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

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December 2011

Abstract:

This paper investigates the mortgage lending of banks operating in multiple metropolitan areas of the U.S. during the housing market collapse of 2007-2009. Some regions of the U.S. suffered much larger declines in house prices and increases in mortgage delinquencies than others. We use this regional variation to identify whether losses in high-delinquency markets affected multi-market banks' lending in lower-delinquency markets. Our results show that multi-market banks reduced their mortgage lending in lower-delinquency markets in response to these losses, consistent with the view that local shocks to bank capital can have a spillover effect on other regions through banks' internal capital markets. Interestingly, this effect is greatest in highly peripheral markets where multi-market banks originate a very small share of their total mortgage loans. We find that securitized lending may have somewhat mitigated the decline in portfolio lending, but that the effect on total lending is still economically significant. These findings point to greater contagion of local economic shocks due to the geographic diversification of multi-market banks.

Keywords: Contagion, multi-market banks, mortgage lending, securitization
JEL Classification: G21, G32, R12, R31

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We thank Paolo Fulghieri for insightful comments and presentation participants at the FDIC, Bocconi University and Federal Reserve Board as well as Christine Coyer, Sean Flynn, Lieu Hazelwood, Michelle Welch and Eric Hardy for research assistance. The opinions expressed do not necessarily reflect those of the Federal Reserve Board, the Federal Reserve Bank of Kansas City, or their staffs.

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:

$$(1)\quad LNGROWTH_{i,m} = \sum_m a_m \cdot MARKET_{i,m} + b \cdot SIZE_i + c \cdot \Delta TCE_i + d \cdot \Delta NRNPL_i + e \cdot \Delta LOCALLOSS_{i,m} + \sum f_k \cdot PERIPHERAL^k_{i,m} + \sum_k g_k \cdot PERIPHERAL^k_{i,m} \cdot \Delta OTHERLOSS_{i,m} + \varepsilon_{i,m}$$

Only bank/market observations with positive mortgage originations in both the pre-crisis and crisis periods are included in the sample. The dependent variable, $LNGROWTH_{i,m}$, is the log growth in bank *i*'s mortgage originations in metro area *m* from the pre-crisis period (2006 and 2007 combined) to the crisis period (2008 and 2009 combined).

As indicated above, each regression includes a set of dummy variables for the 376 metro markets in the sample, $MARKET_{i,m}$, to control for differences in mortgage demand across markets. The next set of explanatory variables control for bank-level characteristics that could affect a bank's lending in all markets. Bank size, $SIZE_i$, is measured by the log of the bank's assets at the end of 2007. As will be documented below, 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 during the crisis. ΔTCE_i is the change in the ratio of bank *i*'s tangible equity capital to assets from the end of 2005 to the end of 2007. $\Delta NRNPL_i$ is the change over the same period in the percent of bank *i*'s loans other than home mortgages that were non-performing. These last two variables control for bank-level supply shocks in the period leading up to the crisis. Assuming high values of ΔTCE_i represent positive shocks to capital and high values of $\Delta NRNPL_i$ represent negative shocks to capital, the coefficient *c* should be positive and the coefficient *d* should be negative.

The remaining variables in (1) are at the bank/market level. $\Delta LOCALLOSS_{i,m}$ is the average change in the delinquency rate from the end of 2005 to the end of 2007 in metro market *m* for bank *i*. This average is computed by weighting the change in the delinquency rate on all mortgages in each county in metro market *m* by the share of that county in bank *i*'s total originations in market *m*. This variable measures the tendency of a bank to lend in those counties of a metro area that have experienced more severe housing problems. Thus, it represents an additional control besides market fixed effects for local mortgage demand. Specifically, market fixed effects control for differences in mortgage demand across markets, while $\Delta LOCALLOSS_{i,m}$ controls for difference in local demand within a metro market.

The remaining variables are nonzero only for multi-market banks, defined here as banks that lend in more than one market and originate less than 99 percent of their loans in a single market. $PERIPHERAL^{k}_{,m,i}$ are dummy variables indicating the share of market *m* in bank *i*'s total mortgage lending, with higher values of *k* corresponding to smaller shares of total lending. Put another way, higher values of *k* indicate that market *m* is more peripheral to bank *i*. These dummy variables enter the regressions in two ways--alone and interacted with the variable $\Delta OTHERLOSS_{m,i}$. The latter variable is the average change in the mortgage delinquency rate from the end of 2005 to the end of 2007 in all metro markets in which bank *i* originated loans other than market *m*.

In each regression, the sign and magnitude of the coefficients g_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 estimate the regressions for two categories of mortgage originations--portfolio loans and total loans. Portfolio loans are those originated and held on banks' books. Total loans are the sum of portfolio loans and securitized loans, which are defined as those originated and sold to GSEs or to non-affiliates in the private sector. 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 total loans indicates whether banks offset the impact of outside economic shocks on their local portfolio lending by changing their local securitized lending in the opposite direction.

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:

$$(1)\quad LNGROWTH_{i,m,t} = \sum_m a_m \cdot MKTYEAR_{i,m,t} + b \cdot SIZE_{i,t-1} + c \cdot \Delta TCE_{i,t-1} + c \cdot \Delta NRNPL_{i,t-1} + e \cdot \Delta LOCALLOSS_{i,m,t-1} + \sum_k f_k \cdot PERIPHERAL^k_{i,m,t-1} + \sum_k g_k \cdot PERIPHERAL^k_{i,m,t-1} \cdot \Delta OTHERLOSS_{i,m,t-1} + \varepsilon_{i,m,t}$$

In this case, each regression includes a set of dummy variables, $MARKET_{i,m,t}$, for the 1,504 market/year combinations in the sample (376 x 4). These variables control for differences in local demand across metro markets in each of the four years. The other variables in (2) are the same as in equation (1), except that they are for the previous year instead of the pre-crisis period.

Again, we estimate our pooled regressions using as dependent variable both the growth in portfolio originations and the growth in total originations.

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). For portfolio lending, 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. For total lending, we add those loans that are sold to GSE's or non-affiliates in the private sector. 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 lending 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 change in the local loss rate and the change in the other loss rate, our measures of the deterioration in local and outside housing markets, are computed as follows. For any metro market, a bank's local loss rate is a weighted average of the 90-day mortgage delinquency rates reported by TrenData in all the component counties in which the bank originated loans in the pre-crisis period. The weight for each of these counties is the share of the county in the bank's total pre-crisis mortgage originations in the market in question. The local loss rate is defined for both single-market and multi-market banks. For any metro market, a bank's other loss rate is a weighted average of the 90-day mortgage delinquency rates for all other metro countries in which the bank originated loans in the pre-crisis period. In this case, the weight for each of these counties is the share of the county in the bank's total pre-crisis, metro-area originations outside the market in question. In contrast to the local loss rate, the other loss rate is defined only for multi-market banks.

Table 1 presents statistics on the dollar volume of mortgage originations by type of bank and type of lending. The data are for the sample used to estimate equation (1). As a result, they include only those bank/market observations for which portfolio originations were positive in both the pre-crisis and crisis periods. Single-market banks are those with that originated at least 99 percent of their loans in a single market in the pre-crisis period. Multi-market banks are those that made loans in more than one market and originated less than 99 percent of their total loans in each of those markets.

Three facts are apparent from the table. First, though single-market banks represent almost a quarter of banks in the sample, they account for only a tiny fraction of total mortgage originations due to their small size. Second, while portfolio lending declined at both types of banks in the sample from the pre-crisis period to the crisis period, the decline was especially great at the multi-market banks that account for the vast majority of mortgage loans--66.3 percent. The overall magnitude of the decline in portfolio lending at multi-market banks suggests that the sample may provide a good opportunity for examining the effect of loan losses in depressed markets on a bank's lending in healthier markets. Third, at multi-market banks, securitized originations were about equal to portfolio originations in the pre-crisis period and exceeded portfolio originations during the crisis. This fact raises the possibility that above-average declines in local portfolio lending by some banks due to spillover effects may have been offset by below-average declines in local securitized lending by the same banks. Estimating our regression equations for total originations provides a check against this possibility.

Table 2 presents statistics on bank size, growth in total mortgage originations, and mortgage loss rates for the same sample as in Table 1. The 14,491 bank/market observations in the sample are broken down by the share of the market in the bank's total pre-crisis portfolio originations. For multi-market banks, we refer to a market that accounts for 50 to 99 percent of the bank's total portfolio originations as a "core" market for the bank. Note that by this definition, a bank whose lending was highly diversified across markets could have no core market. A market accounting for 1 to 50 percent of the bank's total originations is referred to as "peripheral," and a market representing less than 1 percent of the bank's originations as "highly peripheral."

Table 2 highlights a number of interesting differences among the categories of observations. Not surprisingly, median bank size increased with the extent to which the market was peripheral to the bank. At one extreme, single-market banks in the sample had median assets of only $156 million at the end of 2007. At the other extreme, banks lending in markets that were highly peripheral for them had median assets of $72 billion. Table 2 also shows that the growth of total originations from pre-crisis to crisis was lower in markets that were more peripheral to the bank. Median loan growth in log terms ranged from a high of 5.0 percent in single-market banks to a low of -93.2 percent in highly peripheral observations. Finally, although both local loss rates and other loss rates increased, the other loss rate went up only slightly more than the local loss rate in core markets but quite a bit more than the local loss rate in peripheral markets. The gap was especially great in highly peripheral markets, where the median change in the other loss rate was three times the median change in the local loss rate.

Table 3 reports the correlations in the sample among the growth in originations and the two loss rates. The third column shows that in all three types of markets in which multi-market banks originated loans, the growth in originations from the pre-crisis period to the crisis period was negatively correlated with the change in the other loss rate. Furthermore, the correlation was more negative in peripheral markets than in core markets, and more negative in highly peripheral markets than in peripheral markets. These results are consistent with the view that the spillover effect dominated the substitution effect, causing shocks to local housing markets to be transmitted across markets. It is important to note, however, that in both core markets and peripheral markets, the correlation between the change in the local loss rate and the change in the other loss rate was highly positive. Furthermore, in both types of markets, the growth in originations was just as negatively correlated with the change in the local loss rate as with the

change in the other loss rate.[1] These facts suggest that the negative relationship between the growth in originations in a market and the change in the loss rate in the bank's other markets could simply reflect a tendency for loan demand in all of the markets in which the bank lends 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 4 shows the regression results for equation (1), in which the dependent variable is the growth in portfolio loan originations from the pre-crisis period to the crisis period. As described in the previous section, our main variables of interest are the interaction of our multi-market variables with the other loss rate. These interactions identify whether a multi-market bank's losses in other, non-local markets affects its mortgage lending in the local market. This is the main spillover hypothesis that we want to test.

The three columns differ in how granularly we divide our observations on multi-market banks. In column (1), we treat all multi-market banks as a single category, defining them as banks that originate less than 99 percent of their mortgage loans in the local market. In column (2), we divide observations on multi-market banks into two categories: Core Market and Peripheral Market. Core Market indicates a multi-market bank that does 50 to 99 percent of its mortgage lending in the local market, whereas Peripheral Market indicates a multi-market bank that does less than 50 percent of its mortgage lending in the local market. In other words, the terms "core" and "peripheral" refer to whether the market is core or peripheral to a bank's

[1]In highly peripheral markets, it was also true that the correlation between the two loss rates was positive and the correlation between the growth in originations and the change in the local loss rate was negative. However, both correlations were considerably smaller than in core and peripheral markets.

mortgage lending operations. Lastly, in column 3, we separate out Highly Peripheral Market, which indicates a multi-market bank that does less than 1 percent of its mortgage lending in the local market. In all three cases, we interact the dummy variables for how peripheral the market is to the bank with the weighted average loss rate in the bank's other markets. These interactions 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 4 show the estimated coefficients for our three bank-level variables: size (log of total assets), the change in tangible common equity (TCE), and the change in the non-residential non-performing loan rate (NRNPL). Bank size is negative and significant in all three columns, suggesting that large banks reduced their mortgage lending more than small banks during the transition from the pre-crisis period to the crisis period. Given that multi-market banks tend to be much larger than single-market banks, this is consistent with the basic descriptive statistics in Table 2 showing that multi-market banks dramatically reduced their mortgage lending in the crisis.

The changes in TCE and NRNPL can be thought of as bank-level supply shocks stemming from changes in a bank's overall health. The coefficient on our measure of the change in the bank's capitalization is negative and statistically significant in all three columns, implying that increases in bank capital reduce bank lending. This result is somewhat counterintuitive, but it is consistent with some previous findings on the relationship between bank capital and liquidity creation. For example, Berger and Bouwman (2006) find a negative relationship between capital and liquidity creation at small banks, which they note is consistent with the "financial fragility-crowding out" hypothesis of Diamond and Rajan (2000) and Gorton and Winton (2000). The negative coefficient on the change in TCE in Table 4 could also 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.

We find support for the idea that home mortgage lending decreased in response to banks' higher delinquencies on loans other than home mortgages. The coefficient on the change in the non-performing loan rate for non-residential loans is negative in all three regressions, indicating that banks reduced their home mortgage lending in response to losses on other types of loans, such as commercial and consumer. This is our first evidence of spillover of loan losses to lending, but across different types of loan markets rather than different regions.

The next set of rows show the coefficient estimates for our bank/market variables. As can be seen in the first of these rows, the coefficients on the change in local loss rate are negative and significant. This result indicates that banks that lend to higher-delinquency counties within a market tend to reduce their local lending more than banks that lend to lower-delinquency counties in the same market. To evaluate the economic significance of this effect, we consider a 30-basis point increase in the local loss rate, which is well within the range for the median change in this variable in Table 2. The coefficient of -13.1 in Column 3 indicates that a 30 basis point increase in the local loss rate would be associated with about a 3.9 percent decrease in local lending. This result could signify that the higher-delinquency counties within a market experience bigger declines in borrowers' demand for mortgages or in borrowers' average creditworthiness.

The first variable of interest for our hypotheses about the cross-market transmission of economic shocks is the interaction of the change in the 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 change in 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. A 50 basis-point increase in the other loss rate would be well within the range of median changes in this variable shown in Table 2. The coefficient of -25.1 on the interactive variable indicates that such an increase in the other loss rate would be associated with about a 12.5 percent decrease in local lending. In other words, multi-market banks significantly reduced their lending in a local market when they suffered typical losses on their mortgage lending in other markets. We believe that this result provides a clean test of how a shock external to local demand can affect local lending through changes in bank loan supply.

Our next variables of interest are the interactions of the change in the other loss rate with dummy variables indicating the degree to which the local market is peripheral to the bank's lending operations. In Column 2, the coefficient on the interactions of the change in the other loss rate with Core Market and Peripheral Market are both negative but significant, but the coefficient on Peripheral Market is over twice as large and significant at the 1 percent level. (The difference in the interaction coefficients is significant at the 5 percent level.). The coefficient of -39.8 on the Peripheral Market interaction implies that a 50-basis point increase in other loss rate would be associated with almost a 20 percent drop in local lending. These results indicate that a bank's mortgage losses in other markets have a bigger effect on its local market lending if the bank is doing less than half of its lending in the local market than if is doing more than half of its lending in that market. In other words, 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 highly peripheral markets. As described above, we define a market to be highly

peripheral for a multi-market bank when the bank is doing less than 1 percent of its lending in that market. Interestingly, we find that the spillover effect increases as the local market becomes more peripheral. The coefficient on the interaction of Core Market with the change in the other loss rate is -15.7 and significant at the 5 percent level, but the interaction of Highly Peripheral with the change in other loss rate is -81 and significant at the 1 percent level. (The difference in the interaction coefficients is significant at the 1 percent level.) The latter result implies that a 50-basis point increase in the other loss rate would be associated with a more than 40 percent drop in local lending in these highly peripheral markets, an effect over five times as large as when the local market is a core market for the bank. 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.

Our results so far suggest that portfolio mortgage lending declines in response to higher delinquency rates in other markets. We interpret this result to be consistent with a local shock to the bank's capital being transmitted through the bank to other markets via the bank's internal capital market. However, it is possible that securitized mortgage lending may mitigate the decline in portfolio mortgage lending by providing a means of mortgage origination which does not rely on the bank's balance sheet. If securitized lending fully replaced the portfolio lending in these situations, there would not be any significant real effects due to the cross-market spillover of shocks that we have identified. To determine whether the effect on securitized loans offsets the adverse effect on portfolio loans, we examine the response of total loan originations (portfolio and securitized loans) to economic shocks in other markets.

Table 5 presents the regression results for the growth rate of total mortgage loan originations using the same three specifications as in Table 3. The results for our bank-level

variables are roughly consistent with our previous results, but the effect of the change in the bank's non-residential non-performing loan rate appears to be somewhat dampened. 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 change in the other loss rate in column 1 is -14.6 and significant at the 1 percent level. This estimate suggests that a 50 basis point increase in the other loss rate leads to a 7 percent contraction in the growth rate of total mortgage originations. This result suggests that securitized lending only partially offsets the reduction in portfolio lending 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.

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 Market and Highly Peripheral Market with the change in the other loss rate in column 3 are -16.7 and -49.1 respectively, both significant at the 1 percent level (the difference between the highly peripheral interaction and the core interaction is 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 25 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 (2) for the entire period, 2006-2009. The dependent variables are now the annual growth rate of portfolio loan originations and the annual growth of total loan originations, shown in columns 1 and 2 respectively. Notice that unlike the previous tables, which use three different specifications, Table 6 uses our preferred specification, which breaks down the lending of multi-market banks into three categories of markets—core, peripheral, and highly peripheral (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 over the four-year period. As before, the coefficients on the change in tangible common equity and the change in non-residential non-performing loan rate are also negative and significant in both columns.

Regarding the interaction of the change in the 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 only partly offset by changes in securitized lending. Column 1 shows the estimates for the growth rate of portfolio loan originations. The coefficients on the interactions of Peripheral Market and Highly Peripheral Market with the change in the other loss rate are both negative and significant. Moreover, the coefficient on the latter interaction is twice as big as that on the former interaction (-18.3 versus -7.1, a difference that is significant at the 1 percent level). This result is not only consistent with a spillover effect in portfolio lending but also indicates that the effect is larger in highly peripheral markets.

Column 2 shows the estimation results for the growth of total originations and provides further evidence that securitized lending failed to offset the reduction in portfolio lending due to losses in other markets. The coefficients on the interactions of Peripheral and Highly Peripheral with the change in the other loss rate are again negative. The coefficient on the interaction terms for Peripheral is only slightly less negative for total lending than for portfolio lending. Also, in contrast to Tables 4 and 5, the coefficient on the interaction term for Highly Peripheral is slightly larger for total lending than portfolio lending. Notice finally that the results in the pooled regressions differ from our previous cross-section results in the smaller size of the interaction coefficients. One possible explanation for these differences is that the coefficients in Table 6 are based on annual growth in originations, while those in Tables 4 and 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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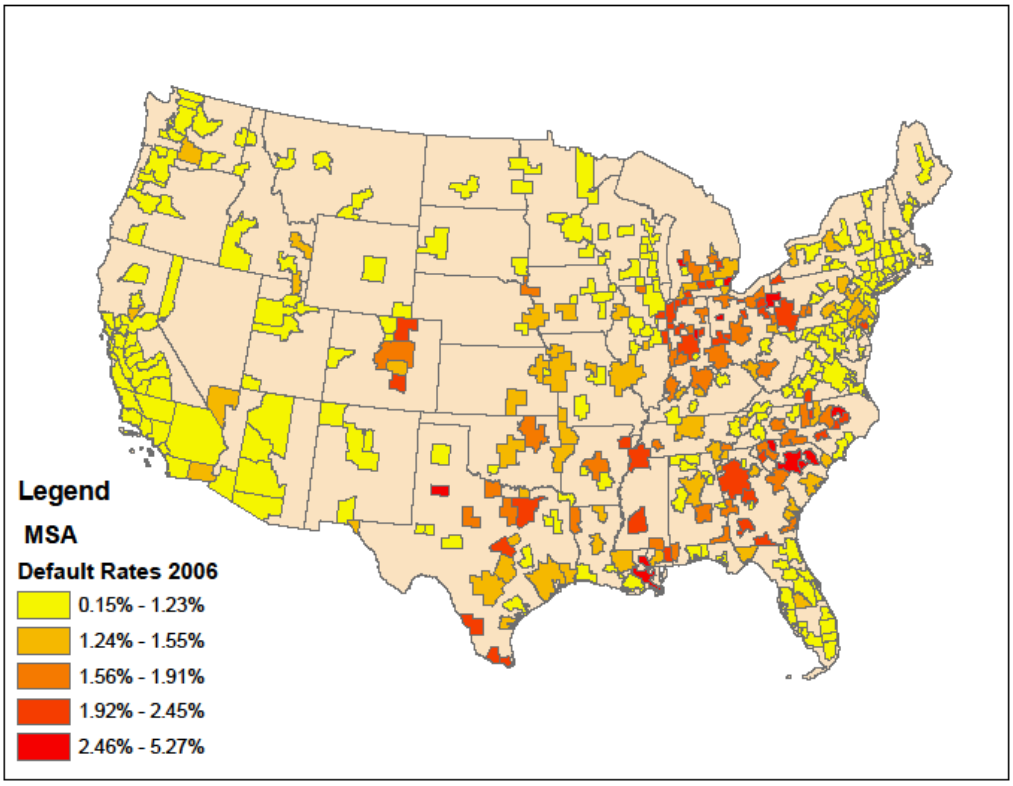
Figure 1: Market (MSA) Default Rates



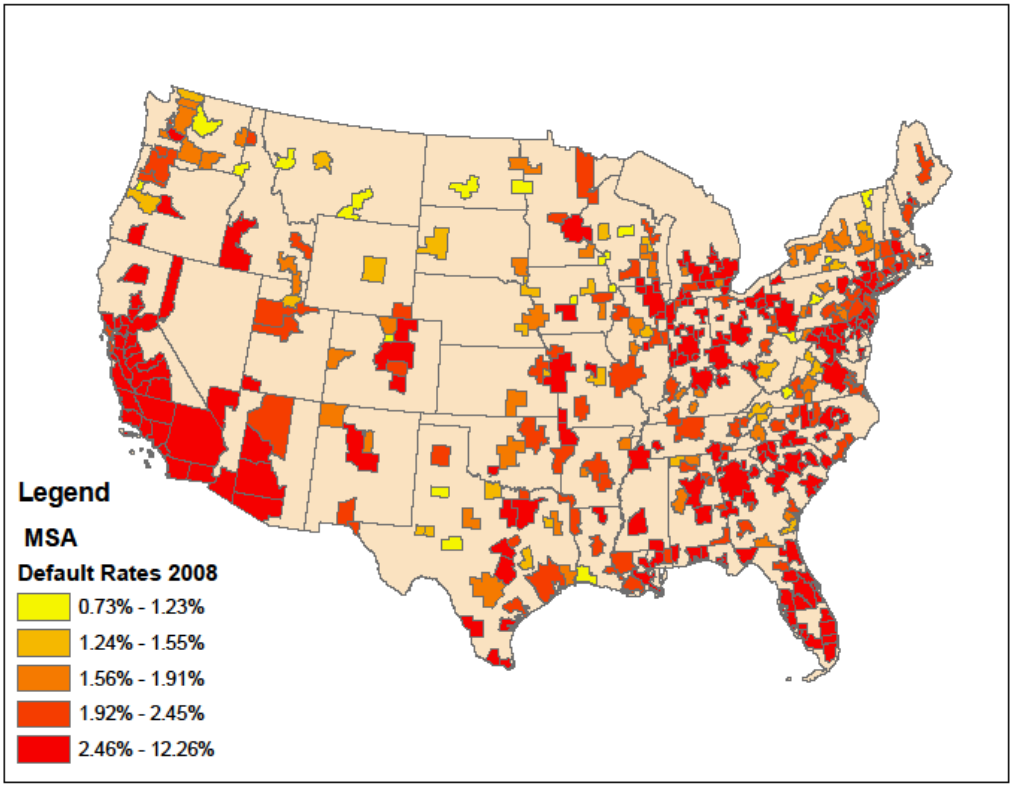


Table 1: Sample Statistics on Mortgage Originations, Pre-Crisis versus Crisis

Type of bank and type of lending	Pre-crisis originations (2006-2007), millions of dollars	Crisis originations (2008-2009), millions of dollars	Percent change
Single-market banks (1,273)	8,385.2	8,621.8	2.8
Portfolio	5,617.1	5,451.0	-3.0
Securitized	2,768.1	3,170.8	14.6
Multi-market banks (4,222)	951,285.5	407,140.7	-57.2
Portfolio	487,200.0	164,501.4	-66.3
Securitized	464,085.5	242,639.3	-47.7

Note: Single-market banks are those that originated at least 99 percent of their home mortgage loans in a single market in 2006-2007. Multi-market banks are all others. Sample is restricted to bank/market observations for which portfolio originations were positive in both pre-crisis and crisis periods.

Table 2: Sample Statistics on Bank Size, Growth in Total Originations, and Loss Rates

Type of bank/market observation (share of market in bank's total pre-crisis originations)	Number of observations	Median bank size at end of 2007 (millions of dollars)	Median log growth of originations, pre-crisis to crisis (percent)	Median change in local loss rate, 2005- 2007 (percentage points)	Median change in other loss rate , 2005-2007 (percentage points)
Single-market bank (>.99)	1,273	156	5.0	0.26	NA
Multi-market bank, core market (.50 to .99)	1,774	359	-14.2	0.30	0.35
Multi-market bank, moderately peripheral market (.01 to .50)	4,801	1,572	-35.0	0.41	0.55
Multi-market bank, highly peripheral market (<.01)	6,643	72,600	-93.2	0.29	0.90

Notes: Total originations are the sum of portfolio and securitized loans. Sample is restricted to bank/market observations for which portfolio originations were positive in both pre-crisis and crisis periods.

Table 3: Correlations among Growth in Total Originations, Local Loss Rate, and Other Loss Rate

Type of bank/market observation (share of market in bank's total pre-crisis originations)	Number of observations	Correlation coefficients		
		Log growth in originations and change in other loss rate	Change in other loss rate and change in local loss rate	Log growth in originations and change in local loss rate
Single-market bank (>.99)	1,273	NA	NA	.009
Multi-market bank, core market (.50 to .99)	1,774	-.10***	.60***	-.11***
Multi-market bank, moderately peripheral market (.01 to .50)	4,801	-.20***	.59***	-.19***
Multi-market bank, highly peripheral market (<.01)	6,643	-.35***	.095***	-.04***

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

Notes: Total originations are the sum of portfolio and securitized originations. Sample is restricted to bank/market observations for which portfolio originations were positive in both pre-crisis and crisis periods.

Table 4: Portfolio Loan Growth from Pre-Crisis Period to Crisis Period

This table reports regression estimates for equation (1). The dependent variable is portfolio loan growth, measured as the log growth in portfolio mortgage originations from the pre-crisis period (2006 and 2007) to the crisis period (2008 and 2009). The variable labels for Core Market, Peripheral Market and Highly Peripheral Market indicate the share of the bank's mortgage originations in that market. Each specification has market fixed effects. All data are winsorized at the 1% level. Robust standard errors are in brackets, with *, **, and *** indicating significance at 10%, 5% and 1% respectively.

	(1)	(2)	(3)
Bank-Level Variables			
Size (Log of Total Assets)	-16.021***	-15.907***	-17.233***
	[0.393]	[0.457]	[0.552]
ΔTangible Common Equity	-2.587***	-2.597***	-2.397***
	[0.455]	[0.455]	[0.451]
ΔNon-Residential Non-Performing Loan Rate	-2.087***	-2.037***	-1.823***
	[0.623]	[0.632]	[0.625]
Bank/Market Variables			
ΔLocal Loss Rate	-11.605***	-11.894***	-13.063***
	[3.915]	[3.875]	[3.813]
Multi-Market Bank	17.785***		
	[3.900]		
Multi-Market Bank * ΔOther Loss Rate	-25.068***		
	[2.628]		
Core Market (.50 to .99)		-1.496	-1.059
		[5.074]	[5.014]
Core Market (.50 to .99) * ΔOther Loss Rate		-17.106**	-15.671**
		[7.778]	[7.756]
Peripheral Market (< .50)		30.778***	
		[4.058]	
Peripheral Market (< .50) * ΔOther Loss Rate		-39.764***	
		[3.032]	
Peripheral Market (.01 to .50)			17.037***
			[4.203]
Peripheral Market (.01 to .50) * ΔOther Loss Rate			-28.958***
			[4.152]
Highly Peripheral Market (< .01)			83.101***
			[5.155]
Highly Peripheral Market (< .01) * ΔOther Loss Rate			-81.022***
			[5.489]
Market Fixed Effects	Yes	Yes	Yes
Observations	14491	14491	14491
Adjusted R-squared	0.20	0.21	0.22

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

This table reports regression estimates for equation (1). The dependent variable is total loan growth, measured as the log growth in total mortgage originations (portfolio and securitized loans) from the pre-crisis period (2006 and 2007) to the crisis period (2008 and 2009). The variable labels for Core Market, Peripheral Market and Highly Peripheral Market indicate the share of the bank's mortgage originations in that market. Each specification has market fixed effects. All data are winsorized at the 1% level. Robust standard errors are in brackets, with *, **, and *** indicating significance at 10%, 5% and 1% respectively.

	(1)	(2)	(3)
Bank-Level Variables			
Size (Log of Total Assets)	-13.578***	-13.583***	-14.107***
	[0.364]	[0.427]	[0.503]
ΔTangible Common Equity	-2.927***	-2.928***	-2.822***
	[0.478]	[0.479]	[0.478]
ΔNon-Residential Non-Performing Loan Rate	-6.656***	-6.636***	-6.497***
	[0.657]	[0.663]	[0.656]
Bank/Market Variables			
ΔLocal Loss Rate	-8.563**	-8.815**	-9.552**
	[3.803]	[3.797]	[3.739]
Multi-Market Bank	6.114*		
	[3.699]		
Multi-Market Bank * ΔOther Loss Rate	-14.592***		
	[2.282]		
Core Market (.50 to .99)		-7.907*	-7.929*
		[4.741]	[4.692]
Core Market (.50 to .99) * ΔOther Loss Rate		-6.81	-5.714
		[6.943]	[6.992]
Peripheral Market (< .50)		14.830***	
		[3.880]	
Peripheral Market (< .50) * ΔOther Loss Rate		-23.809***	
		[2.767]	
Peripheral Market (.01 to .50)			6.537*
			[3.904]
Peripheral Market (.01 to .50) * ΔOther Loss Rate			-16.690***
			[3.805]
Highly Peripheral Market (< .01)			44.317***
			[5.140]
Highly Peripheral Market (< .01) * ΔOther Loss Rate			-49.136***
			[4.813]
Market Fixed Effects	Yes	Yes	Yes
Observations	14491	14491	14491
Adjusted R-squared	0.18	0.18	0.19

Table 6: Pooled Regressions of Loan Growth with Annual Data

This table reports regression estimates for equation (2). The dependent variable is the annual log growth in portfolio mortgage originations in Column 1 and total mortgage originations (portfolio and securitized loans) in Column 2. The data include annual growth in the years 2006 to 2009. The variable labels for Core Market, Peripheral Market and Highly Peripheral Market indicate the share of the bank's mortgage originations in that market. Each column has market fixed effects interacted with year fixed effects. All data are winsorized at the 1% level. Robust standard errors are in brackets, with *, **, and *** indicating significance at 10%, 5% and 1% respectively.

	(1) *Portfolio Loan Growth*	(2) *Total Loan Growth*
Bank-Level Variables		
Size (Log of Total Assets)	-6.183***	-4.802***
	[0.284]	[0.230]
ΔTangible Common Equity	-1.471***	-2.707***
	[0.281]	[0.271]
ΔNon-Residential Non-Performing Loan Rate	-2.072***	-1.977***
	[0.354]	[0.315]
Bank/Market Variables		
ΔLocal Loss Rate	-1.379	-2.52
	[2.063]	[1.861]
Core Market (.50 to .99)	-6.328***	-4.994***
	[2.108]	[1.906]
Core Market (.50 to .99) * ΔOther Loss Rate	-4.371***	-3.138**
	[1.402]	[1.275]
Peripheral Market (.01 to .50)	1.085	0.812
	[2.249]	[1.957]
Peripheral Market (< .50) * ΔOther Loss Rate	-7.050***	-6.354***
	[1.440]	[1.301]
Highly Peripheral Market (< .01)	25.477***	18.075***
	[2.521]	[2.164]
Highly Peripheral Market (< .01) * ΔOther Loss Rate	-18.266***	-19.717***
	[1.281]	[0.978]
Market * Year Fixed Effects	Yes	Yes
Observations	55348	55348
Adjusted R-squared	0.06	0.07