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Federal Reserve Bank of Chicago

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Abstract: The growth of securitization made it easier for banks to sell home mortgage loans that they originated. I explore how mortgage sales affected banks in the years leading up to the financial crisis that began in 2007 and how their pre-crisis mortgage sales affected banks during the crisis. Loan sales are important because most banks sell mortgages as part of the securitization process, but few actually do the securitization. I find that stock returns increase when banks increase sales of mortgages used for refinancing rather than home purchase, suggesting that some banks scale up lending during refi booms. It is this flexibility that is both a plus and a potential minus of this model, since banks profited by scaling up during refi booms, but borrowers during refi booms were riskier than at other times, possibly adding risk to the financial system. I also find that losses during the financial crisis were related to pre-crisis mortgage sales, with the losses being roughly of the same magnitudes as the gains due to mortgage sales from 2001-2006.

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The impact of the originate-to-distribute model on banks before and during the financial crisis

The recent financial crisis began in 2007 when problems surfaced in mortgage-backed securities (MBS) markets. Securitization, especially of home mortgages, has been around for about forty years but securitization in general, and MBS in particular, grew rapidly in the last fifteen years (see Figure 1). The growth of securitization in the pre-crisis period along with the losses on securitized assets during the crisis led many to explore the importance of securitization in the financial crisis. There is a growing literature that focuses on agency problems in the securitization process. A common argument in these papers is that the securitization process reduced incentives for banks to screen out (or monitor) risky, unqualified borrowers (see, e.g., Purnanandam, 2009; Keys, *et al.*, 2010). However, securitization also had another impact on mortgage lending, one that may have been associated with the buildup of weak loans during the pre-crisis period but can also be thought of as a potential benefit of the securitization process. Liquid securitization markets make it easy for banks to hold loans they originate for only a short period of time. The originate-to-distribute (OTD) model of lending gives banks the flexibility to change the volume of mortgages they make quickly without having to make large adjustments to their equity capital or asset portfolio. That is, banks can ramp up and ramp down mortgage originations a lot without much impact on other parts of the bank. In this paper, I show that one of the features of mortgage lending in the pre-crisis period was that banks using the OTD model were able to quickly adjust lending to absorb refinancing (refi) booms.

The flexibility to adjust mortgage origination volumes quickly has both micro and macro effects. On a micro level, individual banks were able to profit from refi booms, in part by making riskier loans. I show that, prior to the crisis, bank stock returns were increasing in the volume of refi loans that banks sold. At the same time, banks made *ex ante* riskier mortgages during refi booms than during other periods (where risk is measured by the loan-to-income ratio of the borrower). This may have reflected borrowers using refinancing as an opportunity to cash out some of the equity value in their homes. Thus, on a macro level, the ability to scale up lending in boom periods may have increased the riskiness of outstanding mortgage loans.

To help understand the role of securitization in mortgage markets, I focus on the origination and first sale of mortgages. The presence of securitization lets banks change their lending process. Instead of the traditional model that combines originating a loan with holding it to maturity, securitization allows banks to use the OTD model. With the OTD model, banks originate mortgages and then sell them off to be part of a securitization. Understanding

mortgage sales helps determine the importance of the OTD model to banks and the role of securitization in mortgage lending. In this paper, I explore *which* banks used the OTD model, *why* they did, and, importantly, *what* flexibility the presence of a liquid loan sale market allowed.

Securitization is the issuance of bonds that are repaid by the payments on a pool of assets, where the assets also serve as collateral. Securitized bonds backed by mortgages, that is, MBS, are issued by either government-sponsored entities (the GSEs that issue MBS are Fannie Mae and Freddie Mac) or private financial firms such as commercial and investment banks (I refer MBS issued by private firms as private-label MBS). A mortgage can get into the pool that backs MBS by several paths (see Figure 2). The most direct path from origination to securitization is when a bank pools the loans it originates and then makes them the collateral for a securitization it issues (see the top illustration in Figure 2). But, only a handful of the largest banks originate enough mortgages to do this and even these banks also sell mortgages to either other financial firms or to the GSEs. Overall, about half of mortgages that are sold end up with the GSEs. Many of the mortgages in the pools backing private-label MBS come from banks other than the issuing bank (see the second illustration in Figure 2). It is possible that a mortgage is sold several times before ending up in an MBS pool (see the alternative path in Figure 2). In this paper, I focus on the first sale only. It is ability of lenders to easily make this first sale that made the OTD business model possible. Of course, the first sale is aided by the fact that the participants know that, in the end, the mortgage is likely to end up in an MBS pool.

A bank can use loan sales as a means of earning revenues from origination (the OTD model), but the sales can also affect the type of loans that it keeps on its balance sheet. Early academic papers on securitization discuss how banks can use loan sales to tailor risk (see, e.g., Greenbaum and Thakor, 1987). The first question addressed in this paper is how the ability to sell mortgages affects the loans a bank has on its balance sheet. I provide evidence consistent with mortgage sales having only a small effect on the loans banks keep on the balance sheets. An increase in mortgage sales is accompanied by an increase in the mortgages a bank has on its balance sheet, but the increase in these loans is consistent with the timing of the sales. That is, banks do not generally sell loans on the day they are originated, so there are loans that a bank holds temporarily as part of the sale process. The increase in mortgages held in portfolio in response to an increase in mortgage sales is of the same magnitude as one would expect from the loans that are in the pipeline to be sold. Still, banks could be using mortgage sales to adjust the risk of the loans they retain. However, there is no evidence that this is happening. There is no impact on future non-performing mortgages when bank loan sales go up. Moreover, there is also no effect on the portfolio shares of the other loans a bank keeps on its balance sheet. This suggests that banks largely view mortgages they sell as part of an add-on business to their other activities.

The OTD model makes loan sales mostly a fee-for-service business. Banks hope to earn a margin on loan origination. There is some risk since, as noted, the selling process is not instantaneous. While a bank is holding a loan in the sale pipeline, conditions in mortgage and securitization markets can change. When mortgage rates change, banks can have capital gains or losses on the mortgages they hold, including those in the sale pipeline. In addition, if securitization markets shut down (as the private markets did in the financial crisis), then banks can be forced to hold onto their pipeline loans. I examine how mortgage sales affect the return and risk of banks.

I find that, before the financial crisis, increases in loan sales were associated with higher profitability. Interestingly, the higher profit was due entirely from the sale of loans used to refinance homes rather than the purchase of new homes. Figure 3 shows that much of the variation across time in mortgage sales comes from changes in refinancing activity. This is not surprising to anyone who has a home mortgage. Many mortgages (at least in the United States) have no penalty for prepayment. As mortgage rates fall, the option to refinance at a lower interest rate becomes more in the money, leading to an increase in activity. The OTD model is easily scalable, so banks that use it can ramp up their originations during refinancing booms. Thus, these booms offer a way for banks to earn what are, in effect, bonus profits. During booms, the banks more involved in mortgage sales increase their sales of refi loans (those made to refinance an existing mortgage) at a faster rate than banks with less sale activity, consistent with the easy scalability of OTD origination. That this is a boom effect is supported by evidence on the persistence of mortgage volume changes. I show that sales of mortgages backing refinancings are not persistent either in an absolute sense or relative to other kinds of mortgages (that is, those made for purchase or refi mortgages that are kept by a bank on its balance sheet). These results are evidence that the OTD model is valuable to some banks because it allows them to scale up when mortgage market conditions are especially strong.

It is reasonable to ask whether banks change their lending standards when mortgage markets strengthen or weaken. If capital was costly, one would expect banks to be pickier when the demand for mortgages increases. However, if securitization markets allow banks to increase originations at a minimal capital cost, then there is no reason for banks to get pickier. Measuring borrower risk using the loan-to-income ratio of the borrower, I find that the risk of loans increases in refi booms. Moreover, the increase in risk is concentrated at the banks most focused on OTD mortgage lending.

Most of this paper looks at the period leading up to the financial crisis that began in 2007. Since the financial crisis, which hurt banks significantly, is partially attributed to mortgage lending, I explore how the gains in the pre-crisis period are related to losses during the crisis.

The average loss of value for banks in my sample during 2007 and 2008 was 26%, with almost one quarter of the banks losing over 50% of their market value. I find that larger mortgage sales in the period leading up to the crisis predict a larger decline in stock prices in 2007-2008. Further, the association is due to the volume of mortgages for refinancing that were sold. The decline in equity value during 2007-2008 predicted by mortgage sale activity is roughly comparable in magnitude to the increase in 2001-2006 equity value predicted by the same activity. Thus, in a sense, what went up later came down.

Two other interesting observations are generated in my analysis. First, I am the first that I know of to derive the average amount of time a mortgage is held in the sale pipeline by a bank. I estimate that it takes an average of 39 days from the time a loan is originated to the time it is sold. This is significantly short than the estimated 3-6 months it takes for the entire securitization process for private-label issues (Gordon and D'Silva, 2008). The second observation is more well known, but still worth pointing out. A large part of the increase in mortgage sale activity was concentrated at a relatively small proportion of banks. The vast majority of banks originate and sell mortgages, but for most, it is a small part of their overall business. A few banks seem to specialize in mortgage sales and, for them, the ups and downs in recent years were much larger.

The remainder of the paper is organized as follows. The next section offers a brief literature review. I then discuss the data I use for my analysis. This section also includes my estimate of the amount of time a loan is held in the mortgage pipeline. Section IV focuses on the period prior to the financial crisis and Section V examines the impact of the financial crisis. Finally, the last section offers some concluding comments.

II. Literature review

This paper examines how loan sales affected bank risk and return. There are two general ways that loan sales, especially those motivated by securitization, can help banks. The first is by allowing the bank to adjust its level of risk. A large number of papers discuss the role of securitization in credit risk transfer (CRT) from the point of view of the securitizing banks. Loan sales and securitization can allow banks to reduce expected regulatory costs (Pennacchi, 1988) or bankruptcy costs (Gorton and Souleles, 2006). These papers suggest that loan sales allow banks to reduce risk. Alternatively, loan sales may increase bank risk if banks sell the safest of their loans or other assets and replace them with riskier assets (Benveniste and Berger, 1987) or if they hold recourse for the loans they sell (Pennacchi, 1988). These papers focus on loan sales for risk management rather than as a way of generating profit. As I discuss below, an alternative

view is that the loans banks sell were originated with the sole intent of selling them to earn fees (i.e., the OTD model).

The empirical evidence on whether CRT makes banks riskier is mixed. U.S. banks that securitize assets reduce insolvency risk (Jiangli and Pritsker, 2008), especially from the securitization of home mortgages (Casu, et al., 2010). Participating in the commercial loan sales market allows banks to make riskier loans but hold less risk than other banks (Cebenoyan and Strahan, 2004). There is also evidence that banks use securitization to increase capital ratios (Calomiris and Mason, 2004). But, evidence suggests European banks that issue CDOs get riskier (Hansel and Krahen, 2007).

Another potential use for securitization is regulatory arbitrage. For example, banks can reduce capital requirements by selling loans and purchasing MBS (see Elul, 2005, for an example). The evidence leans against this as a major factor in securitization. Spanish banks do not appear to use securitization for this purpose (Martin-Oliver and Saurina, 2007) and, in the U.S., finance companies, where regulatory arbitrage is not an issue, appear at least as likely to securitize assets as banks (Minton, et al., 2004). However, there is a belief by market observers that regulatory arbitrage plays a role in securitization.

The papers that examine the role of CRT and regulatory arbitrage focus mostly on banks that securitize assets. In this paper, I examine the sale of loans rather than securitization. This difference can be important. Banks that securitize assets (securitizers) actually put together the pools of assets that are sold. There are a large number of banks that sell loans without being securitizers and there are also a smaller number of banks with a significant securitization business with few loan sales. Securitizers tend to be larger than banks that just sell loans.

The second way that loan sales can help banks is by allowing them to earn revenue through the OTD model. Some of the early academic work on securitization looked at how agency problems between banks and investors may limit the ability to securitize or sell loans. One problem was the adverse selection incentive of banks to securitize (or sell) loans the bank knew to be riskier than investors though they were. One solution to this was to have banks securitize only their safest assets (Greenbaum and Thakor, 1987), although this may end up making banks riskier (Benveniste and Berger, 1987). Another solution was for banks to keep a share of the risk, such as through recourse (Gorton and Pennacchi, 1995). The extent of the adverse section problem is related to the degree to which a bank has soft information (Stein, 2002). Soft information cannot be credibly communicated, so banks that want to sell loans have less incentive to collect soft information (Rajan, Seru, and Vig, 2009). To the extent that banks grant mortgages based on hard information such as a credit score this is less likely to be a problem for

these loans. The evidence suggests that reliance on hard information for subprime loans increased as securitization did (Rajan, Seru, and Vig, 2009).

Another potential agency problem more relevant for mortgage lending is that lenders have less incentive to screen loans that they are planning to sell. Some have argued that banks did less screening for subprime mortgages they planned to sell (e.g., Keys, *et al.*, 2010). Further evidence for this is that banks using the OTD model took losses when they got stuck with loans after securitization markets shut down at the start of the financial crisis (Purnanandam, 2009). These papers examine the types of loans banks issued rather than the impact of loan sales on banks, as in this paper. But, one thing to take from these papers is that they are consistent with banks separately considering loans they plan to sell and investments that they plan to keep on their balance sheets.

III. Data Development

A. Data sources

The primary source of mortgage data that I use comes from information that lenders are required to report under the Home Mortgage Disclosure Act (HMDA). HMDA mandates that lenders report data for the vast majority of all mortgage applications.¹ For each application, the HMDA data provide the name of the lender, loan information, and what the lender had done with the loan as of the end of the year it was granted (more on this last point below). Lenders are required to report information on all types of residential mortgages, including purchases of homes, purchases of multifamily dwellings, loans to refinance existing mortgages, and loans for home improvement. To make the comparisons in this article as revealing as possible, I restrict the sample to loans used for purchase or refinance of homes.²

I match the HMDA data with accounting data and stock market information for banks.³ The accounting data comes from the Call Reports on Income and Condition that banks are required to file and the Y-9 regulatory accounting forms that bank holding companies and financial holding companies are required to file.⁴ In the final sample, I include only commercial banks and holding companies that own commercial banks (which I refer to collectively as banks), and I use

¹ For details, see Federal Financial Institutions Examination Council (2008). In general, very small lenders are exempt from filing, as are lenders that do not make loans in metropolitan statistical areas.

² Home mortgages are loans backed by 1-4 family homes.

³ The matching is based on a data set provided by Robert Avery, of the Board of Governors of the Federal Reserve System.

⁴ These are available for download on the Federal Reserve Bank of Chicago's website.

the consolidated balance sheet of the parent organization where possible.⁵ I get stock market information for banks from the CRSP data.⁶

I have HMDA data starting in 1995. Since I need lagged values for some variables, this means that the first year in much of my analysis is 1996. I start by examining 1996-2006, the period leading up to the financial crisis. As discussed below, I also analyze the crisis period using data from 2007-2008.

B. Use of the OTD model in the pre-crisis period

The key variable to examine the impact and importance of the OTD model is the flow of loans a bank originates but intends to sell. There is a complication when measuring this flow. As mentioned earlier, the HMDA requires the reporting of the status of a loan made during a calendar year as of the last day of that year. A loan made in the later months of the year that a bank intends to sell may still be on the bank's balance sheet at the end of the year. For example, if it takes one month from the date of origination for a bank to sell a loan, then all the loans made in December will be reported as held by the bank at the end of the year even if some are later sold.

To estimate how long it takes a bank to sell a mortgage, I take advantage of the fact that the HMDA data includes the date that a mortgage is originated as well as the status of the mortgage at the end of the year. As Figure 4 shows, the proportion of mortgages reported sold by the end of the year is much lower for mortgages made late in the year. I can use the differences in the share of mortgages sold across months to estimate how long mortgages stay in a bank's portfolio before being sold. Let $SOLD\ SHARE_m$ be the share of mortgages made in month m that are sold by the end of the year. For mortgages made in December, only those sold within the month they are originated are reported as sold. If mortgages are made uniformly through the month, then the average mortgage made in December is on the originating bank's balance sheet for 0.5 months. Under a similar assumption, mortgages made in November are outstanding an average of 1.5 months by the end of the year. If I further assume that the probability a mortgage is sold is independent of when it is made, then a share equivalent to $SOLD\ SHARE_{12}$ of the mortgages made in November should be sold by the end of November. The remaining share, $SOLD\ SHARE_{11} - SOLD\ SHARE_{12}$, is the share of mortgages made in November that are sold in December. On average, the November mortgages sold in December are held for one month by the bank before they are sold. Working backward, I can estimate the average duration of

⁵ If data is not available for the parent organization, I aggregate the information for the commercial banks owned by the parent.

⁶ The information from the Call Reports and Y-9 forms is matched with the CRSP data using the matching file provided by the Federal Reserve Bank of New York.

mortgages made in the earlier months of the year. Combining these gives an estimate of the average time a mortgage spends in the pipeline between its origination date and the date it is sold:

$$\text{PIPELINE TIME} = + 0.5 / 12 \times \text{SOLD SHARE}_{12} \quad (1)$$

where the pipeline time is expressed in years. The average pipeline time for banks in my sample is 0.106 years, or about 39 days. This estimate is quite robust. The pipeline for banks that are in the top ten in loans sold in a given year is 37 days while the pipeline for other banks in the sample is 44 days.⁷

Using both Figure 4 and my estimate of pipeline holding time suggests that the most mortgages that a bank intends to sell are sold within six months. Thus, I estimate the flow of mortgages that a bank makes intending to sell by using data on sales for mortgages made in the first six months of the year. Let $\text{PCT SOLD}_{i,t}$ be the mortgages made from January through June of year t and sold by the end of the year divided by the total mortgages made from January through June of that year whether or not they were sold. Then, to estimate the quantity of mortgages originated in year t by bank i that is sold by the end of the year, multiply $\text{PCT SOLD}_{i,t}$ by the total number of mortgages the bank originates in the year.

To compare the importance of the OTD model across banks, it is useful to normalize the flow of mortgages. The OTD model may be more important to a \$10 billion bank that originates and sells \$2 billion of mortgages in a year than to a \$100 billion bank that originates and sells \$3 billion of mortgages in the same year. To compare across banks, I divide the flow of mortgages by the total assets of the bank. Let $\text{SOLD}_{i,t}$ be the flow of mortgages originated by bank i in year t , as estimated above, divided by the total assets of the bank at the end of year t . To control for outliers, in my analysis I winsorize this ratio (and all other variables except bank size) at the 1% level.⁸ I refer to mortgages that a bank makes intending to sell as sold mortgages.

It is easy to see that the use of the OTD model, by which I mean originating and then selling mortgages, varies a lot across banks. Figure 5 shows the median, 75th percentile, and 90th percentile for $\text{SOLD}_{i,t}$ by year from 1996 through 2006. Loan sales play a small role for the

⁷ My estimate of the pipeline time is shorter than that of Gordon and D'Silva (2008), who claim that it can take as long as nine months from when a loan is originated to when it becomes part of a securitization. Some of this difference is likely because they are thinking about the time until securitization while I only consider the time until a loan leaves a bank's balance sheet. The loan may be sold by the bank to an aggregator who collects a group of loans to be put into securitizations. The difference between loan sales and securitization is discussed further in the next section.

⁸ There are a small number of banks with loan sale activities out of proportion to their size. For example, in 2002, Crescent Bank reported loan sales of over 12 times their total assets compared to a sample average of 4%.

median bank, but they are quite important for the most active loan sellers. Active loan sellers come from all bank size classes. The average size of the most active loan sellers in my sample is roughly equal to the average size of the other banks in the sample (see Table 1).

The ups and downs over time in Figure 5 are largely due to changes in the number of loans that are used to refinance a home rather than to purchase a new home. This difference between refi sold mortgages ($REFI\ SOLD_{i,t}$) and purchase sold mortgages ($PURCH\ SOLD_{i,t}$) proves interesting below. As Table 1 shows, on average banks make about the same share of refi sold mortgages and purchase sold mortgages. An issue that this brings up is that a refi is paying off an existing loan, and thus might not be expected to increase overall loan supply. That is, why are refis not a zero sum game? One reason is that many borrowers use refis to pull some equity out of their home (see, e.g., Greenspan and Kennedy, 2008).

Another way to gauge the importance of loan sales is to compare the mortgages a bank sells to those that it keeps in its portfolio. For these mortgages, we have data on both flows and stocks. The flow of portfolio mortgages, those a bank originates intending to keep in its portfolio, is the complement of sold mortgages. Let $PORT_{i,t}$ be the portfolio mortgages made in year t by bank i normalized by the total assets of the bank. Then $PORT_{i,t}$ equals $MORT_{i,t} - SOLD_{i,t}$, where $MORT_{i,t}$ is the total mortgage originations for bank i in the HMDA data in year t divided by the bank's total assets at the end of that year. The stock of residential mortgages on bank balance sheets is reported in the Call Reports and Y-9 forms. Let $RES_{i,t}$ be the stock of mortgages divided total bank assets. Table 1 shows that banks that are more active loan sellers also originate more loans to keep in their portfolio. However, the variation across the shares of portfolio mortgages is much smaller than the variation across the shares of sold mortgages.

The final column of Table 1 reports the stock market return for banks by how active the banks are in selling loans. Return is defined as the percentage return on a bank's stock (including reinvested dividends) net of the return on a value-weight bank stock index over a calendar year. Return is weakly increasing in loan sale activity.

IV. The impact of loan sales prior to the financial crisis

In this section, I examine the role of mortgage sales in the period leading up to the financial crisis that began in 2007. In order to focus on banks for which mortgages and loan sales are relevant, I require that banks are at least somewhat active in home mortgages. Specifically, each bank in the sample has an average of at least 100 home mortgages loans per year and must sell at least some of the home mortgages it issues. With these restrictions, I have a

sample of 460 banks for the pre-crisis analysis. Table 2 provides summary statistics for the banks in the sample.

A. *Loan sales and balance sheet composition*

Securitization, by making loan sales easier, can potentially change the amount of mortgages that a bank keeps in its portfolio. A bank using the OTD model can increase the velocity of loan originations without any intent of keeping additional loans in its portfolio (except temporarily until the loans are sold). But the bank can also use loan sales for loans that it otherwise would have kept on its balance sheet.

If a bank is using the OTD model, then there should be little impact of loan sales on its balance sheet. There might be a small increase in the bank's mortgage holdings, but there should be little effect on other asset holdings or on the riskiness of the mortgage portfolio. On the other hand, there may be significant moral hazard associated with the securitization process, as is consistent with some models of the securitization process. Banks may sell their safest loans to reassure investors (Greenbaum and Thakor, 1987) which may leave them with riskier assets on their balance sheets (Benveniste and Berger, 1987). Alternatively, if they can get away with it, banks may choose to sell their riskiest loans (consistent with Keys, *et al.*, 2010), leaving them with safer assets on their balance sheets.

To test these alternative views, I examine how changes in the amount of mortgages that a bank sells affect the bank's asset portfolio starting with the stock of real estate mortgage loans. I assume that the stock of mortgages in a bank's portfolio is a function of the flow of qualified mortgage borrowers that it attracts, the return from selling mortgages, the risk and return characteristics of the bank as a whole, and general economic conditions. Because I have no direct measures of the return from keeping or selling mortgages, I instead examine how the effect of mortgage flow differs depending on what the bank does with the loan (portfolio or sale) and the type of loan (for purchase or refinance). The differential impact reflects the bank's opinion of the relative returns from the different kinds of loans. The general empirical relationship I posit is:

$$RES_{i,t} = f(\text{mortgage flow indicators, bank-specific controls, year dummies}) \quad (2)$$

One issue with this specification is that the bank-specific controls may miss out on differences across banks based on local market conditions, market positioning, or bank efficiency. To reduce the impact of these factors, I take the first difference of (2) as my baseline empirical model:

$$\Delta RES_{i,t} = f(\Delta \text{mortgage flow indicators, bank-specific controls, year dummies}). \quad (3)$$

The bank-specific variables that are included fall into two groups. The first captures elements of the securitization process while the second group is meant to control for differences in the risk-return tradeoff. I also include a lagged version of the dependent variable as a control. All the results are robust to dropping any of the control variables except the year dummies. I also run (but do not present) a fixed-effects version of (2) as a robustness check.

Previous work on securitization focuses on banks that actually securitize assets. Here, I want to distinguish the loan sale process from the act of underwriting a securitization or of servicing the loans once they have been securitized. I use data from Dealscan on the firms that put together securitization issues. In my sample, 2.9% of bank-year observations included securitization activity while, by construction, all the banks have mortgage sales.⁹ The risk-return tradeoffs for the (primarily very large) banks with securitization activity may be different than for other banks. To capture this, let $SECUR_{i,t}$ be the dollar value of the bonds issued in mortgage-backed securitizations put together by bank i in year t divided by the assets of the issuing bank. Note that the mortgages backing the securitized bonds may or may not have been originated by the issuing bank. To parallel the mortgage flow indicators, I use the change in $SECUR$ as a control variable.

If banks retain a residual interest in the loans that they sell, it can affect their incentive to originate and distribute the loans. Banks report the stock of loans that they securitize for which they retain servicing rights or provide credit enhancements.¹⁰ Unfortunately, this mixes something that can increase bank profit (servicing rights) with something that is more likely to be a drag on profit (providing credit enhancements). This, however, is the best measure of servicing rights that banks report, so I include it in my analysis. Let $SERV_{i,t}$ be the stock of loans that bank i has securitized but retained servicing rights or enhanced credit divided by the total assets of the bank at the end of year t . I use the change in $SERV$ as a control. Clearly, caution needs to be used when interpreting the coefficients on this variable.

The other control variables are meant to account for factors beyond the opportunities to originate mortgages that may differ across banks. Larger banks can be more diversified than smaller banks. But, larger banks may also have off-balance sheet and non-bank activities that smaller banks do not. These may mean that large banks face a different risk-return tradeoff than smaller banks. I include the log of the market value of the bank ($MKT\ VAL_{i,t}$) as a control. I also include the market-to-book ratio ($MKT/BK_{i,t}$) as a further proxy for the risk of the bank. A

⁹ My sample contains all the commercial banks with securitization activity but not all the commercial banks with loan sale activity.

¹⁰ This is sometimes used as a measure of securitization (e.g., Jiangli and Pritsker, 2008), but many more banks retain servicing rights or offer credit enhancements compared to the share of banks that actually securitize mortgages. In my sample, 18.6% of bank-year observations have $SERV > 0$ while only 2.9% have securitization activity.

larger market-to-book ratio may reflect a riskier bank, either because a higher ratio means more growth opportunities or because it means more (presumably risky) off-balance sheet activities. The loan-to-asset ratio ($LOAN/TA_{i,t}$) of the bank is another control. The interpretation of this is tricky. A higher loan-to-asset ratio indicates, all else equal, a riskier bank since loans are riskier than many other bank assets. However, it also may mean that the bank is above its target level of loans. When estimating (3), I use year t-1 values for these variables.

General macroeconomic and financial market conditions may also affect the stock of mortgages held by a bank. Year dummies are used to control for economy-wide effects. Note that the year dummies will pick up general changes in securitization over time.

The first column of Table 3 presents the results of a regression of the share of mortgages in a bank's portfolio on the quantity of mortgages that the bank makes along with other controls. The coefficient on SOLD, the measure of mortgages sold, is 0.015. This means that for every dollar of new loans made in year t and held in portfolio at the end of the year, the quantity of loans in the portfolio at the end of year t is larger by 1.5 cents. To get a feel for how large 0.015 is, we can look to PORT, the measure of mortgages made that are still in the bank's portfolio at the end of the year. The coefficient on PORT is 0.196, which is over ten times as large as the coefficient on SOLD. This opens the question of whether the increased lending following loan sales reflects the bank attracting more loans that it wishes to keep or whether it reflects so-called pipeline holdings. A bank may not immediately sell a mortgage it originates, even if it made the mortgage intending to sell it. To minimize the costs of selling the mortgage, the bank may hold it in portfolio temporarily, for example, until it gets a sufficient number of mortgages to sell. I use my estimate of the length of time the average mortgage is held by a bank before a sale to see whether 0.015, the coefficient on SOLD in the regression in column (1), is of an order of magnitude suggestive of pipeline holdings. Recall, that the average length that a sold mortgage is held before sale is estimated to be 0.106 years (39 days). If one dollar of portfolio mortgages originated increases the stock of mortgages held by 0.196 dollars, then one dollar of sold mortgages should increase the stock of mortgages held by about $0.196 * 0.106 = 0.021$, very close to the coefficient on SOLD in the regression. This indicates that the positive coefficient on SOLD may reflect pipeline holdings.

The coefficients on the regression in the first column of Table 3 are consistent with sold mortgages affecting a bank's balance sheet only through pipeline holdings. However, sold mortgages combine those for home purchase and those for refis. Since refis are much less predictable than home purchases, it might be that banks sell refis because the bank does not have enough flexibility in its capital structure to keep in portfolio the refis it gets during a refinancing

boom.¹¹ To test this, I divide sold and purchase mortgages into those for purchase and refis. As the regression results presented in the second column of Table 3 show, there is no significant difference between the coefficients on the purchase and refi sold mortgage variables or the coefficients on the purchase and refi portfolio mortgage variables.

Mortgages sales may not be adding to portfolio holdings except through pipeline holdings, but that does not necessarily mean that the risk of a bank's mortgage portfolio remains constant. Some academic studies suggest that securitization may lead banks to change the riskiness of their portfolios to solve adverse selection problems (e.g., Greenbaum and Thakor, 1987), to take advantage of difference in risk aversion (e.g., Keys, *et al.*, 2010), or for other reasons. Consistent with this, banks may change the risk of the mortgages they keep by systematically selling the safest (Greenbaum and Thakor, 1987) or riskiest (Benveniste and Berger, 1987) of their mortgages. To test this, I examine whether changes in mortgage flows affect future mortgage defaults. This is a difficult task since, prior to the expansion of subprime mortgage lending in the early 2000s, few mortgages defaulted and those that did often did not do so for a number of years. It was not until nearly the end of the pre-crisis sample period that subprime mortgages started to default within the first few months of issue (Demyanyk and Van Hemert, 2010). Given the short sample period, however, too many observations are lost if I look too far back. So, I ask whether changes in non-performing mortgages from year $t-1$ to year t are affected by changes in mortgage flows from year $t-2$ to year $t-1$. Non-performing mortgages are those that are at least 60 days past due. The final column of Table 3 reports the results of a regression of changes in mortgage flows on changes in non-performing mortgages. The coefficient on sold mortgages is small in magnitude and not significantly different from zero. This suggests that banks are not changing the risk of their mortgage portfolio when they increase loan sales. Of course, not finding a significant result is at best suggestive given the low power of the test.

Table 4 presents the results of regressions that examine whether mortgage sale activity affects the holdings of non-mortgage assets at banks. Consistent with the OTD model, the results in Table 4 show that mortgage sales have no impact on the holdings of other assets. None of the coefficients on SOLD are statistically significant and they are all small in magnitude.

When increased mortgage activity leads to banks holding a larger share of mortgages on their portfolio, it must squeeze out the share of other asset classes. As the regression results in Table 4 show, banks reduce the share of the other major loan categories when they bring more mortgages into their portfolios. The fourth column of Table 4 looks at the relationship between mortgage-backed security (MBS) holdings and the flow of mortgage originations. Not surprisingly, there

¹¹ The average standard deviation of $REFI_{i,t}$ across banks is 60% higher than the average standard deviation of $PORT_{i,t}$ is.

is a negative correlation between mortgages that are brought into a bank's portfolio and the share of MBS on the bank's portfolio. Whole mortgage loans and MBS are close substitutes except for differences in regulatory capital treatment.

The analysis so far has assumed that the decision to sell a loan versus put it in portfolio is exogenous. There is evidence that banks have private information about some borrowers (e.g., Keys, *et al.*, 2010, Purnanandam, 2009). It is possible that banks use this information to cherry pick the best loans to keep while selling their worst loans. However, as shown in the final column of Table 4, there no significant correlation between the sold mortgages and portfolio mortgages at banks. Still, I will return to the endogeneity issue below.

B. Did the OTD model benefit banks?

If banks sell loans that they otherwise would not make, then they should do so only if it increases their expected profit. In this section, I extend the results in Table 1 that show return is increasing in loan sales. Profit is measured using the percentage return on the bank's stock, a market measure, and the return on assets, an accounting measure. The market data capture information about expected profit from a loan when the loan is originated. But, to the extent that a loan is expected, it should be already incorporated into the stock price. Accounting data has the benefit of directly reflecting the fees generated by loan sales, but the accounting data has noise because of loan sales where the origination date is in one calendar year and the sale date is in another calendar year.

There are three ways that loan sales can benefit banks. The first is that when a bank sells a loan, it receives a fee. I assume that the fee-based returns from a loan sale are proportional to the size of the loan and use $SOLD_{i,t}$ and its breakdown by purchase and refi loans to measure this income.¹² The second way that a sold loan could benefit a bank is if the bank retains the right to service the loan. Servicing offers a flow of fees over the life of the loan. To measure servicing, I use $SERV_{i,t}$ which, as defined earlier, is the stock of loans for which banks retain servicing rights or provide credit enhancements. This is, at best, a noisy measure of servicing income. Third, a bank can sell loans to another member of its corporate family that can then underwrite a securitization backed by those loans. As noted, this only is relevant at a few very large banks, but I still control for the possibility that it is the underwriting not the loan sales that benefit banks by including $SECUR_{i,t}$ as a control.

¹² There is also some risk that conditions could change between the time the bank originates a loan and the time it sells it. Additionally, there is also the possibility that the buyer will return the loan under certain conditions. I touch on both of these issues later in the paper.

The baseline model is similar to the model in the previous section. The change in return in a given year is a function of the change in mortgage flow and controls:

$$\Delta \text{return}_{i,t} = f(\Delta \text{mortgage flow indicators, } \Delta \text{servicing rights indicator, } \Delta \text{securitization activity, bank-specific controls, year dummies}). \quad (4)$$

I use the same set of controls as above.

Panel A of Table 5 presents the regression results. Focusing first on sold mortgages, the results indicate that increases in mortgage flows increase return for refis but not for purchase loans. The coefficients on REFI SOLD in columns (2) and (5) can be used to estimate the impact on return of adding loan sales. Increasing REFI SOLD by one standard deviation (0.180) increases market return by 0.50 ($= 0.279 * 0.180$) and accounting return by 0.0009 ($= 0.005 * 0.180$). These changes are 11% and 21% of the standard deviation of the return measures, respectively. So, changes in loan sales have a noticeable effect on profit.

One would expect that the fees from a loan sale would be immediately reflected in the accounting return. Thus, the difference between the accounting returns on refi sold loans and purchase sold loans suggests that different mechanisms underlie the selling process for the two types of loans. One explanation consistent with these results is that the overhead needed to attract mortgage borrowers is costly, and that in most cases they offer banks low returns. However, when mortgage rates are low, many borrowers want to refinance so the marginal cost of originating a mortgage is fairly low. Mortgages are more profitable when there is high demand, and high demand for mortgages is often associated with refi booms. This explanation is also consistent with the results for the stock return regression since it is likely to be harder to predict which banks are able to expand mortgage origination during a refi boom than during more settled times.

The results in Panel A of Table 5 also indicate that mortgages that go into portfolios have essentially no impact on ROA. This likely reflects the fact that mortgages often have little or no upfront fees, so the benefit from a portfolio mortgage will be recognized over many years, rather than shortly after it is made, as with a sold mortgage. The weak results for the stock market return may reflect the fact that portfolio mortgages are a lot more predictable than sold mortgages. For example, the standard deviation of refi sold mortgages is over twice as large as the standard deviation on refi portfolio mortgages per dollar of mortgage. The coefficients on SERV are insignificant, consistent with it being a noisy measure of servicing income. The regressions also offer no evidence that underwriting mortgage securitizations adds to return. This may be because the profit from this process comes from the loan sales, but it more likely is the result of the small number of banks in the sample that underwrite mortgage securitizations.

Panel A of Table 5 also includes results for regressions where banks are split into those that specialize in OTD lending and others. The Top 10% or high-OTD banks are those in the top 10% of $SOLD_{i,t}$ in the year prior to the observation while the Bottom 90% or low-OTD banks include all other banks. The impact of loan sales on stock return is only significant for banks in the top 10% of $SOLD$, but the coefficients on $REFI\ SOLD$ for low-OTD banks are positive and not significantly different from those for the high-OTD banks. Thus, there is no evidence that return increased disproportionately at high-OTD banks.

The increase in return from mortgage sales appears to be concentrated on refi sales. Since the demand for refi loans varies over time, it makes sense to examine whether the use of the OTD model is associated with higher risk. Risk is measured using $STD\ RET_{i,t}$, the standard deviation of bank i 's weekly stock price during year t . I examine whether risk increases with mortgage activity using the same independent variables as in (4). The results are reported in the final column in Panel A of Table 5. Risk increases with mortgage sales, but only for high-OTD banks. This suggests that there is a risk-return tradeoff involved in intensively using the OTD model. I return to this implicitly in Section V, when I examine the losses of banks during the 2007-2008 financial crisis.

As noted at the end of the last section, the implicit assumption in the regressions in Panel A of Table 5 is that the decision about whether to sell or hold a mortgage is exogenous. However, it may be that a bank bases its decision to sell a particular mortgage on factors that include how well the bank is doing in that year. To control for such endogeneity issues, I use percentage of its mortgages that a bank sells in the first six months of year $t-1$ to instrument for the percentage of mortgages that a bank sells in year t . The suffix *IV* on a variable indicates that the use of this instrument. Panel B reports the results of regressions using the '*IV*' variables. The results are broadly consistent with those in Panel A. One difference is that the coefficients on mortgages held in portfolio in column (1) and mortgages for purchase held in portfolio in columns (2) and (3) are negative and significant, although they are of about the same magnitude as the similar coefficients in Panel A. Banks that hold mortgages in portfolio are punished by the stock market if they increase originations.

C. Refi booms

One interpretation of the results in Table 5 is that the ability to sell loans, that is, the OTD model, allows banks to pick up the extra demand from increased mortgage activity during a refi boom. To test this, I examine how the flow of mortgages sold is affected by a refi boom. To measure a refi boom, I use $REFI\ BOOM_t$, the share of (all) mortgage originations that are for

home refinancing in year t . The banks most likely to scale up are those that already specialize in mortgage sales. This can be tested using:

$$\text{REFI SOLD}_{i,t} = f(\text{REFI BOOM}_t, \text{REFI SOLD}_{i,t-1}, \text{REFI BOOM}_t * \text{REFI SOLD}_{i,t-1}, \text{other controls}). \quad (5)$$

I use the same controls as for the regressions of the effect of mortgage flows on portfolio shares, except that I drop the year dummies. The results are robust to the exclusion of the controls.

The differential effect of refi booms on mortgage sales is apparent from the results reported in the first two columns of Table 6. The coefficients reported in the first column are for a regression of (5) without the interaction term. The positive and significant coefficient on REFI BOOM indicates that banks increase their sales of loans for refinancing when there is a refi boom. When the flow of mortgages increases, sales go up. The regression in the second column adds the interaction term between the refi boom and lagged refi sales. A positive coefficient on the interaction term means that the ratio of refis sold to total assets during a refi boom increases more for banks with a larger ratio of refis sold to total assets prior to the boom. This can be interpreted as saying that the banks that are more involved in refi sales increase refis more during booms than other banks do. The increase may arise, in part, because these high-refi banks have a larger flow of mortgage applicants coming to them in booms. A stronger test is whether the coefficient on the interaction term is greater than one, implying that high-refi banks increase sales more than proportionally during refi booms. The coefficient on the interaction term in the regression reported in the second column of Table 6 is 3.984, which is much larger than one, suggesting that that high-refi banks increase sales more than proportionally during refi booms.

To see how refi booms affect other mortgage activity, Table 6 reports the results of regressions similar to (5) for the other mortgage flow variables. During a refi boom, the share of refis that banks keep on their balance sheet increases. However, this increase is less than the share of refis that they sell, providing further evidence that the mortgage sale market serves as a safety valve for the increased flow during booms. In addition, the coefficient on the interaction term is statistically smaller than one, indicating that the share of refi mortgages that a bank takes into its portfolio is less than proportional to the bank's pre-boom refi activity. This is also true for mortgages used to purchase homes, as the regressions in the final two columns of the table indicate.

As further evidence that some banks are temporarily increasing mortgage flow during refi booms, I examine whether the increases in volume by banks during the booms are permanent or temporary. That is, do some banks use refi booms to increase their market shares? If so, do they attempt to increase their overall mortgage market share or just to boost refis? To test this, I

break down the mortgage volume at date t into three parts: the volume in period $t - n$, the change in volume from period $t - n$ to period $t - n - 1$, and the change from period $t - n - 1$ to period t . Focusing on sold mortgages for refinancing, this is equal to:

$$\begin{aligned} \text{REFI SOLD}_{i,t} - \text{REFI SOLD}_{i,t-n} \\ = \Delta \text{REFI SOLD}_{i,t-n-1} + \text{REFI SOLD}_{i,t-n} - \text{REFI SOLD}_{i,t-n-1}. \end{aligned} \quad (6)$$

To measure of permanence, I run the following regression:

$$\text{REFI SOLD}_{i,t} - \text{REFI SOLD}_{i,t-n} = \alpha + \beta \Delta \text{REFI SOLD}_{i,t-n-1} + \gamma' \mathbf{X}_{i,t} + \varepsilon. \quad (7)$$

where $\mathbf{X}_{i,t}$ is a vector of year dummies. If the shock from period $t-n$ to period $t-n-1$ is permanent, then the coefficient on β will be 1.

Table 7 presents two sets of results. The first set, in the odd-numbered columns, examines the impact of changes in mortgage flows on overall mortgage activity. The implicit model here is that an increase in one type of mortgage activity, say refinancing, indicates a desire by a bank to increase its overall origination business. The second set, in the even-numbered columns, looks at the flows in the individual subcategories of mergers. It examines the effect of a change in one type of loan on future originations of that type only.

The results for refi sold mortgages, given in the first two columns of Table 7, show that changes in refinancing activity persist for a short while but then disappear. The coefficients indicate that there is no residual increase in refi mortgages that are sold after three years. This decline is larger than for the other types of mortgages. This supports the idea that the ability to sell loans makes it easier for banks to take advantage of refi booms to temporarily gear up mortgage activity.

While refi booms benefited banks, did they increase the risk of mortgage debt overall? One might say that the answer to this is no because a refinancing merely replaces one loan with another. However, many borrowers used refinancing as a method to cash out some of the equity in their homes (Greenspan and Kennedy, 2008). While the amount of cash out trended up during my sample period, the rate was larger during refi booms. Thus, borrowers were using refinancing to increase leverage. Looking backward from the financial crisis, it seems clear that some borrowers were highly levered, in part because they cashed out home equity when they refinanced. The questions I address here are how the risk of borrowers changes over a refi cycle and whether the changes are different for high- versus low-OTD banks. To measure borrower risk, I use the ratio of the size of the mortgage to the income of the borrower as reported in the HMDA data. A large amount-to-income ratio is a signal of a more leveraged, and therefore

riskier, borrower. Let $B \text{ AMT/INC}_{i,t}$ be the amount-to-income ratio for bank i in year t for mortgages of type B . The generic test I use is:

$$B \text{ AMT/INC}_{i,t} = f(\text{REFI BOOM}_t, \text{trend term}, \text{other controls}). \quad (8)$$

I use the same controls as for the regressions on the effect of refi booms on mortgage sales. A trend term is included to capture any sample-long increases in borrower leverage (there are no year dummies). I also include bank dummies to capture any systemic differences across banks.

The results reported in Table 8 allow us to see how borrower risk changes during refi booms. The coefficients on REFI BOOM in the first two columns of the table are not statistically different from zero. But, these hide differences across banks. The regressions in the next two columns contain variables that are interactions of the REFI BOOM variable with both a high-OTD dummy and a low-OTD dummy. The results in column (3) imply that high-OTD banks make riskier refi mortgages during refi booms than during other periods. To get a feel for the economic magnitude, the share of refis ranges from 29% in 2000 to 73% in 2003. An increase in REFI BOOM of 44 percentage points would imply an increase in the amount-to-income ratio for refis at high-OTD banks of 0.168 ($= 0.383 * 0.44$), about 10% of the average value of AMT/INC for refis. Thus is significantly larger than the impact on the riskiness of refi borrowers at low-OTD banks. When looking at mortgages for home purchase, the coefficients are smaller in magnitude and not significantly different from zero. However, the coefficient on REFI BOOM for high-OTD banks is substantially larger than the same coefficient for low-OTD banks. These results suggest that high-OTD banks increase riskiness of borrowers more than low-OTD banks during refi booms.

Overall, much of the abnormal profit from securitization seems to come from refinancings that banks sell after originating (Table 5). This suggests that much of the value of the OTD model for banks comes from the flexibility it gives them to scale up mortgage origination during refi booms. But the results in Table 8 point out that what is good for the banks is not necessarily good for society as a whole. Banks, especially high-OTD banks, lend to riskier borrowers during refi booms, and this may increase the risk of the financial system. This is a topic that needs more attention.

V. The aggregate impact of loan sales on banks

As the saying goes, what goes up must come down. Banks were hard hit by the final crisis that began in 2007. On average, the banks in my sample lost over one-quarter of their value in

2007-2008. In this section, I explore the contribution of loan sales to these losses. I also provide some estimates comparing the gains in the runup to the crisis to the losses during the crisis.

Dating the end of the boom period and the start of the financial crisis is difficult. In 2006, there were already signs that housing markets might be turning. The rate of increase in home prices had slowed to close to zero and defaults on subprime adjustable-rate mortgages began to rise. But, overall measures of risk such as corporate bond spreads and the Chicago Board Options Exchange's volatility index (the VIX) were still at very low values by historical standards. Also, at this point, securitization markets were still going strong. Haircuts on securitized bonds in the repurchase market were still extremely small (Gorton and Metrick, 2009).¹³ As housing prices began to decrease, large problems in financial markets became clear. Starting in June 2007, the credit rating agencies began to downgrade risky mortgage-backed securities. By August 2007, it was apparent that there were major problems at some financial firms and investment funds because of losses on mortgage-related products including MBS. By this time, several large subprime mortgage lenders had gone bankrupt. Markets reacted by increasing risk spreads, especially on bank-related securities. Haircuts on securitized assets in the repurchase markets started to climb. By late 2007, the market for newly-issued mortgage-backed securities issued by private firms had ground to a virtual halt. The crisis was certainly underway by late 2007.

For the analysis here, I consider all of 2007 and 2008 to be the crisis period. As the previous paragraph indicates, it is likely that the crisis started sometime in 2007. Bank stocks peaked in value in July of 2007. But, because I am using annual data for most of my controls, it is easier to consider all of 2007 as part of the crisis period. The qualitative results are unchanged if I use return data that starts in mid-2007.

Banks that relied on the OTD model faced three potential problems as the financial crisis heated up. First, as shown above, the OTD model was profitable for banks in the pre-crisis period. As private securitization markets dried up, some of that potential profit may have disappeared (MBS backed by Ginnie Mae, Fannie Mae, and Freddie Mac were still being created, so the ability of banks to sell loans for securitizations did not disappear completely). Second, banks may have been caught as loans they intended to sell (pipeline loans) were still on the banks' balance sheet when private securitization markets shut down (Purnanandam, 2009; Gordon and D'Silva, 2008). Third, there are typically clauses in loan sale contracts that say that the buyer can put the loan back to the seller if the loan is immediately nonperforming or if there was fraud. As the crisis hit, buyers were a lot more careful in checking to see whether loans

¹³ Haircuts measure the excess collateral a firm must offer to use a particular security as collateral. A 10% haircut would mean that a firm could only borrow \$90 for every \$100 of collateral it offered.

violated these clauses and, if they did, giving them back to the selling banks. All three of these problems could have contributed to a decline in the value of banks that sold mortgages.

The baseline model I use to test whether involvement in the loan sale market affect the value of banks is similar to (4) above, except in levels rather than changes:

$$\text{return}_i = f(\text{mortgage flow indicators, servicing rights indicator, bank-specific controls, year dummies}), \quad (9)$$

where return is the stock market return of bank i during 2007-2008. One issue is that some of the banks in the sample were acquired or failed during the crisis period. As is common in studies of long-term stock returns, I assume that banks earn the return for banks as a whole (using a value-weighted return on an index of bank stocks) for the period after they leave the sample.

The first two columns of in Panel A of Table 9 report the results of a regression of bank stock market return against mortgage flow and servicing rights indicators. In the reverse of the pre-crisis period relationship, higher levels of mortgages sold in 2006, especially those that financed refis, are associated with larger decreases in stock values during 2007-2008. To ensure that this was not an artifact of something specific to 2006 which, after all, was a transition year, I take the average of the control variables over the 2001-2006 period, with a requirement that a bank be in the sample for at least three of the years (obviously including 2006). These are used as the controls in the regressions are reported in the third column of Panel A. The coefficient on REFI SOLD is negative and significant, as in the regressions in the second column. These results suggest that what went up in the pre-crisis period went down during the crisis.

As a basis for comparison, I regress the total stock market return during 2001-2006 against average measures of mortgage flow for the same period. This gives a common set of control variables for the regressions in the third column of Panel A. The results with the total stock market return during 2001-2006 as the dependent variable are reported in the fourth column of Panel A. Focusing on the coefficients for REFI SOLD, the coefficient of 1.510 for the pre-crisis return is roughly twice the magnitude of -0.705, the coefficient for the crisis return. This suggests that during the crisis, banks lost a substantial fraction of their gains from the pre-crisis period.

To see whether the impact of loan sales on losses from the financial crisis was stronger at high-OTD banks, the regressions in the last columns in Panel A of Table 9 include the mortgage variables interacted with the high- and low-OTD dummies, respectively. Not surprisingly, the high-OTD banks were affected disproportionately more by the crisis. In the regression in column (5), the coefficient on REFI SOLD is -0.820 for high-OTD banks and -0.278 for low-OTD banks, with only the first of those being statistically significantly different from zero. The

larger decline for high-OTD banks could have been caused by mortgages in the pipeline that the banks were unable to sell (Purnanandam, 2009) or the loss of future loan sale business. For high-OTD banks, as in the full sample regressions, the coefficient on REFI SOLD in the pre-crisis period is twice the magnitude, although of opposite sign, as the coefficient in the crisis period.

To translate the coefficients in Panel A of Table 9 to estimates of difference in return across banks, Panel B of Table 9 shows the change in return for banks as a function of their pre-crisis mortgage activity. I rank the banks based on their overall mortgage sale activity as a share of total assets from 2001-2006. The results show that mortgage sale activity is associated with a slight decline in return during the crisis period for banks with little sale activity, but the impact is larger for the more active banks. Banks with mortgage sale activity in the top 10% lost an estimated average of 29.53% of their value because of mortgage sales, over 60% their total loss of 46.72%. Banks in the bottom 90% of mortgage sale activity lost an estimated average of 1.54% of their value because of mortgage sales. This was less than 7% of the total average loss of 22.97% by banks in this group. The final two columns in Panel B of Table 9 present estimates of the impact on the total return from mortgage activity in the pre-crisis period. As noted above, high-OTD banks gave back about half of their gains from refi mortgages they sold. Looking at the returns from mortgage sales as a whole, the stock price declines during the crisis are on the order of the magnitudes of the increases during the runup to the crisis. In other words, over the entire 2001-2008 periods, banks roughly broke even from loan sales.

VI. Concluding comments

Bank sales of mortgages into the process that led to securitization played an important role in housing markets in recent years. With the financial crisis in 2007, private-label securitization markets largely shut down leaving the GSEs as virtually the sole mortgage purchasers, and the GSEs had their own problems.¹⁴ The turmoil in securitization markets affected loan sales, which had been a profitable business for banks. I explore the impact of mortgage sales on banks, both before and during the financial crisis. Examining this piece of the securitization process can teach us something about securitization going forward.

Most banks involved in loan sales appeared to use the OTD model. Increases in sales had little impact on bank balance sheets except for the need to temporarily hold mortgages while the sale process took place. Also, the sale of mortgages was profitable, with much of the profit coming from refi booms. This suggests one big advantage of the OTD model: it can be easily

¹⁴ In September 2008, both Fannie Mae and Freddie Mac were put into conservatorship because they had negative net worth. This put the government in control of the GSEs.

scalable. When mortgage rates fall and borrowers want to refinance, banks can accommodate them by originating and selling mortgages, just scaling up their sales operation without needing to raise significant capital or otherwise adjust their balance sheets. The high-OTD banks both profited disproportionately more from mortgage sales and were more flexible in refi booms.

The profit from mortgage sales was essentially reversed during the financial crisis. A portion, but not all, of the stock market decline for banks in 2007-2008 seems related to the banks' pre-crisis sale activity. The proportion of a bank's stock price decline that seems attributable to mortgage sale activity, not surprisingly, was larger for banks with more significant sales. This brings up the point that while the vast majority of banks had mortgage sales (over 80% of traded banks reported at least some sales), only a few banks specialized in originating and selling mortgages. For most banks, mortgage sales were a small part of their business. The issues in securitization markets had an impact on these low-OTD banks that was, in general, not likely to be solvency-threatening.

The evidence suggests that, overall, banks benefited – or at least were not significantly harmed – from their mortgage sale business. One of the features of the OTD model is its flexibility. It is this flexibility that is both a plus and a potential minus of the OTD model. Much of the abnormal profit for banks came from scaling up during refi booms. This flexibility may have come at a cost to the financial system, however. Borrowers during refi booms were riskier than at other times.

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Table 1: Average mortgage flows as a fraction of total assets, 1996-2006.

Banks are ranking based on SOLD, the ratio sold mortgages to total bank assets, in year t. SOLD, REFI SOLD, PURCH SOLD, PORT, REFI PORT, and PURCH PORT are measures of mortgage flows, RES is mortgages loans as a fraction of total assets, TA is total assets (in billions of dollars), and STK RET NET is the bank's stock return minus the return on a value-weighted index of bank stocks in year t.

Loan sales	SOLD	PURCH SOLD	REFI SOLD	PORT	PURCH PORT	REFI PORT	RES	TA (\$ bil)	STK RET NET
Below median	1.99%	0.82%	1.17%	3.62%	1.77%	1.85%	19.33%	29.90	2.26%
Median-75 th pctl	6.76%	2.86%	3.90%	3.72%	1.95%	1.78%	19.92%	39.80	3.72%
75-90 th pctl	14.48%	6.30%	8.18%	4.57%	2.40%	2.18%	22.49%	13.60	3.71%
90-100 th pctl	67.75%	32.34%	35.45%	5.77%	3.06%	2.82%	27.13%	29.80	5.95%
Sample mean	11.71%	5.34%	6.38%	4.01%	2.04%	1.98%	20.74%	30.00	3.22%

Table 2: Summary statistics

The sample includes 460 banks over 1996-2006. There are a total of 2,408 observations.

	Mean	Median	Std dev
Sold mortgages (\$billions)	2.42	0.11	12.22
SOLD (Sold mortgages/TA)	0.11	0.04	0.26
PURCH SOLD (Purchase sold mortgages/TA)	0.05	0.02	0.13
REFI SOLD (Refi sold mortgages/TA)	0.06	0.02	0.17
Portfolio mortgages (\$billions)	0.95	0.08	5.62
PORT (Portfolio mortgages/TA)	0.04	0.03	0.04
PURCH PORT (Purchase portfolio mortgages/TA)	0.02	0.01	0.02
REFI PORT (Refi portfolio mortgages/TA)	0.02	0.01	0.02
SERV (Loans securitized/TA)	0.02	0.00	0.17
SECUR (Value of loans securitized/TA) × 1000	2.68	0.00	23.98
LOAN/TA (Loan-to-asset ratio)	0.67	0.68	0.11
RES (Residential mortgages/TA)	0.21	0.20	0.10
Past-due RES × 1000	5.13	3.83	5.27
Commercial RE loans/TA	0.15	0.14	0.08
RE construction loans/TA	0.02	0.01	0.02
Consumer loans/TA	0.07	0.06	0.06
Commercial loans/TA	0.12	0.10	0.07
MBS (MBS/TA)	0.10	0.09	0.09
STK RET (Return on stock)	0.19	0.14	0.31
STK RET NET (Return on stock net of bank VW index)	0.03	-0.01	0.25
ROA (Return on assets)	0.01	0.01	0.00
Total assets (\$billions)	28.60	2.39	128.00
Market value (\$billions)	4.60	0.36	19.07
MKT VAL (Log of market value)	13.28	12.92	1.90
MKT/BK (Market-to-book ratio)	2.10	1.97	0.84
AMT/INC (Mortgage amount / borrower income)	1.79	1.75	0.39
Memo: REFI BOOM (one observation per year)	0.71	0.69	0.18

Table 3: Results of regressions examining the effect of mortgage flows on the mortgages in bank portfolios and past-due mortgage loans.

Dependent variable: VARIABLES	RES		Past-due RES
	(1)	(2)	(3)
Δ SOLD	0.015** (0.020)		-0.006 (0.854)
Δ PORT	0.196*** (0.000)		-0.177 (0.237)
Δ PURCH SOLD		0.002 (0.953)	
Δ REFI SOLD		0.016*** (0.008)	
Δ PURCH PORT		0.259*** (0.004)	
Δ REFI PORT		0.281*** (0.000)	
Lagged dependent	0.037 (0.375)	0.044 (0.306)	0.323*** (0.000)
Lag(MKT VAL)	0.000 (0.544)	0.000 (0.596)	0.002 (0.670)
Lag(MKT/BK)	0.001 (0.468)	0.001 (0.375)	-0.012* (0.087)
Lag(LOAN/TA)	-0.060*** (0.000)	-0.059*** (0.000)	0.078 (0.282)
Δ SERV	-0.016 (0.686)	-0.017 (0.658)	0.349 (0.129)
Δ SECUR	0.151*** (0.001)	0.154*** (0.001)	0.701 (0.381)
Observations	2408	2408	1865
R-squared	0.100	0.110	0.136

Year dummies are included but not reported. Robust p-values in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

Note: The regression in column (5), the change in past due loans in from year t-1 to year t is regressed on the change in mortgage flows from year t-2 to year t-1.

Table 4: Results of regressions examining the effect of mortgage flows on the non-mortgage assets in bank portfolios.

VARIABLES	(1) Commercial loans	(2) Commercial RE loans	(3) Consumer loans	(4) MBS	(5) Δ PORT
Δ SOLD	-0.006 (0.854)	0.001 (0.871)	-0.004 (0.444)	-0.000 (0.824)	-0.000 (0.955)
Δ PORT	-0.177 (0.237)	-0.037** (0.026)	-0.009 (0.617)	-0.027** (0.031)	-0.016 (0.645)
Lagged dependent Lag(Δ SOLD)	0.050 (0.139)	0.103*** (0.000)	0.157*** (0.000)	0.060** (0.032)	-0.146** (0.035)
Lag(MKT VAL)	0.002 (0.670)	0.000 (0.423)	-0.001*** (0.000)	-0.000 (0.419)	0.000 (0.833)
Lag(MKT/BK)	-0.012* (0.087)	-0.001 (0.496)	-0.000 (0.529)	-0.001 (0.116)	0.002 (0.301)
Lag(LOAN/TA)	0.078 (0.282)	-0.012*** (0.005)	-0.013*** (0.003)	-0.011*** (0.000)	0.057*** (0.000)
Δ SERV	0.349 (0.129)	-0.021 (0.126)	0.002 (0.890)	-0.003 (0.784)	0.042 (0.272)
Δ SECUR	0.701 (0.381)	0.022 (0.609)	0.032 (0.137)	-0.020 (0.621)	0.011 (0.880)
Observations	2408	2408	2408	2408	2195
R-squared	0.045	0.051	0.057	0.107	0.075

Year dummies are included but not reported. Robust p-values in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

Table 5: Results of regressions examining the effect of mortgage flows on the bank profit.

Panel A. Baseline specification

VARIABLES	(1)	(2)	(3)		(4)	(5)	(6)		(7)	
	STK RET	STK RET	STK RET		ROA	ROA	ROA		RET STD DEV	
			Top 10% SOLD	Bottom 90% SOLD			Top 10% SOLD	Bottom 90% SOLD	Top 10% SOLD	Bottom 90% SOLD
Δ SOLD IV	0.217*** (0.000)				0.004*** (0.005)					
Δ PORT IV	-0.291 (0.131)				-0.005 (0.421)					
Δ PURCH SOLD IV		-0.054 (0.799)	0.256 (0.308)	-1.341** (0.013)		0.001 (0.580)	-0.002 (0.654)	-0.018** (0.016)	0.004 (0.105)	-0.006 (0.289)
Δ REFI SOLD IV		0.279*** (0.000)	0.268*** (0.000)	0.536 (0.253)		0.005*** (0.009)	0.002* (0.061)	0.008 (0.168)	0.005*** (0.010)	0.002 (0.320)
Δ PURCH PORT IV		-0.379 (0.513)	-0.729 (0.439)	-0.174 (0.803)		-0.014 (0.212)	-0.038* (0.056)	-0.003 (0.883)	-0.023 (0.358)	-0.010 (0.323)
Δ REFI PORT IV		-0.385 (0.424)	-1.480* (0.065)	-0.006 (0.991)		-0.000 (0.939)	0.025* (0.094)	0.001 (0.956)	-0.004 (0.602)	-0.000 (0.978)
Δ SERV	-0.399 (0.236)	-0.430 (0.206)		-0.435 (0.210)	0.001 (0.802)	0.001 (0.910)		0.000 (0.913)		-0.003 (0.585)
Δ SECUR	-0.126 (0.719)	-0.103 (0.770)		-0.171 (0.648)	-0.009* (0.083)	-0.009* (0.081)		-0.009* (0.075)		-0.002 (0.874)
Lagged dependent	-0.487*** (0.000)	-0.484*** (0.000)		-0.484*** (0.000)	-0.303*** (0.000)	-0.300*** (0.000)		-0.300*** (0.000)		-0.153*** (0.000)
Observations	2290	2290		2290	2261	2261		2261		2256
R-squared	0.628	0.629		0.630	0.159	0.160		0.162		0.473

Year dummies and other controls (MKT VAL, MKT/BK, and LOAN/TA) are included but not reported. Robust p-values in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

Table 5: Results of regressions examining the effect of mortgage flows on the bank profit.

Panel B. Robustness test: lagged origination variables as instrument

VARIABLES	(1)	(2)	(3)		(4)	(5)	(6)		(7)	
	STK RET	STK RET	STK RET	STK RET	ROA	ROA	ROA	ROA	RET STD DEV	RET STD DEV
			Top 10% SOLD	Bottom 90% SOLD			Top 10% SOLD	Bottom 90% SOLD	Top 10% SOLD	Bottom 90% SOLD
Δ SOLD	0.201*** (0.000)				0.004*** (0.008)					
Δ PORT	-0.352** (0.012)				-0.002 (0.351)					
Δ PURCH SOLD		-0.043 (0.889)	0.242 (0.469)	-0.895 (0.168)		0.000 (0.932)	0.001 (0.914)	-0.001 (0.918)	0.000 (0.938)	-0.005 (0.711)
Δ REFI SOLD		0.808*** (0.006)	1.148*** (0.002)	0.432 (0.317)		0.007* (0.067)	0.013** (0.019)	-0.002 (0.622)	0.000 (0.943)	0.008 (0.416)
Δ PURCH PORT		-0.706** (0.016)	-0.438 (0.130)	-1.116* (0.070)		0.004 (0.509)	0.007 (0.292)	0.001 (0.948)	-0.004 (0.657)	-0.020 (0.156)
Δ REFI PORT		-0.149 (0.633)	-0.438 (0.201)	0.026 (0.962)		-0.005 (0.261)	-0.010* (0.085)	-0.002 (0.812)	0.013* (0.052)	0.003 (0.763)
Δ SERV	-0.369 (0.260)	-0.345 (0.277)		-0.281 (0.397)	0.002 (0.737)	0.003 (0.562)		0.003 (0.502)		-0.002 (0.745)
Δ SECUR	-0.200 (0.576)	-0.262 (0.461)		-0.298 (0.420)	-0.010* (0.095)	-0.010 (0.105)		-0.011* (0.080)		-0.003 (0.757)
Lagged dependent	-0.479*** (0.000)	-0.486*** (0.000)		-0.485*** (0.000)	-0.313*** (0.000)	-0.311*** (0.000)		-0.313*** (0.000)		-0.154*** (0.000)
Observations	2094	2094		2094	2065	2065		2065		2109
R-squared	0.633	0.630		0.633	0.153	0.129		0.135		0.495

Year dummies and other controls (MKT VAL, MKT/BK, and LOAN/TA) are included but not reported. Robust p-values in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

Table 6: Results of regressions examining the refi booms on mortgage flows.

VARIABLES	(1) REFI SOLD	(2) REFI SOLD	(3) REFI PORT	(4) PURCH SOLD	(5) PURCH PORT
REFI BOOM	0.221*** (0.000)	0.009 (0.492)	0.019*** (0.000)	-0.007 (0.264)	-0.010** (0.027)
REFI BOOM *		3.984*** (0.000)	0.656*** (0.000)	0.506*** (0.005)	0.131 (0.615)
lag(SOLD)					
Lagged dependent	0.623*** (0.000)	-1.707*** (0.000)	0.174* (0.080)	0.607*** (0.000)	0.608*** (0.000)
Lag(MKT VAL)	-0.001 (0.668)	-0.002 (0.252)	-0.000 (0.422)	0.000 (0.999)	-0.001*** (0.003)
Lag(MKT/BK)	-0.002 (0.648)	0.007 (0.329)	0.000 (0.499)	-0.002 (0.264)	0.000 (0.470)
Lag(LOAN/TA)	0.130*** (0.001)	0.123*** (0.000)	0.005 (0.176)	0.009 (0.484)	0.002 (0.453)
Observations	2409	2409	2409	2409	2409
R-squared	0.534	0.708	0.401	0.778	0.582

Robust p-values in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

Table 7: Persistence of changes in mortgage flows.

The results of a regression of dependent variable $_{i,t}$ – dependent variable $_{i,t-n} = \alpha + \beta \Delta$ independent variable $_{i,t-n-1} + \gamma' \mathbf{X}_{i,t} + \varepsilon$ where \mathbf{X} is a vector of year dummies. The coefficient β is reported in the table along with the p-value for a test that $\beta = 1$.

Dependent variable: Independent variable:	(1) MORT Δ REFI SOLD	(2) REFI SOLD	(3) MORT Δ PURCH SOLD	(4) PURCH SOLD	(5) MORT Δ REFI PORT	(6) REFI PORT	(7) MORT Δ PURCH PORT	(8) PURCH PORT
1-year persistence	1.081	0.837	1.128	0.907	1.645	0.760	1.176	0.885
p-value for coef. = 1	0.536	0.143	0.695	0.357	0.221	0.000	0.108	0.404
2-year persistence	0.772	0.573	1.130	0.855	1.263	0.591	0.958	0.775
p-value for coef. = 1	0.113	0.014	0.700	0.222	0.578	0.000	0.117	0.275
3-year persistence	-0.333	-0.365	0.466	0.755	1.419	0.466	1.671	0.924
p-value for coef. = 1	0.000	0.000	0.447	0.197	0.347	0.000	0.098	0.301
4-year persistence	-0.062	-0.160	1.765	0.960	1.265	0.480	1.233	0.968
p-value for coef. = 1	0.000	0.000	0.040	0.823	0.778	0.000	0.075	0.305

Table 8: Results of regressions examining the effect of refi booms on borrower risk.

VARIABLES	(1) REFI AMT/INC	(2) REFI AMT/INC	(3) PURCH AMT/INC	(4) PURCH AMT/INC
REFI BOOM	0.123 (0.360)		-0.000 (0.998)	
REFI BOOM TOP 10		0.383** (0.018)		0.133 (0.352)
REFI BOOM BOT 90		0.098 (0.459)		-0.013 (0.930)
Trend	0.035*** (0.001)	0.035*** (0.002)	0.045*** (0.000)	0.045*** (0.000)
Lag(MKT VAL)	0.097*** (0.005)	0.098*** (0.004)	0.048** (0.036)	0.048** (0.036)
Lag(MKT/BK)	-0.016 (0.212)	-0.015 (0.245)	-0.005 (0.715)	-0.005 (0.756)
Lag(LOAN/TA)	-0.047 (0.716)	-0.059 (0.642)	-0.269* (0.058)	-0.275** (0.050)
Observations	2409	2409	2409	2409
R-squared	0.817	0.820	0.784	0.785

Year dummies are included but not reported. Robust p-values in parentheses.

*** p<0.01, ** p<0.05, * p<0.1

Table 9.

Table 9, Panel A: Results of regressions examining the effect of pre-crisis mortgage flows on the bank return during 2007-2008 (the financial crisis).

The dependent variable in columns (1)-(3) and (5) is the total change in stock market equity value during 2007-2008. The dependent variable in columns (4) and (6) is the total change in stock market equity value during 2001-2006.

	(1)	(2)	(3)	(4)	(5)		(6)	
Stock return for:	2007-08	2007-08	2007-08	2001-06	2007-08		2001-06	
Independent variables for:	2006	2006	2001-06	2001-06	2006		2001-06	
OTD dummies:					Top 10% SOLD	Bottom 90% SOLD	Top 10% SOLD	Bottom 90% SOLD
SOLD	-0.615*** (0.001)							
PORT	-0.607 (0.552)							
PURCH SOLD		1.281*** (0.009)	-0.105 (0.779)	-2.199*** (0.005)	-0.004 (0.992)	-0.184 (0.892)	-1.649** (0.032)	-4.130* (0.076)
REFI SOLD		-3.414*** (0.000)	-0.705*** (0.000)	1.510*** (0.000)	-0.820*** (0.000)	-0.278 (0.815)	1.797*** (0.000)	2.131 (0.395)
PURCH PORT		-0.724 (0.677)	-2.772 (0.243)	2.392 (0.667)	-7.359* (0.079)	-2.505 (0.350)	6.863 (0.612)	3.786 (0.536)
REFI PORT		0.968 (0.712)	2.602 (0.324)	-2.276 (0.683)	5.926 (0.196)	1.869 (0.576)	-12.711 (0.174)	1.073 (0.880)
Observations	227	227	227	227	227		227	
R-squared	0.379	0.415	0.347	0.239	0.350		0.248	

Year dummies and other controls (MKT VAL, MKT/BK, LOAN/TA, ΔSERV, and ΔSECUR) are included but not reported. Robust p-values in parentheses.

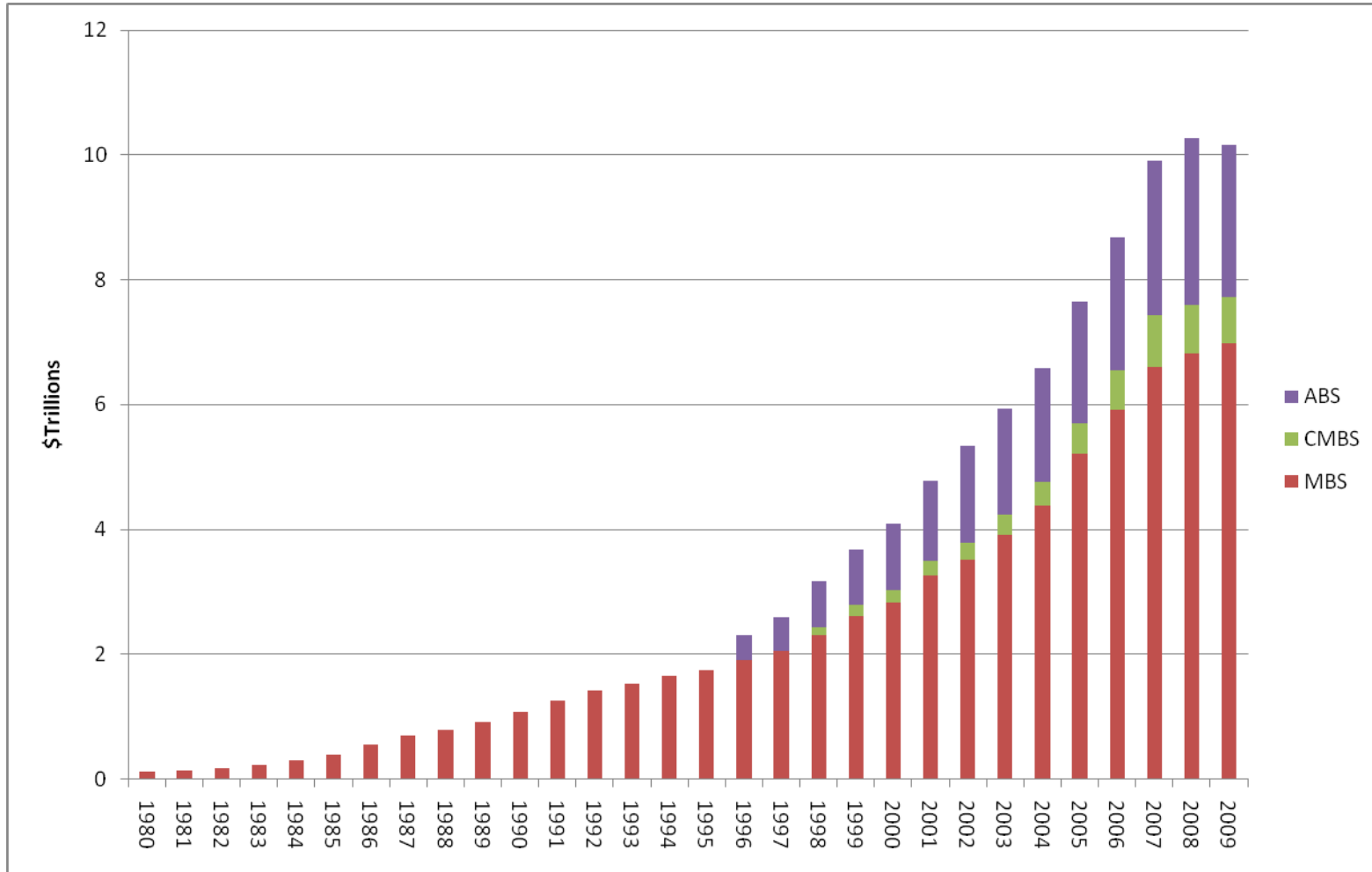
*** p<0.01, ** p<0.05, * p<0.1

Table 9, Panel B: Estimated change in return predicted by pre-crisis mortgage flows.

The estimates are based on the regression coefficients in Panel A of this table. The 90th percentile rankings are based on the average value of SOLD over 2001-2006. The return drop is the total average return for banks' stock for 2007 and 2008 (not an annual rate).

	2007-2008 Return			2001-2006 Return		
	Regression	0-90 th pct	90 th – 100 th pct	Regression	0-90 th pct	90 th – 100 th pct
PURCH SOLD	(5)	-0.47%	-0.10%	(6)	-10.51%	-39.60%
REFI SOLD	(5)	-1.07%	-29.43%	(6)	8.21%	64.50%
Memo: average of SOLD, 2001-2006		6.39%	60.17%			
Memo: Return, 2007-2008		-22.97%	-46.72%			

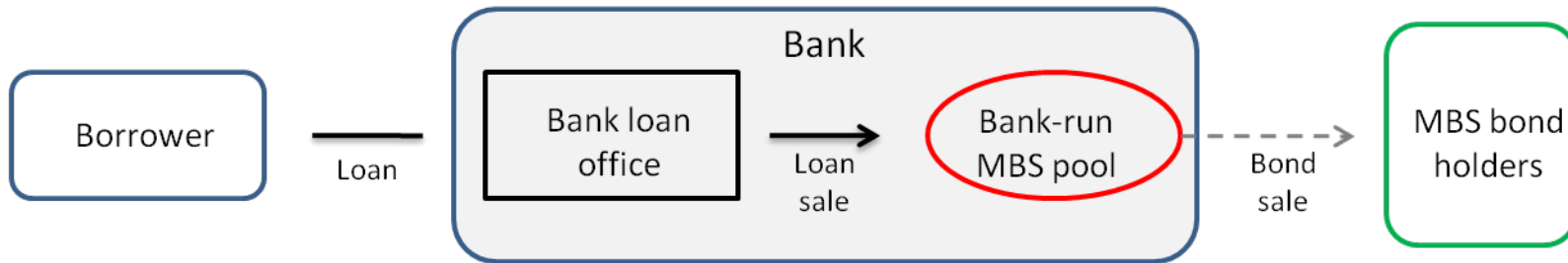
Figure 1. The growth of securitization: outstanding asset-backed and mortgage-backed securities, 1980-2009.



Sources: MBS (mortgage-backed security) data from Inside Mortgage Finance, CMBS (commercial mortgage-backed security) data from Mortgage Bankers Association quarterly date book (available from 1998-2009), and ABS (asset-backed security) data from SIFMA (available from 1996-2009).

Figure 2. Examples of the path from the borrower to the MBS bond holder.

Bank securitizes its own loans



Bank sells loans which others securitize

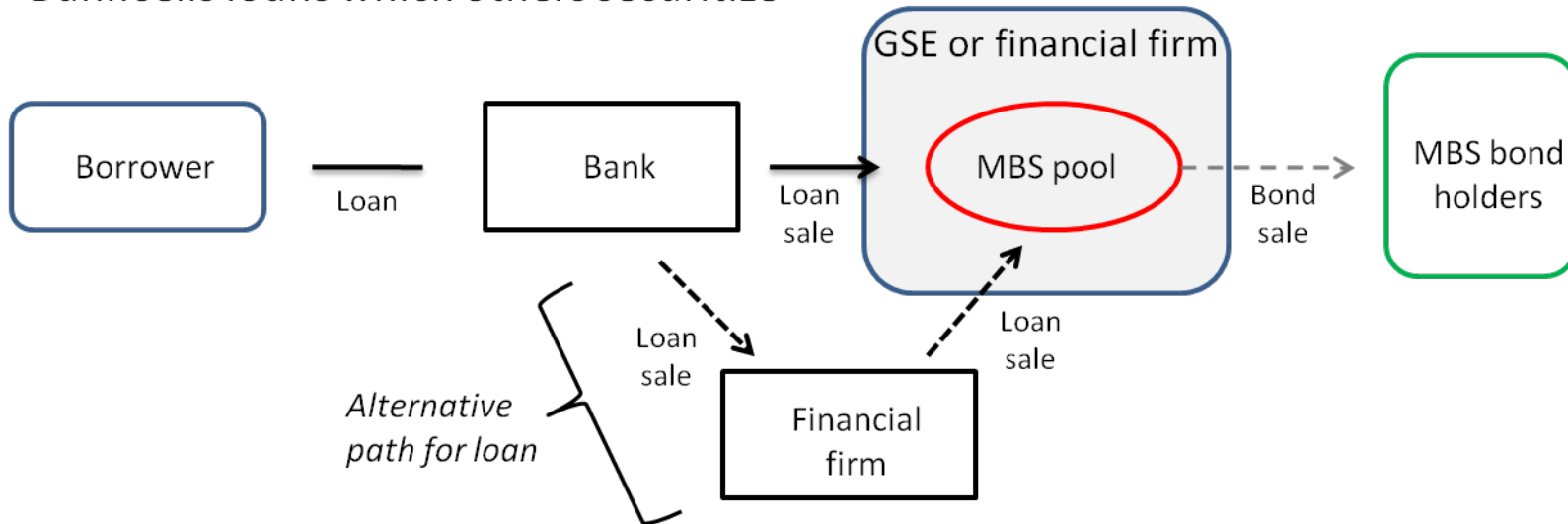
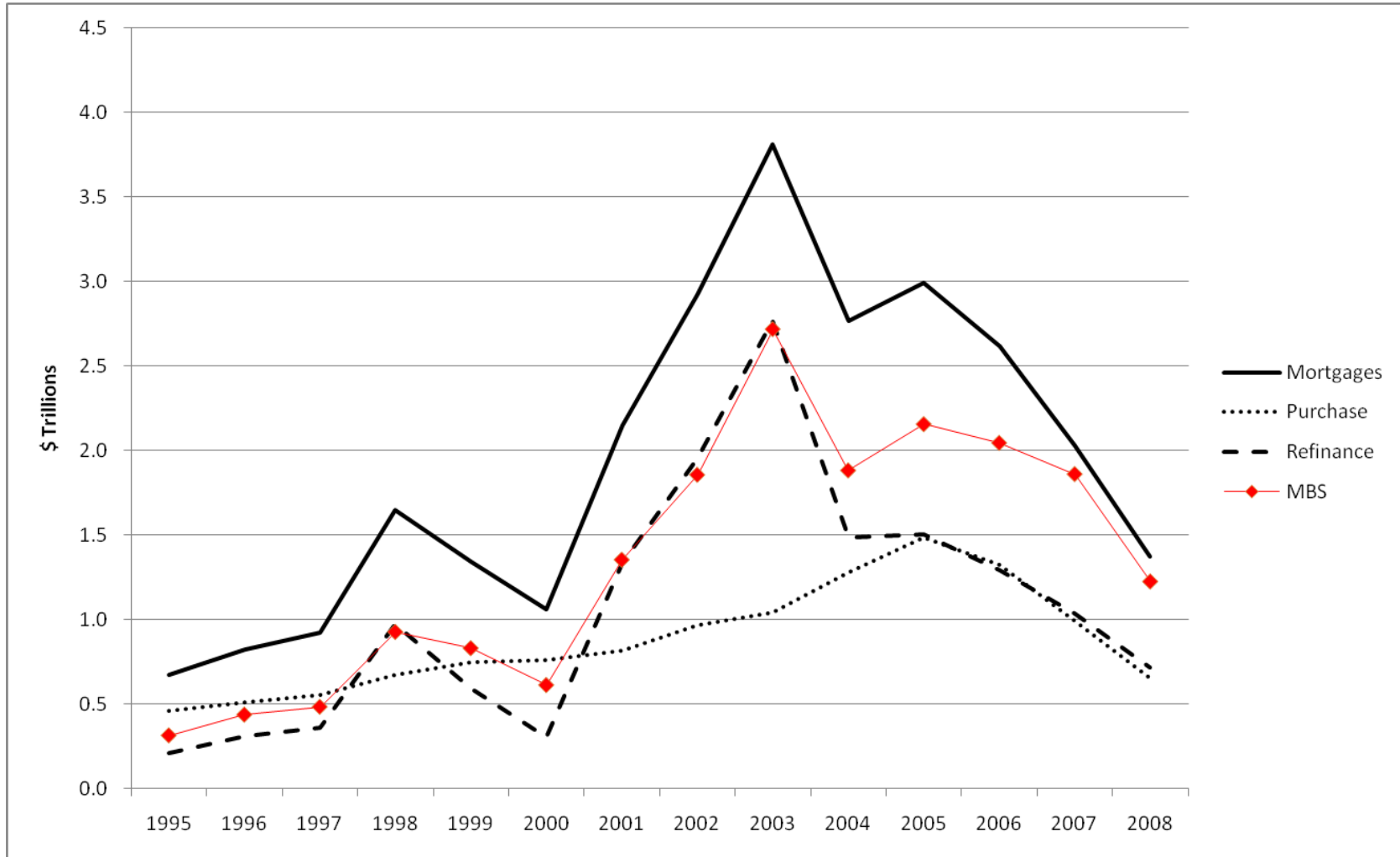
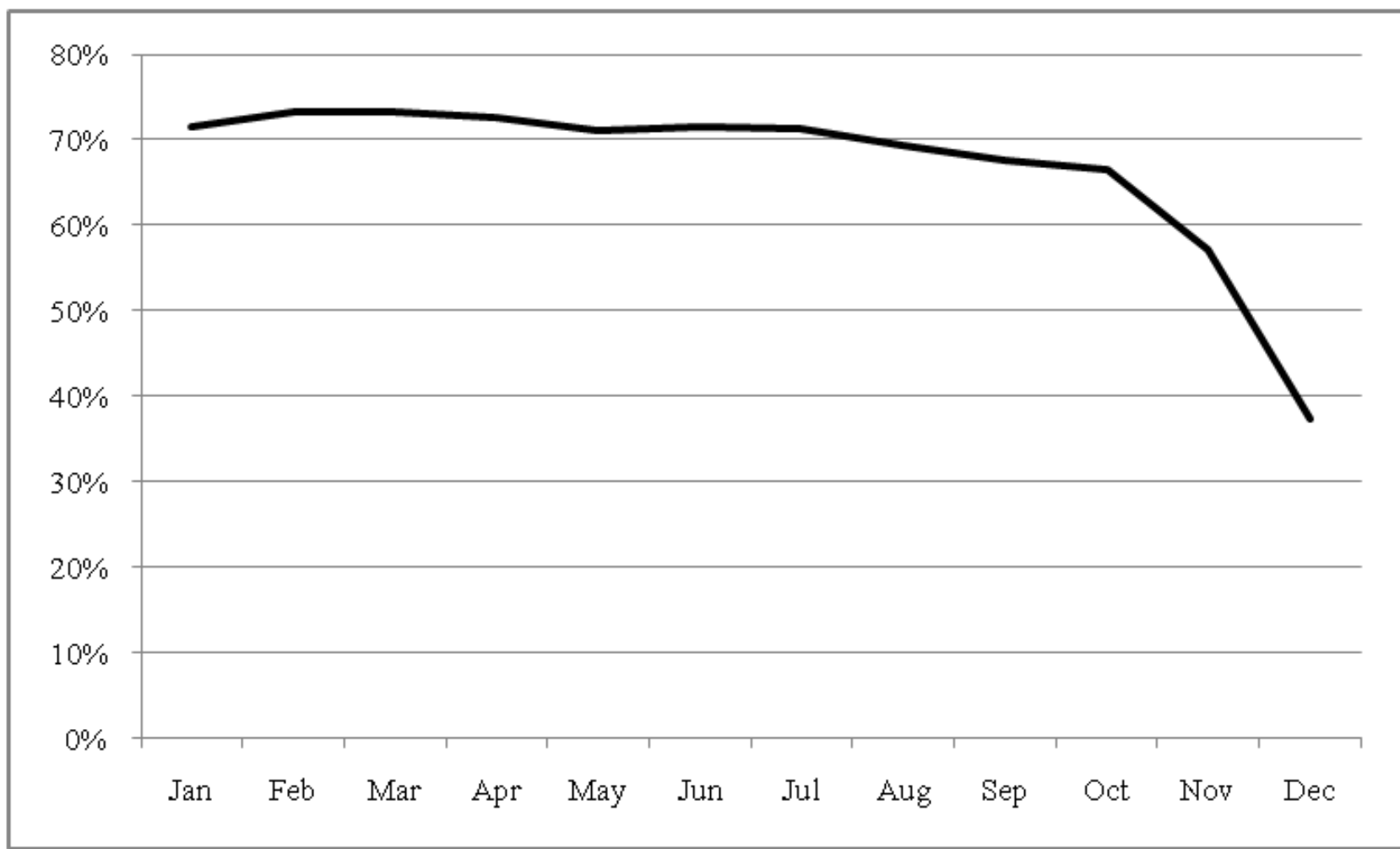


Figure 3. Mortgages granted by purpose of loan, 1995-2008.



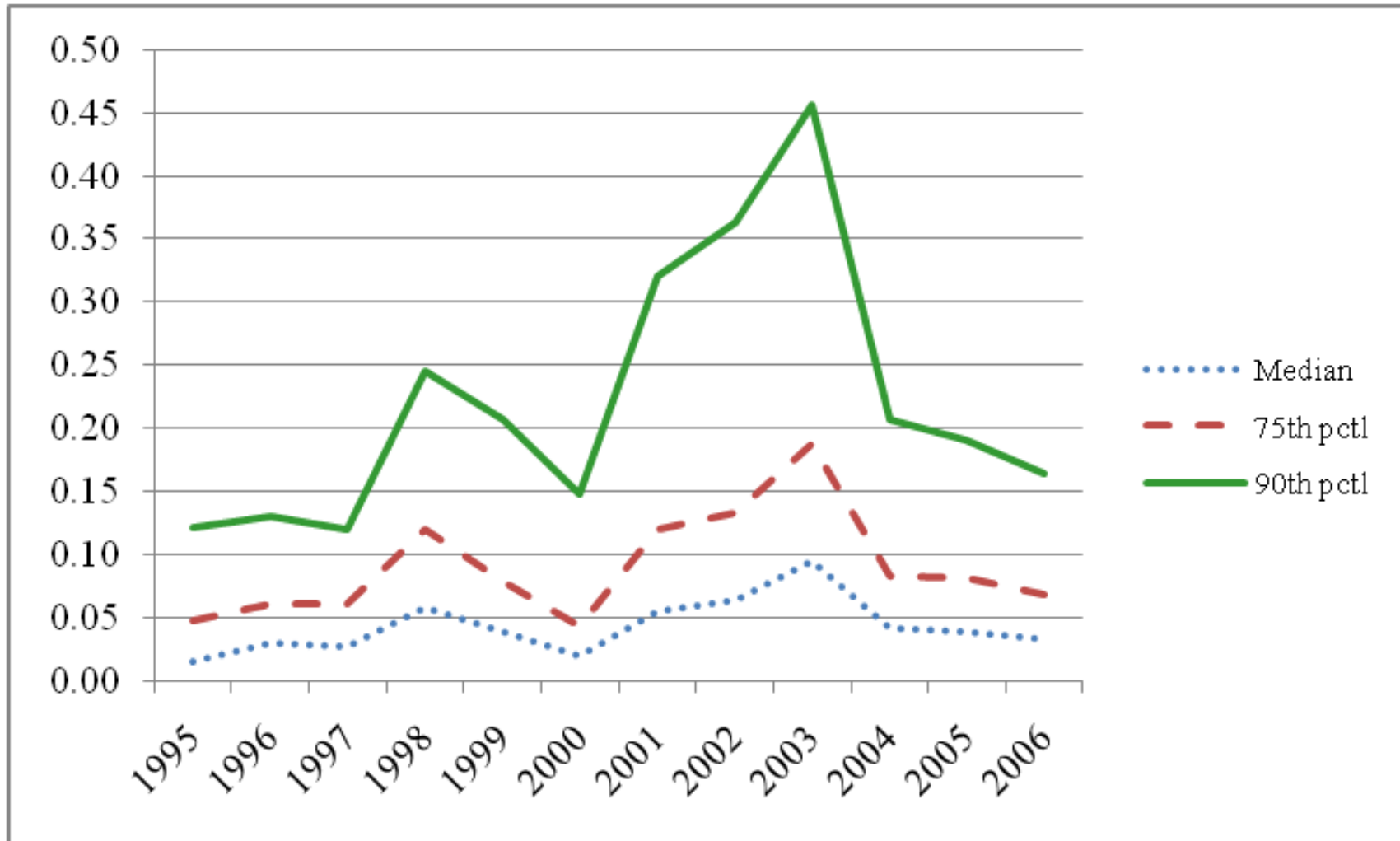
Source: MBS data from Inside Mortgage Finance and mortgage data from HMDA data set.

Figure 4. Proportion of mortgages granted in each month that are reported as sold by the end of the calendar year in the HMDA data, 1995-2008.



Source: HMDA data.

Figure 5. For the ratio of mortgages sold to total assets (SOLD): the median, 75th percentile, and 90th percentile values, 1995-2006.



Source: HMDA data, Call Report data, and Y-9 data.

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