Market Power in Mortgage Lending and the Transmission of Monetary Policy*

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September 2014

Abstract

We present evidence that high concentration in mortgage lending reduces the sensitivity of mortgage rates and refinancing activity to mortgage-backed security (MBS) yields. We isolate the direct effect of concentration and rule out alternative explanations in two ways. First, we use a matching procedure to compare high- and low-concentration counties that are very similar on observable characteristics and find similar results. Second, we examine counties where bank mergers increase concentration in mortgage lending. Within a county, sensitivities to MBS yields decrease after a concentration-increasing merger. Our results suggest that the strength of the housing channel of monetary policy transmission varies in both the time series and the cross section. In the cross section, the overall impact of a decline in MBS yields is only 42% as large in a high-concentration county as it is in an average one. In the time series, a decrease in MBS yields today has a 32% smaller effect on the average county than it would have had in the 1990s because of higher concentration today.

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* This paper was previously circulated under the title "Concentration in Lending, Refinancing Activity, and Mortgage Rates." We are grateful to Zahi Ben-David, Scott Frame, Andreas Fuster, Ed Golding, Laurie Goodman, Amir Kermani, David Lucca, Karen Pence, Monika Piazzesi, Amit Seru, Jeremy Stein, Amir Sufi, and seminar participants at Berkeley, the Federal Reserve Bank of New York, the Federal Reserve Board, Harvard University, the NBER Corporate Finance Spring Meetings, Ohio State, Stanford, Texas, the UCLA/FRB-San Francisco Conference on Housing and the Macroeconomy, and the Urban Institute for helpful comments and suggestions. We thank Freddie Mac for data and Toomas Laarits for excellent research assistance. We also thank the Harvard Business School Division of Research for financial support.

I. Introduction

Housing is a critical channel for the transmission of monetary policy to the real economy. As shown by Bernanke and Gertler (1995), residential investment is the component of GDP that responds most strongly and immediately to monetary policy shocks. In addition, housing can be an important channel through which monetary policy affects consumption. An easing of monetary policy can reduce mortgage rates, enabling households to refinance their mortgages at lower rates and reduce their payments. If borrowers have higher marginal propensities to consume than lenders, as would be the case if borrowers are more liquidity constrained, then refinancing can boost aggregate consumption.

Using monetary policy to support housing credit has been a particular focus of the Federal Reserve in recent years. The Federal Reserve's purchases of mortgage-backed securities (MBS) in successive rounds of quantitative easing have had the explicit goal of supporting the housing market. One of the aims of quantitative easing was to lower mortgage rates by reducing financing costs for mortgage lenders (Bernanke 2009, 2012). However, the widespread use of fixed rate mortgages introduces several frictions that may impede the transmission of these low rates to borrowers. For instance, it has been argued that the efficacy of quantitative easing has been hampered by the high indebtedness of many households (Eggertson and Krugman, 2012; Mian, Rao, and Sufi, 2012). "Underwater" households whose mortgage balances exceed the values of their homes have been unable to refinance, potentially reducing the impact of low interest rates on the economy.

Others have noted that the reduction in MBS yields from quantitative easing has only been partially passed through to borrowers, leading to historically high values of the so-called "primary-secondary spread" – the spread between mortgage rates and MBS yields (Dudley, 2012). Fuster, et al. (2012) consider a number of explanations for the increase in spreads, including greater costs of originating mortgages, capacity constraints, and market concentration, but conclude that the increase remains a puzzle.

In this paper, we explore in more detail whether market power in mortgage lending can impede the transmission of monetary policy to the housing sector. We build on the literature in industrial organization that argues that cost "pass-through" is lower in concentrated markets than in competitive markets – when production costs fall, prices fall less in concentrated markets than they do in competitive markets because producers use their market power to capture larger profits (e.g., Rotemberg and Saloner, 1987). In the context of mortgage lending, this suggests that when the Federal Reserve lowers interest rates, mortgage rates will fall less in concentrated mortgage markets than in competitive markets. This could dampen the effects of monetary policy in locations where mortgage lending is more concentrated or at times when there is more concentration.

Evidence from the aggregate time series is broadly consistent with the idea that concentration in mortgage lending impacts mortgage rates. As shown in Figure 1, concentration in the mortgage lending industry increased substantially between the mid-1990s and 2011. Figure 2 shows the average primary-secondary spread calculated as the difference between the mortgage rate paid by borrowers and the yield on MBS for conforming loans guaranteed by the government-sponsored entity (GSE) Freddie Mac. [1] The yield on Freddie Mac MBS is the amount paid to investors in the securities, which are used to finance the mortgages. Thus, the spread is a measure of the revenue going to mortgage originators and servicers. The spread rose substantially between the mid-1990s to 2011. Moreover, as shown in Figure 3, the spread is highly correlated with mortgage market concentration. The correlation is 66% in levels and 59% in changes, so the correlation does not simply reflect the fact that both series have a positive time trend.

One reason that market power has not received much scrutiny as an explanation for recent increases in the primary-secondary spread is that the spread spiked in 2011 and 2012, though concentration in mortgage lending has not increased since 2010 (Avery, et al., 2012; Fuster, et al., 2012). However, as we discuss below, in the presence of capacity constraints, the effects of concentration are most clearly revealed when MBS yields fall, as they did in 2011 and 2012 with the expansion of the Federal Reserve's quantitative easing programs. Thus, the time series correlation between spreads and concentration may understate the true relationship. In this paper, we use panel data to examine the effects of mortgage market concentration at the county level. Rather than focus on the level of the spread between mortgage rates and MBS yields, we

[1] Specifically, Figure 2 shows the time series of the borrowing rate reported in Freddie Mac's Weekly Primary Mortgage Market Survey minus the yield on current coupon Freddie Mac MBS minus the average guarantee fee charged by Freddie Mac on its loans.

instead study the relationship between concentration and the pass-through from MBS yields to mortgage rates. We provide evidence that increases in mortgage market concentration are associated with decreased pass-through at the county level.

Using the yield on GSE-guaranteed MBS as a proxy for the costs of mortgage financing, we find that mortgage rates are less sensitive to costs in concentrated mortgage markets. Relative to the average county, the impact of a decrease in MBS yields on mortgage rates is 17% smaller in a county with concentration one standard deviation above the mean. Moreover, when MBS yields fall, the quantity of refinancing increases in the aggregate. However, the quantity of refinancing increases 50% less in the high-concentration county relative to the average county. The effects on mortgage rates and the quantity of refinancing compound each other. In a high-concentration county, fewer borrowers refinance, meaning that fewer households see their mortgage rates reduced at all. And of the borrowers that do refinance, the rates they are paying fall less on average. The magnitude of the combined effect is substantial: monetary policy transmission through the mortgage market is only 42% as large in a high-concentration county as it is in the average county.

Of course, mortgage market concentration is not randomly assigned, so it is difficult to ascribe causality to these results. We attempt to address endogeneity concerns in a variety of ways. First, our basic results are robust to a battery of controls including county and time fixed effects, population, wages, house prices, and mortgage characteristics. Moreover, we control for the interaction of changes in MBS yields with these characteristics. Thus, our results show that market concentration reduces the sensitivity of mortgage rates to MBS yields even after controlling for the possibility that this sensitivity can vary with county characteristics. Second, we use a matching procedure to ensure that the counties we study are similar on observable dimensions. This does not affect the results.

Third, we use bank mergers as an instrument for mortgage market concentration. Specifically, we examine a sample of counties where mortgage lending concentration is increased by bank mergers, but the counties in the sample were not the key motivation for the merger. In particular, we focus on counties where the banks involved in a merger are important, but the county itself makes up only a small fraction of the banks' operations. Mergers increase the concentration of mortgage lending in such counties. However, because the county makes up a small fraction of each of the bank's operations, it is unlikely that the county was an important driver of the merger. In this sample of counties, we show that the sensitivity of refinancing and mortgage rates to MBS yields falls after the merger, consistent with the idea that increased concentration causes less pass-through. The exclusion restriction here is that bank mergers affect the sensitivity of refinancing and mortgage rates to MBS yields within a county only through their effect on market concentration in that county. For the exclusion restriction to be violated, it would have to be the case that bank mergers are anticipating changing county characteristics that explain our results, which seems unlikely.

Finally, using data on bank profits and employment, we provide evidence consistent with the view that the market power mechanism is behind the lower pass-through of MBS yields into mortgage rates. Interest and fee income from real estate loans, reported in the Call Reports banks file with the Federal Reserve, is typically positively correlated with MBS yields because interest income falls when yields fall. However, we show that interest and fee income is less sensitive to MBS yields in high-concentration counties. This suggests that banks in concentrated mortgage markets are able to use their market power to protect their profits when MBS yields fall. Similarly, employment in real estate credit is typically negatively correlated with MBS yields; as MBS yields fall originators hire more workers to process mortgage applications, or there is entry in mortgage origination. However, the sensitivity is less negative (i.e., lower in absolute terms) in high-concentration counties, meaning that in such counties originators expand hiring less aggressively in response to a decline in MBS yields, or there is less entry. Thus, while it is true that capacity constraints limit mortgage origination, these capacity constraints are endogenous to the degree of competition in the market. In all, the evidence is consistent with the idea that mortgage market concentration decreases the transmission of monetary policy to the housing sector.

Our results have both time series and the cross-sectional implications for the effectiveness of monetary policy. Specifically, the impact of monetary policy could be decreasing over time due to the increase in average mortgage market concentration documented in Figure 1. In addition, even in the absence of a time series trend, monetary policy could have different impacts across counties due to cross sectional variation in mortgage concentration across counties.

The remainder of this paper is organized as follows. Section II gives some relevant background on the mortgage market, and Section III presents a brief model to motivate our empirics. Section IV describes the data, and Section V presents the main results. Section VI concludes.

II. Background

A. The Conforming Mortgage Market

We begin with a brief review of the structure of the mortgage market. Our analysis focuses on prime, conforming loans, which are eligible for credit guarantees from the government-sponsored enterprises (GSEs), Fannie Mae and Freddie Mac. Such mortgages may be put into MBS pools guaranteed by the GSEs. The GSEs guarantee investors in these MBS that they will not suffer credit losses. If a mortgage in a GSE-guaranteed pool defaults, the GSE immediately purchases the mortgage out of the pool at par, paying MBS investors the outstanding balance of the mortgage. Thus, investors in GSE MBS bear no credit risk except for the GSEs' credit risk, which is generally small. In return for their guarantee, the GSE charges investors a guarantee fee. In addition to the fees charged by the GSEs, borrowers also pay mortgage lenders origination and servicing fees.

Conforming mortgages must meet certain criteria. For instance, their sizes must be below the so-called conforming loan limit, which is set by the Federal Housing Finance Agency. In addition, the mortgages must meet basic GSE guidelines in terms of loan-to-value ratios (LTVs), credit (FICO) scores, and documentation.

An important fact for our empirical analysis is that GSE guarantee fees do not vary geographically. Indeed, until 2008 the GSEs charged a given lender the same guarantee fee for any loan they guaranteed, regardless of borrower (e.g., income, FICO), mortgage (e.g., LTV, loan type), and collateral (e.g., home value) characteristics.[2] In 2008 the GSEs began to charge fees that vary by FICO score, LTV, and loan type, but do not vary by geography or any other borrower characteristics.[3] Thus, for the loans we focus on in our analysis, the only two dimensions of credit quality that should materially affect rates on GSE-guaranteed mortgages are

[2] However, there is some relative minor variation in fees charged across lenders.
[3] Fannie Mae publishes their guarantee fee matrix online at: https://www.fanniemae.com/content/pricing/llpa-matrix.pdf

FICO and LTV.[4,5] Moreover, our results hold in the period prior to 2008, suggesting that borrower-level variation in GSE guarantee fees are not driving the results.

B. Definition of the Local Mortgage Market

A key assumption underlying our empirical analysis is that competition in the mortgage market is local. Specifically, we are assuming that county-level measures of concentration are good proxies for the degree of competition in a local mortgage market. The advent of Internet-based search platforms like Bankrate.com and LendingTree.com has certainly improved the ability of borrowers to search for the best mortgage terms. However, it has been shown that there is still pricing heterogeneity for homogeneous products listed on the Internet (Dinerstein, Einav, Levin and Sundaresan, 2014). Moreover, there is substantial evidence that many borrowers still shop locally for their mortgages. Analyzing data from the Survey of Consumer Finances, Amel, Kennickell, and Moore (2008) find that the median household lived within four miles of its primary financial institution in 2004. They find that 25% of households obtained mortgages from this primary financial institution, while over 50% of households obtained mortgages from an institution less than 25 miles away.

In addition, borrowers report that they exert little effort in shopping around for lower mortgage rates. According to Lacko and Pappalardo (2007), in a survey conducted by the Federal Trade Commission, the average borrower considered only two loans while shopping.[6] Thus, it is likely that local competition has effects on the local mortgage market. Competition could affect loan terms like rates and points charged upfront but could also manifest itself in other ways. For instance, lenders may advertise more in more competitive markets, leading to greater borrower awareness of lower mortgage rates and increased refinancing activity. Indeed, Gurun, Matvos,

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[4] Loan type does not affect our analysis of mortgage rates because we restrict our sample to 30-year fixed rate, full documentation loans.

[5] Other determinants of credit quality may have a small effect on the rates of GSE-guaranteed mortgages due to prepayment risk. When a GSE-guaranteed mortgage defaults, the GSEs immediately pay investors the remaining principal and accrued interest. From an investor's perspective, it is as though the loan prepays. If defaults correlate with the stochastic discount factor, which is likely, this risk will be priced by investors. However, since prepayments induced by default are much smaller than prepayments induced by falling mortgage rates, this effect will be very small.

[6] Ausubel (1990) documents the impact of this kind of consumer behavior on the effective level of competition in the credit card market.

and Seru (2013) find evidence that local advertising affects consumer mortgage choices, suggesting that local competition is important.

Data from RateWatch, a vendor that surveys lenders about the mortgage rates they charge, provides more direct evidence that mortgage markets are partially local. RateWatch surveys different branches of the same lender and, crucially, keeps track of how many rate-setting locations a particular lender has. For instance, if the lender sets one national rate, it will have one rate-setting location. In contrast, if each branch has the authority to set its own mortgage rates, RateWatch will record each branch as a rate-setting location. Of the 63,615 surveyed branches, 31,086 (49%) have rate-setting locations in the same MSA. The median rate-setting location covers just four branches, while the average rate-setting location covers 16 branches. While there are some large lenders that set a single rate nationally, the median rate-setting location covers a single MSA, and the average rate-setting location covers two. Within the median MSA, there are eight rate-setting locations, and the average MSA has 18 rate-setting locations.

III. Model

We now briefly present a simple model of mortgage market competition. The model is stylized – it is meant to motivate our empirical analysis, and to demonstrate that our findings can be rationalized in a model where differences in market competition are the driving force. The model features Cournot competition with capacity constraints, a key feature of which is that the impact of these capacity constraints on equilibrium prices and quantities depends on the degree of competition. There are two main results. First, the pass-through of MBS yields to mortgage rates is larger in markets with more competing lenders. Second, differences in pass-through between high- and low-concentration markets are highest when yields are low. We assume linear demand for mortgages so that

$$p(Q) = a - bQ,$$

where $p(Q)$ is the mortgage rate corresponding to demand of Q in the local area given this rate. The linear demand assumption can be motivated by assuming that there are fixed costs to refinancing and pre-existing mortgage rates are uniformly distributed.[7] Each mortgage originator is assumed to have pre-existing production capacity $\bar{q}$. When production is below the pre-existing capacity, the only costs of mortgage production are the costs of funding the loan, given by the MBS yield, *r*. Thus, we are effectively normalizing other production costs associated with mortgage origination to zero when production is below pre-existing capacity. However, if a lender wishes to produce more than its pre-existing capacity, it faces increasing, convex production costs, which capture the idea that it is costly to produce above pre-existing capacity. For instance, one could think of these convex costs as capturing loan officer overtime, strain on back-office capabilities, and other short-run costs of very high production. Formally, production costs are given by

$$C(q) = \begin{cases} rq & \text{if } q \le \bar{q} \\ rq + \frac{1}{2}c\left(q - \bar{q}\right)^2 & \text{if } q > \bar{q} \end{cases}.$$

We assume Cournot competition,[8] so firms solve the following maximization problem:

$$\max_q p(Q)q - C(q).$$

We solve for the symmetric Nash equilibrium, labeling optimal production of individual lenders q^* and total equilibrium production $Q^* = nq^*$.

Proposition 1. *Total equilibrium production depends on the MBS yield r and is given by*

$$Q^*(r) = \begin{cases} Q^*_{low}(r) & \text{if } r \ge \bar{r} \\ \bar{Q} & r \in \left[\underline{r}, \bar{r}\right] \\ Q^*_{high}(r) & \text{if } r < \underline{r} \end{cases},$$

where

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[7] In particular, suppose that borrowers have existing mortgages and that the rates on their mortgages, p_0, are uniformly distributed on the interval [x-Δ/2,x+Δ/2]. Refinancing is desirable if the new rate, p, plus transaction costs, k, are less than the old rate, p_0. Thus, the quantity of refinancing, Q, is equal to M[1-(p+k)/ Δ], where M is a measure of the size of the market (e.g. population). We can therefore write the demand function p(Q) = a – bQ, where a=Δ-k and b = Δ/M.

[8] While it is more natural to model mortgage market competition as Bertrand, as argued by Kreps and Scheinkman (1983), Bertrand competition with capacity constraints is similar to Cournot competition under certain conditions. Furthermore, the model is merely meant to be illustrative, and Cournot competition simplifies the analysis considerably.

$$Q^*_{low}(r) = \frac{(a-r)N}{b(N+1)},\ \overline{Q} = N\overline{q},\ Q^*_{high}(r) = \frac{(a-r)N}{b(N+1)+c}$$

and

$$\underline{r} = a - \overline{q}\big(b(N+1)+c\big),\ \underline{r} = a - \overline{q}b(N+1).$$

Proof. *All proofs are given in the Appendix.*

The equilibrium depends on the MBS yield *r*. When the MBS yield is high, the cost of producing loans is high, and lenders will produce few mortgages using existing capacity. In contrast, if MBS yields are low, lenders will wish to produce many mortgages and will add capacity to do so. For intermediate values of MBS yields, the increase in marginal cost associated with adding capacity is too large, and firms operate exactly at capacity.

We can now study pass-through, the sensitivity of prices and quantities to changes in MBS yields, in each region of the equilibrium. Since we are interested in the behavior of pass-through as the number of competing lenders changes, it is useful to normalize pre-existing capacity so that it is fixed at the industry level. Specifically, let $\overline{q} = \overline{Q}/N$ where $\overline{Q}$ is aggregate industry capacity. Thus, as we vary *N*, aggregate industry capacity is fixed but is distributed among a larger number of lenders. Note that this normalization implies that both $\underline{r}$ and $\overline{r}$ approach $a - b\overline{Q}$ as *N* grows large; as the industry becomes very competitive, the range of MBS yields where lenders operate exactly at capacity vanishes.

The following proposition describes how the aggregate sensitivities of quantities and prices to changes in MBS yields vary with the degree of competition.

Proposition 2. *Mortgage quantities rise when MBS yields fall:* $\partial Q^* / \partial r < 0$. *In addition, mortgage rates fall when MBS yields fall:* $\partial P(Q^*) / \partial r > 0$. *Finally, these sensitivities are larger in magnitude when there are more lenders:* $\partial^2 Q^* / \partial r \partial N < 0$, $\partial^2 P(Q^*) / \partial r \partial N > 0$.

When MBS yields fall, the marginal cost of lending falls. Therefore, lenders produce more mortgages, and the market clearing price is lower. This is true even in the region of the parameter space where lenders must add more capacity. If MBS yields are low enough, the profits from producing more mortgages will be high enough that it is worthwhile for lenders to add capacity. The second part of the proposition is the key for our empirics. As the number of lenders increases, each has less effective market power, so more of the benefit of low MBS yields is passed through to borrowers. [9] Thus, pass-through is higher in low-concentration areas than in high-concentration areas.

When are these differences in pass-through between low- and high-concentration areas largest? The following proposition shows that under certain conditions, the differences will be largest when MBS yields are low.

Proposition 3. *Differences in pass-through between low- and high-concentration areas are largest when MBS yields are low, provided* $b\left(N^2-1\right)>c$ *. Under this condition, we have* $\frac{\partial^2 Q^*_{high}}{\partial r \partial N} < \frac{\partial^2 Q^*_{low}}{\partial r \partial N}$ *and* $\frac{\partial^2 P\left(Q^*_{high}\right)}{\partial r \partial N} > \frac{\partial^2 P\left(Q^*_{low}\right)}{\partial r \partial N}$.

The condition $b\left(N^2-1\right)>c$ will hold for sufficiently large *N*, sufficiently large *b*, or sufficiently small *c*. Essentially, if the cost of adding capacity *c* is too high, then no lenders will add capacity when rates are low. In this case, capacity decisions will not contribute to the difference between high- and low- concentration counties. However, for more moderate values of *c*, lenders in low-concentration areas will add more capacity than lenders in high-concentration areas when rates are low. These differences in capacity decisions will amplify the differences in pass-through between high- and low-concentration areas.

The model, while simple, serves to motivate our empirical analysis and shows that the intuitive link between pass through and market competition can be formalized. Moreover, the model underscores the link between industry capacity constraints and mortgage market competition. It shows that while capacity constraints may be related to high spreads, the full impact of the capacity constraints is related to the degree of competition. In markets with few lenders, lenders will be reluctant to add capacity to meet increased demand for mortgages.

[9] It is worth noting that low pass-through can be a symptom of high market power, but it need not be (Bulow and Pfleiderer, 1983). The model is meant for illustrative purposes, and the results are sensitive to functional form assumptions. Ultimately the relationship between pass-through and market power is an empirical question.

IV. Data

The data in the paper come primarily from two sources. The first is the loan application register data required by the Home Mortgage Disclosure Act (HMDA) of 1975. The data contain every loan application made in the United States to lenders above a certain size threshold. Of primary interest in this paper, the data contain information on whether the loan application was for a refinancing or a new home purchase, whether the loan application was granted, a lender identifier, as well as loan characteristics including year, county, dollar amount, and borrower income. We construct an annual, county-level sample of mortgage refinancing using this data over 1990-2011. Summary statistics for the sample of HMDA data we use are shown in Table 1 Panel A. Unfortunately, the data lack information on mortgage rates as well as FICO scores and loan-to-value ratios, which play a critical role in determining rates.

Since the HMDA database includes lender identifiers, we can use it to construct county-level measures of competition in mortgage lending. The measure of concentration we use in all our baseline specifications is the share of each county's market served by the top 4 mortgage lenders in the county. Figure 1 shows the time series of nationwide top 4 concentration as well as the time series of the average county-level top 4 concentration. Other quantiles of the cross-sectional distribution of top 4 concentration show similar variation over time. As we discuss further below, our results are robust to using other measures of concentration.

To supplement the HMDA data and analyze the determinants of mortgage rates, we use aggregates from the CoreLogic loan level servicing database. This database contains information on all the loans (including loans guaranteed by the GSEs) from a set of servicers that have data-sharing agreements with CoreLogic. All large servicers are included, and loan volumes in the database range from 30-50% of loan volumes in HMDA. The data we work with are quarterly aggregates at the county level for prime, full documentation, 30-year fixed-rate refinancing loans. The sample runs from 2000-2011, and the data contain mortgage rates, FICO scores, and LTVs.

Finally, we supplement these data sources with county-level demographic and wage statistics from the Census Bureau and historical yields on current coupon Fannie Mae MBS, which we obtain from Bloomberg.

V. Results

A. Baseline Results: Quantity of Refinancing

We now turn to the results. We begin by examining the frequency of refinancing in the HMDA sample. For each county, we measure refinancing activity by the number of mortgages refinanced in a given year, normalized by the county's population in that year.[10] We regress the change in this measure on the change in 30-year Fannie Mae current coupon MBS yields over that year, county-level top 4 concentration lagged one year, and the interaction of the two.[11] Formally, we run:

$$\Delta\left(\frac{Refi}{Pop}\right)_{i,t} = \alpha + \beta_1 \cdot \Delta MBS\ Yield_t + \beta_2 \cdot Top\ 4_{i,t} + \beta_3 \cdot \Delta MBS\ Yield_t \times Top\ 4_{i,t} + \varepsilon_{i,t}.$$

The coefficient of interest is β_3, which measures the difference in sensitivities to MBS yields between high and low concentration counties.

Note that the dependent variable is the change in refinancing, rather than the level. We use the change in refinancing rather than its level because we are interested in the stimulative effect of MBS yield reductions. The stimulative effect of a change in MBS yields relative to the previous period is determined by the change in behavior relative to the previous period. However, all of the results in the paper, including our matching and instrumental variables results described below, also go through using levels of refinancing rather than changes. The key for our results is that the important independent variable is the change in MBS yields, not the level. The incentive to refinance depends on how much borrowers can reduce the rates they are paying (Campbell, 2006; Schwartz and Torous, 1989). This is related more to recent changes in rates, rather than the level of rates. If the level of yields has been low for a while, then borrowers do not have an incentive to refinance, as they will have already done so. It is only if yields have

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[10] Similar results are obtained using dollar loan volume as a measure of the quantity of refinancing, rather than the number of refinancing transactions. In addition, the results are robust to normalizing the number of refinancing transactions by the number of owner-occupied housing units in the county, which were obtained from the Census Bureau's American Community Survey. Thus, differences in homeownership rates across counties cannot account for our results.

[11] The current coupon MBS yield is meant to represent the yield on newly issued MBS. It is derived from prices in the forward market for GSE MBS, called the to-be-announced or TBA market, on MBS to be delivered in the current month. In untabulated results, we also find that our results are robust to using the 10-year Treasury yield as a proxy for funding costs.

fallen recently that borrowers have a strong incentive to refinance. Indeed, in the aggregate, refinancing is much more closely correlated with the change in MBS yields than its level.[12]

Table 2 Panel A shows the results. The first column shows that a 100 bps decrease in MBS yields (for reference, the standard deviation of MBS yields is 60 bps) increases the quantity of refinancing per person by 0.7% (percentage points) in a county with an average level of mortgage market concentration (50.8%). Relative to the standard deviation of refinancing per capita of 1.2%, this is a large effect. Consistent with the predictions of the model in Section III, the positive coefficient on the interaction of MBS yields and concentration implies that higher mortgage market concentration mitigates this effect. A one standard deviation increase in concentration (21.4%) decreases the effect of MBS yields by 50% (=.016 * 21.4%/0.7). The second column shows that the effects are stronger once we add county and year fixed effects. Including the time fixed effects shows that the results are not simply due to changes in the sensitivity of refinancing to MBS yields over time that are correlated with changes in concentration. Our results are unchanged when we isolate the cross-sectional variation in our data.[13] Including county fixed effects has no meaningful effect on the results. Similarly, the third column shows that our results are equally strong if we restrict the sample to the period before the financial crisis, 1990-2006.

The fourth column shows that the difference between high- and low-concentration counties in the sensitivity of refinancing to changes in MBS yields is particularly large at times when MBS yields are falling. This finding is consistent with Proposition 3 above, which makes this prediction if the marginal cost of adding capacity is not too high.[14]

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[12] In untabulated results, we verify this as follows. We use the difference between the average coupon of MBS in the Barclays MBS Index and the 30-year primary mortgage rate from Freddie Mac's survey as a proxy for the incentive to refinance. This measure has a -76% correlation with the one-year changes in MBS yields but only a -26% correlation with the level of MBS yields.

[13] Consistent with this observation, we obtain similar results when we fix Top 4 for each county at its value at the beginning of the sample.

[14] The formal prediction from the model is that the difference between high- and low- concentration counties should be large when MBS yields are low, while here we show that the difference is large when MBS yields are falling. The distinction between model and empirics is due to the fact that the model is static and the empirics are dynamic. The spirit of Proposition 3 is that the difference between high- and low-concentration areas is large when the quantity of refinancing is high—when lenders face a decision about whether to add capacity. In the model, this is when yields are low. But as discussed above, empirically the key determinant of the quantity of refinancing is the change in MBS yields. Therefore, in the empirics, we should expect to find large differences between high- and low-concentration areas when MBS yields have fallen.

The remaining columns show that the results are robust to a battery of additional controls including county-level change in log population, average wages, loan size, loan-to-income ratios,[15] and house prices.[16] In addition, Panel B of Table 2 shows that the results are robust to controlling for the interaction of changes in MBS yields with these characteristics as well as an additional set of controls including measures of the elderly population, children, race, and education and their interactions with changes in MBS yields (the direct effects of the controls are suppressed for compactness). It is reassuring to note that the coefficients across specifications and controls are remarkably consistent. While these specifications cannot completely account for unobservable differences between counties, they do suggest that our results are not driven by a variety of observable county characteristics.

An additional concern with our results could be that our concentration measures are proxying for the type of lender, and different types of lenders have different sensitivities to MBS yields. In particular, it is possible that small localized lenders are more likely to hold loans on their balance sheet rather than securitize them (Loutskina and Strahan, 2011). This could make their refinancing behavior less sensitive to MBS yields.

Table 3 shows that lenders respond to local mortgage market conditions the same way, whether they are localized or not. Each column reports results of the baseline specification from Table 2 but restricts the sample to lenders that operate in the number of counties given by the column header. For instance, the first column restricts the sample to loans made by lenders operating in fewer than two counties, and the second column restricts the samples to loans made by lenders that operate in two or more counties.[17] We rescale the dependent variable by the national market share of the lenders in the sample to make the coefficients comparable to those in the Table 2. Thus, the coefficients can be interpreted as the sensitivity of refinancing to MBS yields, assuming all refinancing in the country was done by the lenders in our restricted sample. For instance, the first column of Table 3 shows the sensitivity of refinancing to MBS yields,

[15] The loan-to-income ratios used here are from HMDA, and thus reflect the ratio of mortgage debt to income for mortgage borrowers. Our results are also robust on controlling for the ratio of total debt to income at the county level, which is studied Mian, Rao, and Sufi (2012).

[16] Our house price data is from Zillow and is restricted to a limited number of MSAs starting in 1996, which explains the sharp decrease in the number of observations. The results are robust to using MSA house price data from the Federal Housing Finance Agency. The more modest reductions in the number of observations relative to the earlier columns stem from missing data in HMDA.

[17] At the beginning of our sample in 1990, the median lender operates in two counties. By the end of the sample in 2011, the median lender operates in six counties.

assuming all refinancing was performed by lenders that operate in fewer than two counties. The results in Table 3 are uniform across lender types. Refinancing loans originated by both small and large lenders are less sensitive to MBS yields in more concentrated markets.

B. Baseline Results: Mortgage Rates

We next turn to the behavior of mortgage rates in the CoreLogic data over the shorter period for which we have data, 2000 - 2011. For each county-quarter, we take the average rate on prime, full-documentation, and 30-year fixed-rate loans. We restrict the sample to county-quarters with at least five loans, average FICO scores greater than 620, and average LTVs between 50 and 101. We regress the change in rates on the change in 30-year Fannie Mae current coupon MBS yields over the quarter, county-level top-4 concentration lagged one year, and the interaction of the two. Formally, we run:

$$\Delta Rate_{i,t} = \alpha + \beta_1 \cdot \Delta MBS\ Yield_t + \beta_2 \cdot Top\ 4_{i,t} + \beta_3 \cdot \Delta MBS\ Yield_t \times Top\ 4_{i,t} + \varepsilon_{i,t}.$$

Again, the coefficient of interest is β_3, which measures the difference in sensitivities to MBS yields, between high- and low-concentration counties.

Table 4 Panel A shows the results. The first column shows that a 100 bps decrease in MBS yields is associated with a 63 bps decrease in mortgage rates for borrowers in a county with an average level of mortgage market concentration.

Consistent with the model's predictions, the coefficient on the interaction between MBS yields and concentration implies that high concentration reduces the pass through of MBS yields to borrowers. A one standard deviation increase in concentration decreases the pass through of a 100 basis point reduction in MBS yields on mortgage rates by 17% (=.497 * 21.4%/63 bps).[18] The second column in Table 4 Panel A adds county and year fixed effects, indicating that the results are not driven solely by aggregate time trends or by fixed differences across counties. The third column shows that the difference between high- and low-concentration counties in the sensitivity of mortgage rates to changes in MBS yields is particularly large at times when MBS

[18] Here we are using the standard deviation of *Top 4* across the full HMDA sample, which covers more lenders, locations, and years. The standard deviation of *Top 4* in the CoreLogic sample is smaller (8.8% vs. 21.4%) because it only uses counties in MSAs and covers a shorter period. In this calculation, we are thus implicitly assuming that the estimated coefficients would be similar in the broader sample.

yields are falling. This is consistent with Proposition 3 above. The fourth column shows that results persist when we restrict the sample to the pre-crisis period, 2000-2006. Though mortgage market concentration has grown substantially over recent years, the results we document here are not solely driven by the period during and after the financial crisis. The statistical evidence is somewhat weaker here than in Table 2 because our mortgage rate data has a shorter time dimension (2000-2011) than our refinancing quantity data (1994-2011).

The remaining columns of Table 4 Panel A show that the results are robust to controlling for changes in LTV, FICO (column 5), and log house prices (column 6). Panel B of Table 4 shows that the results are also robust to controlling for the interaction of changes in MBS yields with these characteristics as well as an additional set of controls including measures of the elderly population, children, race, and education and their interactions with changes in MBS yields (the direct effects of the controls are suppressed for compactness). Again, it is reassuring to note that the coefficients across specifications and controls are remarkably consistent.

Unfortunately, our data does not contain information on up-front points, fees, and closing costs. Thus, our results essentially assume that these costs do not covary negatively with market concentration. If fees were lower in high-concentration areas, this may offset the smaller sensitivity to MBS yields we find in those counties. In untabulated results using data from the Monthly Interest Rate Survey (MIRS) conducted by the Federal Housing Finance Agency, we find that fees are on average higher in high-concentration counties, not lower. Moreover, in this data set fees are equally sensitive to MBS yields in high- and low-concentration counties.

C. Alternative Measures of Concentration and Markets

So far, we have reported results for one simple measure of concentration, the share of the four largest lenders in a county as calculated from the HMDA database. In the Internet Appendix, we establish that the results are robust to alternative measures of concentration. In particular, the results in Tables 2 and 4 on refinancing and rates are robust to using the Hirschman-Herfindahl Index of concentration calculated using the same HMDA database. Further, these results are robust to measuring concentration as the share of deposits held by the four largest banks within a county.[19] While these measures of concentration are surely imperfect

[19] The correlation of Top 4 with these measures is 86% and 42% respectively.

proxies for the level of local competition, it is only important for our analysis that they capture some of the variation in local competition.[20]

Though we control for population in the regressions, the analysis still equal-weights counties, raising the possibility that our results are driven by small, low-population counties. In the Internet Appendix, we show that this is not the case. Our main results are robust to weighting the sample by population and excluding counties with populations below the median or mean for a given year. In addition, we show that the results are robust to conducting the analysis at the MSA level.

D. Mechanism, Timing and Magnitudes

Mechanism. The findings so far have established that concentration reduces the sensitivity of both refinancing and mortgage rates to MBS yields. Our model indicates that there should be a connection between the two; in locations where mortgage rates are higher, refinancing activity should be lower. Table 5 establishes that this is the case by regressing the change in annual county-level refinancing rates on the annual change in county level mortgage rates. As predicted, Column 1 shows that there is a negative relationship between the two. The remaining columns indicate that this negative relationship is robust to including year and county fixed effects as a well as a battery of controls. While not establishing a causal link between price and quantity, these findings are consistent with the idea that low refinancing rates are affected by price considerations.

Timing. While the refinancing analysis is conducted at the annual level, the mortgage rate analysis is conducted at the quarterly level. It is possible that concentration affects the speed of pass-through in rates, although not the ultimate magnitude of pass-through. In the Internet Appendix we show that this is not the case. The results do indicate that at one- and two-month frequencies pass-through in the average county is significantly less than it is in the quarterly analysis reported in Table 3; for each 100 bps reduction in MBS yields rates fall by 36 bps at the one-month horizon and 51 bps at the two-month horizon compared to 62 bps at the quarterly

[20] In addition, in untabulated results we find that the results are similar when we exclude county-years where the fraction of loans originated by brokers and correspondents is high. Because HMDA may not account for sales through brokers and correspondents properly, the scope for mismeasuring concentration is greater in these counties. The robustness of our results to the exclusion of these counties shows that such measurement error is unlikely to be driving our results.

horizon. However, beyond the quarterly horizon, the increase in pass-through levels off and is stable for longer horizons. This indicates that there are persistent differences across counties in the pass-through of MBS yields to mortgage rates.

Magnitudes. What is the total economic magnitude of the effects of market concentration we are finding? One way to answer this question is by assessing the relative effect across counties. Note that the effect of concentration on mortgage rates compounds with the effect on refinancing. In a high-concentration county, fewer borrowers refinance, meaning that fewer households see their mortgage rates reduced at all. And of the borrowers that do refinance, the rates they pay fall less on average. The results in Table 2 imply that a decrease in MBS yields has a 50% smaller effect on the quantity of refinancing in a county with concentration one standard deviation above the mean than in a county with average concentration. For the households that do refinance, the results in Table 4 show that a decrease in MBS yields has a 17% smaller effect on mortgage rates in the high-concentration county. Taken together, these imply that the effect of a decrease in MBS yields is only 42% as large in the high-concentration county as it is in the average county.[21]

Another way to analyze the economic magnitude of the effects of market concentration is to look at changes through time. As Figure 1 shows, there was a large increase in average market concentration from the mid-1990s. For example, in 1997 the average concentration was 11 percentage points lower than it was in 2011. Thus, our estimates imply that MBS yields have a 25% smaller effect on the quantity of refinancing in the more recent period relative to the earlier one. Moreover, the effect on rates is 9% lower in the recent period than in the earlier period. Thus, the overall effect of a reduction in MBS yields is 32% lower in the recent period. To the extent that refinancing has stimulative effects because borrowers have higher marginal propensities to consume than lenders, this suggests that the strength of the monetary policy transmission mechanism has declined fairly significantly over time.[22]

[21] The frequency of refinancing is only 50% as high in the high-concentration county, and each refinancing reduces rates 83% as much. Thus, the total effect is only 50%x83% = 42% as large in the high-concentration county.

[22] Mian, Rao, and Sufi (2012) provide evidence that marginal propensities to consume vary strongly with indebtedness. Thus, it is quite likely that borrower have higher marginal propensities to consume than lenders (i.e., net savers).

E. Discussion of Endogeneity Concerns

While the results above are quite robust to a variety of controls, one might still be concerned that market concentration is just a proxy for some other endogenous relationship, rather than directly causing the observed effects through market power. That is, one may worry that our results are driven by unobservable differences between counties along dimensions other than mortgage market concentration. Of course, all our baseline specifications include county fixed effects, which absorb the average effect of any unobservable characteristics on changes in refinancing quantities and mortgage rates. However, unobservable characteristics could still affect the *sensitivities* of the variables to MBS yields.

There are two broad types of confounds one may be concerned about. The first is confounds based on loan characteristics. For instance, as discussed above, low credit quality can impede refinancing when MBS yields fall. If high market concentration is correlated with poor credit quality, then households in high-concentration counties may have trouble refinancing when MBS yields fall. However, as shown in the Internet Appendix, we generally find that high concentration is associated with high, not low, credit quality. Moreover, our controls for county-level FICOs, LTVs, and house prices in our results on mortgage rates (Table 4) should absorb such factors. Recall that our analysis focuses on conforming loans, which are eligible for GSE guarantees. Since GSE guarantee fees depend on only FICO scores, LTVs, and year of origination, controlling for these factors should absorb all priced differences in credit quality between conforming loans. Thus, any differences in the response of mortgage rates to MBS yields should not be driven by differences in the credit quality of loans in high- versus low-concentration counties.[23] Moreover, our results are equally strong if we restrict our sample to the years before the financial crisis – before problems with high indebtedness emerged. Nonetheless, one may still be concerned that our controls only absorb linear effects of observable characteristics. Therefore, in the next section we use a matching procedure to ensure that our results are comparing counties that are very similar on observables.

The second type of confound that may raise concerns is based on demographic characteristics. Demographic characteristics are known to be correlated with household financial

[23] In untabulated results, we find that our results are robust to controlling for the measure of county-level indebtedness used by Mian, Rao, and Sufi (2012).

decisions (Campbell, 2006). Again, to the extent that such confounding demographic characteristics are observable, our controls are likely to absorb them. Nevertheless, there could be important borrower characteristics not fully captured by our controls. In general, the response of prices to costs depends on the curvature of the demand function as well as market structure (Dornbusch, 1987; Knetter, 1989; Bergin and Feenstra, 2001; Atkeson and Burstein, 2008). If market structure is correlated with local characteristics that impact the curvature of the demand function, our results may reflect differences in characteristics rather than market power.[24] For instance, borrower sophistication is difficult to measure, and it could be the case that borrowers in high-concentration counties are less sophisticated than those in low-concentration counties. Thus, they could be slower to refinance when MBS yields fall and search less intensively for the best mortgage rate, leading us to observe less variation in borrowing rates as yields fall. However, it seems likely that such borrowers are more profitable from the lender perspective; unsophisticated borrowers who do not search for the best deal are likely to pay excessively high fees to originators. Thus, their presence would encourage more entry in the mortgage market and lower market concentration. For borrower sophistication to drive our results, it would have to be the case that unsophisticated borrowers are more costly to serve, so that fewer lenders enter areas where they predominate.

To address concerns about demographic confounds, in Section IV.G we examine variation in mortgage market concentration *within a given county* induced by bank mergers that are unlikely to be related to county characteristics. That is, we examine changes in mortgage market concentration in counties that are essentially an unintended consequence of a bank merger. Our results continue to hold when we restrict our attention to this merger-related variation in mortgage market concentration. Assuming that county characteristics are not simultaneously changing, this suggests that we are indeed isolating the effect of market power.

[24] A growing literature, including Goldberg and Hellerstein (2008, 2013), Hellerstein (2006), Nakamura and Zerom (2010), has used structural models to study the pass-through of changes in exchange rates to local prices. These studies are interested in decomposing in full all sources of incomplete pass-through, and therefore require structural models. In contrast, we are interested in simply identifying that market power is an important source of incomplete pass-through, so a reduced form approach is adequate (Goldberg and Knetter, 1997).

F. Addressing Endogeneity Concerns: Matched Samples

In this section, we try to address the endogeneity concerns discussed above by employing a propensity score matching procedure to ensure that we are comparing counties that are very similar along observable dimensions. We start with the HMDA data. For each year, we estimate the probability that a county has high concentration (above median for the year) based on observable characteristics. We then match each high-concentration county to the county with low concentration that has the most similar propensity score and run our baseline specifications in each matched sample.

The results for the HMDA sample are in Table 6 Panel A. The column headers describe the covariates used to estimate the propensity score. For instance, in the first two columns, the propensity score is estimated using county population and average wages. The second two columns estimate the propensity score using population, average wages, LTI, and loan size. The final two columns estimate the propensity score using population, average wages, LTI, loan size, and house prices. In the Internet Appendix, we show the quality of the matches along each dimension for each matched sample. While some differences remain when only matching on county population and wages, there are no statistically or economically significant differences in the other matched samples.

The results in Table 6 Panel A show that we obtain very similar results to the baseline in Table 2 when we use the matched samples. High mortgage market concentration is associated with a lower sensitivity of refinancing per capita to MBS yields, and the effect is particularly strong when MBS yields are falling.

The results for the CoreLogic sample are in Table 6 Panel B. The first two columns estimate the propensity score using county population and average wages. The second two columns estimate the propensity score using population, average wages, FICO, and LTV. The final two columns estimate the propensity score using population, average wages, FICO, LTV, and house prices. In the Internet Appendix, we show the quality of the matches along each dimension for each matched sample. As with the HMDA data sample, in the CoreLogic data some differences remain when only matching on county population and wages, but there are no statistically or economically significant differences in the other matched samples.

The results in Table 6 Panel B show that we obtain very similar results to the baseline in Table 4 when we use the matched samples. High mortgage market concentration is associated with a lower sensitivity of mortgage rates to MBS yields. The differences between high and low-concentration counties are largest at times when MBS yields are falling, consistent with Proposition 3 in the model.

G. Addressing Endogeneity Concerns: Bank Mergers

Our second attempt to address endogeneity concerns uses bank mergers to create variation in mortgage market concentration that is plausibly unrelated to county characteristics. Using the FDIC's *Summary of Deposits* to identify the county-level locations of bank operations, we construct a sample of counties affected by bank mergers, where the counties in the sample were not the key motivation for the merger.[25] Specifically, we focus on counties where each bank involved in a merger makes up more than 15% of the total deposits in the county, but the county itself makes up no more than 2% of each bank's total deposits. [26] The idea is to isolate counties where the banks involved in the merger each have a relatively large market share as measured by the fraction of the total deposits in the county. This means that the merger is likely to have an effect on mortgage market concentration. However, we also require that the county is not a large part of the bank's total business; the county must contain only a small fraction of the bank's total deposits. This helps to ensure that the characteristics of the county were not a key driver of the merger. Garmaise and Moskowitz (2006) use a similar approach to study the effects of credit availability on crime.[27] Within the sample, we examine how the sensitivity of refinancing and mortgage rates to MBS yields changes after the merger takes place.

There are 562 mergers that meet the criteria for inclusion in our sample. The average merger involves banks totaling $1.7 billion in deposits with branches in 20 counties. The average merger involves banks in two states and median merger involves banks in three states.

[25] We must measure the impact of bank mergers using deposits, not mortgage loans, because we cannot link bank identifiers to HMDA identifiers. HMDA provides links to bank identifiers consistently starting in 2010. Prior to 2010, in our data the only years HMDA can be linked to bank identifiers are 2004-2006, too short a timespan for our analysis.
[26] The cutoffs capture 25% of bank-counties along each dimension. Specifically, 25% of bank shares of total county deposit are above 15%, and 25% of county shares of total bank deposits are below 2%.
[27] Dafny, Duggan, and Ramanarayanan (2012) take a somewhat similar approach in studying the effects of health insurer mergers.

Table 7 present the results. In the first column, we examine the effect of mergers on concentration:

$$Top\ 4_{i,t} = \alpha_t + \beta \cdot Post\ Merger_{i,t} + \varepsilon_{i,t}.$$

The specification includes county and time fixed effects. Thus, the coefficient on the post-merger indicator is not driven by trends in concentration over time, or by the tendency for mergers to occur in concentrated counties. The coefficient is identified off variation within a given county after a merger relative to the experience of other counties that did not experience mergers at the same time. The results show that each merger is associated with an increase in mortgage market concentration of 1.4%.[28] To the extent that we think of mergers as an instrument in this context, the instrument is relevant. Note that while the effect is statistically significant, it is small relative to the total variation we observe in concentration in the full sample. However, the first stage F-statistic is 13.4, well above the minimum value of 10 recommended by Staiger and Stock (1997).

We then use mergers as an instrument for concentration. Specifically, we run an instrumental variables regression where $Top\ 4_{i,t}$ and $\Delta MBS\ Yield_t \times Top\ 4_{i,t}$ are instrumented for using the post-merger indicator and the post-merger indicator interacted with the change in MBS yields. Only counties that experience a merger that meets the criteria discussed above are in the sample.

The results show that the sensitivity of the quantity of refinancing to MBS yields decreases with top 4 concentration when instrumented by the post-merger indicator. The sensitivity of refinancing to MBS yields decreases after a merger at the same time that mortgage market concentration is increasing. Table 7 also shows the reduced form for the results, which makes the interpretation clearer. The results show that the sensitivity of the quantity of refinancing to MBS yields drops after a merger. Since the specification contains county fixed effects, the results show that the sensitivity of refinancing to MBS yields decreases *within a given county* after a merger that increases mortgage market concentration in that county.

[28] The first stage effect is relatively small because we are selecting mergers based on deposit concentration but then looking at the effects on mortgage lending concentration. When we examine the effect of the same mergers on deposit concentration, we find larger effects. In untabulated results, we also find that we obtain similar results doing full IV analysis measuring concentration in terms of deposits.

Note that the magnitudes of the coefficients are larger here than in Tables 2 and 4. The reason is that instrumenting substantially reduces the amount of variation in concentration. As the reduced form makes clear, for each county we are simply comparing the sensitivity to MBS yields before and after the merger.. However, the economic magnitudes are similar to those in our earlier results. A 100 bps decrease in MBS yields is associated with a 0.74% increase in refinancing in the average county but only a 0.37% increase in a county with concentration one standard deviation above the mean. Thus, there is a 50% smaller increase in refinancing in the high-concentration county.

The remaining columns of Table 7 show the analogous results for changes in mortgage rates. The results show that the sensitivity of mortgage rates to MBS yields decreases with top 4 concentration when instrumented by the post-merger indicator. Again, the reduced form helps make the interpretation clearer. The sensitivity of mortgage rates to MBS yields decreases *within a given county* after a merger that increases concentration in that county.

Does our bank merger instrument satisfy the exclusion restriction? The exclusion restriction in this case is that bank mergers affect the sensitivity of refinancing and mortgage rates to MBS yields within a county only through their effect on market concentration in that county. Of course, bank mergers are not random. However, for the exclusion restriction to be violated, it would have to be the case that bank mergers are anticipating changing county characteristics that explain our results. For instance, if the alternative is that our results reflect high mortgage market concentration in counties with unsophisticated borrowers, bank mergers would have to anticipate declining sophistication within a county. This seems unlikely. Moreover, in the Internet Appendix, we show that observable characteristics do not change within a county after the merger. The table also shows characteristics of the counties in the merger samples relative to those excluded. Counties in the first sample are somewhat larger than average, but counties in the second sample are similar to the average county in our full sample.

H. Corroborating Evidence

Finally, we examine non-mortgage data for corroborating evidence of the mechanism. We first analyze the behavior of bank fees and interest income on real estate loans, which is obtained from the Call Reports. If market power in mortgage lending were really driving our results, one might expect that the revenues of lenders would be less sensitive to mortgage rates in high-concentration areas. Lenders in such areas, facing little competition, would have little incentive to offer lower rates when MBS yields fall and thus would be able to keep their revenues high.

To examine this prediction, we restrict the sample to banks completely located in one county, according to the FDIC's *Summary of Deposits*. This ensures that we are picking up variation in local, county-level conditions. The first two columns of Table 8 show the results. A 100 bps decrease in MBS yields is associated with a 5.9% decrease in fee and interest income on real estate loans. However, this effect is mitigated in higher-concentration counties.

Next we examine employment in real estate credit, which we obtain from the Bureau of Labor Statistics *Quarterly Census of Employment and Wages*. If the mechanism highlighted in the model in Section III is really driving our results, lenders in high concentration areas should be less willing to add capacity when mortgage rates fall. Lenders in such areas, facing little competition, would have little incentive to increase their staff in response to increased demand. They could instead raise prices, decreasing the quantity of refinancing demand until it could be met with existing capacity. The last two columns of Table 8 show the results. Decreases in MBS yields are associated with increases in real estate credit employment, but again this effect is mitigated in higher-concentration counties.

VI. Conclusion

We present evidence that high concentration in local mortgage lending reduces the sensitivity of mortgage rates and refinancing activity to MBS yields. A decrease in MBS yields is typically associated with greater refinancing activity and lower rates on new mortgages. However, this effect is dampened in counties with concentrated mortgage markets. Our estimates suggest that the impact of a 100 bps decrease in MBS yields is only half as large in a county with mortgage market concentration one standard deviation above the mean as it is in a county with average concentration.

We isolate the direct effect of mortgage market concentration and rule out alternative explanations based on borrower, loan, and collateral characteristics in two ways. First, we use a matching procedure to compare high- and low-concentration counties that are very similar on observable characteristics and find similar results. Second, we examine counties where concentration in mortgage lending is increased by bank mergers. We show that within a given county sensitivities to MBS yields decrease after a concentration-increasing merger. Finally, we provide corroborating evidence based on banks' interest and fee income on real estate loans and employment in real estate credit that is consistent with the idea that we are isolating the effect of mortgage concentration.

Our results suggest that the effectiveness of housing as a monetary policy transmission channel varies in both the time series and the cross section. Our baseline estimates suggest that the impact on local housing markets of the fall in MBS yields induced by a monetary easing varies substantially across counties. Moreover, given that the average county-level mortgage market concentration has risen over time, the impact of monetary policy on housing may have fallen substantially on average.

Appendix

Proof of Proposition 1. If we are below $\bar{q}$, each firm has first order condition

$$0 = a - bQ - bq - r.$$

In a symmetric equilibrium, we have $Q = Nq$ which implies that

$$q^*_{low} = \frac{a-r}{b(N+1)}.$$

When we are above $\bar{q}$, the first order condition is

$$0 = a - bQ - bq - r - cq.$$

In a symmetric equilibrium, this implies that

$$q^*_{high} = \frac{a-r}{b(N+1)+c}.$$

To find the bounds on *r*, we can plug in to find the values of *r* that yield $\bar{q}$ in each of these expressions:

$$\bar{q} = q^*_{low} = \frac{a-\bar{r}}{b(N+1)} \quad \text{and}$$

$$\bar{q} = q^*_{high} = \frac{a-\underline{r}}{b(N+1)+c}.$$

Proof of Proposition 2. Differentiating gives the pass-through result:

$$\frac{\partial Q^*_{low}}{\partial r} = \frac{-N}{b(N+1)} < 0, \quad \frac{\partial Q^*_{high}}{\partial r} = \frac{-N}{b(N+1)+c} < 0.$$

Differentiating with respect to *N* gives the change with the number of lenders

$$\frac{\partial^2 Q^*_{low}}{\partial r \partial N} = \frac{-1}{b(N+1)^2} < 0, \quad \frac{\partial^2 Q^*_{high}}{\partial r \partial N} = \frac{-(b+c)}{\left(b(N+1)+c\right)^2} < 0$$

Proof of Proposition 3. We want to find conditions under which $\frac{\partial^2 Q^*_{high}}{\partial r \partial N} < \frac{\partial^2 Q^*_{low}}{\partial r \partial N}$. Plugging in the values for these cross-partials from above, we have

$$\frac{-(b+c)}{\left(b(N+1)+c\right)^2} < \frac{-1}{b(N+1)^2}.$$

Rearranging, we have $b(N^2-1) > c$.

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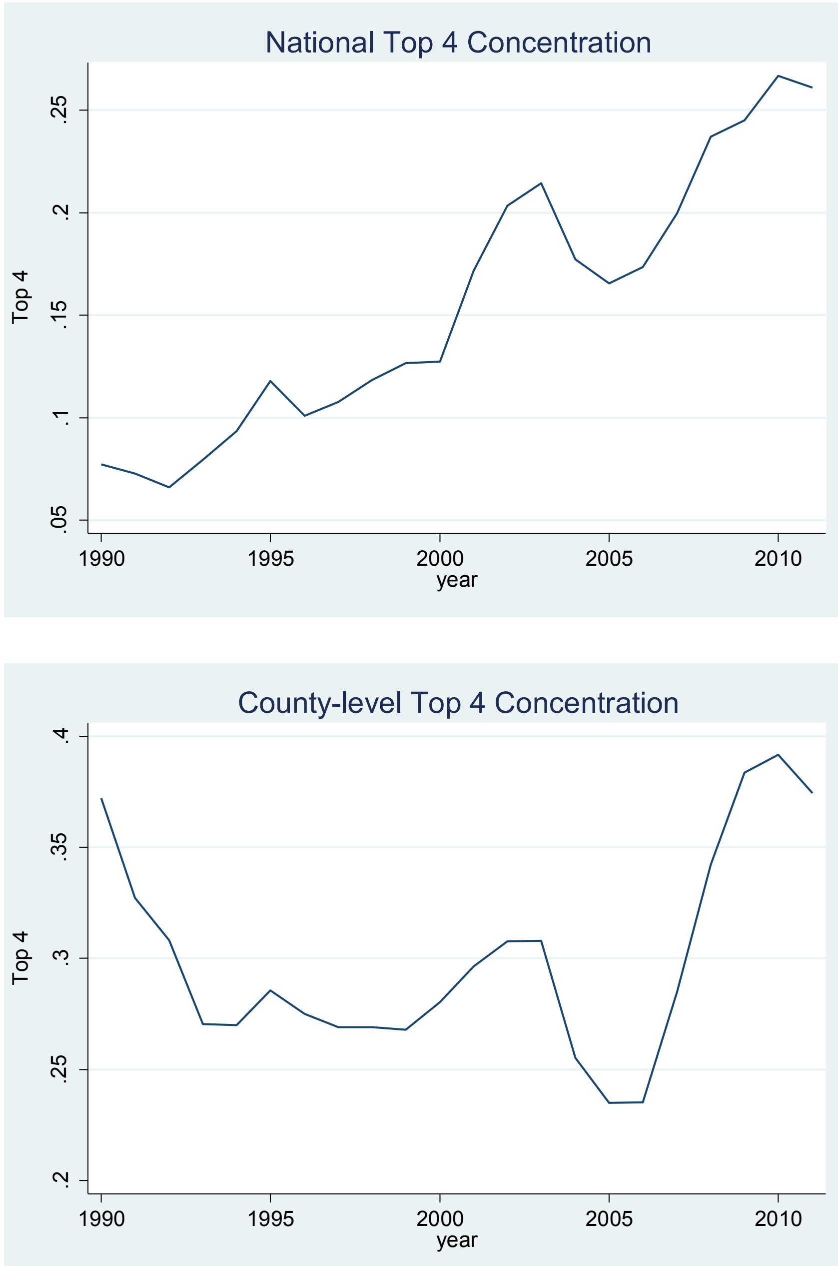


Figure 1
Mortgage Market Concentration in HMDA

This figure shows top 4 mortgage market share at the national level (top) and the value-weighted average of county-level top 4 share (bottom) in data from the Home Mortgage Disclosure Act.

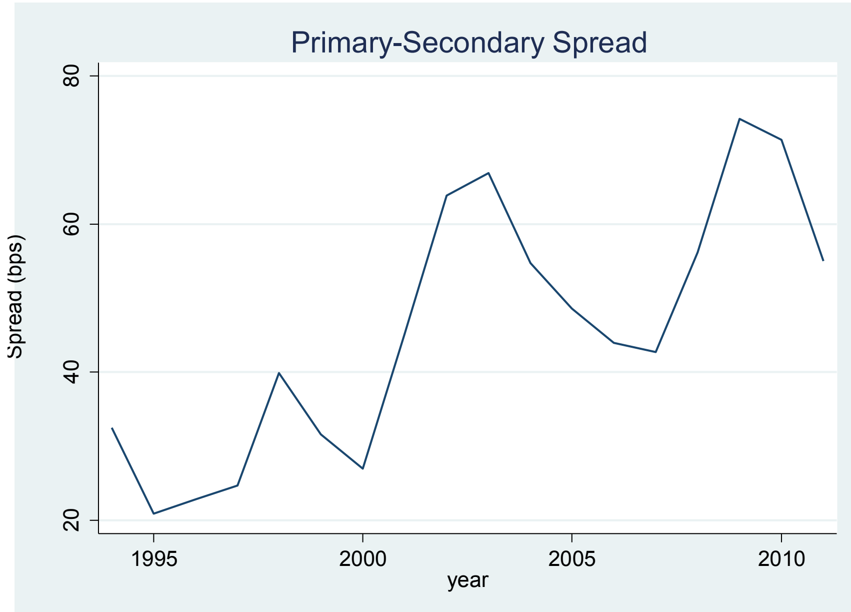
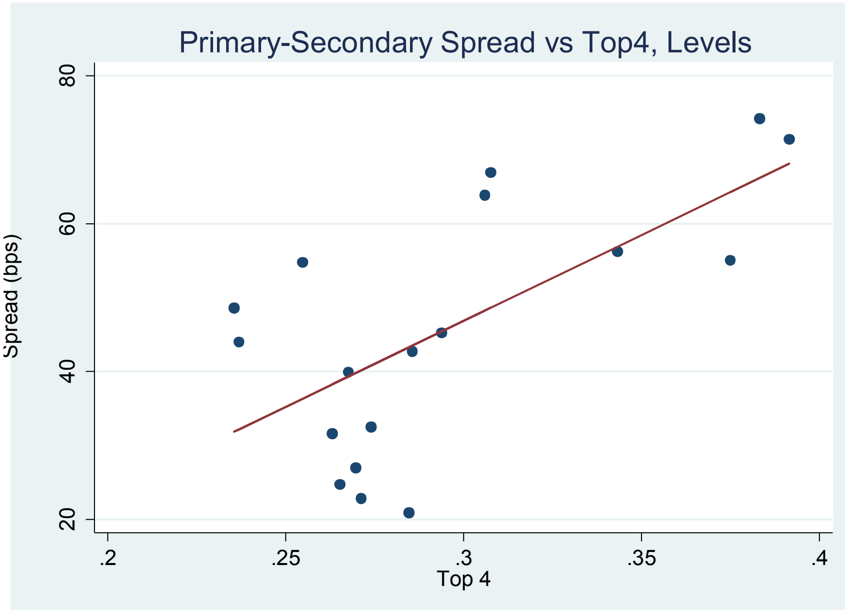


Figure 2
Primary-Secondary Spread

This figure shows the average rate charged to borrowers whose mortgages are guaranteed by Freddie Mac minus the yield on current coupon Freddie Mac MBS minus Freddie Mac's average fee for guaranteed mortgages.



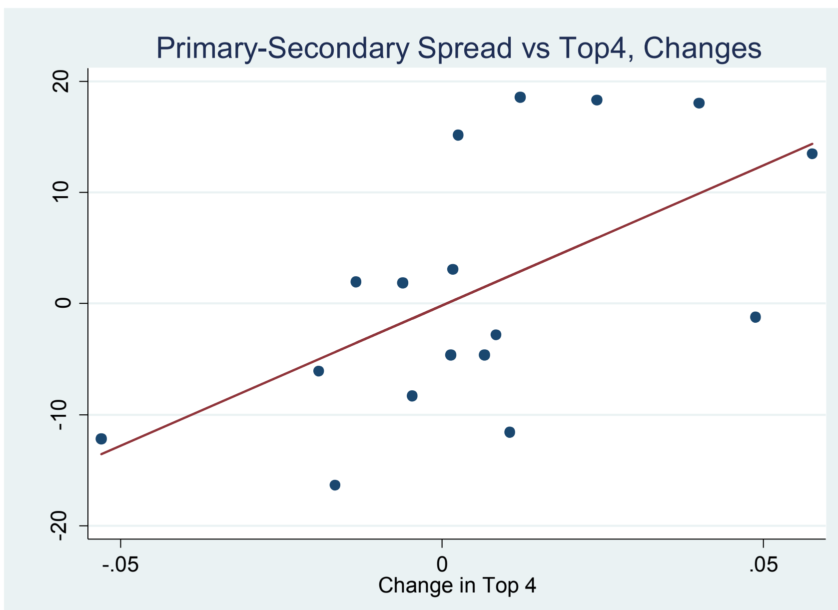


Figure 3
Primary-Secondary Spread vs. Market Concentration in Levels and Changes

This figure plots the relationship between primary-secondary spread and the value-weight average of county-level top 4 mortgage market share. The top figure shows the relationship in levels and the bottom shows it in changes.

Table 1
Summary Statistics

This table presents summary statistics for the two samples used in the paper. Panel A presents summary statistics for the HMDA data, which runs annually from 1990-2011. The unit of observation is county-year. Refi/Population is the number of refinancings in a given county-year in HMDA divided by the population of that county in that year obtained from the Census. ΔRefi/Pop is the change in this ratio within the county from year t to year t+1. ln(Wage) is the log average weekly wage in the county-year from the BLS's Quarterly Census of Employment and Wages. ln(Population) is the log population from the Census. ln(LoanSize) is the log loan size in HMDA in thousands. ln(Price) is the log average price in the county from Zillow. LTI is the loan-to-income ratio calculated for borrowers in HMDA. Top 4 is the share of the top 4 mortgage originators in each county in HMDA. ΔMBS Yield is the change in the current-coupon Fannie Mae 30-year FRM MBS yield from year t to year t+1 from Bloomberg. Panel B presents summary statistics for the CoreLogic data, which runs quarterly from 2000-2011.The unit of observation is county-quarter, and averages across all prime, conforming, fixed rate, full documentation loan in CoreLogic with FICO > 620 and LTV between 50 and 101. The sample is restricted to county-quarters with at least five such loans. Rate is the average mortgage rate reported, FICO is the credit score, and LTV is the loan-to-value ratio. ln(Price) is the log average price in the county from Zillow. Top 4 is the share of the top 4 mortgage originators in each county in HMDA. ΔMBS Yield is the change in the current-coupon Fannie Mae 30-year FRM MBS yield from quarter t to quarter t+1 from Bloomberg. ΔRate is the change in average mortgage rate from quarter t to quarter t+1.

	Panel A: HMDA Sample				
	N	Mean	Std Dev	Min	Max
Refi/Population	62036	0.012	0.012	0.000	0.191
ln(Wage)	62036	6.263	0.271	5.231	8.370
ln(Population)	62036	10.322	1.378	4.949	16.107
ln(LoanSize)	62036	4.438	0.499	0.693	9.546
ln(Price)	8071	11.914	0.508	9.425	13.721
LTI	62036	1.642	0.483	0.549	3.394
Top 4	62036	0.508	0.214	0.118	1.000
ΔMBS Yield	62036	-0.270	0.661	-1.315	1.101
ΔRefi/Pop	62036	0.000	0.008	-0.111	0.184

	Panel B: CoreLogic Sample				
	N	Mean	Std Dev	Min	Max
Rate	25850	6.095	0.902	3.981	8.982
FICO	25850	703.255	20.967	620.667	787.277
LTV	25850	86.505	6.692	50.570	100.290
ln(Price)	17377	12.050	0.473	9.488	13.621
Top 4	25850	0.309	0.088	0.132	0.790
ΔMBS Yield	25850	-0.086	0.382	-1.380	0.768
ΔRate	25850	-0.084	0.314	-2.108	2.100

Table 2
Refinancing and Concentration

This table presents regressions of the form:

$$\Delta\left(\frac{Refi}{Pop}\right)_{i,t} = \alpha + \beta_1 \cdot \Delta MBS\ Yield_t + \beta_2 \cdot Top\ 4_{i,t-1} + \beta_3 \cdot \Delta MBS\ Yield_t \times Top\ 4_{i,t-1} + \varepsilon_{i,t}.$$

The county-level sample runs annually 1990-2011. Refi/Pop is the number of refinancings divided by the population; Top 4 is the share of the top 4 mortgage originators; ΔMBS Yield is the change in the Fannie Mae 30-year FRM MBS yield; $(\Delta MBS\ Yield)^+$ is the maximum of the change in MBS yields and zero; $(\Delta MBS\ Yield)^-$ is the minimum of the change in MBS yields and zero; ln(Wage) is the log average weekly wage; ln(Population) is the log population; ln(LoanSize) is the log loan size in thousands; ln(Price) is the log average price; LTI is the loan-to-income ratio in HMDA. In Panel A the second column reports the specification for the full sample, while the third column restricts the sample to the years before the financial crisis, 1990-2006. Panel B reports specifications with a variety of additional controls. In Panel B, the levels and differences of the controls are suppressed for compactness, but included in the regressions. The third column of Panel B restricts the sample to counties in an MSA. Standard errors are clustered by county and year, and t-statistics are reported in the brackets.

	Panel A: Basic Results						
Δ MBS Yield$_t$	-0.015						
	[-5.38]						
Δ MBS Yield$_t$ x Top4$_{i,t-1}$	**0.016**	**0.018**	**0.019**				
	[5.19]	**[9.33]**	**[10.18]**				
$(\Delta$ MBS Yield$)^+$ x Top4$_{i,t-1}$				**0.013**	**0.013**	**0.013**	0.008
				[3.78]	**[3.88]**	**[3.82]**	[0.74]
$(\Delta$ MBS Yield$)^-$ x Top4$_{i,t-1}$				**0.021**	**0.021**	**0.021**	**0.029**
				[5.79]	**[5.91]**	**[5.89]**	**[2.51]**
Top 4$_{i,t-1}$	0.004	0.002	0.002	0.005	0.005	0.005	0.01
	[1.50]	[0.64]	[0.39]	[1.33]	[1.35]	[1.36]	[1.65]
Δ ln(Wage$_{i,t}$)					0.001	0.001	-0.007
					[0.63]	[0.65]	[-1.27]
Δ ln(Population$_{i,t}$)					0.018	0.019	0.102
					[2.39]	[2.38]	[2.27]
Δ ln(LoanSize$_{i,t}$)						0.000	-0.005
						[-1.03]	[-1.08]
Δ LTI$_{i,t}$						0.000	0.002
						[1.47]	[1.14]
Δ ln(Price$_{i,t}$)							0.013
							[2.80]
R^2	0.357	0.537	0.547	0.539	0.544	0.544	0.777
N	62036	62036	46424	62036	62017	61725	7543
County FE	N	Y	Y	Y	Y	Y	Y
Year FE	N	Y	Y	Y	Y	Y	Y

	Panel B: Additional Controls		
Top 4_{t-1}	0.001	0.001	0.001
	[0.27]	[0.21]	[0.21]
Δ MBS $Yield_t$ x $Top4_{t-1}$	**0.017**	**0.012**	**0.012**
	[2.98]	**[2.60]**	**[2.30]**
Δ MBS $Yield_t$	0.002	0.001	0.001
x ln(Population $_{t-1}$)	[4.06]	[3.41]	[3.14]
Δ MBS $Yield_t$	0. 000	0.003	0.002
x ln($Wage_{t-1}$)	[-0.18]	[1.56]	[1.22]
Δ MBS $Yield_t$	-0.011	-0.006	-0.005
x ln($Price_{t-1}$)	[-3.23]	[-2.50]	[-2.09]
Δ MBS $Yield_t$	0.003	-0.003	-0.004
x DTI_{t-1}	[1.96]	[-1.62]	[-1.57]
Δ MBS $Yield_t$	-0.004	0.002	0.002
x ln(LoanSize $_{t-1}$)	[-1.42]	[0.72]	[0.62]
Δ MBS $Yield_t$		0.000	0.000
x % Over 65		[-1.19]	[-0.45]
Δ MBS $Yield_t$		-0.001	-0.001
x % Under 18		[-3.31]	[-3.05]
Δ MBS $Yield_t$		0.000	0.000
x % White		[-4.34]	[-4.17]
Δ MBS $Yield_t$		0.000	0.000
x % College		[-3.81]	[-3.59]
R^2	0.819	0.839	0.845
N	7543	7543	6520
County FE	Y	Y	Y
Year FE	Y	Y	Y

Table 3
Lender Breakdown

This table examines the behavior of different types of lenders. It presents regressions of the form:

$$\Delta\left(\frac{Refi}{Pop}\right)_{i,t} = \alpha + \beta_1 \cdot \Delta MBS\ Yield_t + \beta_2 \cdot Top\ 4_{i,t-1} + \beta_3 \cdot \Delta MBS\ Yield_t \times Top\ 4_{i,t-1} + \varepsilon_{i,t},$$

restricting the sample to lenders that operate in the number of counties shown in the column heading. For instance, the first column examines refinancing mortgages originated by lenders that operate in less than two counties. In each column we rescale by the national market share of the type of lender we are focusing on. The county-level sample runs annually 1994-2011. Refi/Pop is the number of refinancings divided by the population; Top 4 is the share of the top 4 mortgage originators; ΔMBS Yield is the change in the Fannie Mae 30-year FRM MBS yield. Standard errors are clustered by county and year, and t-statistics are reported in the brackets.

	< 2	≥ 2	< 5	≥ 5	< 10	≥ 10	< 50	≥ 50
Δ MBS Yield $_t$ x	**0.018**	**0.018**	**0.021**	**0.018**	**0.020**	**0.017**	**0.015**	**0.018**
Top4 $_{i,t-1}$	**[6.75]**	**[9.33]**	**[9.42]**	**[9.23]**	**[7.78]**	**[9.22]**	**[6.36]**	**[9.11]**
Top4 $_{i,t-1}$	0.001	0.002	0.001	0.002	-0.001	0.003	-0.003	0.004
	[0.21]	[0.63]	[0.22]	[0.63]	[-0.12]	[0.68]	[-0.46]	[0.98]
R^2	0.047	0.537	0.027	0.531	0.021	0.522	0.196	0.508
N	62036	62036	62036	62036	62036	62036	62036	62036
County FE	Y	Y	Y	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y	Y	Y

Table 4
Mortgage Rates and Concentration

This table presents regressions of the form:

$$\Delta Rate_{i,t} = \alpha + \beta_1 \cdot \Delta MBS\ Yield_t + \beta_2 \cdot Top\ 4_{i,t} + \beta_3 \cdot \Delta MBS\ Yield_t \times Top\ 4_{i,t} + \varepsilon_{i,t}.$$

The county-level sample runs quarterly 2000-2011. Top 4 is the share of the top 4 mortgage originators; ΔMBS Yield is the change in the Fannie Mae 30-year FRM MBS yield; $(\Delta\text{MBS Yield})^+$ is the maximum of the change in MBS yields and zero; $(\Delta\text{MBS Yield})^-$ is the minimum of the change in MBS yields and zero; ln(Wage) is the log average weekly wage; ln(Population) is the log population; Rate is the average mortgage rate reported in CoreLogic, FICO is the credit score, and LTV is the loan-to-value ratio; ln(Price) is the log average price. In Panel A, the third column reports the specification for the full sample, while the fourth column restricts the sample to the years before the financial crisis, 2000-2006. In Panel B, the levels and differences of the controls are suppressed for compactness, but included in the regressions. The third column of Panel B restricts the sample to counties in an MSA. Standard errors are clustered by county and quarter, and t-statistics are reported in the brackets.

	Panel A: Baseline Results					
Δ MBS Yield $_t$	0.877	0.83			0.818	0.879
	[13.52]	[16.59]			[16.49]	[15.01]
Δ MBS Yield $_t$ x Top4$_{i,t-1}$	**-0.497**	**-0.346**			**-0.336**	**-0.553**
	[-3.64]	**[-3.05]**			**[-2.92]**	**[-3.60]**
$(\Delta\text{ MBS Yield})^+$			0.672	0.423		
			[5.86]	[1.82]		
$(\Delta\text{ MBS Yield})^-$			0.928	1.094		
			[7.82]	[11.25]		
$(\Delta\text{ MBS Yield})^+$ x Top4$_{i,t-1}$			0.113	0.497		
			[0.40]	[0.85]		
$(\Delta\text{ MBS Yield})^-$ x Top4$_{i,t-1}$			**-0.631**	**-0.347**		
			[-2.76]	**[-2.08]**		
Top 4$_{i,t-1}$	-0.15	0.005	-0.101	-0.094	0.003	-0.046
	[-2.41]	[0.24]	[-1.45]	[-1.68]	[0.14]	[-1.11]
Δ LTV$_{i,t}$					0.004	0.004
					[2.40]	[2.23]
Δ FICO$_{i,t}$					-0.002	-0.002
					[-6.47]	[-5.82]
Δ ln(Price$_{i,t}$)						-0.071
						[-0.87]
R^2	0.774	0.779	0.78	0.691	0.789	0.808
N	25850	25850	25850	15134	25850	17357
County FE	N	Y	Y	Y	Y	Y
Year FE	N	Y	Y	Y	Y	Y

	Panel B: Additional Controls		
Δ MBS Yield $_t$	4.073	4.797	4.766
	[5.62]	[5.42]	[5.37]
Top 4_{t-1}	-0.022	-0.022	-0.023
	[-0.74]	[-0.76]	[-0.72]
Δ MBS Yield $_t$ x Top4 $_{t-1}$	**-0.364**	**-0.312**	**-0.322**
	[-3.81]	**[-3.26]**	**[-3.34]**
Δ MBS Yield $_t$	-0.013	-0.009	-0.008
x ln(Population $_{t-1}$)	[-2.27]	[-1.57]	[-1.32]
Δ MBS Yield $_t$	-0.077	-0.16	-0.159
x ln(Wage $_{t-1}$)	[-2.07]	[-2.54]	[-2.47]
Δ MBS Yield $_t$	-0.072	-0.079	-0.082
x ln(Price $_{t-1}$)	[-3.50]	[-3.69]	[-3.75]
Δ MBS Yield $_t$	-0.012	-0.011	-0.011
x LTV $_{t-1}$	[-4.67]	[-4.27]	[-4.26]
Δ MBS Yield $_t$	-0.001	-0.001	-0.001
x FICO $_{t-1}$	[-1.75]	[-2.02]	[-1.85]
Δ MBS Yield $_t$		-0.002	-0.002
x % Over 65		[-1.16]	[-1.05]
Δ MBS Yield $_t$		-0.004	-0.003
x % Under 18		[-2.59]	[-2.29]
Δ MBS Yield $_t$		0.000	0.000
x % White		[1.26]	[1.11]
Δ MBS Yield $_t$		0.003	0.003
x % College		[2.41]	[2.30]
R^2	0.816	0.817	0.825
N	17357	17357	16388
County FE	Y	Y	Y
Year FE	Y	Y	Y

Table 5
Refinancing and Mortgage Rates

This table presents regressions of the form:

$$\Delta\left(\frac{Refi}{Pop}\right)_{i,t} = \alpha + \beta \cdot \Delta Mortgage\ Rate_{i,t} + \varepsilon_{i,t}$$

The county-level sample runs annually 2000-2011. Refi/Pop is the number of refinancings divided by the population; Top 4 is the share of the top 4 mortgage originators; ΔMBS Yield is the change in the Fannie Mae 30-year FRM MBS yield; ln(Wage) is the log average weekly wage; ln(Population) is the log population; ln(LoanSize) is the log loan size in thousands; ln(Price) is the log average price; LTI is the loan-to-income ratio in HMDA. Levels and differences of the controls are suppressed for compactness, but included in the regressions. The last column restricts the sample to counties in an MSA. Standard errors are clustered by county and year, and t-statistics are reported in the brackets.

Δ Mortgage Rate $_{i,t}$	**-0.019**	**-0.007**	**-0.003**	**-0.003**	**-0.004**
	[-2.84]	**[-1.85]**	**[-1.73]**	**[-2.04]**	**[-2.06]**
Δ MBS Yield $_t$			0.001	0.001	0.001
x ln(Population $_{t-1}$)			[2.79]	[3.48]	[3.17]
Δ MBS Yield $_t$			-0.001	0.003	0.004
x ln(Wage $_{t-1}$)			[-0.44]	[1.46]	[1.70]
Δ MBS Yield $_t$			0.006	-0.002	-0.003
x DTI $_{t-1}$			[2.15]	[-1.46]	[-1.33]
Δ MBS Yield $_t$			-0.004	0.003	0.002
x ln(LoanSize $_{t-1}$)			[-1.26]	[0.77]	[0.48]
Δ MBS Yield $_t$			0.000	0.000	0.000
x LTV $_{t-1}$			[-1.35]	[0.01]	[-0.02]
Δ MBS Yield $_t$			0.000	0.000	0.000
x FICO $_{t-1}$			[-1.04]	[1.21]	[1.09]
Δ MBS Yield $_t$			-0.013	-0.008	-0.006
x % Over 65			[-3.02]	[-2.50]	[-2.16]
Δ MBS Yield $_t$				0.000	0.000
x % Under 18				[-0.97]	[-0.31]
Δ MBS Yield $_t$				-0.001	-0.001
x % White				[-2.78]	[-2.62]
Δ MBS Yield $_t$				0.000	0.000
x % College				[-3.31]	[-3.16]
Δ MBS Yield $_t$				0.000	-0.001
x % Over 65				[-2.76]	[-2.62]
R^2	0.4	0.753	0.814	0.835	0.841
N	5656	5656	5656	5656	4871
County FE	N	Y	Y	Y	Y
Year FE	N	Y	Y	Y	Y

Table 6
Matched Samples

This table presents results for matched samples. The column headings report the variables that we use to estimate the propensity score. In Panel A, we present results for the quantity of refinancings in the HMDA sample, county-level annual data 1990-2011. The dependent variable is ΔRefi/Pop and is the change in the number of refinancings divided by the population. Standard errors are clustered by county and year, and t-statistics are reported in the brackets. In Panel B, we present results for mortgage rates in the CoreLogic sample, quarterly data 2000-2011. The dependent variable is ΔRate. Top 4 is the share of the top 4 mortgage originators; ΔMBS Yield is the change in the Fannie Mae 30-year FRM MBS yield. Standard errors are clustered by county and quarter, and t-statistics are reported in the brackets.

	Panel A: HMDA Sample					
	Wage, Pop		Wage, Pop, LTI, Loan Size		Wage, Pop, LTI, Size, Price	
Δ MBS Yield $_t$ x Top 4	**0.012**		**0.011**		**0.024**	
	[7.55]		**[7.53]**		**[3.26]**	
$(\Delta$ MBS Yield$)^+$ x Top4		**0.007**		**0.008**		**0.004**
		[2.19]		**[2.17]**		**[0.32]**
$(\Delta$ MBS Yield$)^-$ x Top4		**0.015**		**0.012**		**0.032**
		[5.26]		**[5.29]**		**[2.56]**
Top 4_{t-1}	0.002	0.004	0.002	0.003	0.006	0.012
	[1.29]	[1.85]	[1.38]	[1.67]	[1.29]	[1.59]
R^2	0.479	0.481	0.476	0.477	0.768	0.768
N	43180	43180	42236	42236	5687	5687
Year FE	Y	Y	Y	Y	Y	Y

	Panel B: CoreLogic Sample					
	Wage, Pop		Wage, Pop, FICO, LTV		Wage, Pop, FICO, LTV, Price	
Δ MBS Yield $_t$	0.82		0.823		0.903	
	[16.00]		[15.60]		[13.17]	
Δ MBS Yield $_t$ x Top 4	**-0.281**		**-0.293**		**-0.561**	
	[-2.60]		**[-2.67]**		**[-3.38]**	
$(\Delta \text{ MBS Yield})^+$		0.709		0.714		0.733
		[5.71]		[5.81]		[4.66]
$(\Delta \text{ MBS Yield})^-$		0.886		0.887		1.004
		[7.81]		[7.62]		[6.37]
$(\Delta \text{ MBS Yield})^+$ x Top4		0.019		0.006		-0.09
		[0.07]		[0.02]		[-0.22]
$(\Delta \text{ MBS Yield})^-$ x Top4		**-0.461**		**-0.473**		**-0.851**
		[-2.22]		**[-2.20]**		**[-2.37]**
Top 4_{t-1}	-0.009	-0.076	-0.016	-0.083	0.002	-0.105
	[-0.31]	[-1.19]	[-0.61]	[-1.35]	[0.05]	[-1.08]
R^2	0.754	0.754	0.758	0.758	0.783	0.783
N	19657	19657	19657	19657	12470	12470
Year FE	Y	Y	Y	Y	Y	Y

Table 7
Merger Sample

This table reports results where we use bank mergers as an instrument for concentration. We examine bank mergers where the bank makes up a large fraction (>15%) of deposits in a county, but the county is only a small fraction (<2%) of the bank's deposit base. We examine the effect of the merger on the county's mortgage market concentration in the first column. The columns labeled IV instrument for Top 4 and Δ MBS Yield $_t$ x Top4 $_{t-1}$ using Post Merger and Δ MBS Yield $_t$ x Post Merger. The column headings show the dependent variable. Top 4 is the share of the top 4 mortgage originators; ΔMBS Yield is the change in the Fannie Mae 30-year FRM MBS yield. The columns with refinancings as the dependent variable are run yearly 1990-2011, and standard errors are clustered by county and year with t-statistics reported in brackets. The columns with rates as the dependent variable are run quarterly 2000-2011, and standard errors are clustered by county and quarter with t-statistics reported in brackets.

	First Stage	Δ(Refi/Pop)		ΔRate	
		IV	Reduced Form	IV	Reduced Form
Post Merger$_{i,t}$	**0.014**		0.000		-0.011
	[3.61]		[0.74]		[-0.77]
Δ MBS Yield $_t$				1.834	0.837
				[3.44]	[14.39]
Δ MBS Yield $_t$ x Top4 $_{t-1}$		**0.145**		**-3.527**	
		[4.73]		**[-2.06]**	
Δ MBS Yield $_t$ X Post Merger$_{i,t}$			**0.003**		**-0.124**
			[3.25]		**[-2.16]**
Top 4$_{t-1}$		0.054		0.867	
		[1.38]		[0.19]	
R^2	0.8	0.8	0.556	0.66	0.779
N	32069	32069	32069	18324	18324
County FE	Y	Y	Y	Y	Y
Year FE	Y	Y	Y	Y	Y

Table 8
Bank Profits and Real Estate Credit Employment

This table reports results on bank profits and employment. The column headings show the dependent variable. The first two columns of this table examine the relationship between concentration and loan and fee income on real estate loans for banks exclusively located in a single county. The second two columns examine the relationship between concentration and real estate credit employment. Δ ln(LoanIncome) is the change in interest and fee income from real estate loans averaged across single-county banks in each county from the Call Reports; Top 4 is the share of the top 4 mortgage originators; ΔMBS Yield is the change in the Fannie Mae 30-year FRM MBS yield; Δ ln(RE Employment) is the change in employment in real estate credit, and Δ ln(Employment) is the change in total employment. The county-level sample runs annually 1990-2011 and standard errors are clustered by county and year with t-statistics in brackets.

	$\Delta \ln(LoanIncome_{i,t})$		$\Delta \ln(RE\ Employment_{i,t})$	
Δ MBS Yield $_t$	0.019	0.004	-0.186	-0.168
	[2.84]	[0.56]	[-7.24]	[-7.23]
Δ MBS Yield $_t$ x Top4 $_{i,t-1}$	**-0.044**	**-0.037**	**0.147**	**0.213**
	[-2.92]	**[-2.05]**	**[3.02]**	**[4.40]**
$\Delta \ln(Employment_{i,t})$	0.006	0.012	1.306	0.523
	[0.07]	[0.17]	[3.44]	[2.86]
Top $4_{i,t-1}$	-0.007	0.115	-0.093	-0.169
	[-0.52]	[4.82]	[-1.23]	[-3.18]
R^2	-0.012	-0.008	0.023	0.071
N	29135	29135	13013	13013
County FE	Y	Y	Y	Y
Year FE	N	Y	N	Y