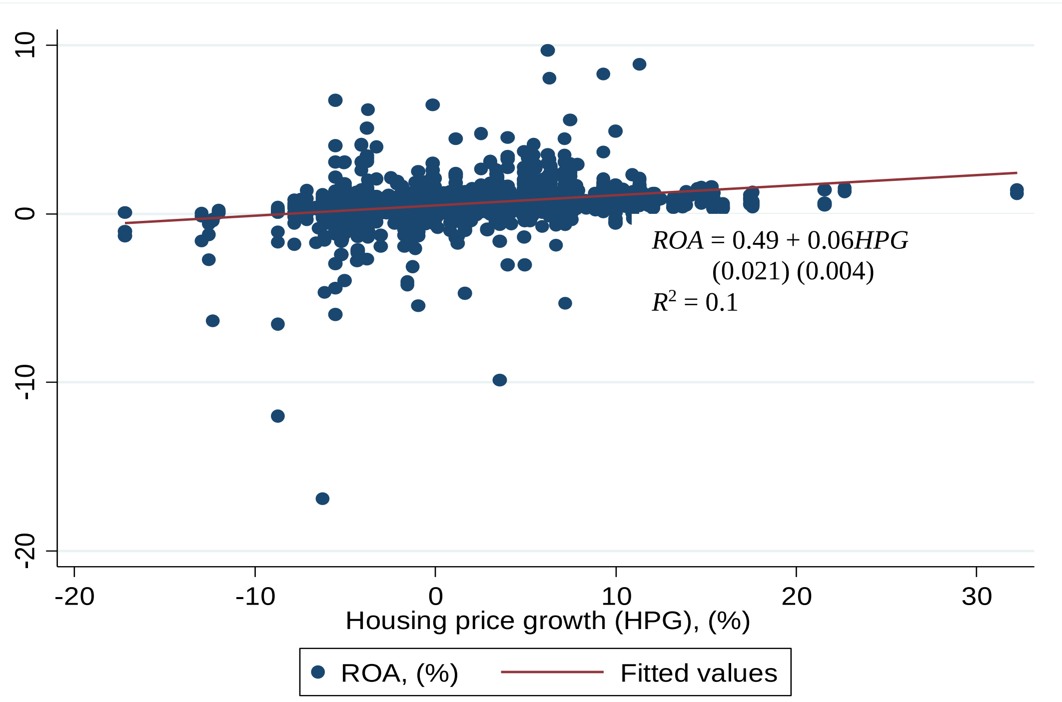



Figure 4 House price growth and ROA




Note: Standard errors are in the parentheses.

Figure 5 House price growth and ROA: by Market- and Bank-based Financial System

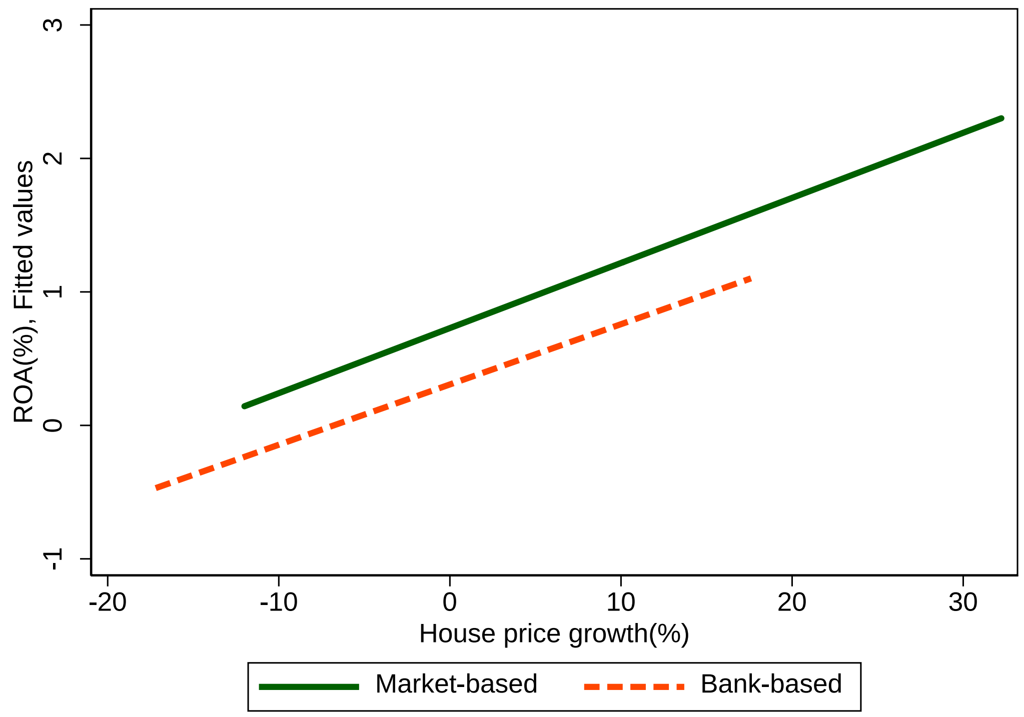



Figure 6 House price growth and ROA: by USA and Non-USA group

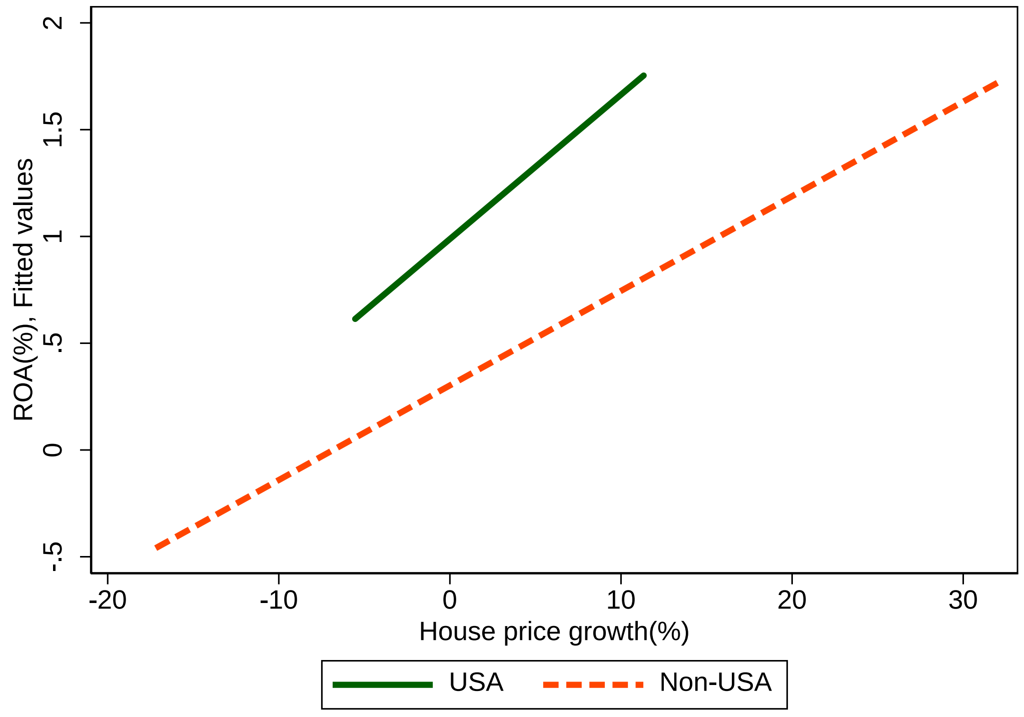


Figure 7 House price growth and ROA: by USA and Non-USA group

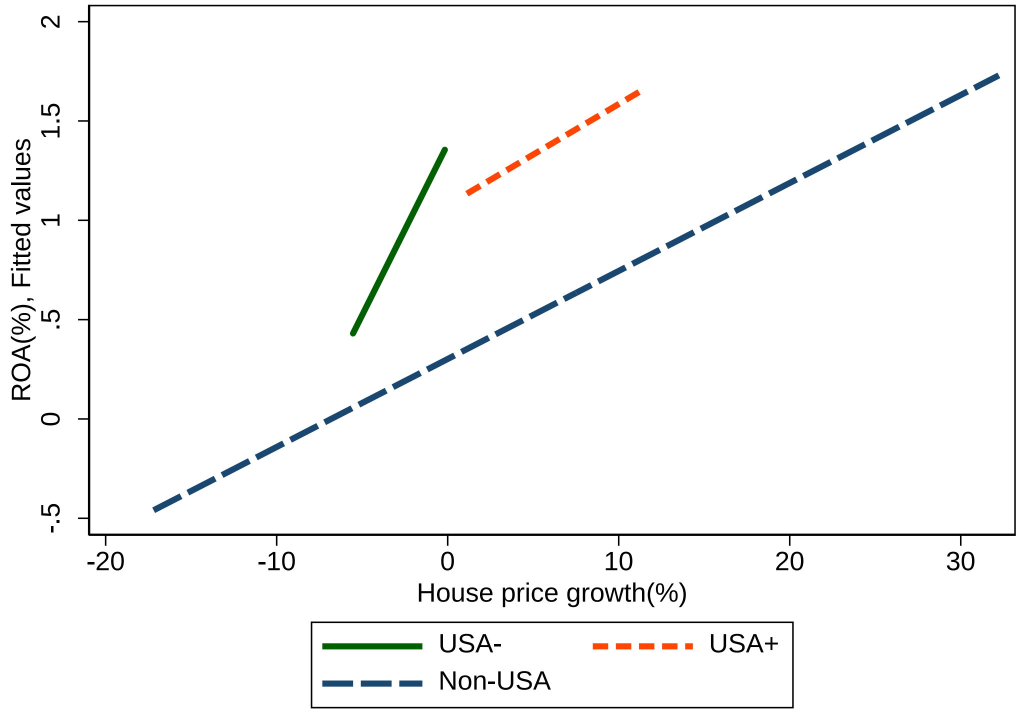
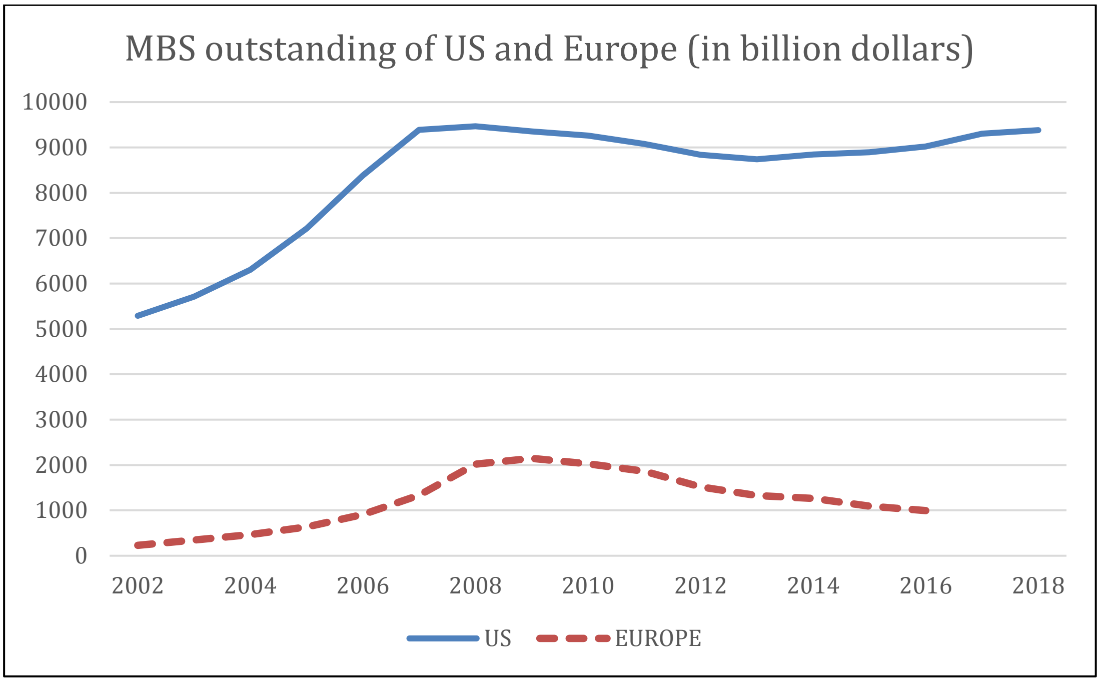
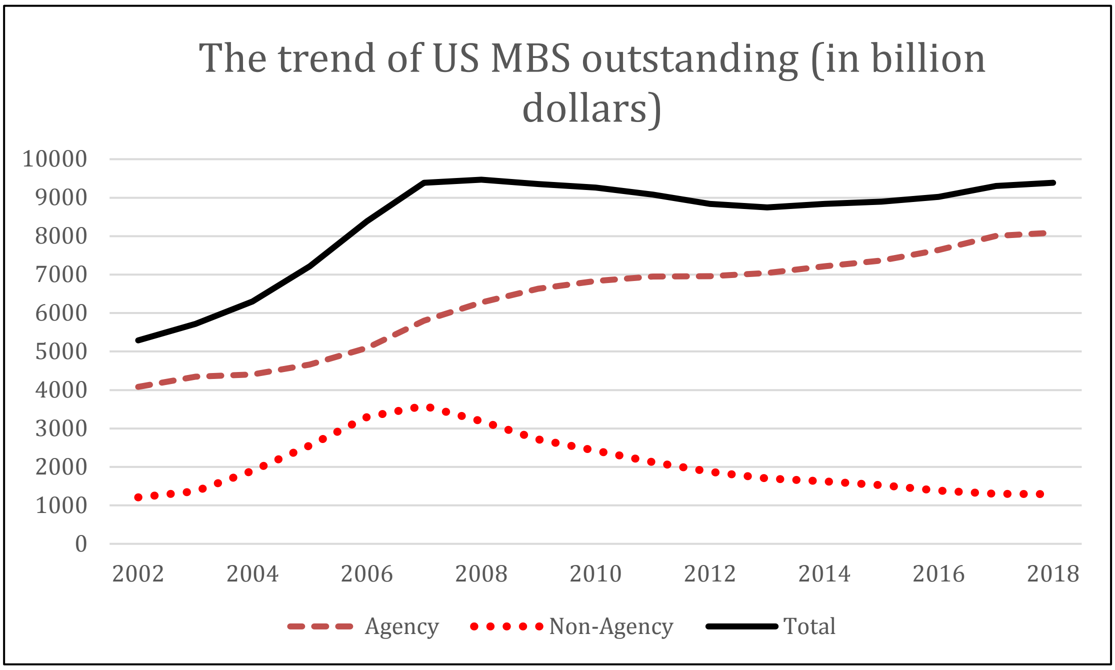



Figure 8 The Trend of MBS outstanding of US and Europe




Source: SIFMA, 2019

Figure 9 The Trend of US MBS outstanding




Note: Agency includes FHLMC, FNMA, GNMA, NCUA, and FDIC.

Source: SIFMA, 2019

Table 1 Number of Banks and Observations by Country

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| Return on Assets (ROA, %) | 2,487 | 0.576 | 1.052 | −16.915 | 9.699 |
| House price growth (HPG, %) | 2,487 | 1.338 | 5.613 | −17.193 | 32.230 |
| Equity/Assets (CAR, %) | 2,487 | 6.998 | 3.844 | −16.921 | 37.458 |
| Nonperforming loans (NPL, %) | 2,487 | 3.398 | 3.947 | 0 | 44.65 |
| Net interest margin (NIM, %) | 2,487 | 2.297 | 1.860 | −1.093 | 18.936 |
| GDP growth rate (GDPR, %) | 2,487 | 1.559 | 2.193 | −8.3 | 8.9 |

Table 2 Number of Banks and Observations by Country

| | Country | No. of Banks | No. of Observations | Market/Bank[1)] |
|---|---|---|---|---|
| 1 | Australia | 4 | 41 | Market |
| 2 | Belgium | 4 | 41 | Bank |
| 3 | Canada | 8 | 42 | Market |
| 4 | Denmark | 4 | 43 | Market |
| 5 | Finland | 2 | 23 | Bank |
| 6 | France | 13 | 132 | Bank |
| 7 | Germany | 7 | 76 | Bank |
| 8 | Ireland | 3 | 33 | Bank |
| 9 | Israel | 4 | 79 | Bank |
| 10 | Italy | 6 | 62 | Bank |
| 11 | Japan | 41 | 695 | Bank |
| 12 | Luxembourg | 1 | 9 | Market |
| 13 | Netherlands | 4 | 32 | Market |
| 14 | New Zealand | 4 | 42 | Bank |
| 15 | Norway | 2 | 21 | Bank |
| 16 | Republic of Korea | 8 | 48 | Market |
| 17 | South Africa | 4 | 43 | Market |
| 18 | Spain | 10 | 91 | Bank |
| 19 | Sweden | 2 | 22 | Market |
| 20 | Switzerland | 3 | 46 | Market |
| 21 | UK | 18 | 163 | Market |
| 22 | USA | 38 | 703 | Market |
| Total | | 190 | 2,487 | |

Notes:

1. Refer to Demirgüç-Kunt and Huizinga (1999, p54) in relation to the classification of bank-based and market-based financial system.

Table 3 Composition of Observations by Year and USA and Non-USA Group

| year | Non-USA | USA | Total |
|---|---|---|---|
| 1993 | 0 | 4 | 4 |
| 1994 | 0 | 26 | 26 |
| 1995 | 0 | 26 | 26 |
| 1996 | 4 | 27 | 31 |
| 1997 | 7 | 27 | 34 |
| 1998 | 40 | 27 | 67 |
| 1999 | 44 | 29 | 73 |
| 2000 | 43 | 29 | 72 |
| 2001 | 43 | 28 | 71 |
| 2002 | 48 | 28 | 76 |
| 2003 | 49 | 29 | 78 |
| 2004 | 63 | 31 | 94 |
| 2005 | 99 | 32 | 131 |
| 2006 | 112 | 32 | 144 |
| 2007 | 116 | 33 | 149 |
| 2008 | 121 | 34 | 155 |
| 2009 | 119 | 37 | 156 |
| 2010 | 135 | 38 | 173 |
| 2011 | 144 | 38 | 182 |
| 2012 | 149 | 37 | 186 |
| 2013 | 149 | 37 | 186 |
| 2014 | 149 | 37 | 186 |
| 2015 | 150 | 37 | 187 |
| Total | 1,784 | 703 | 2,487 |

Table 4 Housing-Price Growth and Bank Performance: Benchmark Model[1]

| VARIABLES | (1)[2] Pooled OLS ROA | (2)[3] Fixed Effects ROA | (3)[3] Random Effects ROA | (4)[4,5] Twostep GMM ROA |
|---|---|---|---|---|
| $ROA_{t-1}$ | | | | 0.223** |
| | | | | (0.095) |
| HPG | 0.029*** | 0.023*** | 0.026*** | 0.025*** |
| | (0.004) | (0.005) | (0.005) | (0.005) |
| Market | -0.218*** | | -0.186** | -0.226*** |
| | (0.062) | | (0.078) | (0.067) |
| GDPR | 0.033*** | 0.052*** | 0.044*** | 0.031*** |
| | (0.010) | (0.011) | (0.011) | (0.011) |
| NPL | -0.070*** | -0.075*** | -0.072*** | -0.058*** |
| | (0.018) | (0.017) | (0.016) | (0.016) |
| CAR | 0.037* | 0.055** | 0.052*** | 0.027** |
| | (0.019) | (0.023) | (0.019) | (0.013) |
| NIM | 0.234*** | 0.131*** | 0.192*** | 0.187*** |
| | (0.027) | (0.042) | (0.022) | (0.017) |
| Constant | 0.035 | 0.037 | 0.017 | 0.055 |
| | (0.101) | (0.173) | (0.110) | (0.083) |
| | | | | |
| Observations | 2,487 | 2,487 | 2,487 | 2,338 |
| R-squared | 0.408 | 0.383 | 0.404 | |
| Number of banks | | 190 | 190 | 190 |
| AR(1) (p-value) | | | | 0.002 |
| AR(2) (p-value) | | | | 0.134 |
| Hansen test (p-value) | | | | 0.213 |

Notes:

1. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Standard errors are in parentheses.
2. Huber/White/Sandwich estimator of variance is used.
3. Heteroscedasticity- and autocorrelation-consistent clustered standard errors in parentheses.
4. Robust errors are used. The conventional estimator with the Windmeijer (2005) correction is computed in twostep GMM estimation.
5. Instruments for differenced equation

   GMM-type: L(1/4).L.ROA

   Standard: D.L.ROA D.HPG D.Market D.GDPR D.NPL D.CAR D.NIM

   Instruments for level equation

   GMM-type: L(1/4).D.L.ROA

   Standard: L.ROA HPG Market GDPR NPL CAR NIM CONS

Table 5 Housing-Price Growth and Bank Performance: Expanded Model[1, 2]

| VARIABLES | (1)[3] Twostep GMM ROA | (2)[4] Twostep GMM ROA | (3)[5] Twostep GMM ROA | (4)[6] Twostep GMM ROA |
|---|---|---|---|---|
| $ROA_{t-1}$ | 0.221** | 0.212** | 0.222** | 0.212** |
| | (0.094) | (0.092) | (0.095) | (0.095) |
| HPG | 0.016** | 0.012*** | 0.020*** | 0.018*** |
| | (0.006) | (0.004) | (0.005) | (0.005) |
| Market*HPG | 0.020** | | | |
| | (0.008) | | | |
| USA*HPG | | 0.036*** | | |
| | | (0.010) | | |
| NEG*HPG | | | 0.016 | 0.007 |
| | | | (0.017) | (0.023) |
| USA*NEG*HPG | | | | 0.084*** |
| | | | | (0.031) |
| UK*NEG*HPG | | | | -0.028 |
| | | | | (0.032) |
| JAPAN*NEG*HPG | | | | -0.006 |
| | | | | (0.020) |
| Market | -0.258*** | | -0.227*** | -0.172** |
| | (0.072) | | (0.068) | (0.068) |
| USA | | -0.395*** | | |
| | | (0.126) | | |
| GDPR | 0.030*** | 0.034*** | 0.030*** | 0.027*** |
| | (0.011) | (0.011) | (0.011) | (0.011) |
| NPL | -0.059*** | -0.061*** | -0.058*** | -0.060*** |
| | (0.016) | (0.017) | (0.016) | (0.017) |
| CAR | 0.028** | 0.036** | 0.027** | 0.033** |
| | (0.013) | (0.015) | (0.013) | (0.013) |
| NIM | 0.187*** | 0.201*** | 0.187*** | 0.193*** |
| | (0.017) | (0.023) | (0.018) | (0.019) |
| Constant | 0.045 | -0.045 | 0.086 | 0.021 |
| | (0.083) | (0.089) | (0.090) | (0.100) |
| | | | | |
| Observations | 2,338 | 2,338 | 2,338 | 2,338 |
| Number of banks | 190 | 190 | 190 | 190 |
| AR(1) (p-value) | 0.002 | 0.002 | 0.002 | 0.002 |
| AR(2) (p-value) | 0.131 | 0.133 | 0.144 | 0.134 |
| Hansen test (p-value) | 0.239 | 0.214 | 0.206 | 0.283 |

Notes:

1. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively. Standard errors are in parentheses.
2. Robust errors are used. The conventional estimator with the Windmeijer (2005) correction is computed in twostep GMM estimation.
3. 

Instruments for differenced equation

GMM-type: L(1/4).L.ROA

Standard D.L.ROA D.HPG D.(Market*HPG) D.Market D.GDPR D.NPL D.CAR D.NIM

Instruments for level equation

GMM-type: L(1/4).D.L.ROA
Standard: L.ROA HPG Market HPG Market GDPR NPL CAR NIM CONS

4.

Instruments for differenced equation
GMM-type: L(1/4).L.ROA
Standard D.L.ROA D.HPG D.(USA*HPG) D.USA D.GDPR D.NPL D.CAR D.NIM
Instruments for level equation
GMM-type: L(1/4).D.L.ROA
Standard: L.ROA HPG USA*HPG USA GDPR NPL CAR NIM CONS

5.

Instruments for differenced equation
GMM-type: L(1/4).L.ROA
Standard: D.L.ROA D.HPG D.(NEG*HPG) D.Market D.GDPR D.NPL D.CAR D.NIM
Instruments for level equation
GMM-type: L(1/4).D.L.ROA
Standard: L.ROA HPG NEG*HPG Market GDPR NPL CAR NIM CONS

6.

Instruments for differenced equation
GMM-type: L(1/4).L.ROA
Standard: D.L.ROA D.HPG D.(NEG*HPG) D.(USA*NEG*HPG) D.(UK*NEG*HPG) D.(JAPAN*NEG*HPG) D.Market D.GDPR D.NPL D.CAR D.NIM
Instruments for level equation
GMM-type: L(1/4).D.L.ROA
Standard: L.ROA HPG NEG*HPG USA*NEG*HPG UK*NEG*HPG JAPAN*NEG*HPG Market GDPR NPL CAR NIM CONS