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ABSTRACT

Between 2003 and 2006, the Federal Reserve raised rates by 4.25%. Yet it was precisely during this period that the housing boom accelerated, fueled by rapid growth in mortgage lending. There is deep disagreement about how, or even if, monetary policy impacted the boom. Using heterogeneity in banks' exposures to the deposits channel of monetary policy, we show that Fed tightening induced a large reduction in banks' deposit funding, leading them to contract new on-balance-sheet lending for home purchases by 26%. However, an unprecedented expansion in privately-securitized loans, led by nonbanks, largely offset this contraction. Since privately-securitized loans are neither GSE-insured nor deposit-funded, they are run-prone, which made the mortgage market fragile. Consistent with our theory, the re-emergence of privately-securitized mortgages has closely tracked the recent increase in rates.

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I Introduction

Ten years after the financial crisis, an unresolved question remains: what role, if any, did monetary policy play in the housing boom that precipitated the crisis? This question has been the subject of an intense debate. On one side, Taylor (2007, 2010) argues that the Fed kept rates "too low for too long" during the housing boom, and that this led to excessive investment in housing. On the other side, Bernanke (2010a,b) argues that monetary policy was not too loose during this period, and that the real culprit was a decline in mortgage lending standards that accompanied the shift from traditional bank lending to securitized lending. He emphasizes in particular the role of private-label securitization (PLS), which did not conform to the stricter lending standards of the government-sponsored enterprises (GSEs).

Underlying this debate is an empirical ambiguity: even if rates were too low in the early years of the housing boom, the peak of the boom coincided with a period of Fed tightening. Between 2003 and 2006 the Fed raised rates by 4.25%, a substantial hike on par with previous cycles. Yet surprisingly, PLS lending accelerated sharply just as the Fed shifted to a tightening stance in mid 2003. Justiniano, Primiceri, and Tambalotti (2017) call this turning point "the mortgage rate conundrum." Figure 1 reproduces one of their main figures (also found in Mian and Sufi 2018), and overlays it with a measure of the stance of monetary policy. Specifically, the figure plots the PLS share of securitized issuance against the one-year Treasury rate from 1996 to 2018. It is clear from the figure that the acceleration of the PLS market from its previous low level coincided with the shift to Fed tightening after 2003. From then on, the two series track each other closely even if we ignore their synchronous collapse in 2008. In particular, we highlight that the PLS market has recently reemerged just as the Fed has been raising rates.

These observations raise the possibility that Fed tightening between 2003 and 2006 contributed to the shift to PLS lending. In fact, this is a prediction of the "deposits channel of monetary policy" of Drechsler, Savov, and Schnabl (2017b) (hereafter, DSS). Under the deposits channel, Fed tightening allows banks to increase the profits they earn on deposits by charging higher deposit spreads (i.e., by keeping their deposit rates low). This induces some deposits to be withdrawn. And since deposits are by far the largest source of bank funding, and are valued for their unique safety and stability, the contraction in deposits leads banks to contract their loan portfolios. Long-term loans such as mortgage loans are particularly affected as it depends heavily on stable deposit funding (Drechsler, Savov, and Schnabl 2017a). Since bank-held loans serve mostly the non-conforming segment of the mortgage market, i.e., the loans that cannot be bought and guaranteed by the GSEs, their only alternative source of credit is the market for PLS. This could explain why the mortgage market shifted to PLS lending as the Fed tightened. Moreover, if the demand for PLS was strong during this period, then this shift could explain why Fed tightening did not significantly curb mortgage lending during the housing boom.

In this paper, we use the lens of the deposits channel to examine whether Fed tightening impacted mortgage lending during the housing boom. We find that it did. First, banks reacted to Fed tightening by sharply increasing deposit spreads, and this led to a 12.4% reduction in the stock of deposits.[1] Second, banks partly absorbed this reduction by contracting their yearly flow of new portfolio mortgage lending by 25.9%. Third, PLS lending largely offset this contraction, led by growth among nonbank mortgage originators (hereafter, nonbanks).[2] We estimate that Fed tightening induced a 10.2 percentage point increase in the PLS share of all non-GSE mortgage lending (inclusive of banks' portfolio lending). This is roughly the entire increase in the PLS share over this period. And fourth, with PLS lending offsetting the contraction in bank portfolio lending, total non-GSE mortgage lending declined by just 4.4%. Thus, Fed tightening had only a modest impact on total lending, even as it induced large shifts in how mortgages were originated and funded. In particular, the shift from stable deposit funding to run-prone capital markets funding exposed the housing sector to a credit freeze like the one that arrived in 2007.

Our results thus suggest a high degree of substitutability between bank portfolio lending

[1] This is consistent with the findings of DSS over a longer sample. Since our focus is on the housing boom, we zoom in on the period from 2003 to 2006 and examine the impact on the mortgage market.

[2] Nonbank lenders, also referred to as "shadow banks," are non-depository institutions outside the scope of traditional banking regulation (Buchak, Matvos, Piskorski, and Seru 2018a,b). Lacking a large balance sheet, nonbanks securitized all of their mortgage loans, selling them off to asset-backed commercial paper conduits, collateralized debt obligations, and structured investment vehicles. These in turn were funded by a range of institutions including money market mutual funds, pension funds, and insurance companies. See Adrian and Ashcraft (2016) for further discussion.

and PLS lending. Specifically, we find that for a given contraction in bank portfolio lending, 65% is offset by increased PLS lending, most of which comes from nonbanks (and the rest by banks). These results are potentially important for future lending cycles.

Given the ambiguities of the aggregate time series and the endogeneity of monetary policy, an important advantage of the deposits channel is that it can be tested in the cross section, since exposure varies across banks and regions.[3] Following DSS, we measure exposure to the deposits channel with the deposit spread beta: the sensitivity of a bank's deposit spread to the Fed funds rate. The deposit spread beta captures a bank's market power over its retail branch network. A high beta implies that when the Fed raises rates the bank is able to charge higher deposit spreads and make more profits. As higher spreads induce greater deposit outflows, a high-beta bank is more exposed to the deposits channel. We estimate spread betas at the branch, bank, and county levels. In each case we use only data up to 2002 to avoid simultaneity with our outcome variables.

We begin by analyzing the impact of Fed tightening on deposit supply between 2003 and 2006. We first confirm that bank branches with higher pre-2002 spread betas increased deposit spreads by more during this period. We then test if they also had lower deposit growth. We run this test both across all branches and by comparing different branches of the same bank (within-bank estimation). This approach controls for any differences in loan demand across branches as banks are free to raise deposits at one branch and lend them at another.

We find that branches with higher deposit spread betas had significantly lower deposit growth during the housing boom. The estimated coefficient on the branch-level beta in the stringent within-bank specification is −21.3% and highly significant. This means that a branch that raised its deposit spread one-for-one with the Fed funds rate (beta of one) had 21.3% lower deposit growth over 2003-2006 than a hypothetical branch that paid the Fed funds rate on its deposits (beta of zero). Since a zero-beta branch is not exposed to the deposits channel, and since the average spread beta is 0.58, this implies that Fed tightening contracted bank deposits by 12.4%. This is a large decrease because deposits are the vast

[3] This is difficult with traditional channels. For instance, in New Keynesian models there is a single Taylor (1993) rule residual that captures the stance of monetary policy for the whole economy. This helps explain why the debate has centered on the aggregate time series with little resolution.

majority of bank funding and because absorbing such a contraction in the *stock* of deposits requires a large negative adjustment in the *flow* of new lending.

We then show that the impact of Fed tightening on deposits aggregates to the bank level: regressing bank-level deposit growth on bank-level deposit spread betas, we get a highly significant coefficient of -26.2%, which is close to the branch-level result. We also find that the contraction in deposits translated into a similar contraction in overall bank liabilities, even though banks raised their share of the more run-prone wholesale funding by 2.7 percentage points.

Next, we turn to the asset side of banks' balance sheets. We look separately at total assets, securities holdings, loans, and real estate loans. For each category, we find a large negative coefficient of similar magnitude to the contraction in deposits. In particular, we estimate that a bank with a beta of one contracted its real estate loan portfolio by 21.3% compared to a hypothetical unexposed bank with a beta of zero.

To see how Fed tightening impacted the broader mortgage market, we turn to the county level. We use administrative data on mortgage lending, which provides information on bank portfolio loans and securitized loans (both by banks and nonbanks). We focus on bank portfolio loans and privately sold (PLS) loans and remove GSE loans. We do so because GSE loans are effectively a separate segment of the market, since they must meet stricter criteria in order to qualify for the subsidized GSE guarantee. We calculate a county-level deposit spread beta by weighting the betas of the banks that lend in a county by their shares of local lending as of 2002.

Consistent with the predictions of the deposits channel, we find that high-beta counties experienced much lower bank portfolio lending over 2003-2006 than low-beta counties. Moreover, the coefficient we estimate is largely unchanged when we control for county characteristics. The controls are needed to absorb potential differences in loan demand across counties with different betas. Among the controls we use is a deposit-weighted county beta, which is similar to our main county beta but uses banks' shares of the local *deposit* market as weights. Conditional on this beta, our lending-weighted county beta picks up variation in the exposure of the local lending market to the deposits channel driven by *other* counties where local lenders raise deposits. Another control we use is the county-level growth in GSE lending, which also picks up differences in local loan demand. The estimate in our most stringent specification implies that bank portfolio lending was 48.6% lower in a maximally exposed county with a beta of one versus a hypothetical unexposed county with a beta of zero. Since the average county beta is 0.53, this implies that Fed tightening reduced bank portfolio lending by 25.9% from 2003 to 2006.

Next, we turn to the shift to PLS. Under the deposits channel, Fed tightening directly impacts bank portfolio lending, which should induce a shift toward securitized lending, and in particular PLS. Thus, counties with a higher exposure to the deposits channel should experience a larger increase in the PLS share of the mortgage market. This is indeed what we see: regressing the change in the PLS share of total mortgage lending on our county beta, we find a large positive and significant coefficient that is robust to our array of controls. The coefficient implies that a county with a beta of one experienced a 19.2 percentage point greater increase in the PLS share of lending than a county with a beta of zero. Multiplying this coefficient by the average county beta, we find that Fed tightening induced a 10.2 percentage point increase in the PLS share, roughly equal to the actual 11.4 percentage point increase over this period.

While both banks and nonbanks originated PLS mortgages, the expansion of PLS allowed nonbanks, which specialize in PLS lending, to gain market share. Regressing the change in the nonbank share of total lending on county beta gives a positive and significant coefficient that is robust to all our controls. We estimate that the nonbank share grew by 12.4 pecentage points more in a maximally exposed county than an unexposed county, a substantial difference compared to the 26.6% average market share of nonbanks as of 2002.

Finally, we look at total lending growth, which nets out the impact of the contraction in portfolio lending with the shift to PLS. We find that, conditional on all the controls, the coefficient on county beta is only −8.5% and statistically insignificant. Thus, total lending growth did not differ significantly across exposed and unexposed counties, despite the large differences in bank portfolio lending growth between them. This is explained by the shift to PLS, which filled in most of the gap created by the reduced supply of bank portfolio lending. We thus find that Fed tightening induced only a modest contraction in total mortgage lending during the housing boom, while simultaneously accelerating the shift to private securitized lending and thus exposing the housing sector to potential instability.

II Related Literature

The paper is related to the large literature on the origins of the housing boom in the mid 2000s. Within that literature, the role of monetary policy has received relatively little attention despite its importance. Moreover, consensus has proved elusive (Taylor 2007, Mishkin 2007, Bernanke 2010b, Bean, Paustian, Penalver, and Taylor 2010, Svensson 2011). One reason for this is that prior studies have relied on aggregate time series data, which are confounded by many factors (e.g., the business cycle). The contribution of our paper is to analyze this question through the lens of the deposits channel. A key advantage of this approach is that unlike other channels (e.g., New Keynesian models), the deposits channel has a heterogeneous impact across geographic areas. This allows us to control for aggregate factors by going to the cross section.

The deposits channel also offers a potential explanation for why private-label securitization (PLS) lending accelerated right when the Fed began tightening (Justiniano, Primiceri, and Tambalotti 2017). Mian and Sufi (2018) show that this acceleration played an important role: areas with higher PLS lending had a bigger housing boom and subsequent bust. One explanation for this is that PLS loans came with weaker lending standards (Keys, Mukherjee, Seru, and Vig 2010).

The literature has proposed several explanations for the growth in PLS lending, including a "global savings glut" (Bernanke 2005), regulation (Gorton and Metrick 2010, Pozsar, Adrian, Ashcraft, and Boesky 2010), low uncertainty (Minsky 1992), and risk neglect (Gennaioli, Shleifer, and Vishny 2012).[4] These theories explain why PLS lending was available as a substitute for bank portfolio lending, but not why it suddenly accelerated in mid-2003.

The proposed explanation in this paper is that Fed tightening induced banks to contract their portfolio lending due to the deposits channel of Drechsler, Savov, and Schnabl (2017b). We highlight an additional impact of the deposits channel through the funding side of the

[4] Supporting these theories, Mian and Sufi (2009) and Justiniano, Primiceri, and Tambalotti (2015) provide empirical evidence that an expansion in credit supply played an important role in the housing boom.

PLS market. Xiao (2018) argues that part of the deposit outflows induced by the deposits channel are recycled back into the financial system as wholesale funding for money market funds, commercial paper conduits, and others. These institutions ended up holding large amounts of PLS securities (Acharya, Schnabl, and Suarez 2013). Note that even if the same deposit dollars ultimately ended up as PLS loans, they were transformed in the process from stable core deposits to run-prone wholesale funding (Hanson, Shleifer, Stein, and Vishny 2015). This increased fragility became evident when the securitization market froze in 2007 (Brunnermeier 2009).

III Data and Estimation

1. Mortgage lending data. We use administrative data on residential mortgage lending in the U.S. provided under the Home Mortgage Disclosure Act (HMDA). The HMDA dataset contains loan-level information on residential mortgages in the U.S. at an annual frequency. We focus on purchase loans made between 2002 and 2006. The data allow us to separately identify portfolio and securitized loans. A loan is classified as a portfolio loan if it has not been sold by the end of the year. Securitized loans include private-label securitization (PLS) and loans sold to Government Sponsored Enterprises (GSEs). For most of our analysis, we exclude GSE loans. We also focus on the number of loans rather than dollar amounts in order to avoid the influence of changing home prices. We use a file provided by the Federal Reserve to identify bank and nonbank lenders in HMDA. The file also contains an identifier that allows us to match the bank lenders to the U.S. Call Reports.

2. Bank Data. The bank data are from the U.S. Call Reports provided by the Federal Reserve Bank of Chicago. We use data from January 1986 to December 2006. The data contain quarterly observations of the income statements and balance sheets of all U.S. commercial banks.

3. Deposit Quantities. The data on deposit quantities are from the Federal Deposit Insurance Corporation (FDIC). The data cover the universe of U.S. bank branches and are released annually in June. We use the data from June 2003 to June 2007. The data contain branch characteristics, including the parent bank, address, and geographic coordinates for a total of 58,604 branches. We link the data to the U.S. Call Reports using the bank identifier.

4. Deposit Rates. The data on deposit rates are from Ratewatch. Ratewatch collects weekly branch-level data on deposit rates for new accounts at the product level. We use the data from January 1997 to December 2006. We focus on branches that actively set their own deposit rates ("rate-setters"). There are 5,556 such branches. We link the data to the U.S. Call Reports using the bank identifier.

We analyze the three main types of retail deposits (savings, interest checking, and small time deposits) by focusing on the most widely offered product within each type: (i) money market deposit accounts with an account size of $25,000 (savings deposits), (ii) interest checking accounts with no minimum account size (interest checking deposits), and (iii) 12-month certificates of deposit with an account size of $10,000 (small time deposits).

5. County Data. We collect data on county population, employment, and median household income from the County Business Patterns dataset from the U.S. Census. We match the data to HMDA using the county identifier.

6. Fed Funds Data. We obtain the Fed funds target rate and the effective Fed funds rate from Federal Reserve Economic Data (FRED).

III.A Deposit Spread Betas

Our empirical analysis uses cross-sectional variation in exposure to monetary policy via the deposits channel. We measure exposure with the deposit spread beta, which was introduced by Drechsler, Savov, and Schnabl (2017b). The deposit spread beta measures the sensitivity of a bank's deposit spread, the difference between the Fed funds rate and the bank's deposit rate, to the Fed funds rate. For instance, a bank with a beta of 0.6 raises its deposit spread by 60 basis points for every 100 bps increase in the Fed funds rate (it raises its deposit rate by 40 bps). Drechsler, Savov, and Schnabl (2017b) show empirically and theoretically that a bank's spread beta captures its market power in retail deposit markets. As the Fed tightens, banks with a lot of market power keep their deposit rates low, raising the spreads they charge their depositors. This leads some depositors to withdraw, inducing outflows.

We estimate deposit spread betas at the branch, bank, and county levels. In each case, we use data only up to 2002, which is before the housing boom period from 2003 to 2006 when all of our outcome variables are measured. This ensures that our betas are predetermined with respect to the housing boom and hence not affected by it. We then use these betas to predict the behavior of deposits and lending during the housing boom.

The branch betas use quarterly observations of deposit rates between 1997 and 2002 from the Ratewatch data. We convert these deposit rates into spreads by subtracting them from the Fed funds rate. We assume that all branches in a given county have the same beta and hence the same exposure to the deposits channel. The interpretation is that market power varies at the local level, for instance because of local competition. Drechsler, Savov, and Schnabl (2017b) show that several local characteristics drive deposit market power, including market concentration, income, education, and demographics. Our approach captures this local variation.[5]

We estimate the betas by running the following panel regression for each of the three representative deposit products (for checking, savings, and small time deposits):

$$\Delta Spread_{b,c,t+1} \quad = \quad \alpha_c + \sum_{\tau=0}^{3} \beta_{c,\tau} \Delta FedFunds_{t+1-\tau} + \varepsilon_{b,c,t+1}, \tag{1}$$

where $\Delta Spread_{b,c,t+1}$ is the change in the deposit spread charged by branch b in county c from t to $t+1$, α_c is a county fixed effect, and $\Delta FedFunds_{t+1-\tau}$ is the change in the Fed funds rate from time $t-\tau$ to $t+1-\tau$. Including three lags of the Fed funds rate change allows deposit spreads to adjust over a full year. We then sum the coefficients $\beta_{c,\tau}$ to obtain a single beta for each product. Finally, we average across the three products and winsorize at the 5% level to get a single beta for each branch ($BranchBeta_b$).

We estimate bank-level betas by following a similar procedure. We use the bank-level Call Reports from January 1986 to December 2002. The outcome variable is a bank's interest expense spread, the difference between the Fed funds rate and the ratio of its annualized interest expense to its average quarterly assets.[6] The interest expense spread is the bank-level

[5] A practical advantage is that it allows us to assign betas to branches that are not in the Ratewatch data but in the FDIC data. This is relevant when we use the FDIC data to analyze the effect of the branch beta on deposit growth.

[6] Interest expense also includes expenses for non-deposit funding. We use it because what matters for lending is banks' total cost of funding. Nevertheless, since deposits account for the vast majority of banks'

analog to the branch-level deposit spread. Thus, we estimate the following panel regression:

$$\Delta Spread_{j,t+1} = \alpha_j + \sum_{\tau=0}^{3} \beta_{j,\tau} \Delta FedFunds_{t+1-\tau} + \varepsilon_{j,t+1}, \tag{2}$$

where $\Delta Spread_{j,t+1}$ is the change in the interest expense spread of bank j from t to $t+1$, α_j is a bank fixed effect. We construct a single beta for each bank by summing the coefficients on the contemporaneous and lagged changes in the Fed funds rate ($BankBeta_j$). We winsorize the bank betas at the 1%-level.

Lastly, we construct a county-level beta as the weighted average of the betas of all the banks that make mortgage loans in that county. Since we are interested in the impact of the deposits channel on local mortgage lending, the weight each bank receives in the county beta is given by its share of total mortgage lending in the county as of 2002, $s_{j,c}$:

$$CountyBeta_c = \sum_{b} s_{j,c} \times BankBeta_j. \tag{3}$$

Thus, a high-beta county is one whose mortgage market is served by banks with a high ex-ante exposure to the deposits channel.

III.B Summary statistics

Table 1 presents summary statistics at the branch level (Panels A and B), bank level (Panel C), and county level (Panel D). The first two columns of each panel report the mean and standard deviation of each variable. The last two columns report means for high- versus low-beta subsamples based on the median beta in each sample.

From Panel A, the average branch beta is 0.581 with a standard deviation of 0.080. It rises to 0.641 in the high-beta half of the sample versus 0.521 in the low-beta half. The panel also shows that deposit spreads rose substantially during the housing boom period from 2003 to 2006: the spread on savings deposits rose by 3.380 percentage points, the spread on small time deposits rose by 1.717 percentage points, and the spread on interest checking accounts rose by 4.054 percentage points. The Fed funds rate rose by 4.25 percentage points over

funding, the results are similar if we estimate banks' spread betas using their deposit interest expense.

this period so these are large increases. Their relative magnitudes line up with the relative liquidity of the deposit products (checking deposits are the most liquid, followed by savings deposits and time deposits). This is consistent with the deposits channel, which predicts that deposits are valued for their liquidity and that the price of this liquidity rises with the nominal interest rate.

Panel A shows that high-beta branches increased spreads by more than low-beta branches: 3.52 versus 3.24 percentage points for savings deposits, 1.81 versus 1.63 percentage points for small time deposits, and 4.11 versus 4.00 percentage points for interest checking. This shows that the pre-housing boom branch betas are persistent and predict deposit pricing *during* the boom.

Panel B reports branch-level summary statistics on deposit quantities. The average bank branch has $76.3 million in deposits, and experiences deposit growth of 23.7% during the housing boom period. As predicted by the deposits channel, deposit growth at high-beta branches is lower than at low-beta branches (20.6% versus 26.7%). Thus, the pre-housing-boom branch betas also predict deposit growth during the housing boom.

Panel C reports bank-level summary statistics. The average bank beta is 0.621 with a standard deviation of 0.095. These estimates are very close to those for the branch betas, even though we are using different datasets (Call Reports versus Ratewatch), different levels of aggregation (bank versus product-branch), and a longer estimation period for the bank-level data. We view this as evidence that our betas provide robust measures of exposure to the deposits channel.

Panel C also looks at banks' deposits and their corresponding spreads. The deposit spread is the difference between the Fed funds rate and the deposit rate (interest expense on domestic deposits divided by quarterly average domestic deposits). Banks raised their deposit spread by 3.05 percentage points during the housing boom period, similar to the branch-level data. The increase was 3.26 percentage points for high-beta banks versus 2.84 percentage points for low-beta banks. Deposit growth was 23.9% overall, reflecting the strong economic growth during the boom. Consistent with the deposits channel, high-beta banks had much lower deposit growth than low-beta banks (19.6% versus 28.2%) and increased their reliance on wholesale funding. Also consistent, high-beta banks also had lower growth in assets, liabilities, securities, loans, and real estate lending.

Taken together, Panels A, B, and C show that a higher pre-boom deposit spread beta predicts a larger increase in deposit spreads (prices) and lower deposit growth (quantities) during the housing boom. The combination of higher prices and lower quantities implies an inward shift in the supply curve for deposits. This shift is predicted by the deposits channel under which Fed tightening induces banks to contract deposit supply.

Panel D of Table 1 presents summary statistics at the county level. Low- and high-beta counties are roughly similar in terms of market size, population, employment, and income measured prior to the housing boom in 2002. They are also similar in terms of mortgage market concentration, measured as the combined share of mortgage lending by the county's top four mortgage lenders.[7] Low-beta counties are slightly larger and have somewhat higher PLS and nonbank shares.

The panel shows significant cross-county differences in lending growth during the housing boom from 2003 to 2006. Consistent with the deposits channel, high-beta counties see lower growth in bank portfolio lending than low-beta counties (9.9% versus 15.4%). They also see lower growth in total bank lending (36.4% versus 44.5%).[8] There also is evidence of substitution to PLS, as the high-beta counties see a greater increase in the market share of PLS lending and the share of nonbank lending. Substitution to PLS narrows the gap in total lending growth between high- and low-beta counties to 40.8% vs. 44.8%.

Panel D also shows summary statistics for a variable called the county deposit-weighted beta, which we use as a control. Similar to the county beta in equation (3), the county deposit-weighted beta is a weighted average of the bank betas. However, it uses banks' deposit market shares rather than their lending shares as weights. As discussed below, by controlling for the county deposit-weighted beta, we control for any variation in county beta that is due to deposit market power in the county where the mortgage lending takes place. Unsurprisingly, the deposit-weighted county beta is also higher in high-beta counties than in low-beta counties, but its correlation with the (lending-weighted) county beta is only 0.38. This shows that there is substantial independent variation in our county betas coming from

[7] Scharfstein and Sunderam (2016) show that this variable captures market power on the lending side.

[8] The difference between bank portfolio lending and total bank lending is bank-originated PLS lending which is not part of portfolio lending.

other counties where local mortgage lenders raise deposits.

IV Results

The deposits channel predicts that Fed tightening during the housing boom induced an inward shift in deposit supply (higher deposit spreads and lower deposit growth). The deposits channel also predicts that the contraction in deposits induced a contraction in bank portfolio lending, which can in turn explain why the mortgage market shifted to PLS lending. In this section we test these predictions.

The main empirical challenge is the potential for omitted factors that could have impacted deposit supply and lending during the housing boom. The most obvious omitted factor is loan demand.[9] As in other cycles, the Fed tightened during a period of high economic growth which leads to strong loan demand. Loan demand can thus mask the impact of the deposits channel in the aggregate time series. We difference it out by going to the cross section where we use deposit spread betas as a source of variation in exposure to the deposits channel.

Turning to the cross section does not fully solve the challenge because it is possible that loan demand varied in a way that is correlated with our deposit spread betas. For example, if banks with higher betas saw lower loan demand during the housing boom, then their deposit and lending growth would be lower even absent the influence of the deposits channel. In order to address this challenge, we conduct our cross sectional analysis at different levels of aggregation: the branch, the bank, and the county. The granularity of the branch-level analysis allows us to fully control for the influence of loan demand on deposit supply. The bank-level analysis provides a bridge to the lending side. And the county-level analysis, which is necessarily coarser, allows us to examine the substitution to PLS lending while controlling for loan demand using observables.

[9]Adelino, Schoar, and Severino (2016) document the importance of loan demand for the housing boom. Gao, Sockin, and Xiong (2016) and DeFusco, Nathanson, and Zwick (2017) further show that housing markets that experienced bigger booms and busts also had more speculative demand.

IV.A Branch-level results

We use the branch-level data to obtain variation in exposure to the deposits channel that is independent of loan demand. The variation comes from comparing different branches of *the same bank* located in counties with different deposit spread betas. Since a bank can raise a deposit dollar at one branch and lend it at another, the decision of how many deposits to raise at a given branch is independent from the decision of how many loans to make at that branch. This means we can control for loan demand by examining within-bank differences in deposit supply.[10]

We proceed in two steps. First, we show that our branch betas, which are estimated from data before the housing boom, predict deposit spreads during the housing boom. This step is a necessary first stage showing that our betas are able to generate variation in deposit pricing that is independent of shocks that occurred during the housing boom period. Second, we show that our branch betas also predict deposit growth, both across and within banks. This step shows the direct effect of Fed tightening on deposit supply during the housing boom.

We start with deposit spreads, focusing on the three main deposit products (savings, small time, and interest checking). For each product, we estimate the following cross-sectional regression:

$$\Delta DepositSpread_b \quad = \quad \alpha + \gamma BranchBeta_b + \varepsilon_b, \tag{4}$$

where $\Delta DepositSpread_b$ is the change in the deposit spread of branch b from January 2003 to December 2006, $BranchBeta_b$ is the branch beta (estimated from pre-2003 data), and α is a constant. We cluster standard errors at the county level.

Figure 2 shows bin-scatter plots of the change in deposit spreads from 2003 to 2006 against the branch betas for savings deposits (Panel A), small time deposits (Panel B), and interest checking (Panel C). The plots show that high-beta branches increased their spreads by more than low-beta branches. Savings deposit spreads increased by 3.6 percentage

[10] This analysis follows Drechsler, Savov, and Schnabl (2017b), who use it to analyze the deposits channel over a longer sample. The difference here is that we focus on the housing boom period.

points at branches with a spread beta of 0.7 versus 3.1 percentage points at branches with a spread beta of 0.4. Small time deposit spreads increased by 1.9 percentage points versus 1.5 percentage points over the same range, and checking deposit spreads increased by 4.1 versus 3.9 percentage points. The relationships are tight and linear. Thus, branches with high market power and hence high spread betas in the pre-boom period also raised their deposit spreads by more during the boom.

Table 2 presents the corresponding regressions. Panel A shows a coefficient of 1.725 for savings deposits (column 1), 1.065 for small time deposits (column 2), and 0.774 for interest checking (column 3). All of the coefficients are significant at the 1% level. Multiplying them by the average branch beta of 0.581 (Table 1), we get a predicted aggregate increase of 100 bps for savings deposit spreads, 62 bps for small time deposits, and 45 bps for interest checking. These predicted increases are economically large although smaller than the realized aggregate spread increases over this period.[11]

Turning to deposit growth, we estimate the following cross-sectional regression:

$$DepositGrowth_b = \alpha + \gamma BranchBeta_b + \varepsilon_b \tag{5}$$

Figure 3 shows bin-scatter plots of deposit growth against the branch betas. Panel A shows the raw relationship and Panel B shows it after controlling for bank fixed effects, which implements our within-bank estimation. In both cases, we find a strong negative relationship: high-beta branches experience lower deposit growth than low-beta branches. From Panel A, branches with a beta of 0.7 have deposit growth of about 20% versus 30% for branches with a beta of 0.4. The difference narrows a bit in Panel B to 21% versus 26%, likely because branches belonging to the same bank are not necessarily fully independent in setting rates.

Panel B of Table 2 presents the corresponding regressions. Column 1 shows the simple univariate regression while column 2 adds in the bank fixed effects. The coefficients are −0.322 and −0.213, respectively. Both are statistically significant at the 1% level. Taking

[11] One reason for this is that we are using a single beta obtained by averaging across products to predict the spreads on individual products. This impacts checking accounts the most because they tend to have much less variation in betas (most banks barely raise their rates on checking accounts when the Fed tightens). In addition to the averaging across products, there is also likely shrinkage in the betas from the pre-boom period to the boom.

the specification with bank fixed effects and multiplying the coefficient by the average beta of 0.581, the predicted aggregate decline in deposit growth is 12.4% (it is 18.7% if we use the coefficient in Panel A). This decline is relative to a counterfactual in which the Fed did not raise rates during the housing boom. Our estimates suggest that such a counterfactual would have seen much higher deposit growth.[12]

Overall, the branch-level analysis shows that as the Fed tightened between 2003 and 2006, banks raised their deposit spreads by more at high-beta branches. These branches then experienced substantially lower deposit growth. These results are not due to differences in loan demand. Instead, they indicate that the deposits channel was in effect during the housing boom, and that through it Fed tightening induced a large contraction in deposit supply.

IV.B Bank-level results

In this section we examine the effects of the deposits channel at the bank level. This allows us to verify that our branch-level results aggregate up using a separate dataset (the Call Reports). It also allows us to look at lending.

The implications of the deposits channel for lending arise because of the uniqueness of deposits as a source of funding. This uniqueness is due to their stability (Hanson, Shleifer, Stein, and Vishny 2015) and low interest-rate sensitivity (Drechsler, Savov, and Schnabl 2017a). It explains why banks use deposits for the vast majority of their funding.

At the same time, exercising market power and maximizing profits from deposits require banks to restrict deposit supply.[13] This induces a trade-off between increasing deposit profits and making long-term loans. A key mechanism of the deposits channel is that monetary policy tips the balance of this trade-off. As the Fed tightens and the nominal interest

[12] The estimates are consistent with profit maximization as the increase in profits per dollar of deposits due to the higher spreads exceeds the decline in profits due to outflows. Specifically, the percentage change in profits is equal to the percentage change in deposit spreads plus the growth in deposits. Scaling the coefficients in Panel A of Table 2 by the average spread for each deposit product in 2006, the percentage increases in deposit spreads are 51%, 107%, and 16% for savings, small time, and interest checking, respectively. These increases more than offset the deposit outflows in Panel B, implying an increase in profits. This is consistent with the deposits channel where banks contract deposit supply in order to maximize profits.

[13] The market power itself comes from the other unique feature of deposits: the liquidity and safety they provide to households. This is what makes households willing to pay such high deposit spreads.

rate increases, banks are able to increase deposit profits by charging higher spreads. This, however, induces outflows and leaves fewer deposits available for long-term lending.

We test this mechanism by regressing different components of banks' balance sheets on our bank-level measure of exposure to the deposits channel, the bank beta. Specifically, we run the following OLS regression:

$$\Delta Y_j \;=\; \alpha + \gamma BankBeta_j + \delta X_j + \varepsilon_j, \tag{6}$$

where ΔY_j is the log change in bank j's balance sheet component (e.g, deposits, assets) from January 2003 to December 2006, $BankBeta_j$ is the bank's deposit spread beta estimated using pre-2003 data, X_j are control variables, and α is a constant.

Figure 4 shows bin-scatter plots for deposit spreads and deposit growth during the housing boom. Panel A shows that high-beta banks increased the deposit spread more than low-beta banks. Deposit spreads increased by 2.4 percentage points at banks with a beta of 0.4 versus 3.5 percentage points for banks with a beta of 0.8. Panel B looks at deposit growth. We focus on core deposits (checking, savings, and small time) because they are sold in retail markets and therefore subject to the deposits channel. The figure shows a strong negative relationship: banks with a beta of 0.4 saw deposit growth of 30% versus only 10% for banks with a beta of 0.8. Thus, the results in this figure are similar to those from the branch-level data.

Panel A of Table 3 presents the corresponding regression estimates. We include as control variables bank size (log assets), capitalization (the ratio of equity to assets), and the ratio of loans to assets. The controls serve to pick up variation in banks' business models that may affect loan demand in a way that is correlated with bank betas.[14] The coefficient on bank beta is 2.28 for the change in the core deposit spread (Column 1) and −0.262 for deposit growth (Column 2). Both are statistically significant at the 1% level.

Column 3 shows the results from a two-stage least squares regression where the first stage is the deposit spread regression in column 1 and the second stage regresses deposit growth on the predicted change in the deposit spread from the first stage. The attractiveness of this

[14]The results are similar and the estimates are slightly larger if we remove the control variables.

approach is that the second stage coefficient gives us an estimate of the semi-elasticity of deposit growth with respect to the deposit spread. The estimated semi-elasticity is -0.115, implying that deposit growth declines by 11.5% for every 100 bps increase in the deposit spread.

We also run the associated OLS regression (without a first stage) of deposit growth on the change in the deposit spread. The bin-scatter plot is in Panel C of Figure 4 and shows a strong negative relationship: banks that raised their spreads by more saw lower deposit growth. Column 4 of Table 3 Panel A shows that the estimated semi-elasticity is -0.151, which is similar to the two-stage estimate.

Next, we analyze whether there is substitution to non-deposit funding. We estimate our main regression using the growth in liabilities as the outcome variable. Column 1 of Table 3 Panel B finds a coefficient of -0.237, which is only slightly smaller than the one for deposits growth (Column 1 of Panel A). This result indicates that there is limited substitution to wholesale funding. Columns 2 and 3 examine funding shares conditional on total liabilities. We use as outcome variables the change in the share of liabilities financed by deposits and wholesale funding, respectively, and find coefficients of -0.047 and 0.044. This results show that the small difference between the coefficient on deposits and liabilities comes from increased wholesale funding among high-beta banks. Taken together, these results show that the deposits channel operates primarily on the extensive margin. High-beta banks reduce total deposit funding and total liabilities as monetary policy tightens relative to low-beta banks.

Turning to the asset side of the balance sheet, Figure 5 shows bin-scatter plots for bank assets (Panel A), securities (Panel B), loans (Panel C), and real estate loans (Panel D). In each case we see a strong negative relationship: banks with higher betas contracted all components of their balance sheets relative to banks with lower betas.

Panel B of Table 3 presents the corresponding regressions. From column 1, the coefficient on bank beta for predicting asset growth is -0.239. This is close to the coefficient for deposits, which indicates that the contraction in deposits is transmitted roughly one-for-one to assets. From column 2, the coefficient for securities is -0.250. Thus, banks absorbed part of the contraction in deposits by shedding securities. From columns 3 and 4, the coefficient for total loans is −0.172, and the coefficient for real estate loans is −0.213. These coefficients are a bit smaller than for deposits and securities, but still indicate that banks strongly contracted their lending in response to the reduction in deposit funding.

Overall, the results in Table 3 are consistent with the prediction of the deposits channel that monetary policy tilts the trade-off between deposit profits and long-term lending in favor of deposit profits. Thus, the bank-level analysis supports the view that Fed tightening during the housing boom restrained bank lending, and in particular real estate lending.

IV.C County level analysis

So far our branch- and bank-level results established that as the Fed raised rates between 2003 and 2006, banks widened deposit spreads and contracted core deposits. We also found that banks shrank their loan portfolios, including their real estate loans. In this section, we examine the impact of this contraction on mortgage markets at the county level. We run regressions of the form:

$$\Delta Y_c = \alpha + \gamma CountyBeta_c + \delta X_c + \varepsilon_c, \tag{7}$$

where ΔY_c is the change in a county-level outcome variable (e.g. logarithm of bank portfolio mortgage lending) from 2003 to 2006, $CountyBeta_c$ is the county beta estimated using pre-2003 data, X_b are control variables, and α is a constant.

Figure 6 presents a bin-scatter plot of the growth in bank portfolio mortgage lending from 2003 to 2006 against the county betas, which are measured up to 2002. There is a strong negative relationship: high-beta counties experience much lower growth in bank portfolio lending than low-beta counties. Bank portfolio lending grew by a cumulative 20% from 2003 to 2006 in counties with a beta of 0.4, versus 0% growth for counties with a beta of 0.7. This is consistent with the prediction of the deposits channel that Fed tightening restrained bank portfolio lending during the housing boom.

Table 4 estimates this relationship in a regression. From column 1, the univariate coefficient is −0.709 and highly significant. The numbers imply that a hypothetical county with zero exposure to the deposits channel (beta of zero) would have experienced cumulative growth in bank portfolio lending of 50.3%, versus −20.6% for a hypothetical maximally exposed county (beta of one).[15]

Column 2 adds in characteristics that control for the size of the mortgage market, employment, and income, which could be correlated with loan demand. The coefficient on county beta grows slightly to −0.779. The coefficients on the controls show that bank portfolio lending grew more in counties with less lending in 2002, but also in counties with higher income and employment. Overall, column 2 shows that the effect of county beta is not driven by the size of the mortgage market or economic conditions as of 2002.

Column 3 adds in controls for the structure of the mortgage market, which could be correlated with loan demand or supply independent of the deposits channel. The coefficient on county beta declines somewhat to −0.436 and remains highly significant. One reason for the decline is the impact of the first additional control, the amount of bank portfolio lending in 2002. This control has a negative coefficient, indicating that bank portfolio lending grew more in places where it was relatively low in 2002. Thus, there was some regression to the mean across counties. We note that this regression to the mean could itself be a result of the deposits channel, in which case the regression would be over-controlled.

The next two controls in column 3 are the PLS and nonbank lending shares. Following Mian and Sufi (2018), these measures capture the initial penetration of the mortgage market by PLS and nonbank lenders, which could be correlated with their subsequent growth and hence also with the growth of bank portfolio lending. Both shares come in with a positive coefficient, but only the nonbank share is significant. Thus, bank portfolio lending grew more in markets where its market share was relatively small as of 2002, again suggesting that there is some regression to the mean in market structure.

Column 3 also controls for local market power on the lending and deposit sides using, respectively, the lending share of the top four lenders from Scharfstein and Sunderam (2016) and the county deposit-weighted beta. The top-four lender share comes in negative and significant, indicating that bank portfolio lending decreased more in counties that were more concentrated. The coefficient on county deposit-weighted beta is insignificant. Thus, a

[15] Note that the estimated percentage change is in the flow of new lending, not the stock of total loans on the balance sheet. This explains why the magnitude of the coefficient is significantly larger than that for the bank-level results.

bank's local deposit share does not predict its lending behavior. Rather, it is the *lending* share that matters, together with its market power over all of its deposit funding (its bank beta). This is consistent with the earlier assumption that banks are able to use deposits raised in one county to lend in another.

Column 4 adds controls for loan demand growth. We include these because it is possible that high-beta counties experience lower demand for mortgages even conditional on observed ex-ante characteristics. The controls are the growth in GSE lending (by both banks and nonbanks), employment, and income. The idea behind controlling for GSE lending is that it captures local demand for mortgage loans that is unaffected by the supply of bank portfolio loans. This is based on the view that a loan that conforms to the GSE's stricter lending standards will always be sold to the GSEs in order to receive the government-subsidized guarantee. Thus, bank portfolio loans cannot be easily substituted by GSE loans, and hence GSE loan growth is a measure of loan demand that is unaffected by the deposits channel.

Consistent with the idea that GSE lending picks up loan demand, the estimates show that higher growth in GSE lending predicts higher growth in bank portfolio lending. Similarly, higher employment and income growth in a county also predict higher portfolio lending. Nevertheless, the controls have almost no effect on the county beta coefficient, which actually becomes more negative (-0.486) and remains significant. The stability of this estimate suggests that county beta is not picking up cross-county differences in loan demand. In summary, the results in Table 4 are consistent with the prediction of the deposits channel that high-beta counties experienced lower growth in bank portfolio lending as the Fed tightened.

Next, we analyze PLS lending to see if it offset the contraction in bank portfolio lending. Figure 7 shows a bin-scatter plot of the change in the PLS lending share between 2003 and 2006 against the county beta. We note that analyzing the PLS share implicitly controls for loan demand by scaling PLS lending by total lending.[16] Consistent with the deposits channel and substitution towards PLS lending, there is a strong positive relationship: counties with high betas see a much larger shift toward PLS lending. The PLS lending share rises by 15 percentage points in counties with a beta of 0.7 versus 9 percentage points in counties with a beta of 0.4.

[16] Recall that we exclude GSE loans from all measures other than the explicit GSE lending controls.

Column 1 of Table 5 provides a formal estimate of this relationship. Regressing the change in PLS lending's share on county beta gives a highly significant coefficient of 0.213. The intercept is zero, implying that a hypothetical unexposed county (beta of zero) would see *no* growth in the PLS lending share. By contrast, a maximally exposed county (beta of one) would see an increase in the share of PLS lending of 21.3 percentage points. To see how large this effect is, notice that for PLS lending share to rise by 21.3 percentage points from its initial mean of 49.7% (Table 1), PLS lending has to grow by 90.7% relative to bank portfolio lending.[17]

Column 2 of Table 5 adds in the controls for market size and economic conditions. The coefficient on county beta rises slightly to 0.227. The coefficients on the controls are small and insignificant.

Column 3 adds in the market structure controls. The coefficient on county beta declines to 0.141, mainly because PLS lending grew more in areas that had a lot of bank portfolio lending as of 2002. This is again the regression to the mean we saw in Table 4. The county deposit-weighted beta and the top-four lenders share also come in with a negative sign. Again, this shows that what matters for the change in the PLS lending share is the exposure of banks that lend in the county, not the banks that raise deposits in the county.

Column 4 controls for loan demand growth using the growth of GSE lending, employment, and income as proxies. The coefficient on county beta rises to 0.192, which is very close to the univariate estimate in column 1. Hence, the effect of county beta on the change in PLS share is unlikely to be explained by cross-county differences in loan demand. Indeed, in going from column 3 to column 4, the coefficient on county beta actually rises, suggesting that loan demand actually masks part of the substitution to PLS lending induced by the deposits channel.

A simple way to relate the cross-sectional estimate to the aggregate growth in PLS is to

[17] Let w and w' be the starting and ending shares of PLS, respectively (hence $1 - w$ and $1 - w'$ are the starting and ending shares of bank portfolio lending). Then g, the difference between the log growth rates of PLS and bank portfolio lending, is given by

$$g = \ln\left(\frac{w'}{w}\right) - \ln\left(\frac{1-w'}{1-w}\right). \tag{8}$$

Plugging in $w = 0.497$ and $w' = 0.497 + 0.213$ gives $g = 0.907$.

multiply the coefficient by the average county beta in Table 1. Under this calculation the deposits channel can account for $0.192 \times 0.526 = 10.2$ percentage points of the total increase in the PLS lending share between 2003 and 2006. This is essentially the entire observed increase reported in Table 1.[18]

Figure 8 and Table 6 look at total bank lending, which includes both bank portfolio lending and bank PLS lending. Here the controls have a more pronounced effect, as the coefficient on county beta declines in magnitude from -0.796 in the univariate specification in column 1 to -0.267 with the full set of controls in column 4. Among the controls, the nonbank share in column 3 stands out with a large positive coefficient, again consistent with regression to the mean in market structure. And in column 4 we see that employment growth also has a large positive coefficient, suggesting that loan demand plays a significant role.

Thus, total bank lending declines by much less than bank portfolio lending as a function of county beta. This suggests that as portfolio lending contracted, banks made up for it in part by shifting into PLS lending. This is consistent with the deposits channel, which applies only to bank portfolio lending since PLS lending is sold in the capital market and hence does not require funding through the balance sheet.

Figure 9 and Table 7 show that nonbanks contribute to the shift toward PLS. From Figure 9, there is a strong negative relationship between the nonbank lending share and the county beta. Counties with a beta of 0.4 see a one percentage point *reduction* in the nonbank share, versus a five percentage point *increase* for counties with a beta of 0.7. Column 1 of Table 7 shows that the corresponding univariate coefficient on county beta is 0.208. The estimates imply that a hypothetical unexposed county with a beta of zero would see a 9.2 percentage point reduction in the nonbank share, versus an 11.6 percentage point increase for a maximally exposed county with a beta of one. To gauge magnitudes, note that for the nonbank share to grow by 20.8 percentage points from an initial mean of 26.6% (Table 1), the log growth of nonbank lending must exceed that of bank lending by 91.1%.

The coefficient on county beta remains unchanged in column 2, where we add controls for market size and economic conditions as of 2002. In column 3 it drops to 0.094, driven mainly by the impact of the initial nonbank share. As in the previous tables, this indicates

[18] We discuss this type of aggregation further in Section IV.D below.

regression to the mean in market structure. Finally, in column 4, where we add the loan demand controls, the coefficient on county beta grows to 0.124, implying a 57% higher log growth in lending by nonbanks than banks. Overall, Table 7 shows that much of the growth in PLS lending was driven by nonbanks.

Finally, Figure 10 and Table 8 look at total (non-GSE) lending. The univariate coefficient on county beta is a large and significant -0.446. However, it drops to -0.085 and becomes insignificant once we add in all the controls in column 4. Among the controls, the nonbank share, the top-four lender share, and employment growth have the strongest impact on total lending growth. Once these controls are added, counties with a high beta see only a small reduction in total mortgage lending relative to counties with a low beta.

The combination of a large contraction in bank portfolio lending (Table 4) and a small contraction total lending implies a high degree of substitutability between bank portfolio lending and PLS lending. The picture emerges that, as the Fed raised rates between 2003 and 2006, bank portfolio lending contracted and mortgage lending migrated to the PLS market, with only a small net impact on overall lending. Thus, the shift to PLS substantially mitigated the contractionary impact of monetary tightening on mortgage lending. This had an important negative impact on the stability of the mortgage market, as stable and run-free government-insured core deposit funding was replaced by run-prone capital markets funding.

IV.D Aggregate impact

In this section we discuss the aggregate implications of our cross-sectional results. We start with bank portfolio lending. From Table 4, column 4, bank portfolio lending fell by 48.6% in a county with a beta of one relative to a county with a beta of zero. By construction, a county with a beta of zero is not exposed to the deposits channel. Hence, it provides us with a counterfactual for how bank portfolio lending would have evolved if the Fed had not tightened. This allows us to interpret the 48.6% estimate as the contraction in bank portfolio lending induced by Fed tightening in a county with a beta of one. And since the weighted average beta of all counties is 0.532 (Table 1), the implied contraction in the growth of aggregate bank portfolio lending induced by Fed tightening is $0.486 \times 0.532 = 25.9\%$.[19]

Against this backdrop, the implied aggregate contraction in total lending is much smaller. Using the estimates in Table 8 column 4, this contraction is only 4.4%. The reason for this small number is the substitution to PLS lending. In particular, using the same approach our numbers imply that Fed tightening induced a 16.6% *expansion* in PLS lending. This expansion was led by 18.8% growth in the nonbank sector.

Therefore, our results imply that the contractionary impact of Fed tightening on total mortgage lending was substantially offset by substitution to PLS lending during the housing boom. It is worth noting, however, that the negative point estimate for total lending suggests Fed tightening still had some impact. Thus, our results do not imply that Fed tightening was counter-productive. However, there was an important side effect due to the risks associated with the PLS lending model.

Our results allow us to estimate the substitutability between bank portfolio lending and PLS lending, which is potentially important for predicting the impact of future tightening cycles. To see how, suppose that Fed tightening induces bank portfolio lending (BP) to contract by some amount dBP. We want to know, how much of the contraction will be offset by PLS lending, i.e., what is $-dPLS/dBP$? Using the fact that total (non-GSE) lending (TL) is the sum of bank portfolio lending and PLS lending, we can infer this substitutability as follows:

$$-\frac{dPLS}{dBP} = -\frac{dTL - dBP}{dBP} = -\left(\frac{dTL/TL}{dBP/BP} \times \frac{TL}{BP} - 1\right). \tag{9}$$

Using the shares reported in Table 1 (the bank portfolio share is one minus the PLS share) and the estimates in column 4 of Tables 4 and 8, we get

$$-\frac{dPLS}{dBP} = -\left(\frac{-0.085}{-0.486} \times \frac{1}{1 - 0.497} - 1\right) = 0.654. \tag{10}$$

Hence, PLS lending offsets 65.4% of the contraction in bank portfolio lending. Similarly, the

[19] We emphasize that since Fed tightening and the housing boom took place during a period of high loan demand growth, bank portfolio lending growth would likely have been high absent Fed tightening. The advantage of going to the cross section is that it allows us to difference out this countervailing force.

substitutability between total bank lending and nonbank lending is 56.8%. These relatively high degrees of substitutability explain why Fed tightening had a much smaller impact on total lending than on bank portfolio lending.

The above estimates implicitly assume that the aggregate substitutability between bank portfolio lending and PLS lending is the same as their observed cross-sectional substitutability. Although this is a natural benchmark, it need not be the case. For instance, it is possible that the aggregate supply of PLS lending was fixed during the housing boom, and that the deposits channel simply reallocated it across counties.

The literature suggests, however, that the aggregate supply of PLS lending was not fixed. For instance, many securitized loans ended up on the balance sheets of ABCP conduits, which were receiving funding from money market funds (Acharya, Schnabl, and Suarez 2013). Money market funds were in turn absorbing the recycled deposits of banks (Drechsler, Savov, and Schnabl 2017b, Xiao 2018). Thus, as bank deposits contracted, the available funding for PLS lending expanded elastically.[20]

Finally, the idea that aggregate PLS lending was exogenously fixed is hard to square with the time series evidence. As we saw in Figure 1, and as documented by Justiniano, Primiceri, and Tambalotti (2017), there is a clear inflection point in PLS lending right as the Fed shifted to a tightening stance in the summer of 2003. Moreover, Figure 1 also shows the PLS market is once again growing rapidly just as the Fed has been raising rates. The aggregate time series thus suggests that PLS lending is similarly sensitive to Fed tightening in the aggregate as in the cross section. This suggests that the aggregate elasticity of PLS lending is similar to the cross sectional one that we find.

V Conclusion

Between 2003 and 2006, the Fed raised rates by 4.25%. This tightening induced a large contraction in deposits, leading banks to substantially reduce their portfolio mortgage lending.

[20] As for the part of PLS funding that was not due to recycled deposits, Mian and Sufi (2018) argue that it was not due to specific views about U.S. housing, but was instead likely driven by a "global savings glut" (Bernanke 2005) or extrapolative beliefs (Gennaioli and Shleifer 2018). Under either of these theories, the supply of PLS lending is not fixed because it is only one outlet for a broader savings imbalance.

Yet, this contraction did not translate into a substantial reduction in total mortgage lending. Rather, an unprecedented expansion in private-label securitization (PLS), led by nonbank mortgage originators, substituted for most of the reduction in bank portfolio lending and thus largely undid the impact of Fed tightening on the mortgage lending boom.

In addition to its impact on total lending, the shift to PLS had the important effect of making the mortgage market more run-prone. Unlike GSE mortgages, which receive an effective government guarantee, or bank portfolio mortgages, which are funded with government-insured deposits, PLS mortgages do not benefit from government support. They are therefore much more exposed to the kind of wholesale funding run and market freeze that began in 2007 and was only ended by government intervention in 2008.

These findings shed light on the debate between Taylor (2007) and Bernanke (2010b). Taylor (2007) argues that more aggressive tightening would have prevented the boom. Since our point estimates suggest that tightening did lead to a modest contraction in total mortgage lending, it is possible that much more aggressive tightening would have contracted lending enough to slow down the boom. However, this may not be an effective or even realistic course as drastically higher rates would damage other parts of the economy.

In this sense, our results are closer to Bernanke's (2010b) view that tighter supervision of mortgage lending standards would have been more effective. It is difficult to predict, however, whether this would have fully insulated the mortgage market from instability once government-insured deposits were replaced with capital markets funding. Ultimately, it was the willingness of end investors to supply this funding that enabled the boom and limited the effectiveness of monetary policy.

Since the financial crisis, regulators have favored stable sources of funding such as insured deposits. Our findings suggest that this will help make monetary policy more effective in influencing lending. Nevertheless, Figure 1 shows that as the Fed has tightened in recent years, investors' appetite for PLS lending has returned. This makes the lessons of the housing boom a useful guide for future policy.

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Table 1: **Summary statistics**

This table provides summary statistics at the branch, bank, and county levels. All panels provide breakdowns by high and low beta using the median beta for the respective sample. Panel A presents branch-level summary statistics on the change in deposit spread by product (in percentage points) from January 2003 to December 2006. The data are from Ratewatch. Panel B presents branch-level summary statistics on branch size (in million dollars) and deposit growth (in percent) from June 2003 to June 2007. The data are from the FDIC. Panel C presents bank-level summary statistics on the change in deposit spread (in percentage points), the change in funding shares, and the percentage growth in deposits, liabilities, assets, securities, loan, and real estate loans from January 2003 to December 2006. The data are from the U.S. call reports. Panel D presents county-level summary statistics on the growth in bank portfolio lending, total bank lending, total lending (in percent) and the change in the private-label market share and the bank market share (in percentage points) from 2003 to 2006. All lending measures exclude GSE lending expect for "Δ Log Bank GSE lending" and "Δ Log Nonbank GSE lending". The data are based on mortgage originations reported under HMDA. The table also reports county characteristics measured in 2002. The data are from the County Business Patterns dataset.

	Panel A: Branch-level characteristics (rates)			
	All branches		Low beta	High beta
	Mean	St.Dev.	Mean	Mean
Branch beta	0.581	0.080	0.521	0.641
Δ Savings deposit spread	3.380	0.992	3.238	3.524
Δ Small time deposit spread	1.717	0.663	1.626	1.806
Δ Interest checking deposit spread	4.054	0.386	4.000	4.107
Observations	5,556		2,764	2,792

	Panel B: Branch-level characteristics (amounts)			
	All branches		Low beta	High beta
	Mean	St.Dev.	Mean	Mean
Branch Beta	0.591	0.087	0.526	0.656
Deposit Growth (in %)	0.237	0.585	0.267	0.206
Deposits (mill. $)	76.3	60.0	85.1	67.6
Observations	58,604		29,079	29,525

	Panel C: Bank characteristics			
	All banks		Low beta	High beta
	Mean	St.Dev.	Mean	Mean
Bank Beta	0.621	0.095	0.551	0.691
Δ Deposit Spread	3.049	0.651	2.836	3.261
Deposit Growth	0.239	0.240	0.282	0.196
Δ Deposits/Liabilities (in %)	-0.661	5.550	-0.356	-0.965
Δ Wholesale Funding/Liabilities (in %)	0.616	5.532	0.299	0.933
Liabilities Growth	0.247	0.241	0.289	0.207
Asset Growth	0.249	0.239	0.291	0.265
Securities Growth	0.124	0.444	0.460	0.421
Loan Growth	0.303	0.276	0.333	0.273
Real Estate Loan Growth	0.378	0.329	0.413	0.342
Observations	6,396		3,198	3,198

	Panel D: County characteristics			
	All counties		Low beta	High beta
	Mean	St.Dev.	Mean	Mean
County beta	0.532	0.061	0.485	0.580
Δ Bank portfolio lending	0.126	0.505	0.154	0.099
Δ Bank lending	0.404	0.426	0.445	0.364
Δ Total lending	0.428	0.365	0.448	0.408
Δ PLS lending share	0.114	0.144	0.105	0.123
Δ Nonbank lending share	0.019	0.129	0.007	0.030
Log total lending (2002)	5.109	1.873	5.296	4.921
Log employment (2002)	9.208	1.524	9.371	9.046
Log median income (2002)	10.463	0.241	10.463	10.464
Log bank portfolio lending (2002)	4.355	1.818	4.475	4.236
PLS lending share (2002)	0.497	0.173	0.530	0.463
Nonbank lending share (2002)	0.266	0.150	0.298	0.233
County deposit-weighted beta	0.575	0.069	0.547	0.603
Top 4 lenders share	0.638	0.140	0.630	0.647
Δ Bank GSE lending	−0.086	0.515	−0.093	−0.079
Δ Nonbank GSE lending	−0.145	0.709	−0.153	−0.137
Δ Employment	0.039	0.082	0.044	0.033
Δ Income	0.096	0.045	0.096	0.096
Observations	3,033		1,517	1,516

Table 2: **Deposits channel at the branch-level**

Panel A presents regressions of the branch-level change in the deposit spread from January 2003 to December 2006 on the branch beta. The branch beta is the equal-weighted average of branch-product betas estimated for the three main deposit products (savings, small time, interest checking) for all branches in a county using data before 2002. The outcome variables are the change in the deposit spread for savings deposits (Column 1), small time deposits (Column 2), and interest checking deposits (Column 3). Panel B presents regressions of the branch-level growth in deposits from June 2003 to June 2007 on the branch beta. The regression in Column 1 does not control for bank fixed effects. The regression in Column 2 controls for bank fixed effects. The standard errors are clustered at the county level.

	Panel A: Deposit Spreads		
	Savings	Time	Checking
	(1)	(2)	(3)
Branch beta	1.725***	1.065***	0.774***
	(0.211)	(0.148)	(0.078)
Observations	5,250	5,528	5,429
R^2	0.018	0.016	0.025

	Panel B: Deposit Growth	
	(1)	(2)
Branch beta	−0.322***	−0.213***
	(5.046)	(6.037)
Bank Fixed Effects	N	Y
Observations	59,700	57,497
R^2	0.002	0.186

Table 3: **Deposits channel at the bank level**

Panel A presents results on bank deposits. Columns 1 and 2 show regressions of the change in deposit spread and deposit growth from January 2003 to December 2006 on bank beta. Bank beta is average spread beta estimated over the years 1986 to 2002. Column 3 presents the second stage from a two-stage regression of deposit growth on the predicted change in the deposit spread from a regression on bank beta. Column 4 presents the corresponding OLS regression. Panel B presents results on the substitution of deposit funding to wholesale funding. Columns 1 and 2 show regressions of the change in share of liabilities funded by deposits and wholesale funding from January 2003 to December 2006 on bank beta, respectively. Panel C presents result on bank assets and loans. Columns 1 to 4 show regressions of the growth in assets, securities, loans, and real estate loans from January 2003 to December 2006 on bank beta. All regressions include controls for the natural logarithm of total bank assets, the equity ratio, and the loan-to-assets ratio. Controls are measured in December 2002. We report robust standard errors.

	Panel A: Deposits			
	Δ Deposit Spread	Δ Deposits	Δ Deposits	Δ Deposits
	(1)	(2)	(3)	(4)
Bank beta	2.281***	−0.262***		
	(0.107)	(0.037)		
Δ Deposit Spread			−0.115***	
(2SLS)			(0.015)	
Δ Deposit Spread				−0.151***
(OLS)				(0.007)
Controls	Y	Y	Y	Y
Observations	6,396	6,396	6,396	6,396
R^2	0.190	0.137	0.271	0.280

	Panel B: Liabilities		
	Δ Liabilities	Δ Deposit Share	Δ Wholesale Funding Share
	(1)	(2)	(3)
Bank beta	−0.237***	−0.047**	0.044**
	(0.038)	(0.010)	(0.010)
Observations	6,396	6,396	6,396
R^2	0.131	0.008	0.008

	Panel C: Assets and loans			
	Assets	Securities	Loans	Real Estate Loans
	(1)	(2)	(3)	(4)
Bank beta	−0.239***	−0.250***	−0.172***	−0.213***
	(0.037)	(0.072)	(0.045)	(0.052)
Controls	Y	Y	Y	Y
Observations	6,396	6,319	6,385	6,367
R^2	0.147	0.055	0.070	0.054

Table 4: **Bank portfolio lending**

This table presents regressions of the growth in bank portfolio lending from 2003 to 2006 on the county beta. The county beta is the average beta of all banks lending in the county, weighted by their 2002 lending shares. The county deposit-weighted beta is the average beta of all banks that raise deposits in a county, weighted by their 2002 deposit shares. The top 4 lenders share is the combined share of the top 4 lenders. Growth rates are in log changes.

	Δ Bank portfolio lending			
	(1)	(2)	(3)	(4)
County beta	−0.709***	−0.779***	−0.436***	−0.486***
	(0.151)	(0.147)	(0.162)	(0.163)
Log total lending (2002)		−0.133***	0.094	0.098
		(0.014)	(0.095)	(0.093)
Log employment (2002)		0.071***	0.084***	0.096***
		(0.016)	(0.016)	(0.016)
Log median income (2002)		0.164***	0.062	0.003
		(0.046)	(0.046)	(0.045)
Log bank portfolio lending (2002)			−0.259***	−0.260***
			(0.095)	(0.093)
PLS lending share (2002)			0.143	0.108
			(0.215)	(0.214)
Nonbank lending share (2002)			0.163**	0.177**
			(0.080)	(0.080)
County deposit-weighted beta			0.147	0.325**
			(0.147)	(0.144)
Top 4 lenders share			−0.304***	−0.454***
			(0.083)	(0.082)
Δ Bank GSE lending				0.123***
				(0.017)
Δ Nonbank GSE lending				0.038***
				(0.012)
Δ Employment				0.414***
				(0.111)
Δ Income				0.144
				(0.186)
Constant	0.503***	−1.146**	−0.417	0.086
	(0.081)	(0.475)	(0.483)	(0.474)
Obs.	2,999	2,998	2,998	2,750
R^2	0.007	0.074	0.138	0.176

Table 5: **PLS lending share**

This table presents regressions of the change in the PLS lending share from 2003 to 2006 on the county beta. The county beta is the average beta of all banks lending in the county, weighted by their 2002 lending shares. The county deposit-weighted beta is the average beta of all banks that raise deposits in a county, weighted by their 2002 deposit shares. The top 4 lenders share is the combined share of the top 4 lenders. Growth rates are in log changes and "Δ PLS lending share" is a simple change.

	Δ PLS lending share			
	(1)	(2)	(3)	(4)
County beta	0.213***	0.227***	0.141***	0.192***
	(0.043)	(0.043)	(0.046)	(0.043)
Log total lending (2002)		0.003	−0.040	−0.034
		(0.004)	(0.027)	(0.024)
Log employment (2002)		0.006	0.008*	0.014***
		(0.005)	(0.005)	(0.004)
Log median income (2002)		−0.026*	0.014	0.026**
		(0.013)	(0.013)	(0.012)
Log bank portfolio lending (2002)			0.040	0.025
			(0.027)	(0.024)
PLS lending share (2002)			−0.207***	−0.283***
			(0.061)	(0.056)
Nonbank lending share (2002)			0.038*	0.050**
			(0.023)	(0.021)
County deposit-weighted beta			−0.089**	−0.173***
			(0.042)	(0.038)
Top 4 lenders share			−0.073***	−0.002
			(0.024)	(0.022)
Δ Bank GSE lending				−0.025***
				(0.005)
Δ Nonbank GSE lending				−0.003
				(0.003)
Δ Employment				0.119***
				(0.029)
Δ Income				−0.072
				(0.049)
Constant	0.001	0.198	0.033	−0.095
	(0.023)	(0.139)	(0.138)	(0.125)
Obs.	3,027	3,026	3,026	2,754
R^2	0.008	0.015	0.120	0.189

Table 6: **Total bank lending**

This table presents regressions of the growth in total bank lending from 2003 to 2006 on the county beta. The county beta is the average beta of all banks lending in the county, weighted by their 2002 lending shares. The county deposit-weighted beta is the average beta of all banks that raise deposits in a county, weighted by their 2002 deposit shares. The top 4 lenders share is the combined share of the top 4 lenders. Growth rates are in log changes.

	Δ Bank lending			
	(1)	(2)	(3)	(4)
County beta	−0.796***	−0.584***	−0.368***	−0.267**
	(0.127)	(0.121)	(0.132)	(0.132)
Log total lending (2002)		0.115***	−0.154**	−0.147**
		(0.022)	(0.078)	(0.075)
Log bank portfolio lending (2002)		−0.262***	−0.028	−0.053
		(0.020)	(0.078)	(0.075)
Log employment (2002)		0.102***	0.118***	0.143***
		(0.013)	(0.013)	(0.013)
Log median income (2002)		0.079**	0.158***	0.090**
		(0.038)	(0.038)	(0.036)
PLS lending share (2002)			0.139	0.034
			(0.175)	(0.173)
Nonbank lending share (2002)			0.785***	0.838***
			(0.065)	(0.064)
County deposit-weighted beta			−0.016	−0.042
			(0.120)	(0.117)
Top 4 lenders share			−0.257***	−0.327***
			(0.068)	(0.066)
Δ Bank GSE lending				0.075***
				(0.014)
Δ Nonbank GSE lending				0.015
				(0.010)
Δ Employment				0.690***
				(0.090)
Δ Income				0.154
				(0.150)
Constant	0.828***	−0.502	−1.333***	−0.764**
	(0.068)	(0.388)	(0.397)	(0.383)
Obs.	3,019	3,018	3,018	2,753
R^2	0.013	0.130	0.176	0.238

Table 7: **Nonbank lending share**

This table presents regressions of the change in the nonbank lending share from 2003 to 2006 on the county beta. The county beta is the average beta of all banks lending in the county, weighted by their 2002 mortgage lending shares. The county deposit-weighted beta is the average beta of all banks that raise deposits in a county, weighted by their 2002 deposit shares. The top 4 lenders share is the combined share of the top 4 lenders. Growth rates are in log changes and "Δ Nonbank lending share" is a simple change.

	Δ Nonbank lending share			
	(1)	(2)	(3)	(4)
County beta	0.208***	0.209***	0.094**	0.124***
	(0.038)	(0.038)	(0.041)	(0.040)
Log total lending (2002)		0.014***	0.019	0.013
		(0.004)	(0.024)	(0.023)
Log employment (2002)		−0.009**	−0.011***	−0.007*
		(0.004)	(0.004)	(0.004)
Log median income (2002)		0.020*	−0.003	0.001
		(0.012)	(0.012)	(0.011)
Log bank portfolio lending (2002)			0.000	0.002
			(0.024)	(0.023)
PLS lending share (2002)			0.052	0.017
			(0.055)	(0.052)
Nonbank lending share (2002)			−0.303***	−0.286***
			(0.020)	(0.019)
County deposit-weighted beta			−0.007	−0.027
			(0.038)	(0.035)
Top 4 lenders share			−0.042**	−0.025
			(0.021)	(0.020)
Δ Bank GSE lending				−0.021***
				(0.004)
Δ Nonbank GSE lending				0.004
				(0.003)
Δ Employment				0.066**
				(0.027)
Δ Income				−0.010
				(0.045)
Constant	−0.092***	−0.288**	0.088	0.029
	(0.020)	(0.123)	(0.123)	(0.116)
Obs.	3,027	3,026	3,026	2,754
R^2	0.010	0.028	0.123	0.159

Table 8: **Total lending**

Results from regressing the growth in total non-GSE lending from 2003 to 2006 on the county beta. The county beta is the average beta of all banks lending in the county, weighted by their 2002 mortgage lending shares. The county deposit-weighted beta is the average beta of all banks that raise deposits in a county, weighted by their 2002 deposit shares. The top 4 lenders share is the combined share of the top 4 lenders. Growth rates are in log changes.

	Δ Total lending			
	(1)	(2)	(3)	(4)
County beta	−0.446***	−0.502***	−0.206*	−0.085
	(0.109)	(0.105)	(0.116)	(0.114)
Log total lending (2002)		−0.126***	−0.176***	−0.183***
		(0.010)	(0.068)	(0.064)
Log employment (2002)		0.094***	0.109***	0.131***
		(0.012)	(0.011)	(0.011)
Log median income (2002)		0.209***	0.185***	0.094***
		(0.033)	(0.033)	(0.031)
Log bank portfolio lending (2002)			0.014	0.006
			(0.068)	(0.065)
PLS lending share (2002)			0.266*	0.190
			(0.154)	(0.149)
Nonbank lending share (2002)			0.335***	0.387***
			(0.057)	(0.055)
County deposit-weighted beta			−0.041	−0.076
			(0.106)	(0.101)
Top 4 lenders share			−0.333***	−0.379***
			(0.060)	(0.057)
Δ Bank GSE lending				0.039***
				(0.012)
Δ Nonbank GSE lending				0.021**
				(0.008)
Δ Employment				0.800***
				(0.077)
Δ Income				0.195
				(0.129)
Constant	0.665***	−1.717***	−1.550***	−0.759**
	(0.058)	(0.340)	(0.349)	(0.330)
Obs.	3,027	3,026	3,026	2,754
R^2	0.006	0.075	0.122	0.184

Figure 1: **Private-Label Securitization and Monetary Policy** The figure is adapted from Justiniano, Primiceri, and Tambalotti (2017) and Mian and Sufi (2018). It plots the private-label securitization share of total mortgage securitized issuance from 1996 to 2018 (left axis) against the 1-Year Treasury rate (right axis). The data for PLS issuance are from the Securities Industry and Financial Markets Association (SIFMA). The Treasury rate is from the Federal Reserve's H.15 release.

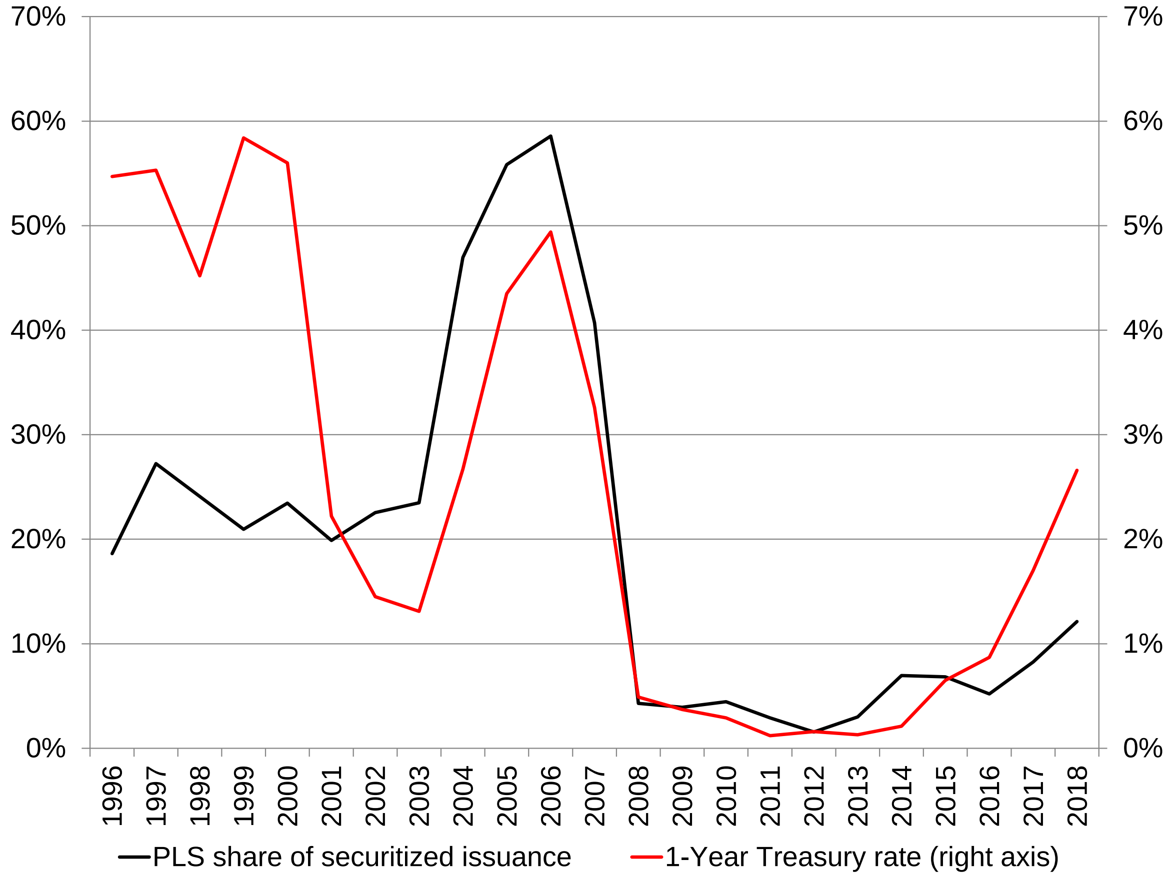

Figure 2: **Branch-level deposit spreads** Bin-scatter plots of the change in deposit spreads from January 2003 to December 2006 against the branch beta. The branch beta is the equal-weighted average of branch-product betas estimated for the three main deposit products (savings, small time, and interest checking) for all branches in a county over the years 1997 to 2002. Branches are sorted into 20 bins based on their branch beta. The figure plots the average change in the deposits spread of savings deposits (Panel A), small time deposits (Panel B), and interest checking deposits (Panel C) against the average branch beta in each bin.

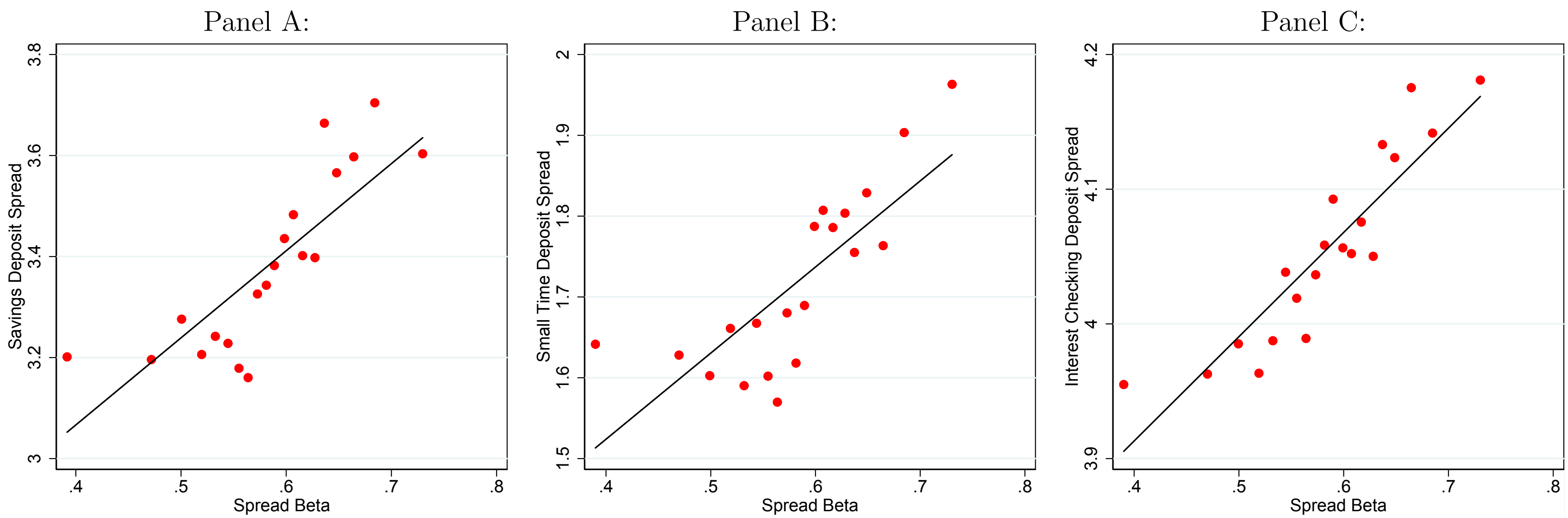

Figure 3: **Branch-level deposit growth** Bin-scatter plots of the deposit growth against the branch beta. The branch beta is the same as in Figure 2. Branches are sorted into 20 bins based on their branch beta. Panel A plots the average deposit growth in percent against the average branch beta in each bin. Panel B plots the same relationship as in Panel A after controlling for bank fixed effects.

Panel A: Panel B:

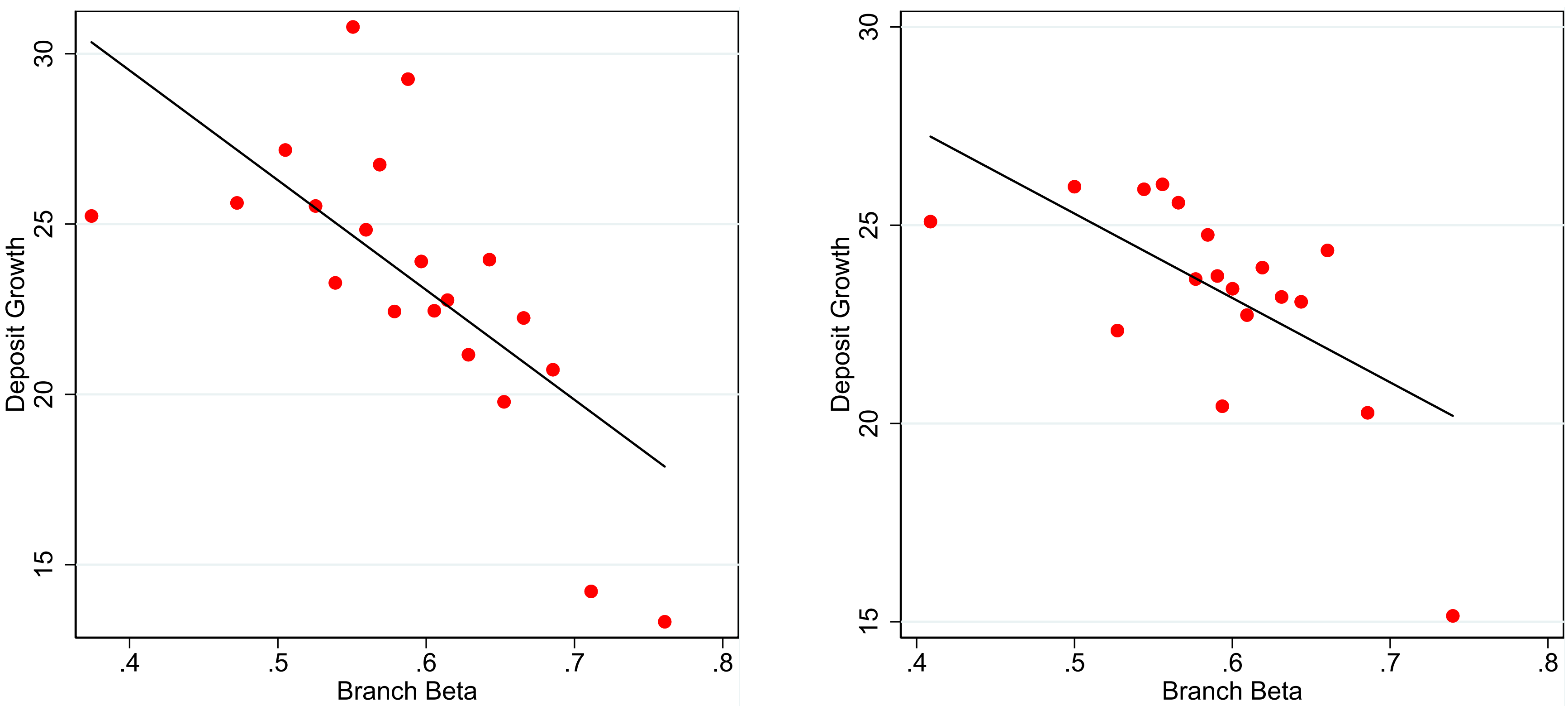

Figure 4: **Bank-level deposit spreads and deposit growth** Panel A and Panel B are bin-scatter plots of the change in deposit spreads from January 2003 to December 2006 against the bank beta. Panel C is a bin-scatter plots of deposit growth from January 2003 to December 2006 against the change in deposit spread over the same time period. The bank beta is estimated over the years 1986 to 2002. Banks are sorted into 20 bins based on their bank beta. The figure plots the average change in deposit growth and change in deposit spread by bin.

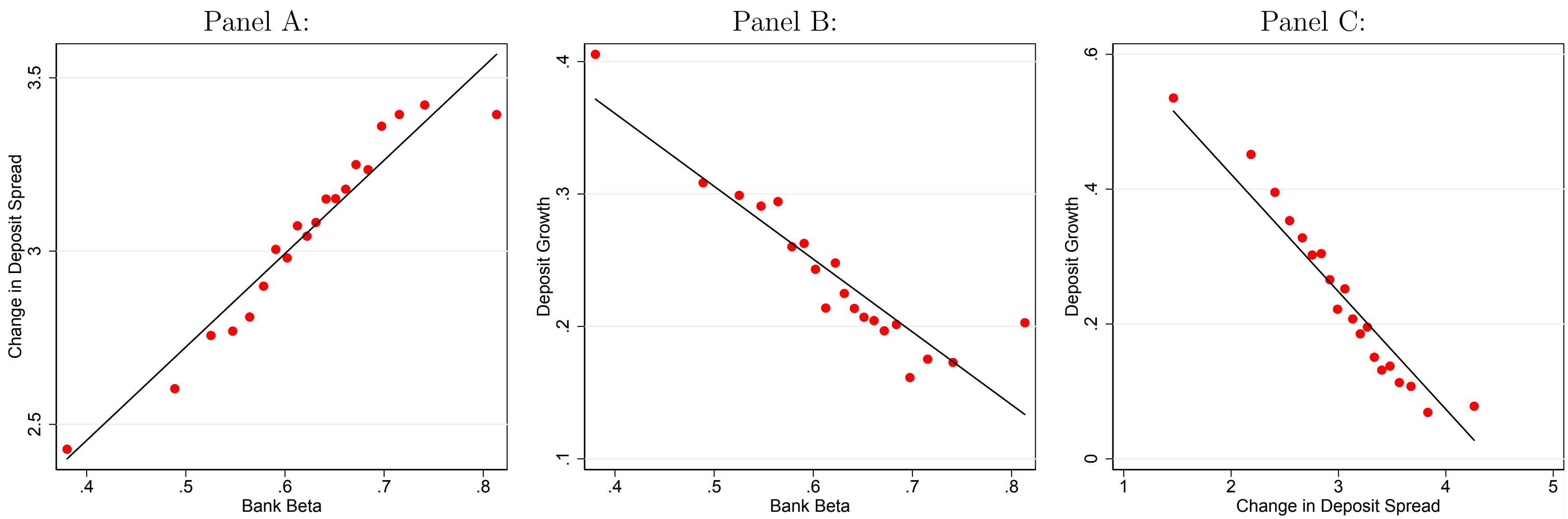

Figure 5: **Bank assets, securities, and loans** Panels A and B are bin-scatter plots of the growth of bank assets and securities from January 2003 to December 2006 against the bank beta. Panels C and D are bin-scatter plots of the growth in bank loans and real estate loans over the same time period. The bank beta is estimated over the years 1986 to 2002. Banks are sorted into 20 bins based on their bank beta. The figure plots the average growth by bin.

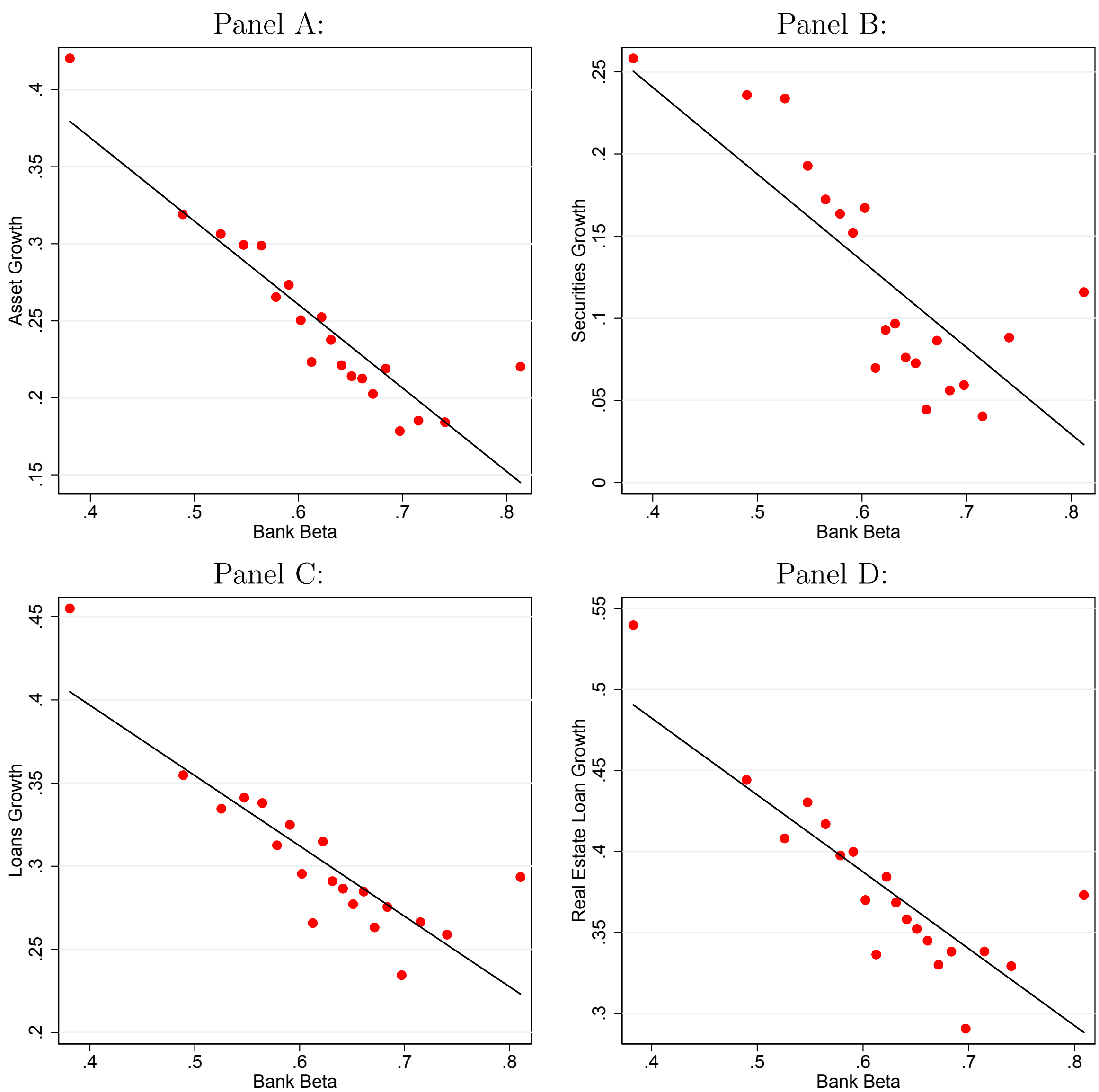

Figure 6: **Bank portfolio lending** This figure presents a bin-scatter plot of the growth in bank portfolio lending from 2003 to 2006 against the county beta. The county beta is the average beta of all banks lending in the county, weighted by their 2002 mortgage lending shares. Counties are sorted into 20 bins based on their county beta. The figure plots the average growth in bank portfolio lending for the counties in each bin.

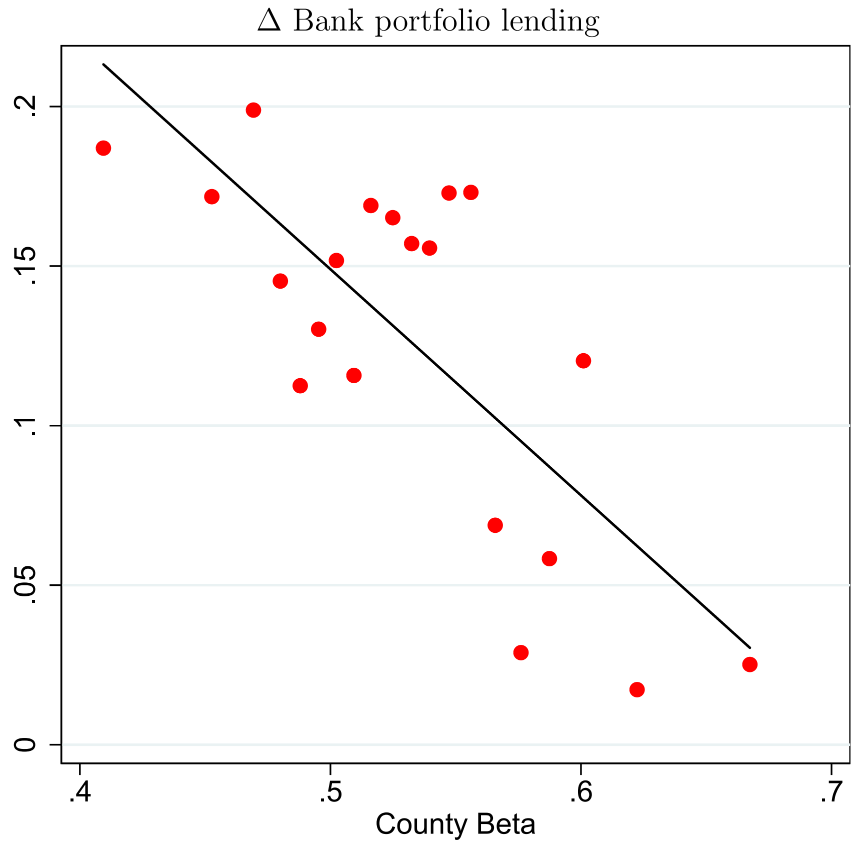

Figure 7: **PLS lending share** This figure presents a bin-scatter plot of the change in the PLS lending share from 2003 to 2006 against the county beta. The county beta is the average beta of all banks lending in the county, weighted by their 2002 mortgage lending shares. Counties are sorted into 20 bins based on their county beta. The figure plots the average change in the PLS lending share for the counties in each bin.

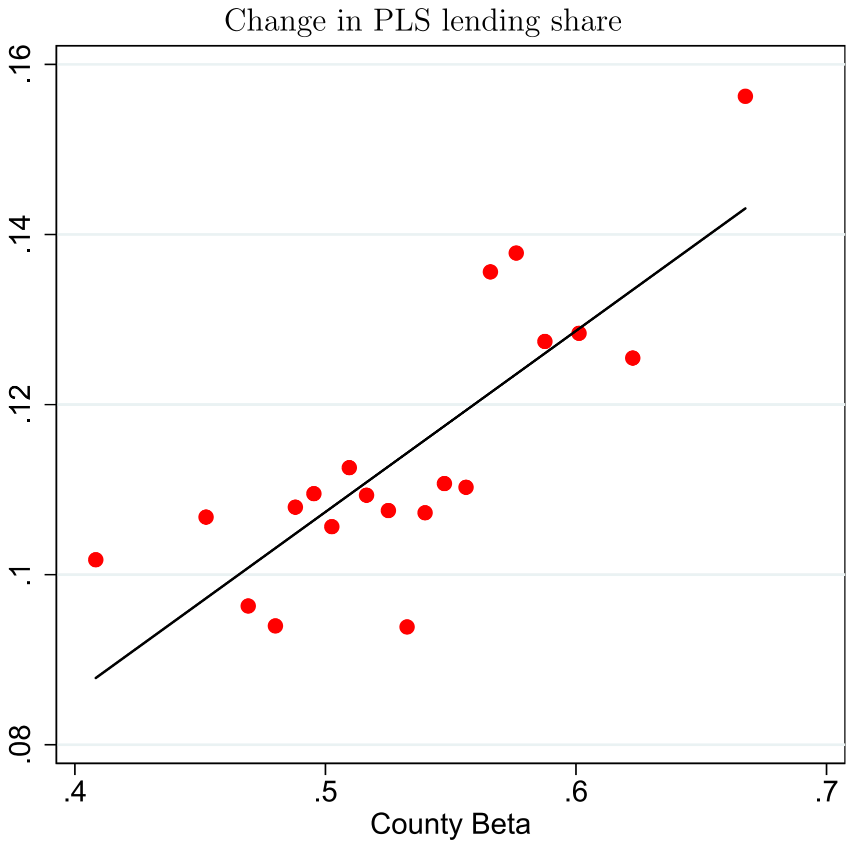

Figure 8: **Total bank lending** This figure presents a bin-scatter plot of the growth in total bank lending from 2003 to 2006 against the county beta. The county beta is the average beta of all banks lending in the county, weighted by their 2002 mortgage lending shares. Counties are sorted into 20 bins based on their county beta. The figure plots the average growth in nonbank lending for the counties in each bin.

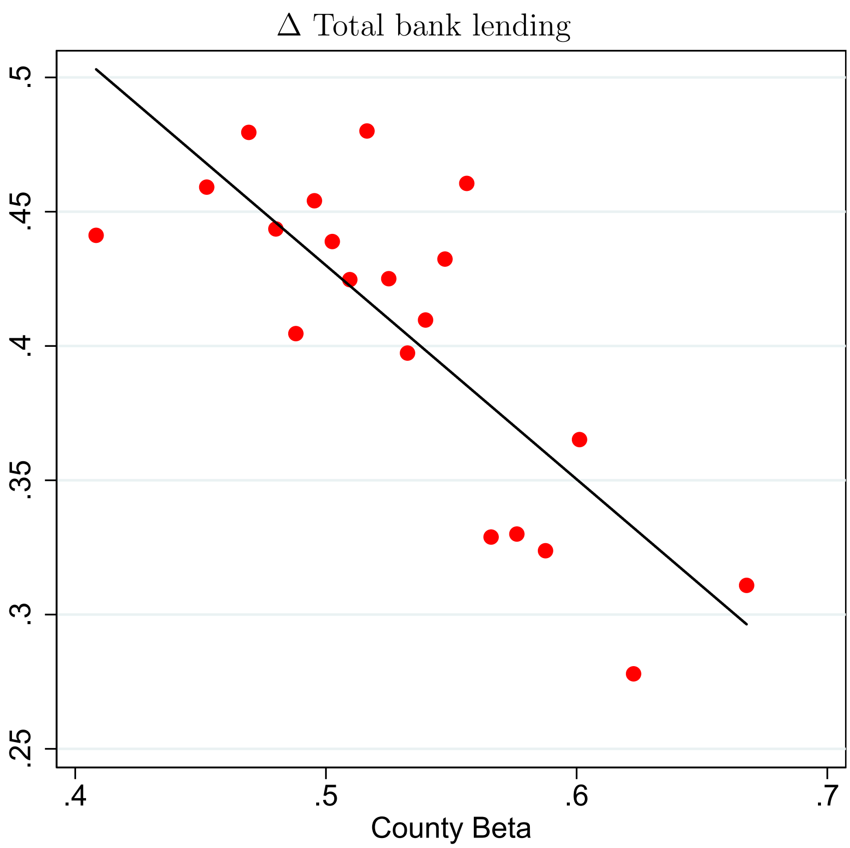

Figure 9: **Nonbank lending share** This figure presents a bin-scatter plot of the change in the nonbank lending share from 2003 to 2006 against the county beta. The county beta is the average beta of all banks lending in the county, weighted by their 2002 mortgage lending shares. Counties are sorted into 20 bins based on their county beta. The figure plots the average change in the nonbank lending share for the counties in each bin.

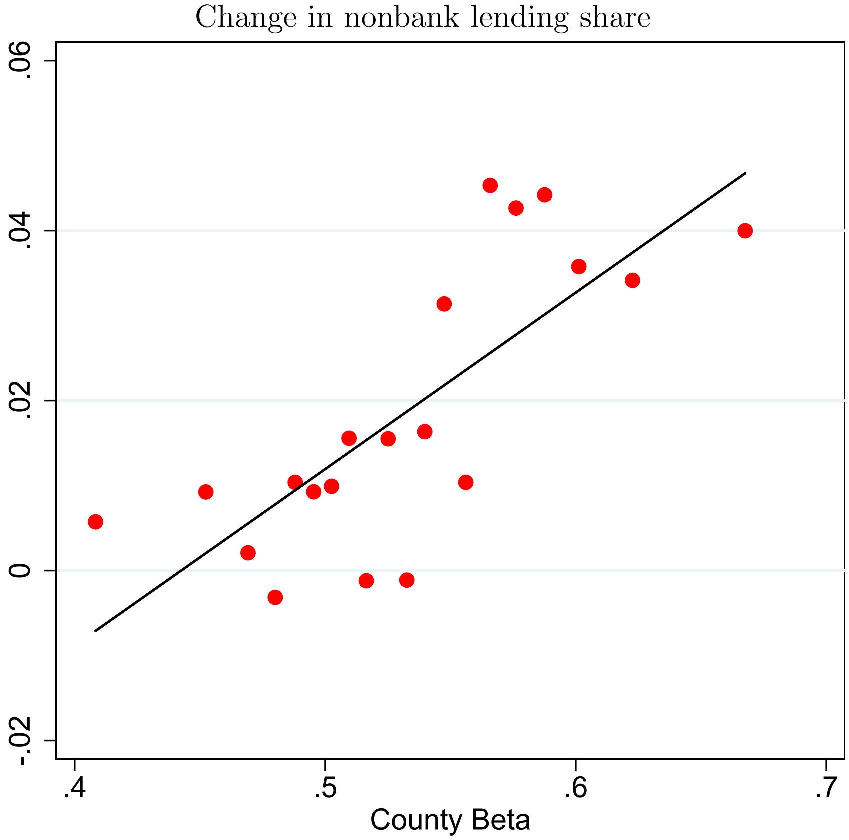

Figure 10: **Total lending** This figure presents a bin-scatter plot of the growth in total non-GSE lending from 2003 to 2006 against the county beta. The county beta is the average beta of all banks lending in the county, weighted by their 2002 lending shares. Counties are sorted into 20 bins based on their county beta. The figure plots the average growth in total lending (excluding GSE lending) for the counties in each bin.