# The Cross-Market Spillover of Economic Shocks through Multi-Market Banks

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Abstract:

This paper investigates the implications of geographic diversification in banking for the spillover of economic shocks across markets. We examine the home mortgage lending behavior of banks operating in multiple metropolitan areas of the U.S. during the housing market collapse of 2007-2009. A key feature of the housing downturn was that some areas suffered much larger declines in home prices and increases in mortgage delinquencies than others. We examine changes in home mortgage lending in U.S. metro areas to see if multi-market banks with heavy exposure to high-delinquency markets reduced lending only in those markets or also in the lower-delinquency markets in which they operated. We find evidence that these multi-market banks did reduce mortgage lending in their lower-delinquency markets, especially in markets peripheral to their operations, consistent with the view that geographic diversification increases the vulnerability of regions to outside economic shocks through a bank capital effect. We also find that securitized lending may have somewhat compensated for reduced portfolio lending.

JEL Classification: G21, G32, R12, R31

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## 1. Introduction

Banking and finance economists have long been interested in the effect of financial shocks on bank lending and spending by bank-dependent borrowers. Reflecting this interest, a large empirical literature has examined the effect of shocks to bank capital on bank lending and economic activity. The recent financial crisis has drawn attention to a closely related issue—the impact of shocks to liquidity or bank capital in one region on bank lending in other regions that did not directly experience the shocks or experienced them to a lesser degree. During the crisis, losses were far greater on subprime mortgages issued in the U.S. than on mortgage loans made in other countries. Nevertheless, a number of global banks with large holdings of U.S. subprime mortgages appeared to curtail lending in many of the markets in which they operated, including those in which loan losses had increased relatively little. A plausible explanation for such cross-market spillovers is that the subprime mortgage losses reduced the capital of global banks, leading these banks to curtail lending across the board.

The emergence of global banks is but one example of a significant increase in the geographic diversification of banking over the last several decades. It has long been recognized that such diversification could alter the vulnerability of markets to *local* economic shocks. Due to their internal capital markets and ability to borrow on external capital markets, multi-market banks should reduce local lending less than single-market banks in response to adverse local loan supply shocks (decreases in local deposit supply or decreases in bank capital due to higher loans losses). On the other hand, because of their ability to shift lending to their other markets, multi-market banks should reduce local lending more than single-market banks in response to adverse local loan demand shocks (decreases in the creditworthiness or credit demands of local borrowers).

The cross-market spillovers observed in the recent financial crisis serve as a reminder that the geographic diversification of banking may also increase the sensitivity of markets to *outside* economic shocks. In principle, multi-market banks could transmit such shocks in two distinct ways, depending on the nature of the shock. If the outside shock reduces a multi-market bank's overall capital or supply of deposits—if the shock affects loan supply—the bank can be expected to reduce its local lending. On the other hand, if the outside shock reduces the creditworthiness or credit demands of borrowers in other markets—if the shock affects loan demand—the bank can be expected to increase local lending as it shifts lending from its other markets. For convenience, we will refer to the first effect as the *spillover effect* and the second effect as the *substitution effect.* The fact that global banks reduced lending even in markets that did not experience heavy subprime mortgage losses in the recent crisis suggests that at least in this instance, the spillover effect dominated the substitution effect. In other words, global banking appears to have magnified the cross-market transmission of adverse economic shocks during the crisis.

This paper seeks to shed light on the cross-market transmission of economic shocks and the relative importance of spillover and substitution effects by examining transmission of shocks at the sub-national level—across different regions of the same country rather than across nations. Specifically, the paper focuses on the home mortgage lending behavior of banks operating in multiple metropolitan areas of the U.S. during the housing market collapse of 2007-2009. A key feature of the housing downturn was that some areas suffered much larger declines in home prices and increases in mortgage delinquencies than other areas. We examine changes in home mortgage lending in U.S. metro areas to see if multi-market banks with heavy exposure to high-delinquency markets reduced lending in the low-delinquency markets in which they operated, as

suggested by the spillover hypothesis, or increased lending in those markets, as suggested by the substitution hypothesis.

In this paper, we also explore whether the sensitivity of local lending to outside economic depends on how important the local market is to a multi-market bank's overall lending. We refer to a market that accounts for a small share of a multi-market bank's lending as a *peripheral* market and a market that accounts for a large share of its lending as a *core* market. In principle, both the spillover effect and the substitution effect should be stronger in multi-market banks' peripheral markets than in their core markets. For example, an increase in the average loan loss rate in other markets should have a greater tendency to reduce the bank's overall capital, and thus a greater tendency to reduce the bank's local lending, if the banks' other markets account for a large share of its lending—i.e. if the local market is peripheral. Similarly, a decrease in average borrower creditworthiness in other markets should lead to a greater total decrease in lending in those markets, and thus a greater shift in lending to the local market, if the local market is peripheral. In the case of the spillover effect, lending in peripheral markets may be especially sensitive to outside economic shocks for an additional reason—when banks retrench in times of financial stress, they may "cut and run" from the markets in which they have the least long-term interest.

A final issue addressed in this paper is whether the transmission of shocks across markets is mitigated by banks' ability to offset changes in portfolio lending (loans originated and kept on the books) with changes in securitized lending (loans originated and sold to non-affiliates). Banks that can easily make this shift may not need to decrease their total lending as much in response to adverse supply shocks or increase their total lending as much in response to adverse demand shocks. For example, a bank faced with adverse loan supply shocks in its other markets

could opt to sell some of the loans it had been planning to originate and hold. By so doing, the bank could make the desired adjustment in the size and risk of its overall portfolio while increasing its fee income from loan sales. Conversely, a bank faced with adverse loan demand shocks in its other markets could choose to hold onto some of the loans it had been planning to originate and sell. In this case, the bank might be able to maintain growth in its total mortgage holdings with less easing in credit standards or less sweetening in loan terms. In both examples, the ability of multi-market banks to shift between portfolio lending and securitized lending dampens the response of total lending to the outside shock, reducing the spillover effect in the first case and the substitution effect in the second case.

Our empirical results suggest that multi-market banks did reduce mortgage lending in their low-delinquency markets during the housing collapse. This finding is consistent with the view that geographic diversification in banking increases the vulnerability of markets to outside economic shocks—i.e., that the spillover effect from outside loan supply shocks outweighs the substitution effect from outside loan demand shocks. We also find evidence that the spillover effect was bigger in multi-market banks' peripheral markets than their core markets. Finally, our results suggest that the decline in mortgage lending in response to outside economic shocks was mitigated to some extent by a tendency for multi-market banks to increase securitized lending at the same time they reduced portfolio lending.

The remainder of our paper is organized as follows. Section 2 reviews the related literature and Section 3 describes the empirical methodology. Section 4 describes the data construction and a sample of descriptive statistics. Section 5 describes the regression results for the cross-sectional and pooled regressions. Section 6 concludes.

## 2. Related literature

One of the central questions of this paper is whether geographic diversification can create a spillover effect, in which adverse loan supply shocks in one regions lead to decreased bank lending in other regions. Several strands of previous literature are relevant to this question.

The first strand of the literature related to the spillover effect documents that supply-side shocks decrease bank lending. One part of this literature focuses on the effect on lending of a decrease in deposits due to tighter monetary policy—the bank lending channel (Bernanke and Gertler 1995). This literature finds substantial evidence that smaller banks lacking access to capital markets respond to an unexpected tightening of monetary policy by contracting lending (Kashyap and Stein 2000). Another part of the literature on supply side shocks focuses on decreases in bank capital due to unexpectedly high loan losses. As noted in the Introduction, much of this literature grew out of the U.S. credit crunch of the early 1990s, when heavy losses on commercial real estate loans were believed to have led to a sharp cutback in bank lending by depleting bank capital (Bernanke and Lown 1991, Sharpe 1995). Most of these studies conclude that the decline in bank capital caused by higher loan losses and the adoption of a new system of risk-based capital requirements at approximately the same time both contributed to the cutback in bank lending.

As Sharpe observes, identifying the effect on bank lending of a decrease in bank capital is difficult because observed decreases in lending could be due to the deterioration in the creditworthiness of prospective borrowers rather than a decline in capital from higher loan losses (Sharpe 1995). However, the few studies have been managed to solve this identification problem have also found that loan supply shocks generally lead to lower bank lending. Peek and Rosengren (2000) show that the U.S. subsidiaries of Japanese banking companies that suffered

heavy losses on loans in Japan significantly reduced their commercial real estate lending in U.S. markets. In a study of the effect of liquidity shocks on bank lending, Khwaja and Mian (2008) address the identification problem by examining the change in lending by Pakistani banks after the unanticipated nuclear tests of 1998 made it harder for banks to borrow abroad. The lending data used in this study is broken down by borrower and lender, and many of the firms in the sample borrowed from more than one bank. The latter feature of the data allows the authors to compare the change in a firm's loans from banks heavily exposed to the liquidity shock to the change in loans from banks only slightly exposed to the shock, effectively controlling for loan demand. As expected, Khwaja and Mian find that firms suffered the biggest cutbacks in lending from those banks that experienced the biggest declines in liquidity.

A second strand of literature related to the spillover effect deals with the effect of geographic diversification on the transmission of local supply-side shocks to local bank lending. Morgan, Rime, and Strahan (2004) note that geographic diversification should increase the sensitivity of local bank lending to local demand shocks, by making it easier for banks to shift lending to other markets. But they also point out that geographic diversification should decrease the sensitivity of local bank lending to local supply shocks, by making it easier for banks to draw on capital or funding sources outside the affected market. They show that the geographic deregulation of banking in the U.S. in the 1980s and early 1990s led to a decline in state-level economic volatility. They interpret this finding as evidence that the tendency of geographic diversification to offset local supply shocks outweighed the tendency to exacerbate local demand shocks.

Other studies have looked at more direct evidence on the implications of geographic diversification for the sensitivity of bank lending to local economic shocks. Becker shows that

geographic deregulation reduced the responsiveness of bank lending to differences in local deposits due to demographic factors—specifically, differences across markets in the percentage of elderly. Keeton (2009) addresses the issue by comparing the change in small business lending at single-market banks and multi-market banks in two types of markets—those severely affected by the economic downturn of 2000-2003 and those only mildly affected by the downturn. He finds that a severe downturn in the local economy reduced local lending more at single-market banks than at multi-market banks that held most of their deposits in other markets. This finding is consistent with the view that geographic diversification reduces the sensitivity of bank lending to local supply shocks. As Keeton notes, however, the finding could also reflect an inability of the headquarters of multi-market banks to detect or respond to changes in credit conditions in distant markets.

A closely related set of studies focuses on the use of internal capital markets to offset liquidity shocks to individual banks in multi-bank holding companies (MBHCs). As noted above, studies of the bank lending channel have found that tighter monetary policy reduces lending at small banks dependent on deposits for funds but not at large banks with access to external capital markets. Campello (2001), Ashcraft (2006), and Huang (2008) examine the role of internal capital markets in the monetary transmission mechanism by comparing the change in lending at small, stand-alone banks with the change in lending at banks of similar size and location belonging to MBHCs. All three studies find that tighter monetary policy reduces lending less at the MBHC subsidiaries, supporting the view that MBHCs offset declines in deposits at their liquidity-constrained banks by shifting deposits from their unconstrained banks or down-streaming funds borrowed on external capital markets.

The last strand of literature related to the spillover effect focuses on the issue of direct concern to this paper—the response of local lending to economic shocks in other markets. The paper by Peek and Rosengren cited earlier was one of the first to document that a multi-market bank's loan losses in one market could spill over to lending in its other markets. Schnable investigates the effect of the Russian debt crisis of 1998 on bank lending in Peru, using a data set and methodology similar to those of Khwaja and Mian. For Peruvian firms borrowing from multiple banks, he compares the change in lending from three classes of banks—domestic banks without access to foreign credit, domestic banks with arm-length loans from foreign banks, and foreign-owned banks with loans from their foreign parents. He finds that lending from foreign-owned banks fell more than lending from domestic banks without access to foreign credit, but less than lending from domestic banks with arms-length loans from foreign banks. In another study covering the period 1997-2008, Correa and Murry (2009) find that lending to foreigners by U.S. banks and their foreign offices was especially sensitive to bank liquidity in periods of unexpectedly tight money. The authors interpret this finding as evidence of a cross-border bank lending channel.

More recent papers investigate the existence of cross-market spillovers during the 2007-2009 financial crisis. Popov and Udell (2010) examine such spillovers using survey data on loan applications by small and medium-size businesses in different markets of emerging Europe before and during the financial crisis. They combine this data with information on the financial condition of parent companies of foreign banks operating in each market. They find that loan rejection rates increased most in those markets in which foreign banks with financially distressed parents had the highest presence, consistent with the view that geographic diversification increases the sensitivity of local lending to outside loan supply shocks.

In another study of bank lending during the financial crisis, Cetorelli and Goldberg use the Khwaja-Mian approach to investigate the spillover of liquidity shocks in developed country banking systems to lending to emerging-market economies. The authors combine data on cross-border bank lending by source country and destination country with measures of the vulnerability of banks in each source country to U.S. dollar funding shocks. They find that emerging markets experienced the biggest declines in lending from the source countries with the greatest vulnerability to dollar funding shocks, suggesting that global banking has made emerging markets more susceptible to loan supply shocks in the developed world.

Our work builds on the previous literature by using the variation in home mortgage lending among multi-market banks with different exposures to mortgage losses in other markets to estimate the spillover of loan supply shocks. Our approach to investigating cross-market spillovers is closest in spirit to that of Cetorelli and Goldberg. To control for local loan demand, they use fixed effects for the different emerging-market countries to which foreign credit is extended, while we use fixed effects for the different metro markets in which multi-market banks originate home mortgages. To test for spillovers from other markets, they exploit the variation among source countries in dollar funding vulnerability, while we use the variation among multi-market banks in exposure to losses in other markets. However, unlike Cetorelli and Goldberg and other studies dealing with spillovers across countries, our paper has direct implications for U.S. regulatory policy and the transmission of financial shocks from some regions of the U.S. to others. Also, we believe our study is unique in carefully distinguishing between spillovers to markets that account for a minor share of a multi-market bank's total mortgage lending (peripheral markets) and spillovers to markets that account for a major share of a bank's total mortgage lending (core markets). In the process, we also document a novel finding that the

majority of mortgage loans originated and held by large banking companies in recent years have been originated in markets each of which accounts for a small share of the company's total originations.

Another key question of the paper is whether the spillover effect of geographic diversification can be offset by a substitution effect, in which decreased loan demand or borrower creditworthiness in one region leads to increased lending in other regions. There are far fewer empirical studies related to this question than to the spillover effect. A couple of studies have found evidence that banks belonging to MBHCs are more likely than stand-alone banks to decrease lending in response to decreases in local demand. Houston and James (1998) found that lending by subsidiaries of MBHCs was more responsive than lending by stand-alone banks to changes in overall loan growth in the state. Similarly, Huang (2008) found that a tightening of monetary policy caused a bigger reduction in bank lending at counties that were dependent on manufacturing—counties in which tighter policy could be expected to cause a bigger increase in loan demand—and that lending in these counties declined more at banks belonging to MBHCs than at stand-alone banks. Neither of these studies looked at whether the decreased lending by MBHCs in markets with weak loan demand was accompanied by increased lending in their other markets. Nevertheless, the findings of the two studies are consistent with the view that geographic diversification can give rise to a substitution effect, causing local lending to rise in response to outside economic shocks instead of falling.

## 3. Empirical methodology

Our empirical methodology is designed to test the relative importance of two different effects of loan losses in some markets on bank lending in other markets—the spillover effect and

the substitution effect. In the spillover effect, the loan losses represent a loan supply shock that causes the bank to reduce lending in all its markets, including those without loan losses. In the substitution effect, the loan losses reflect a loan demand shock—specifically, a decrease in borrower creditworthiness that causes the bank to shift lending to other markets in which borrower creditworthiness has remained unchanged or declined by less.

We test whether the spillover effect is more important than the substitution effect by observing the response of multi-market banks' portfolio lending in a market to increases in loan losses in the other markets in which they operate. If the spillover effect is more important, local portfolio lending should decline. On the other hand, if the substitution effect is more important, local portfolio lending should increase. However, even if the spillover effect does outweigh the substitution effect, the decline in portfolio lending could be partly or completely offset by an increase in securitized lending in the same market. Thus, an important part of our empirical strategy is to determine how increases in loan losses in other markets affect a multi-market bank's securitized lending and total lending in the market.

Our basic approach to estimating these cross-market relationships is to regress the growth in a bank's mortgage originations in a market on a measure of the bank's exposure to other markets with high mortgage delinquency rates. In these regressions, we control for local mortgage demand by using market fixed effects, similar to Kwaja and Mian, Schnable, and Cetorelli and Goldberg. Also, to control for bank-wide loan supply shocks—those that are not specific to particular markets—we include in each regression a measure of the bank's capital and a measure of its delinquencies on loans other than home mortgages.

We begin by estimating a set of cross-section regressions for the change in mortgage originations from the pre-crisis period to the crisis period:

$$(1)\qquad LNGROWTH_{i,m} = \sum_k b_k \cdot PERIPHERAL^k_{m,i} + \sum_k c_k \cdot PERIPHERAL^k_{,m,i} \cdot, OTHLOSS_{m,i} + d \cdot TCE_i + e \cdot NRNPL_i + f \cdot SIZE_i$$

Only bank/market observations with positive mortgage originations in both the pre-crisis and crisis periods are included in the sample. Each regression includes fixed effects for the 376 metro markets in the sample. $LNGROWTH_{i,m}$ is the log growth in bank *i*'s mortgage originations in metro area *m* from the pre-crisis period (2006 and 2007) to the crisis period (2008 and 2009). The variables $PERIPHERAL^k_{,m,i}$ are dummy variables indicating how important markets other than *m* are in bank *i*'s total originations, with higher values of *k* corresponding to greater importance of other markets. These dummy variables enter the regressions in two ways—alone and interacted with the variable $OTHLOSS_{m,i}$. The latter variable is the average mortgage delinquency rate at the end of 2007 in all markets other than market *m* in which bank *i* has originated loans.

In each regression, the sign and magnitude of the coefficients $c_k$ on the interactive terms provide our test of the relative importance of the spillover and substitution effects. These coefficients are expected to be negative if the spillover effect dominates (multi-market banks reduce local lending when delinquency rates in their other markets increase). On the other hand, the coefficients should be positive if the substitution effect dominates (multi-market banks substitute lending in the local market for lending in other markets when delinquency rates in those markets increase). Furthermore, the coefficients should be more negative or more positive, the more peripheral the market is to the bank—i.e. the greater is the importance of other markets in the bank's total loan originations (i.e., the higher is *k*).

We estimated the regressions for three categories of mortgage originations—portfolio loans (loan originated and held on bank books), securitized loans (loans sold to non-affiliates other than GSEs), and total loans (the sum of portfolio and securitized loans). Estimating equation (1) for portfolio loans provides a good test of whether the spillover effect from outside economic shocks dominates the substitution effect. Estimating equation (1) for securitized loans allows us to determine if banks respond to outside economic shocks by increasing securitized lending at the same time they decrease portfolio lending. Finally, we estimate equation (1) for total loans to test whether the net effect of outside economic shocks is to decrease total lending—i.e. whether the negative spillover effect on portfolio lending is big enough to outweigh the positive substitution effect on portfolio lending and the compensating increase (if any) in securitized lending.

The remaining variables in (1) control for bank-level characteristics that could affect a bank's lending in all markets. $TCE_i$ is the ratio of bank *i*'s tangible equity capital to assets at the end of 2007, while $NRNPL_i$ is the percent of bank *i*'s loans other than home mortgages that were non-performing at that time. These variables control for bank-level supply shocks. Assuming increases in $TCE_i$ represent positive shocks to capital and increases in $NRNPL_i$ represent negative shocks to capital, the coefficient *d* should be positive and the coefficient *e* should be negative. However, we expect these coefficients to be significant only in the regressions for portfolio loans and total loans, since there is no obvious reason why a negative shock to capital should reduce a bank's willingness to originate loans that do not remain on the balance sheet. The last variable in the equation is bank size, measured by the log of the bank's assets. Multi-market banks tend to be much larger than single-market banks. As a result, it is important to

control for size in the regressions to be sure that declines in lending by multi-market banks do not just reflect a tendency for large banks to cut back lending more than small banks.

We next estimate a set of pooled regressions for the years 2006-2009, using the growth in originations from the previous year as the dependent variable:

$$(2) \quad LNGROWTH_{i,m,t} = \sum_k b_k \cdot PERIPHERAL^k_{m,i,t-1} + \sum_k c_k \cdot PERIPHERAL^k_{,m,i,t-1} \cdot OTHLOSS_{m,i,t-1} + d \cdot TCE_{i,t-1} + e \cdot NRNPL_{i,,t-1} + f \cdot SIZE_{i,t-1}$$

Again, we estimate our pooled regressions using the growth rate of portfolio loans, securitized loans, and total loans. Each of these regressions includes not only fixed effects for the 376 metro markets but fixed effects for the four years.

**4. Data and sample statistics**

Our mortgage lending data consist of data collected annually under the Home Mortgage Disclosure Act (HMDA). These data include information on the location of the borrower, allowing us to compute mortgage originations at the county and metro-area levels. We include loans that are owner-occupied, conventional (i.e., non-government guaranteed), for purchase, and larger than $50,000 (as a proxy for first liens). We include only those loans that are either held by the originator or sold to an affiliate, and only those loans that are originated by banks, thrifts, or their affiliates. The data are aggregated by holding company and are adjusted for bank mergers to ensure that growth in a banking organization's mortgage originations in a market is not artificially inflated by the acquisition of other banks operating in that market. For convenience, we often refer to lenders in the sample as banks, even though some are bank

holding companies or stand-alone thrifts. Data on tangible equity capital and delinquencies on loans other than home mortgages are taken from the bank and thrift call reports.

Figure 1 displays the changes in home mortgage default rates in metro areas of the U.S. from before the financial crisis (2006 in the upper panel) to the middle of the financial crisis (2008 in the lower panel). The figure shows that a considerable number of metro areas experienced deteriorations in loan performance over the period. These metro areas shifted from relatively low default rates (yellow-shaded areas) to moderately high default rates (orange-shaded areas) in northern states, and to very high default rates (red-shaded areas) along the coasts and in the southern states. Some metro areas, however, experienced only modest declines in loan performance during the same period. These regional differences in the severity of the housing downturn highlight the advantages of using differences in multi-market banks' exposure to distressed housing markets to identify cross-market spillovers to lending.

The other loss rate, our measure of the average delinquency rate in a multi-market bank's other markets, is computed as follows. We first calculate the average 90-day mortgage delinquency rate for each metro area by taking the county-level delinquency rates reported by TrenData and weighting each delinquency rate by the share of the county in total metro area originations by all banks in the past two or three years. For each market and multi-market bank, we then calculate the average delinquency rate in the bank's other markets by weighting the metro area delinquency rate in each of the bank's other markets by the share of that market in the bank's total origination in other markets.

Table 1 presents descriptive statistics for observations on single-market banks, multi-market banks, and all banks during the pre-crisis period (2006 and 2007) and during the crisis-period (2007 and 2008). The table documents that multi-market banks reduced their lending

much more than single-market banks during the crisis period. The average annual rate of decline in mortgage originations was 4 to 5 times larger for banks operating in multiple markets than banks operating in a single market. Furthermore, throughout our sample period, multi-market banks were larger and less capitalized and faced higher loss rates in their loan portfolios (mortgage and non-mortgage) than single-market banks.

Table 2 presents sample statistics broken down by the share of the bank's loan originations in other markets. For each group of bank/market observations, the third column shows the median growth in total originations—including mortgages held in portfolio and mortgages sold to non-affiliates other than GSEs—from the pre-crisis period to the crisis period. The fourth column shows the median mortgage loss rate in the other markets in which the bank originates loans, while the last column shows the correlation between the growth in originations and the loss rate in other markets. The table provides further evidence that the steepest declines in lending during the crisis occurred in peripheral markets—with those accounting for less than one percent of a multi-market bank's total originations. The decline was especially sharp in extremely peripheral markets—those in which the share of other markets in the bank's originations was greater than 99 percent.

The table also shows that there was a negative and statistically significant correlation in peripheral markets between growth in originations and the other loss rate. These negative correlations are consistent with the view that the spillover effect dominated the substitution effect, causing shocks to local housing markets be transmitted across markets. It is important to note, however, that banks' mortgage loss rates were positively correlated across the markets in which they operated. Thus, the negative relationship between the growth in originations in a market and the mortgage loss rate in the bank's other markets could simply reflect a tendency for

loan demand in all of a bank's markets to move in the same direction during the crisis. A major advantage of our empirical strategy is that it can control for this effect by comparing the loan growth in each market of banks with high other loss rates to the loan growth in the same market of banks with low other loss rates.

## 5. Regression results

### 5.1 Cross section regression: from pre-crisis period to crisis period

Table 3 shows the regression results for equation (1), in which the dependent variable is the change in portfolio loan originations from the pre-crisis period to the crisis period. The three columns differ in terms of how finely we divide our observations on multi-market banks. Let $OTHSHARE_{m,i}$ be the share of bank *i*'s mortgages that are originated in markets other than market *m.* In column (1), we lump all multi-market observations together, defining them as observations in which OTHSHARE exceeds .01 In column (2), we divide observations on multi-market banks into two categories—those in which OTHSHARE, lies between .01 and .50, and those in which OTHSHARE falls between .50 and 1. Lastly, in column 3, we separate out the extreme peripheral markets by creating a third category of observations in which OTHSHARE exceeds .99. In all three cases, we interact the dummy variables for OTHSHARE with the other loss rate. These interactive variables allow us to determine if local lending responds differently to losses in other markets depending on the degree to which the local market is peripheral to the bank's overall lending.

The first rows in Table 3 show the estimated coefficients for our three measures of bank-level characteristics: the non-residential non-performing loan rate, bank size (log of total assets) and tangible common equity (TCE). Bank size is negative and significant in all three columns.

This finding suggests that large banks reduced their mortgage lending more than small banks during the transition from the pre-crisis period to the crisis period. We do not find any support in the table for the idea that home mortgage lending decreased in response to higher delinquencies on loans other than home mortgages or increased in response to higher capital. The coefficient on the delinquency rate on non-residential loans is positive in all three regressions, contrary to our expectation. Our measure of bank capital also fails to have the expected effect on home mortgage lending. The coefficient on this variable is statistically significant but negative in all three columns, implying that increases in bank capital actually reduce bank lending. This result could reflect the fact that well-capitalized banks tended to be conservative banks that reduced their exposure to mortgages faster than other banks during the crisis.

Our first variable of interest for our hypotheses is the interaction of other loss rate with the multi-market dummy in Column 1. The negative and significant coefficient on the interaction of multi-market dummy and the other loss rate provides support for the view that multi-market banking increases the vulnerability of markets to outside economic shocks. In particular, the result suggests that the spillover effect of outside loan supply shocks dominates the substitution effect of adverse loan demand shocks. To evaluate the economic significance of this effect, we consider a 50-basis point increase in other loss rate, which is well within the range of differences in the median for this variable across the pre-crisis and crisis years in Table 2. The coefficient of -19.8 on the interactive variable indicates that a 50 basis point increase in the other loss rate would be associated with about a 10 percent decrease in local lending. In other words, multi-market banks significantly reduced their lending in a local market when they suffered losses on their mortgage lending in other markets.

Our next variables of interest are the interactions of the other share dummy variables with the other loss rate when multi-market observations are broken down by the other share. In Column 2, the coefficient on the interaction of Peripheral (.01 to .50) with the other loss rate is negative but insignificant. This result implies that a bank's mortgage losses in other markets do not significantly reduce lending in a local market if the bank is doing less than half of its lending in other markets. On the other hand, the coefficient on the interaction of Peripheral (.50 to 1) with the other loss rate is both highly negative and significant at the 1 percent level. The coefficient of -31.3 implies that a 50-basis point increase in other loss rate would be associated with a greater than 15 percent drop in local lending. Based on these results, there appears to be a larger spillover effect in peripheral markets than in core markets.

Column 3 divides the multi-market observations still further to identify the spillover effect in extremely peripheral markets. Here, we define the Peripheral (.99 to 1) variable for those observations in which a multi-market bank is doing less than 1 percent of its lending in the local market. Interestingly, we find that the spillover effect increases as the local market becomes more peripheral. The coefficient on the interaction of Peripheral (.50 to .99) with the other loss rate is -23.6 and significant at the 1 percent level, but the interaction of Peripheral (.99 to 1) with other loss rate is -82.1 and significant at the 1 percent level. The latter result implies that a 50-basis point increase in other loss rate would be associated with a more than 40 percent drop in local lending in these extremely peripheral markets, an effect which is over three times as large as that in less peripheral markets. Here we find support for our hypothesis that the spillover effect is greatest in markets that represent just a small percentage of a multi-market bank's overall lending.

Table 4 shows the estimation results for the growth rate of securitized loans using the same three specifications as in table 3. As in table 3, the coefficient on bank size is negative and significant in all three columns, implying that large banks reduced their mortgage securitization more than small banks. The coefficients on the two measures of bank-level supply shocks were expected to be insignificant, since securitized loans do not remain on the bank balance sheet. Surprisingly, the coefficient on the non-residential non-performing loan rate is negative and significant in all three specifications, suggesting that securitized mortgage lending declines when delinquency rates go up on loans other than home mortgages. Moreover, the coefficient on the tangible equity capital ratio is positive and significant, indicating that securitized lending also falls in response to a decline in capital.

Regarding the impact of outside economic shocks, Table 4 shows some evidence that increases in securitized lending compensated for decreases in portfolio lending. In other words, we find that multi-market banks increase their securitized lending in local markets in response to higher loss rates in other markets. The coefficient on the interaction of other loss rate with the multi-market dummy in Column 1 is positive and significant at the 10 percent level. Our estimate indicates that a 50 basis point increase in the other loss rate leads to a 6 percent increase in the growth rate of securitized loans. When multi-market observations are broken down by their other share, our findings suggest that the shift from portfolio lending to securitized lending is larger in more peripheral markets. For instance, in column 2, the coefficient on the interaction of Peripheral (.01 to .50) with the other loss rate is positive and significant at the 10 percent, and in column 3, the coefficient on the interaction of Peripheral (.50 to .99) with the other loss rate is again positive and significant at the 10 percent level. However, we do not find a significant effect of the other loss rate on securitized loans in extremely peripheral markets (greater than .99).

Our results so far suggest that securitized mortgage lending helps offset the decline in portfolio mortgage lending in response to higher delinquency rates in other markets. We also examine the response of total loans (portfolio and securitized loans) to the outside economic shock to see if the positive effect on securitized loans completely offsets the adverse effect on portfolio loans.

Table 5 presents the regression results for the growth rate of total mortgage loans. Interestingly, we find that total loan originations decrease in response to higher delinquencies on loans other than home mortgages and increase in response to higher capital. More importantly, we still find support for our spillover hypothesis when looking at total mortgage loans: multi-market banks reduce their total mortgage lending in response to increased losses in other markets. The coefficient on the interaction of the multi-market dummy and the other loss rate in column 1 is -11.9 and significant at the 1 percent level. This estimate suggests that a 50 basis point increase in the other loss rate leads to a 6 percent contraction in the growth rate of total mortgage loans. This result also suggests that securitized loans only compensates for part of the reduction in portfolio loans following an increase in the loan default rates in other markets. As discussed in the Introduction, local portfolio lending by multi-market banks may be affected by both loan supply and loan demand shocks in the banks' other markets. A plausible interpretation of the negative response of total mortgage lending to mortgage losses in other markets is that the strongly negative spillover effect on portfolio lending from adverse supply shocks in other markets outweighs both the positive substitution effect on portfolio lending from adverse demand shocks in those markets and the compensating increase in securitized lending. Furthermore, columns 2 and 3 of table 5 indicate that, as before, the negative effect of the outside shock is bigger in more peripheral markets. The coefficients on the interactions of Peripheral (.50

to .99) and Peripheral (.99 to 1) with the other loss rate in column 3 are -14.3 and -58.4 respectively, both significant at the 1 percent level. The second coefficient implies that a 50-basis point increase in other loss rate would be associated with an almost 30 percent drop in local lending in these extremely peripheral markets.

### 5.2 Pooled regressions of the annual growth rate of mortgage loans

Table 6 shows the pooled regression results for equation (1), in which the dependent variable is now the annual growth rate of portfolio loan originations, securitized loans and total loan originations, each shown in columns 1, 2 and 3 respectively. Notice that unlike previous tables, which use three different specifications, table 6 presents the results using our most preferred specification, which breaks down the lending of multi-market banks in different splits of peripheral markets (column 3 in previous tables). The results are qualitatively similar to those in the cross-section regressions that examine the effects on the growth rate of mortgage originations from the pre-crisis to the crisis-period. As before, the coefficient on bank size is negative and significant in all three columns. This finding suggests that large banks reduced their mortgage lending more than small banks. The coefficients on the non-residential non-performing loan rate are significant in all three columns, but negative for portfolio loans and total loans and positive for securitized loans. These results are consistent with our findings in the cross-section regression and highlight again the different response of portfolio and securitized mortgage lending to higher delinquencies on loans other than home mortgages. However, we do not find much support in the pooled regressions for a positive effect of capital on mortgage lending. The coefficient on our measure of capital is positive and significant only for total loan originations.

Regarding the interaction of other loss rate with different peripheral market splits, Table 6 provides additional evidence that the spillover effect dominates for portfolio lending and that declines in portfolio lending are partly offset by increases in securitized lending. Column 1 shows the estimates for the growth rate of portfolio loans. The coefficient on the interactions of Peripheral (.50 to .99) and Peripheral (.99 to .1) with the other loss rate are negative and significant. Moreover, the coefficient on the latter interaction is 4 times bigger than that on the former interaction (-17.1 versus -4.7), which not only is consistent with a spillover effect in portfolio lending but also indicates that this effect is larger in highly peripheral markets. Our estimates for the growth of securitized loans in column 2 show that the coefficients on the two interactive terms are positive, though significant only for the interaction of Peripheral (.99 to .1) with the other loss rate. The latter result suggests that multi-market banks increased their securitized mortgage lending in extremely peripheral markets in response to higher loan losses in other markets, consistent with some replacement of portfolio lending by securitized lending in extremely peripheral markets. Lastly, column 3 shows the estimation results for the growth rate of total loans and provides further evidence that securitized loans to some extent compensate for the reduction in portfolio loans. The coefficient on the interactions of Peripheral (.50 to .99) and Peripheral (.99 to .1) with the other loss rate are negative and significant, but smaller than their counterparts in column 1. For example, the coefficient on the interactions of Peripheral (.99 to .1) with the other loss rate is -17.1 for portfolio mortgage loans (column 1) compared with -12.4 for total mortgage loans (column 3). This result implies that 50-basis point increase in other loss rate would lead to about a 9 percent drop in portfolio mortgage originations in highly peripheral markets, but to only a 6 percent drop in total mortgage originations in those markets. Notice that the results in the pooled regressions differ from our previous cross-section results primarily in

the smaller size of the interaction coefficients. One possible explanation for the difference is that the coefficients in Table 6 are based on annual growth in originations, while those in Tables 3-5 are based on growth from the two pre-crisis years to the two crisis years.

## 6. Conclusion

This paper builds on previous literature on the transmission of financial shocks across markets and countries. We use the variation in home mortgage lending among multi-market banks with different exposures to mortgage losses in other markets to study the transmission of outside economic shocks across U.S. metro areas during the recent financial crisis. We find that multi-market banks reduced their local mortgage lending in response to increased mortgage delinquency rates in other markets. This finding is consistent with the view that geographic diversification in banking increases the vulnerability of markets to outside economic shocks through the spillover of adverse loan supply shocks. We also find evidence that this spillover effect was bigger in multi-market banks' peripheral markets than their core markets. Finally, our results suggest that the cross-market transmission of economic shocks was mitigated to a modest degree by a tendency for multi-market banks to increase their securitized lending at the same time they reduced their portfolio lending.

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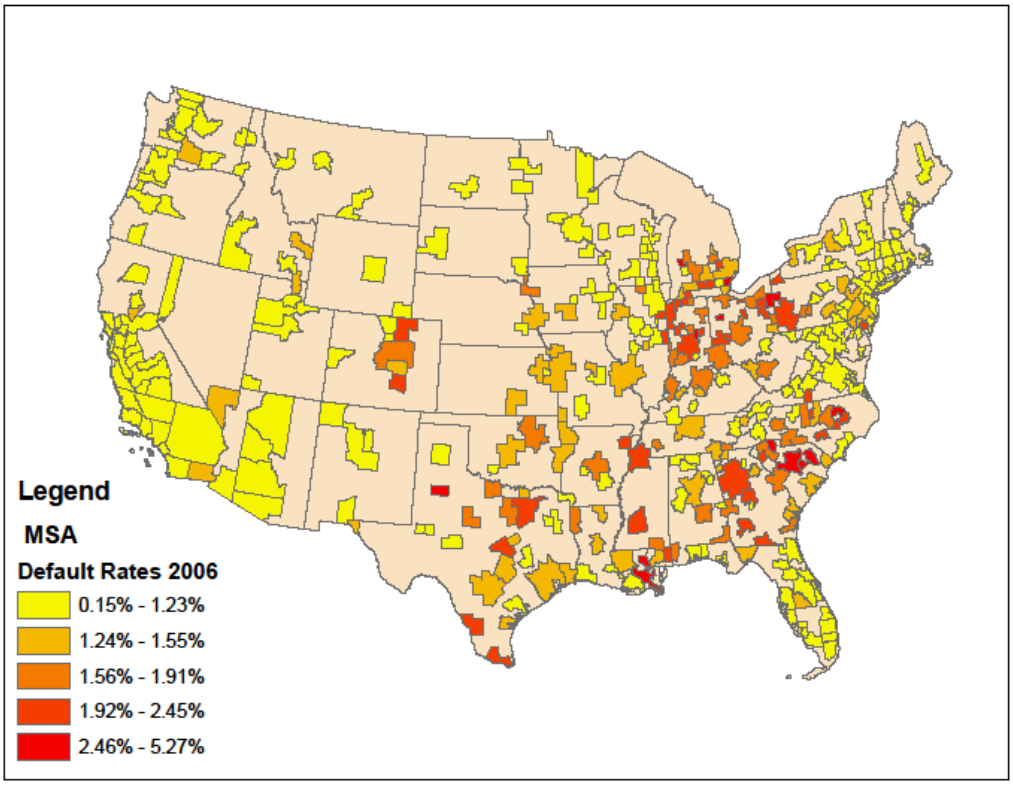
**Figure 1: Market (MSA) Default Rates**



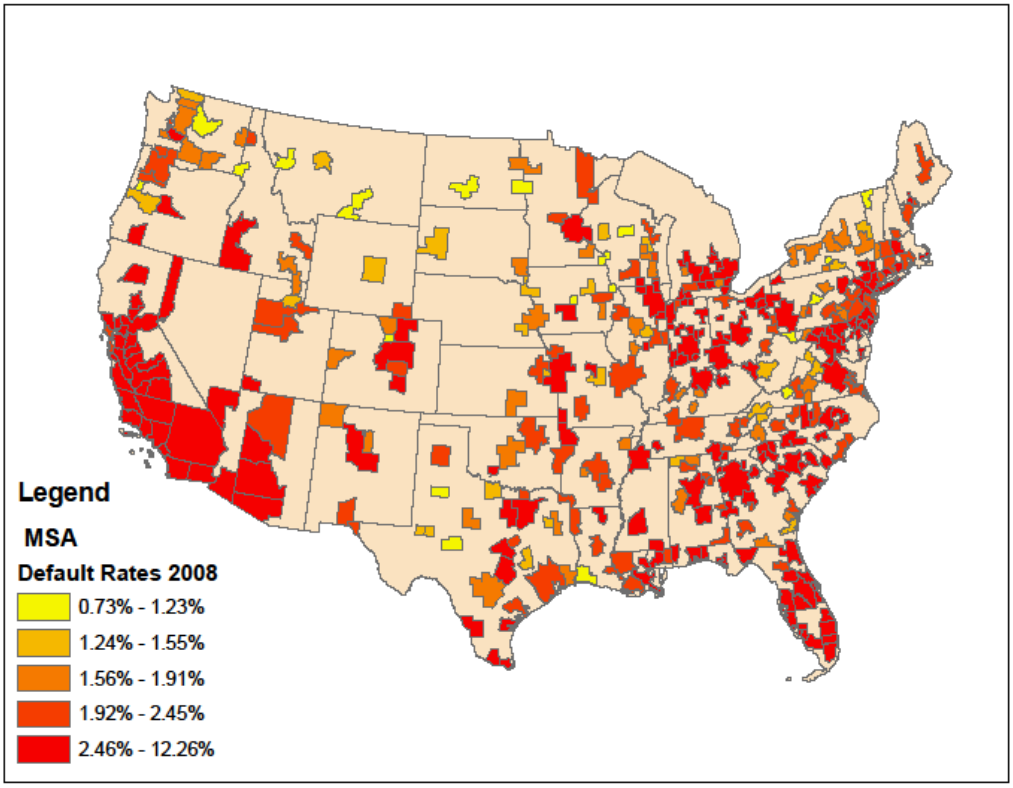



**Table 1: Summary Statistics (Means) for Single and Multi-Market Banks**

| | Pre Crisis 2006-2007 | Crisis 2008 - 2009 |
|---|---|---|
| Single Market | | |
| Bank Size (Total assets in millions) | 337 | 394 |
| Tangible Common Equity (TCE) | 9.94 | 9.96 |
| Non Residential Non Performing Loan Rate | 0.30 | 1.41 |
| Loan Growth: Portfolio + Securitized | -3.44 | -10.65 |
| Loan Growth: Portfolio | -4.07 | -6.66 |
| Loan Growth: Securitized | 0.15 | -25.81 |
| Multi Market | | |
| Bank Size (Total assets in millions) | 184,000 | 302,000 |
| Tangible Common Equity (TCE) | 7.35 | 7.33 |
| Non Residential Non Performing Loan Rate | 0.44 | 2.01 |
| Loan Growth: Portfolio + Securitized | -18.25 | -61.17 |
| Loan Growth: Portfolio | -13.37 | -54.74 |
| Loan Growth: Securitized | -31.82 | -64.36 |
| Full Sample | | |
| Bank Size (Total assets in millions) | 159,000 | 243,000 |
| Tangible Common Equity (TCE) | 7.71 | 7.85 |
| Non Residential Non Performing Loan Rate | 0.42 | 1.89 |
| Loan Growth: Portfolio + Securitized | -16.21 | -51.25 |
| Loan Growth: Portfolio | -12.09 | -45.30 |
| Loan Growth: Securitized | -29.40 | -58.51 |

**Table 2: Banks' Loan Growth and Share of Organization's Loan Originations in Other Markets (Median)**

| Banks | Other Share | Growth of loan originations from Pre Crisis to Crisis (%) | Other Loss Rate (%) | Correlation Coefficient | Number of Observations |
|---|---|---|---|---|---|
| Single Market | < .01 | 57.842 | 0.011 | NA | 1730 |
| Multi Market | > .01 | -24.608 | 1.939 | -0.102*** | 6853 |
| | ( .01 to .50 ) | -9.531 | 1.803 | -0.037 | 876 |
| | ( .50 to .99 ) | -14.689 | 1.884 | -0.086*** | 2831 |
| | ( .99 to 1 ) | -37.732 | 2.026 | -0.112*** | 3146 |

**significant at 5 percent level; ***significant at 1 percent level

## Table 3: Portfolio Loan Growth from Pre-Crisis Period to Crisis Period

This table reports regression estimates for equation (1). Loan growth is the log growth in mortgage originations from the pre-crisis period (2006 and 2007) to the crisis period (2008 and 2009). Robust standard errors are in brackets. Each specification has market fixed effects. All data are winsorized at the 1% level.

| | ( 1 ) | ( 2 ) | ( 3 ) |
|---|---|---|---|
| Non-residential non-performing loan rate | 0.899 | 0.966 | 0.924 |
| | [0.589] | [0.588] | [0.586] |
| Bank size (Log of Total Assets) | -15.845*** | -16.378*** | -17.566*** |
| | [0.433] | [0.474] | [0.562] |
| Tangible common equity (TCE) | -0.935** | -0.876** | -0.715* |
| | [0.413] | [0.412] | [0.410] |
| Multi Market | 43.609*** | | |
| | [6.179] | | |
| Multi market * Other loss rate | -19.837*** | | |
| | [2.990] | | |
| Peripheral (.01 to .50) | | 15.676 | 15.573 |
| | | [13.241] | [13.185] |
| Peripheral (.01 to .50) * Other loss rate | | -11.499 | -10.693 |
| | | [7.192] | [7.160] |
| Peripheral (.50 to 1) | | 71.309*** | |
| | | [7.420] | |
| Peripheral (.50 to 1) * Other loss rate | | -31.329*** | |
| | | [3.705] | |
| Peripheral (.50 to .99) | | | 56.233*** |
| | | | [8.144] |
| Peripheral (.50 to .99) * Other loss rate | | | -23.606*** |
| | | | [4.108] |
| Peripheral (.99 to 1) | | | 187.752*** |
| | | | [16.461] |
| Peripheral (.99 to 1) * Other loss rate | | | -82.083*** |
| | | | [8.069] |
| Market Fixed Effects | yes | yes | yes |
| Observations | 8583 | 8583 | 8583 |
| Adjusted R-squared | 0.27 | 0.28 | 0.29 |

*significant at 10 percent level; **significant at 5 percent level; *** significant at 1 percent level

## Table 4: Securitized Loan Growth from Pre-Crisis Period to Crisis Period

This table reports regression estimates for equation (1). Loan growth is the log growth in securitized mortgage loans from the pre-crisis period (2006 and 2007) to the crisis period (2008 and 2009). Robust standard errors are in brackets. Each specification has market fixed effects. All data are winsorized at the 1% level.

| | ( 1 ) | ( 2 ) | ( 3 ) |
|---|---|---|---|
| Non-residential non-performing loan rate | -6.074*** | -6.166*** | -5.574*** |
| | [1.986] | [1.990] | [1.991] |
| Bank size (Log of Total Assets) | -21.680*** | -22.225*** | -25.139*** |
| | [1.005] | [1.093] | [1.299] |
| Tangible common equity (TCE) | 5.882*** | 5.981*** | 6.485*** |
| | [1.154] | [1.158] | [1.160] |
| Multi Market | 6.911 | | |
| | [14.015] | | |
| Multi market * Other loss rate | 11.862* | | |
| | [6.611] | | |
| Peripheral (.01 to .50) | | 34.101 | 36.808 |
| | | [28.006] | [27.938] |
| Peripheral (.01 to .50) * Other loss rate | | -6.091 | -5.958 |
| | | [15.248] | [15.207] |
| Peripheral (.50 to 1) | | 6.005 | |
| | | [16.563] | |
| Peripheral (.50 to 1) * Other loss rate | | 14.479* | |
| | | [8.123] | |
| Peripheral (.50 to .99) | | | 6.051 |
| | | | [17.669] |
| Peripheral (.50 to .99) * Other loss rate | | | 16.270* |
| | | | [8.719] |
| Peripheral (.99 to 1) | | | 96.330** |
| | | | [40.440] |
| Peripheral (.99 to 1) * Other loss rate | | | -14.616 |
| | | | [19.715] |
| Market Fixed Effects | yes | yes | yes |
| Observations | 3778 | 3778 | 3778 |
| Adjusted R-squared | 0.24 | 0.24 | 0.25 |

*significant at 10 percent level; **significant at 5 percent level; *** significant at 1 percent level

## Table 5: Total Loan Growth from Pre-Crisis Period to Crisis Period

This table reports regression estimates for equation (1). Loan growth is the log growth in total mortgage originations (portfolio loans and securitized loans) from the pre-crisis period (2006 and 2007) to the crisis period (2008 and 2009). Robust standard errors are in brackets. Each specification has market fixed effects. All data are winsorized at the 1% level.

| | ( 1 ) | ( 2 ) | ( 3 ) |
|---|---|---|---|
| Non-residential non-performing loan rate | -1.959*** | -1.939*** | -1.983*** |
| | [0.562] | [0.561] | [0.559] |
| Bank size (Log of Total Assets) | -15.699*** | -16.348*** | -17.607*** |
| | [0.413] | [0.452] | [0.537] |
| Tangible common equity (TCE) | 1.184*** | 1.242*** | 1.376*** |
| | [0.393] | [0.393] | [0.392] |
| Multi Market | 26.394*** | | |
| | [5.890] | | |
| Multi market * Other loss rate | -11.864*** | | |
| | [2.850] | | |
| Peripheral (.01 to .50) | | 10.472 | 10.791 |
| | | [12.632] | [12.591] |
| Peripheral (.01 to .50) * Other loss rate | | -9.791 | -9.193 |
| | | [6.861] | [6.837] |
| Peripheral (.50 to 1) | | 47.042*** | |
| | | [7.079] | |
| Peripheral (.50 to 1) * Other loss rate | | -19.490*** | |
| | | [3.535] | |
| Peripheral (.50 to .99) | | | 36.823*** |
| | | | [7.777] |
| Peripheral (.50 to .99) * Other loss rate | | | -14.253*** |
| | | | [3.923] |
| Peripheral (.99 to 1) | | | 139.854*** |
| | | | [15.720] |
| Peripheral (.99 to 1) * Other loss rate | | | -58.443*** |
| | | | [7.706] |
| Market Fixed Effects | yes | yes | yes |
| Observations | 8583 | 8583 | 8583 |
| Adjusted R-squared | 0.31 | 0.31 | 0.32 |

*significant at 10 percent level; **significant at 5 percent level; *** significant at 1 percent level

## Table 6: Pooled Regressions of Loan Growth with Annual Data

This table presents regression estimates for equation (2). The dependent variable is the annual log growth in portfolio loans, securitized loans and total loans. Robust standard errors are in brackets. Each specification has market and time fixed effects.

| | Portfolio Loans (1) | Securitized Loans (2) | Total Loans (3) |
|---|---|---|---|
| Non-residential non-performing loan rate | -1.918*** | 1.403** | -1.056*** |
| | [0.289] | [0.628] | [0.265] |
| Bank size (Log of Total Assets) | -4.543*** | -5.743*** | -4.201*** |
| | [0.291] | [0.543] | [0.267] |
| Tangible common equity (TCE) | 0.249 | 0.097 | 0.593*** |
| | [0.228] | [0.484] | [0.209] |
| Peripheral (.01 to .50) | -3.675 | 9.534 | -5.537 |
| | [5.092] | [9.294] | [4.664] |
| Peripheral (.01 to .50) * Other loss rate | -3.696 | -3.198 | -1.227 |
| | [2.788] | [5.188] | [2.553] |
| Peripheral (50 to .99) | 1.246 | -7.415 | -0.567 |
| | [2.795] | [5.197] | [2.561] |
| Peripheral (.50 to .99) * Other loss rate | -4.698*** | 0.614 | -3.765*** |
| | [1.241] | [2.226] | [1.136] |
| Peripheral (.99 to 1) | 31.015*** | -43.781*** | 12.784*** |
| | [2.753] | [5.250] | [2.521] |
| Peripheral (.99 to 1) * Other loss rate | -17.097*** | 19.056*** | -12.411*** |
| | [0.971] | [1.983] | [0.890] |
| Year Fixed Effects | yes | yes | yes |
| Market Fixed Effects | yes | yes | yes |
| Observations | 44192 | 19354 | 44192 |
| Adjusted R-squared | 0.06 | 0.10 | 0.08 |

*significant at 10 percent level; **significant at 5 percent level; *** significant at 1 percent level