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Lender-specific mortgage supply shocks and macroeconomic performance in the United States*

Franziska Bremus[†] Thomas Krause[‡] Felix Noth[§]

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Abstract

This paper provides evidence for the propagation of idiosyncratic mortgage supply shocks to the macroeconomy. Based on micro-level data from the Home Mortgage Disclosure Act for the 1990-2016 period, our results suggest that lender-specific mortgage supply shocks affect aggregate mortgage, house price, and employment dynamics at the regional level. The larger the idiosyncratic shocks to newly issued mortgages, the stronger are mortgage, house price, and employment growth. While shocks at the level of shadow banks significantly affect mortgage and house price dynamics, too, they do not matter much for employment.

JEL-Classifications: E44, G21, R20

Keywords: Credit supply shocks, mortgage market concentration, real effects from housing markets.

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1 Motivation

Building on the concept of granularity (Gabaix, 2011), this paper investigates the role of mortgage market concentration for the propagation mechanism of micro-level mortgage supply shocks affecting aggregate mortgage, house price, and employment dynamics across U.S. regions.

US mortgage market concentration has increased substantially since the 1990s. While the top 1% of all U.S. lenders supplied around 50% of mortgages in the 1990s, they accounted for almost 80% of total mortgages in 2007 (see Figure 1).¹ Moreover, the share of total mortgage origination by less regulated non-bank lenders not only almost doubled between 2007-2015, but also increased heavily in the riskier borrower segment (Buchak et al., 2018).² Given these features of the mortgage market structure, this paper asks whether U.S. banking market concentration renders the real economy vulnerable to idiosyncratic mortgage supply shocks. The idea is that *lender-specific* shocks to mortgage origination can impact macroeconomic variables if mortgage market concentration is very high (Stanton et al., 2014). If some lenders are so large that they dominate the market, diversification effects are dampened. That way, idiosyncratic supply shocks propagate to the macroeconomic level and lead to movements in aggregate mortgage supply, house prices, and, ultimately, real economic activity.

– Insert Figure 1 about here –

We analyze the nexus of lender-specific mortgage supply shocks, house prices, and employment dynamics in U.S. regions in two steps. First, we examine if the degree of concentration in the market for newly issued mortgages is high enough for granular effects on regional variables to emerge. Technically speaking, we have to test whether mortgage lenders' size distribution follows a fat-tailed power law. Second, we investigate whether and how lender-specific mortgage supply shocks drive aggregate activity at the regional level. We further analyze whether the linkages with housing and employment dynamics differ across the bank and non-bank mortgage lenders.

Our identification strategy rests on two features. First, we extract idiosyncratic shocks to bank-level mortgage origination by exploiting loan application data from the Home Mortgage

¹Concentration in the U.S. banking sector has continued to rise after the financial crisis, e.g., due to takeovers of ailing competitors by the largest American banks. According to <https://politicsandpoverty.oxfamamerica.org/2016/01/too-big-to-fail-and-only-getting-bigger/>, while accounting for about 10% of total bank assets at the beginning of the 1990s, the biggest five American banks own nearly half of total bank assets in the United States today.

²In 2011, half of all new mortgages were issued by the three largest U.S. banks (JPMorgan Chase, Bank of America, Wells Fargo). In 2016, this share declined to about 20%. At the same time, six out of the top ten mortgage lenders were non-banks (Washington Post, February 23, 2017).

Disclosure Act (HMDA). The HMDA data allow for assigning mortgages to the region they are supplied to, such that lender-specific shocks can be precisely linked to the region they affect. Also, since financial institutions in our sample lend to multiple regions, we can follow the identification strategy by Khwaja and Mian (2008) to reduce concerns that regional demand factors plague our shock measure. We weight each lender's mortgage supply with its regional market share and aggregate at the level of U.S. Metropolitan Statistical Areas (MSA) in order to get a simple shock measure at the regional level. Second, we apply an instrumental variable approach to isolate exogenous variation in market shares with a regulatory shock that relaxed bank branch restrictions in the United States.

Our analysis yields four key findings. First, we provide evidence that the mortgage market is highly concentrated at the MSA-level. Estimations of the power-law coefficient of the regional distributions of new mortgages show that mortgage size follows a power law with a fat right tail in all MSAs. Thereby, we can show that the necessary condition for granular effects to emerge from the mortgage market is fulfilled at our level of analysis.

Second, our regression results reveal a positive and statistically significant link between idiosyncratic shocks to newly issued mortgages and house price growth. These findings are in line with previous results from the granularity-literature (Amiti and Weinstein, 2018), and confirm that credit shocks at the micro-level can translate into aggregate movements. The larger the shocks to mortgage lending at the level of lenders are, the higher is aggregate mortgage origination and house price growth. Hence, the presence of large mortgage lenders amplifies the effects of idiosyncratic mortgage supply shocks compared to less concentrated markets. In terms of magnitudes, lender-specific mortgage supply shocks account for 5 to 18% of MSA-level growth in mortgage origination and house prices, depending on the specification.

Third, we present evidence that idiosyncratic mortgage supply shocks have macroeconomic effects beyond the housing market. Supply shocks originating from large mortgage lenders are positively linked to house price growth and real economic variables like employment. Hence, the presence of large mortgage lenders and increasing concentration in the mortgage market affect macroeconomic performance.

Fourth, we show that granular effects from non-bank mortgage lenders on new mortgage and house price growth are similar to those originating from traditional deposit-taking institutions. However, idiosyncratic mortgage supply shocks from non-bank lenders play a less critical role in the real economy. They only show a weak impact on employment in U.S. regions in our

sample. One explanation is that the concentration among shadow banks is lower than among banks (see Figure 1). Also, despite the growing relative importance of the non-bank mortgage sector after the Dodd-Frank Act, non-bank mortgage lenders contributed, on average, only 34% to total annual mortgage origination over the last quarter of the last century (see Figure 2). Overall, granular effects from the non-bank mortgage sector translate to a smaller degree into macroeconomic outcomes.

At first glance, idiosyncratic shocks should not matter for aggregate outcomes in an economy with many firms and banks, like the United States. Bank-specific events, including financial innovations, fine payments, computer glitches, and unexpected managerial decisions, should not have any far-reaching power beyond the micro-level.³ If firm sizes follow a normal distribution, the law of large numbers will smooth out the impact of idiosyncratic shocks, ultimately showing negligible effects on aggregate variables. However, if markets are highly concentrated, as they are in manufacturing (Di Giovanni et al., 2011) and especially in banking (Bremus et al., 2018), such diversification effects are dampened. Gabaix (2011) demonstrates, both theoretically and empirically, that a fat-tailed power-law distribution of firm sizes implies a significant role of idiosyncratic, firm-level shocks for aggregate volatility. Intuitively, idiosyncratic fluctuations in Nokia’s sales cannot be easily counteracted by other firms, exposing Finland’s economic activity to the fates of one big market player. Gabaix (2011) labels this phenomenon as “Granularity” and presents evidence that firm-specific shocks hitting the largest manufacturing firms in the United States explain one-third of aggregate output fluctuations.

Existing literature emphasizes that credit supply dynamics are the key in understanding the housing boom before the Great Recession (Justiniano et al., 2019). Furthermore, *common* mortgage supply shocks explain a significant portion of house price movements (Favara and Imbs, 2015) and of employment (Di Maggio and Kermani, 2017) through changes in housing net worth and hence aggregate demand (Mian et al., 2013; Mian and Sufi, 2014b). Moreover, Mondragon (2018) and Gilchrist et al. (2018) use variation in credit supply at the lender level to document mortgage credit supply effects on local housing markets and the real economy.

We contribute to this strand of literature in two distinct ways. First, our analysis extends the literature by shifting the focus towards the role of granular effects and mortgage market

³In the case of a monopoly market, there would be a direct link between bank-level shocks and aggregate outcomes if no possibilities of substitution from other regions are available. However, as soon as several lenders are active in a given market, idiosyncratic shocks should average out. In our analysis, we focus on MSA-year observations, where at least 30 lenders are present.

concentration for the real economy. Given that risk at the level of individual financial institutions can harm aggregate economic stability, this paper asks whether *idiosyncratic* changes in the mortgage supply of the largest lenders impact house price growth and real economic performance through a skewed distribution of mortgages. Thus, it aims at shedding light on how sensitive the U.S. economy is for idiosyncratic credit supply shocks both in normal and in exceptional times – a question that is of utmost importance given that U.S. mortgages are the world’s largest asset class (Economist 2016) and the growing relative importance of mortgage lending to total lending (Figure 3). Second, given the importance of the shadow banking sector for financial supervisors and politicians who face the challenge of making the financial system resilient, we are the first to investigate granular effects in this segment of the mortgage market.

2 Related Literature

Our analysis is related to three main strands of the literature. Regarding the macroeconomic consequences of movements in mortgage supply and house prices, Jorda et al. (2016) identify mortgage booms as a critical reason for financial as well as real fluctuations. Loutskina and Strahan (2015) show that financial integration within the United States has led to a closer link between house price developments, the real economy, and finally, macroeconomic volatility. According to the household balance sheet view of Mian and Sufi (2014a), macroeconomic performance in the United States crucially depends on household debt dynamics and house prices: the larger the growth in house prices, the more that leverage builds up in the household sector, such that default risk rises. In case of a sudden drop in house prices, households have to deleverage, which depresses aggregate demand. Taken together, linkages between the credit market and house prices appear to be crucial determinants of macroeconomic performance.

Micro-level evidence by Adelino et al. (2012) reveals that easier credit supply positively affects house prices. Mian and Sufi (2009) show that securitization led to an extension of subprime mortgages and, finally, to increased house price growth. Based on U.S. branching deregulation as an instrument for credit growth, empirical findings by Favara and Imbs (2015) support that access to credit is an essential driver of house prices – both in statistical and economic senses. Turning to the real effects, Di Maggio and Kermani (2017) find that U.S. counties with greater mortgage origination have seen higher house prices and employment increases in booms, and steeper reductions during busts. Aggregating lender-specific mortgage supply shocks at the

county-level, Mondragon (2018) documents that about 20% of employment losses during the Great Recession can be attributed to the household credit channel.

Concerning the effects of lending by large banks, Chen et al. (2017) investigate how the retrenchment of the Top-4 U.S. banks from small business lending affected credit conditions and labor market outcomes after 2008. Gete and Reher (2018) use the exposure to the Top-4 U.S. banks as an instrument to estimate the effects of the mortgage supply contraction after the Great Recession on housing rents. In a recent paper, Gabaix and Koijen (2020) propose “granular instrumental variables” based on size-weighted idiosyncratic shocks to large firms or banks that can be used to identify causal relations in macroeconomic and macro-finance settings.

Our study is closely related to the literature on the granular origins of aggregate fluctuations in the banking sector. Blank et al. (2009) are the first to measure granular effects from banking to investigate how bank concentration affects the German banking system’s stability. For a panel of Eastern European countries, Buch and Neugebauer (2011) find significant effects of idiosyncratic shocks to large banks on the real economy. Using a linked bank-firm level data set, Amiti and Weinstein (2018) demonstrate that idiosyncratic credit supply shocks explain about 40% of the aggregate loan and investment fluctuations in Japan. The findings by Galaasen et al. (2020) for a linked Norwegian bank-firm dataset support that granular credit risk sizably affects the aggregate economy. Bremus et al. (2018) provide a discrete-choice model of granular effects from the credit market and empirical support that bank-specific credit shocks affect the real economy in a broad set of countries.

For the large and well-diversified U.S. economy, the evidence of the financial sector’s granular effects is so far minimal. Landier et al. (2017) demonstrate that – due to high concentration and hence granular effects – financial integration is an essential driver of the increased synchronization of house prices across U.S. states. Hoffmann and Stewen (2019) show that banks in U.S. states that deregulated interstate banking earlier expanded mortgage supply more in response to capital inflows from abroad, resulting in house price increases. We add to this literature by studying how the market structure in the U.S. mortgage market affects macroeconomic performance in regional house prices and employment.

3 Data and Methodology

To test whether lender-specific mortgage supply shocks affect house price and employment dynamics at the regional level, we proceed in three steps. First, we calculate idiosyncratic shocks to mortgage supply. Second, we construct a measure of granular effects from the regional mortgage market using lenders’ regional mortgage market shares. We then regress our macroeconomic variables of interest (new mortgages, house prices, and employment) on this granular effects measure. Table 1 provides detailed information about our data and variable definitions.

– Insert Table 1 here –

3.1 Mortgage Market Data

To measure idiosyncratic mortgage supply shocks, we rely on HMDA data. This data set provides annual information on every newly issued mortgage loan from individual mortgage lenders to individual households. To determine whether institutions are serving the housing finance needs of their local communities, the Home Mortgage Disclosure Act from 1975 requires approximately 80% of all mortgage lending institutions nationwide to disclose information about the geographic location and other characteristics of the mortgage loans they originate, like the year of application, the dollar amount of the loan, and the application outcome. Most depository institutions (commercial banks, savings associations, and credit unions) with home or branch offices in an MSA must report. The only exemptions are small institutions with assets of less than \$35 million for the 2006 reporting year, lenders not in the home-lending business, or those that have offices exclusively in rural areas (non-MSAs). Non-depository consumer- and mortgage-finance companies do have to report if they originate one hundred or more home purchase or home refinancing loans per year covered. To identify each lender correctly, we combine two pieces of information: the agency code (acode), which identifies the federal agency to which the lender reports, and the respondent ID (RID), which identifies the bank or financial institution. Both variables are needed since some respondent IDs belong to two institutions reporting to different federal agencies.

Our sample includes both depository and non-depository institutions covered by the HMDA. We define non-bank mortgage lenders (or: shadow banks) as mortgage lenders without access to deposit funding or, more generally, according to Adrian and Ashcraft (2016) as a “web of

specialized financial institutions that conduct credit, maturity, and liquidity transformation without direct, explicit access to public backstops.” We classify mortgage lenders like banks or non-banks with the HMDA lender file kindly provided by Robert Avery. Figure 1 illustrates that concentration is high both in mortgage origination from banks and non-banks, with the top 1% of bank and non-bank lenders having market shares of about 60% and 30%, respectively.

– Insert Figure 1 here –

The HMDA data have two critical advantages over bank balance sheet data typically used in the granularity-literature. First, they provide information about newly issued mortgages (a flow variable). In contrast, balance sheet data provide information about the stock of credits only, such that newly issued credit can only be approximated by looking at credit growth. Moreover, second, the HMDA data allow for assigning mortgages to the regions where they are supplied, which bank balance sheet data does not permit.

Our regression sample covers annual information on mortgages for 371 MSAs from 1990 through 2016. A sufficient number of (large) lenders are needed at the MSA-year observation level to study granular effects. Hence, we restrict the estimation sample such that more than thirty lenders are active per year in each MSA, and lenders are active in at least three MSAs (see Table 2).

Exploiting the HMDA data set, we aggregate all accepted mortgage loans for each lending institution according to the purchased property’s location, namely by MSA. In the baseline scenario, we group all lenders, i.e., both depository and non-depository institutions, to analyze the linkages between lender-specific mortgage supply shocks and the real economy. In Section 3.6, we then analyze granular effects from the depository and non-depository mortgage lenders separately.

We keep all loan purpose types⁴, all lien types, and all owner-occupancy types. Also, since most loan type indicators are available as of 2004 only, removing certain loan types would make the data incomparable with past sample years.

3.2 Granular Effects from the Mortgage Market

Intuitively, the idea behind the mortgage market’s granular effects is that idiosyncratic shocks matter for aggregate house prices and real economic activity if the concentration is high enough.

⁴Home purchase, home improvement and refinancing loans.

If market shares in the credit market are relatively equal, idiosyncratic shocks cancel out across many lenders. Yet, when concentration is high, such that the largest players dominate the market, they can contribute to aggregate movements in house prices and the real economy.⁵

Following the exposition by Landier et al. (2017), we posit that mortgage origination of lender b in region m at time t can be decomposed into a lender-specific lending shock, $\epsilon_{bm,t}$, and a common shock, ζ_t . Mortgage growth at the level of the lender can then be expressed as

$$\frac{\Delta L_{bm,t}}{L_{bm,t-1}} = \zeta_t + \epsilon_{bm,t} . \quad (1)$$

We interpret the idiosyncratic shock $\epsilon_{bm,t}$ as a shock to a lender's loan origination policy, e.g., due to unexpected managerial decisions, or as a lender-specific funding shock that translates into a change in mortgage origination.

Based on findings from previous literature (Adelino et al., 2012; Favara and Imbs, 2015; Amiti and Weinstein, 2018), we hypothesize that macroeconomic outcomes in region m are affected by credit supply, so that

$$\frac{\Delta Y_{m,t}}{Y_{m,t-1}} = \mu \frac{\Delta L_{m,t}}{L_{m,t-1}} + \eta_{m,t} \quad (2)$$

where $L_{m,t} = \sum_1^B L_{bm,t}$ is the aggregate volume of mortgage loans in region m at time t , $Y_{m,t}$ denotes regional housing and labor market variables like house prices or employment, and $\eta_{m,t}$ is a fundamental macroeconomic shock to $Y_{m,t}$.

Combining the two equations above yields

$$\frac{\Delta Y_{m,t}}{Y_{m,t-1}} = \mu \left[\zeta_t + \sum_1^B \epsilon_{bm,t} \left(\frac{L_{bm,t-1}}{L_{m,t-1}} \right) \right] + \eta_{m,t} . \quad (3)$$

Equation (3) reveals that the growth rate of the aggregate variable, Y_t , depends (i) on the common credit shock ζ_t , (ii) on the idiosyncratic mortgage supply shocks, $\epsilon_{bm,t}$, weighted by lender b 's market share in region m , $L_{bm,t-1}/L_{m,t-1}$, and (iii) on the fundamental shock to the macroeconomic variable considered $\eta_{m,t}$. While Favara and Imbs (2015) have focused on the identification of a causal link between house price growth and a common, exogenous mortgage supply shock ζ_t , the goal in this paper is to investigate how idiosyncratic mortgage supply shocks $\epsilon_{bm,t}$ that originate from the business of large mortgage lenders affect the housing market and

⁵For a theoretical derivation of granular effects, see Gabaix (2011), Section 2.3.

ultimately the real economy.

Concentration in mortgage origination. Before testing whether lender-specific mortgage supply shocks affect house price growth in U.S. regions, we must check whether the necessary condition for the mortgage market’s granular effects is fulfilled. To that goal, the dispersion of newly issued mortgages’ distribution has to be high enough, such that idiosyncratic shocks do not cancel out across a large number of mortgage suppliers. A first look at the data reveals that U.S. mortgage origination is indeed dominated by large lenders (Figure 1).

Since granular effects can emerge only if mortgage origination is highly concentrated, we must test whether the distribution of newly issued mortgages follows a fat-tailed power law (Gabaix, 2011, Proposition 2). This is the case if the power-law coefficient of the distribution is less than one in absolute value.

Following Gabaix and Ibragimov (2011), we estimate the dispersion parameter of the size distribution of newly issued mortgages for each MSA using the following regression equation

$$\ln(\text{Rank}_{bm} - 0.5) = \alpha + \beta \ln(\text{NL}_{bm}) + \epsilon_{bm} , \quad (4)$$

where Rank_{bm} is the rank of lender b ’s newly issued mortgages in MSA m , and NL_{bm} is the corresponding number of newly issued mortgages. β is the power-law coefficient, i.e., the parameter of interest here. As pointed out by Acemoglu et al. (2012), a consistent estimate of the power-law coefficient can be obtained by constraining the sample to the observations in the fat tail of the distribution. We thus follow Acemoglu et al. (2012) and estimate β for the top 20% of the number of originated mortgages which account for nearly 90% of total mortgage origination in a given MSA and year.

– Insert Figure 4 here –

Figure 4 illustrates the estimation results. It plots the histograms of the estimated power-law coefficients across MSAs for each year between 1990 and 2016. The figure reveals that nearly all estimates are below two, meaning that the distribution of newly issued mortgages is extremely dispersed with infinite variance. In very few cases, during 1990 - 1992, some estimated coefficients exceed the value of two. Estimation results based on CDF binning following Di Giovanni et al. (2011) confirm that the number of mortgage origination follows a fat-tailed power law. When estimating power-law coefficients – in this case for the top 40% of lenders to assure a sufficient

number of observations for the binning – we observe values around one but well below two in all cases.

Thus, the distribution of new mortgages follows a fat-tailed power law in our sample. Thereby, the necessary condition for granular effects from the mortgage market is fulfilled. Thereby, idiosyncratic shocks can play a role in house price growth and employment since mortgage origination concentration is high enough for large lenders to affect the economy.

Measuring mortgage supply shocks. To identify the idiosyncratic mortgage supply shocks, we regress the growth rate of newly issued mortgage credits of lender b in MSA m at time t on a set of lender-time and MSA-time fixed effects⁶

$$\Delta \ln(NL_{bm,t}) = \alpha_{b,t} + \delta_{m,t} + \tilde{\epsilon}_{bm,t} . \quad (5)$$

The goal is to purge lender b 's new mortgages extended to MSA m from all macroeconomic and common mortgage market factors. Extracting the residual from this specification yields the lender-specific mortgage supply shock at the MSA-level that is exogenous to local mortgage demand and other common credit disturbances: $\alpha_{b,t}$ purges newly issued mortgages from all time-variant and -invariant characteristics of lender b , like its general business model, its size or its asset quality. Thus, the shock contains only innovations to lenders' mortgage origination specific to a given market (MSA), like unexpected changes or managerial decisions at the local level. To control for mortgage demand effects, we apply the approach proposed by Khwaja and Mian (2008) and define a mortgage loan as a lender-MSA pair. Since every MSA borrows from multiple institutions, the combined MSA-and-year fixed effects, $\delta_{m,t}$, account for time-varying credit demand changes across regions. Moreover, the MSA-and-time fixed effects also control for all changes common to all MSAs in a given year, like changes in credit, general funding conditions, or economic growth.

– Insert Table 2 here –

The first panel of Table 2 presents summary statistics for the mortgage origination shock $\tilde{\epsilon}_{bmt}$. It reveals that even if the sample mean of lender-specific mortgage supply shocks is close to zero (0.15), the measure takes on negative and positive values with a standard deviation of 0.76.

⁶We use the Stata-command *reghdfe* (Correia, 2017) to absorb the different sets of fixed effects so that the mortgage shocks are estimated non-parametrically.

As shown by Equation (5), positive values present positive deviations of newly issued mortgages (by lender b to MSA m in year t) from the conditional mean due to lender-specific events like unexpected managerial decisions on credit supply. Negative values reflect negative deviations in mortgage origination, e.g., due to idiosyncratic funding shortages.

Given that the existing granularity-literature focuses on firm-specific effects on aggregate fluctuations, as an alternative to the shock specification in Equation (5), we also compute lender-specific shocks that comprise both a component common to all destinations and a destination-specific component.⁷ To that goal, instead of using lender-time fixed effects in Equation (5), we use time-invariant lender fixed effects together with MSA-time fixed effects and retrieve the residual, $\epsilon_{bm,t}$.

This broader shock measure can thus be decomposed into two parts, similar to the approach by Di Giovanni et al. (2014),

$$\epsilon_{bm,t} = \omega_{b,t} + \tilde{\epsilon}_{bm,t}, \quad (6)$$

where $\omega_{b,t}$ denotes the lender-specific shock that affects a lender's mortgage origination in all regions it serves, while $\tilde{\epsilon}_{bm,t}$ is the shock that is lender-MSA-specific, i.e., that varies across the MSAs the lender is active in. As highlighted by Di Giovanni et al. (2014) and Eaton et al. (2011), both firm-specific shocks that are common to all sales destinations and destination-specific shocks at the firm level can be important in explaining aggregate fluctuations.

In terms of the interpretation of the lender-specific shock and its components, ω_{bt} captures all innovations at the lender level that are common to all MSAs credit is supplied to, like lender-wide changes in productivity, changes in the lender's business model or unexpected managerial decisions that pertain to the bank as a whole. In contrast, the destination-specific shocks, $\tilde{\epsilon}_{bmt}$, i.e., our baseline and more conservative shock measures can be interpreted as an innovation to mortgage lending at the branch-level of a lender, e.g., due to local computer glitches or unexpected changes in mortgage origination policies at the regional level.

Granularity in regional mortgage markets. To compute a measure of granular effects from the mortgage market at the MSA-level, the *Banking Granular Residual (BGR)*, we weigh the idiosyncratic mortgage shocks from the previous section with the respective market share of each of the top 20% of mortgage lenders in an MSA and year. Market shares are defined

⁷More precisely, we test the aggregate effects of a somewhat broader measure of idiosyncratic shocks that are a combination of lender-and-year effects, time-invariant lender-MSA effects and lender-MSA-year effects.

as the share of each bank in total mortgage lending of all top 20% of banks in each MSA and year. According to theoretical considerations for non-financial (Gabaix, 2011) and financial firms (Bremus et al., 2018) and following the econometric approach by Greenstone et al. (2014) and Mondragon (2018), we aggregate these weighted shocks, in our case at the MSA level

$$BGR_{m,t} = \sum_{b=1}^B \frac{NL_{bm,t-1}}{NL_{m,t-1}} \tilde{\epsilon}_{bm,t}, \quad (7)$$

where $NL_{bm,t-1}/NL_{m,t-1}$ is the lagged market share in mortgage origination of lender b in MSA m , and $\tilde{\epsilon}_{bm,t}$ is the contemporaneous regional mortgage supply shock of lender b . This yields our measure of granular effects from the mortgage market at the MSA level, which is available at annual frequency for the period 1990-2016.

According to the granularity concept, we expect the effect of the BGR on aggregate house price growth and real economic activity to be positive. If the concentration in mortgage origination is high enough, the bigger lender-specific shocks or concentration are – and thus the more substantial the BGR –, the stronger should be the link to these macroeconomic variables.

– Insert Figure 5 here –

To visualize the regional differences of the BGR , the top panel of Figure 5 plots the average BGR s for MSAs in the United States between 1990-2016. Even if the BGR can take on negative and positive values in individual years (see Table 2), on average, we observe negative values for our measure of mortgage supply shocks at the MSA level. If anything, we find a weak geographical pattern in our measure of micro-level mortgage supply shocks – high values of the BGR (dark colors) tend to be more frequent in the MSAs in the East and the center of the United States. We find very high values for the BGR for MSAs in Illinois (e.g., Champaign-Urbana, Kankakee, Rockford, and Springfield) and New York (e.g., Buffalo-Cheektowaga-Niagara Falls, Ithaca or Rochester), while MSAs in Nevada (Carson City), Utah (St. George), Delaware (Dover and Salisbury), and California (e.g., El Centro, Hanford-Corcoran, Madera and Merced) are at the bottom of the range.

3.3 Macroeconomic Outcomes and Control Variables

Before turning to the link between large mortgage lenders' granular effects on house price and real dynamics, we check whether idiosyncratic shocks to large lenders can be felt in aggregate

mortgage origination at the MSA-level.⁸ We aggregate mortgage origination volumes from the HMDA data set for each MSA and year to that goal. Growth rates are computed as log-differences.

Our second dependent variable of interest, house price growth, is computed based on the Freddie Mac House Price Index (FMHPI), which is available for 383 MSAs between 1975 and 2016. The FMHPI bases on an ever-expanding database of loans purchased by Freddie Mac or Fannie Mae. It is constructed using a repeat-transactions methodology, which is an increasingly common practice in housing research (Bollerslev et al., 2016). The FMHPI index is estimated with data including transactions on one-family and town-home properties serving as collateral on loans originated between January 1, 1975, and the end of the most recent index month. Given that the original data are published monthly, we take the median to get to annual frequency. Taking the mean of monthly house prices or the last month of each quarter leaves our results mostly unaffected.

The middle panel of Figure 5 shows average house price growth for MSAs in our sample between 1990 and 2016. From this graphical inspection, there is even less indication of a pattern for house price growth across the United States than for the *BGRs*.

Our third macroeconomic outcome of interest is employment growth at the MSA level, which we take from the Bureau of Economic Analysis (BEA). The data are available for 382 MSAs. More detailed information is provided in Table 1.

A set of control variables at the MSA level is included in the regression models for mortgage origination, house price growth, and employment. Following Favara and Imbs (2015), we include per capita personal income growth and population growth and the first lags of these controls. The data are available for 382 MSAs from the BEA.

3.4 Idiosyncratic Mortgage Supply Shocks and the Housing Market

To analyze whether micro-level mortgage supply shocks have aggregate effects on aggregate mortgage origination and house prices in U.S. regions, we run the following regression model

$$\hat{Y}_{m,t} = \lambda_m + \gamma_t + \beta BGR_{m,t} + \Gamma X_{m,t} + \epsilon_{m,t} , \quad (8)$$

⁸The discrete choice model by Bremus et al. (2018) links bank-specific credit growth and credit market concentration to aggregate credit growth. Given that firms in the model finance working capital through loans, idiosyncratic credit shocks are directly linked to aggregate output growth.

in which standard errors are clustered at the MSA level. $\hat{Y}_{m,t}$ is the growth of annual mortgage origination or house prices at the MSA level, computed by the log-difference of new mortgage volumes and the house price index described above, respectively. To control for region-specific differences in house prices as well as common time trends that affect house prices in all MSAs, a set of regional (λ_m) and time fixed effects (γ_t) is included in each regression. $BGR_{m,t}$ is the banking granular residual, and $X_{m,t}$ includes a set of the time-varying MSA-specific control variables. It is well known that house prices display considerable geographic heterogeneity in the United States (Ferreira and Gyourko, 2011). Such heterogeneity can arise from the demand side of the market, simply because income, demographic factors, and amenities are geographically heterogeneous (Lamont and Stein, 1999; Gyourko et al., 2013; Glaeser and Gyourko, 2007; Glaeser et al., 2008; Favara and Song, 2014). We follow Favara and Imbs (2015) and include per capita personal income growth and population growth here.

3.5 Idiosyncratic Mortgage Supply Shocks and Employment

In order to analyze whether micro-level mortgage supply shocks have aggregate implications also beyond the housing market, we run the following regression model

$$\hat{E}_{m,t} = \lambda_m + \gamma_t + \beta_1 BGR_{m,t} + \beta_2 \widehat{HP}_{m,t} + \Gamma X_{m,t} + \epsilon_{m,t} . \quad (9)$$

Again, we provide standard errors clustered at the MSA level. $\hat{E}_{m,t}$ is annual employment growth. To control for regional differences in labor market outcomes as well as common time trends that affect all MSA's labor markets, a set of regional (λ_m) and time fixed effects (γ_t) is included in each regression. $BGR_{m,t}$ is the banking granular residual, $\widehat{HP}_{m,t}$ is house price growth, and $X_{m,t}$ includes the same control variables as in the baseline regressions for mortgages and house prices. We expect a positive direct link between the BGR and real economic outcomes, in line with previous findings for other countries (Amiti and Weinstein, 2018; Bremus et al., 2018; Bremus and Buch, 2017).

Following the reasoning by Mian and Sufi (2014b) and Di Maggio and Kermani (2017), increased mortgage supply fosters house prices, thereby increasing households' housing wealth, so that their balance sheets improve. This leads to a rise in consumer demand and, finally, in employment. In additional regressions, we thus also include an interaction term between house price growth and the BGR . The coefficient on the interaction term is expected to be positive.

The more substantial house price growth, the more pronounced is the effect of (idiosyncratic) mortgage supply shocks on the real economy. This hypothesis is in line with the amplification mechanism between borrowing constraints and asset prices in the model developed by Kiyotaki and Moore (1997).⁹

3.6 Granular Effects from Non-Bank Mortgage Lenders

The market share of non-depository mortgage lenders almost doubled between 2007 and 2015. Moreover, these less-regulated financial institutions gained even more weight in lending activity to less creditworthy borrowers (Buchak et al., 2018). The growing importance of this less regulated market segment raises concerns about financial stability. To investigate whether granular effects from non-bank mortgage lenders differ from those of traditional mortgage banks, we adjust our baseline regression model as follows

$$Y_{m,t} = \lambda_m + \gamma_t + \beta_1 BGR_{m,t}^{bank} + \beta_2 BGR_{m,t}^{shadow} + \Gamma X_{m,t} + \epsilon_{m,t} , \quad (10)$$

where $BGR_{m,t}^{bank}$ is the banking granular residual based only on depository mortgage lenders, whereas $BGR_{m,t}^{shadow}$ denotes the banking granular residual including only non-depository mortgage lenders.

In line with the previous rationale for a positive link between the BGR and macroeconomic outcomes, we also hypothesize the same positive link between granular effects from non-bank mortgage lenders and aggregate outcomes. However, the strength of the economic impact may differ between the regulated and the less regulated lenders. For example, if idiosyncratic shocks are larger for non-bank mortgage lenders as they engage in riskier market segments, granular effects from shadow banks could be stronger. On the other hand, given that concentration is lower when considering mortgages provided by non-depository lenders only, granular effects may be weaker.

⁹In their model, small shocks can result in large swings in asset prices and real economic activity, as durable assets – like buildings – serve as collateral for loans. If the collateral value decreases, credit-constrained firms are forced to reduce (residential) investment. For markets to clear, house prices have to fall, which, in turn, tightens credit limits. Persistence and amplification reinforce each other, and real economic activity decreases. Hence, the model predicts a negative link between (tighter) borrowing constraints and real economic activity.

4 Results

4.1 MSA-Specific Shocks at the Lender Level

Table 3 provides our baseline regression results for *BGR* based on idiosyncratic shocks to lenders' mortgage supply specific to a given MSA. It reveals that lender-specific shocks at the MSA level are positively linked to aggregate mortgage origination, house prices, and employment.

– Insert Table 3 here –

In line with theoretical predictions (Bremus et al., 2018), Column (1) confirms the positive link between granular credit supply shocks at the micro-level and aggregate credit outcomes. Conditional on income and population growth, idiosyncratic mortgage supply shocks at the largest lenders level are felt in mortgage origination growth at the regional level.

Similarly, in Column (2), we find a positive and statistically significant effect of the *BGR* on house price growth. This means that positive innovations to mortgage origination at the level of individual large mortgage lenders lead to more substantial housing price growth. Vice versa, adverse lender-specific mortgage supply shocks dampen house price growth. Thus, our results provide evidence for granular effects from the U.S. mortgage lending sector on the regional housing market. The more concentrated mortgage origination is, the easier do lender-specific shocks spread across the housing market.

Columns (3) to (6) show how the *BGR* affects real economic activity measured by employment growth. The link with granular effects from the mortgage market is statistically significant at the 1%-level for the baseline model and if house prices are included as a regressor. Regarding the interactions between house price growth and the *BGR*, our results support the hypothesis made above. Stronger house price growth coincides with a tighter link between mortgage market granularity and real economic outcomes. When introducing an interaction term between house price growth and the *BGR*, the direct effect of shocks to large lenders' mortgage supply turns statistically insignificant. However, the positive and significant interaction effect means that the link between the *BGR* and employment becomes closer with more house price growth.

All control variables have the expected positive effects on the aggregate variables: the higher income and population growth is in an MSA, the higher is the demand for housing. This, in turn, fosters mortgage and house price growth. Employment growth is also positively related to growth in income and population.

Quantitatively, the estimated coefficient in Column (1) reveals that an increase in the *BGR* by one standard deviation (0.135) leads to an increase in MSA-level mortgage growth by 2.3 percentage points. According to the normalized beta-coefficient, variation in lender-specific mortgage supply explains 7% of the variation in mortgage growth at the MSA-level.¹⁰ In comparison, contemporaneous population growth explains 13% of mortgage origination growth at the MSA-level, while income growth explains 5%.

The economic significance of granular effects on house price growth looks similar, with the *BGR* explaining 5% of the variation in house price growth in our sample. Compared to the more direct effects on house price growth, the normalized beta-coefficients of the *BGR* based on market-specific idiosyncratic shocks to mortgage origination of large lenders are smaller for employment. For this variable, income and population growth are the most critical determinants in our setup.

4.2 Lender-Specific Shocks

Having discussed the effects of lender specific mortgage supply shocks that occur in a given MSA, we further investigate how idiosyncratic shocks at the level of lenders, i.e., shocks that have a component common to all MSAs the lender operates in, are linked to regional economic outcomes. Table 4 repeats our baseline specification with the *BGR* based on this broader shocks described in Equation (6). These shocks are a combination of lender-time effects, time-invariant lender-MSA effects, and lender-MSA-time shocks. The regression results support the positive link between lender-specific shocks and aggregate mortgage, house price, and employment growth. The estimated effects are more pronounced than in Table 3 with normalized beta-coefficients of 18% for mortgage and house price growth and 2-6% for employment growth, depending on the specification. Moreover, the effect of the *BGR* remains statistically significant when including the interaction with house price growth (Column (6)). Consequently, the comparison of the results from Tables 3 and 4 shows that lender-year shocks, i.e., shocks to mortgage origination policy common across all MSAs the lender operates in, explain an important part of aggregate mortgage and house price growth.

– Insert Table 4 here –

In line with the fact that mortgage origination concentration is very high, we thus conclude

¹⁰We calculate the normalized beta-coefficient by multiplying the estimated coefficient of interest with the standard deviation of the corresponding regressor and dividing by the standard deviation of the dependent variable.

that idiosyncratic shocks to mortgage supply have aggregate effects. The estimation results, both based on the lender-MSA-specific shocks and the lender-specific shocks, support the expectation that idiosyncratic changes in mortgage lending, positively affect house price and even employment growth at the MSA level.

Our results are in line with both theory (Di Giovanni et al., 2011; Gabaix, 2011; Bremus et al., 2018), and empirical research. Amiti and Weinstein (2018) demonstrate a significant role of granular shocks to the banking system for the real economy in Japan. In their case, granular effects from banking explain roughly 40% of the variation in aggregate investment. Buch and Neugebauer (2011) also find a positive impact of the *BGR* on short-run GDP growth, explaining 16% of the short-run, cyclical variation in per capita GDP growth within a given country. Bremus and Buch (2017) establish that 5-16% of the variation in GDP per capita growth in a panel of 79 countries can be attributed to bank-specific shocks to asset growth due to granular effects. Keeping in mind that the mortgage business is a sub-component of total credit and that the U.S. economy is highly diversified, our findings thus seem plausible compared to the size of the estimated effects in the studies discussed above.

4.3 Robustness

Endogeneity of market shares. Recent empirical literature (Mondragon, 2018; Chen et al., 2017; Gilchrist et al., 2018; Hoffmann and Stewen, 2019) points out that aggregating arguably exogenous shocks at the bank level to a higher regional level may introduce substantial noise. As demonstrated by Mondragon (2018), even if the lender-specific shocks themselves are exogenous, a weighted average of these shocks may still be related to other local shocks. For example, market shares in MSAs may be driven by regional house price developments or expectations about regional economic performance.

To address the concern of potentially endogenous mortgage market shares, we run a first-stage regression to explain lenders' mortgage market shares. The idea is to filter out the endogenous part of the variation in mortgage market shares and only use the exogenous prediction of market shares from this regression to calculate the aggregated shocks at the MSA level. Since the lender-specific shocks from Equations (5) and (6) are commonly regarded as exogenous, we follow Hoffmann and Stewen (2019) and instrument only the endogenous part of the aggregated shocks. A major argument for tackling the endogeneity issue with market shares in the weighted shock measure directly is that we may lose part of the precious exogenous variation coming from the

idiosyncratic bank shocks if we instrumented the overall *BGR*. Therefore, we explain mortgage market shares of banks as the potentially endogenous part of the aggregated shock

$$\frac{NL_{bmt}}{NL_{mt}} = \alpha_b + \alpha_t + \beta_1 LIB_{mst} + \beta_2 Size_{bt} + \beta_3 RoA_{bt} + \Gamma X_{mt} + \epsilon_{bmt} \quad (11)$$

where $NL_{bm,t-1}/NL_{m,t-1}$ is the market share in mortgage origination of lender b in MSA m . Our first instrument, *LIB*, indicates whether and by how much the state s in which an MSA is located has liberalized its banking markets in terms of entry restrictions for out-of-state branching during and after the Riegle-Neal Interstate Banking and Branching Efficiency Act (IBBEA) of the 1990s (Rice and Strahan, 2010; Goetz et al., 2016; Gropp et al., 2019). We use the reversed index by Rice and Strahan (2010), which takes on values between zero and four. It indicates more liberalized regions (or: regions with fewer restrictions) by a higher value. Given that the Rice and Strahan index is only available for the period 1994-2005, we extend it to our sample period using deregulation information from Section 613 of the Dodd-Frank Act which abolished the opt-in election of states to allow for de novo branching.¹¹ The index then spans the period 1990 to 2016. Additionally, we use two bank characteristics: bank size approximated by the natural logarithm of total assets, and bank profitability, measured as the return on assets. Both variables are measured at the bank level and not at the bank-MSA level. Our idea is that larger banks, particularly more profitable banks, find it easier to do business in areas outside their home market, thus driving their market shares in different MSAs. At last, $X_{m,t}$ includes our standard set of the time-varying MSA-specific control variables: growth in per capita personal income and population.

– Insert Table 5 here –

Column (1) of Table 5 shows regression results for Equation (11) and provides evidence that the reduction of entry restrictions for regional banking markets (or: deregulation) significantly reduces lenders' market shares in MSAs that are more liberalized. To investigate the effects of deregulation on market shares further, we re-run the regression from Column (1). Since the deregulation index varies at the state-year level, we follow Goetz et al. (2013) and use the distance between a lender's headquarters and the destination where the lender originates the mortgage loan to get a lender-specific measure of deregulation. Based on Goetz et al. (2013) we assume

¹¹See for example <https://www.banknews.com/blog/the-dodd-frank-act-opens-states-to-interstate-de-novo-branching/>.

that (i) lenders have lower market shares in markets further away from their headquarters, but (ii) they are more likely to enter distant markets if the markets are more liberalized. Our results in Column (2) of Table 5 show that lenders have significantly smaller market shares in more distant, less liberalized markets, and in their home market where distance is zero if this market is more liberalized (the single term for deregulation). Moreover, the significant interaction effect shows that lenders' market shares are relatively higher in markets further away if those markets are less restrictive in terms of entry.

Both columns of Table 5 show that market shares at the MSA level significantly correlate with bank size and profitability. The larger a lender is, the larger is its market share in the MSAs where it originates the mortgage loans. Similarly, more profitable banks have larger market shares.

Overall, our three instruments (Deregulation, RoA, and Size) significantly explain the variation of lenders' market shares and thereby prove the relevance assumption. In terms of the exclusion restrictions, the instruments' validity rests on the assumption that they only affect the outcome variables on the MSA level through the market shares of a particular bank in the same MSA. Since the effects on banking competition and market shares of the banking liberalization efforts in the 1990s are well-documented (e.g., Rice and Strahan, 2010; Gropp et al., 2019), we argue that direct effects on aggregate mortgages, house prices and employment bypassing banks' market shares are not likely. Further, it is reasonable to believe that size and profitability correlate with market shares in more distant MSAs but are unlikely to affect the outcome variable there other than through lenders' market shares.

– Insert Table 6 here –

Table 6 shows the regression results for the *BGRs* with the predicted market shares from the first stage regressions presented in Table 5. Columns (1) to (5) present the baseline results for the *BGR* with predicted market shares based on the deregulation index described above. The estimations confirm the positive and statistically significant effect of idiosyncratic shocks at the level of large lenders on our three outcome variables of interest. The economic significance is very similar to, and even a bit larger than in our baseline estimations with normalized beta coefficients of 7% for mortgage growth, 5% for house price growth, and 4% for employment growth.¹² Using the *BGR* with market shares predicted from the deregulation index interacted

¹²Note that we use a non-standard IV approach here. Therefore, to calculate the beta coefficients, we use the

with distance (and the other instruments and controls discussed above), our results are a bit weaker but remain mostly statistically significant (Columns (6) to (10)).

Taken together, our results are robust to instrumenting the potentially endogenous mortgage market shares. The effects even become a bit larger in some cases.

Alternative specifications of the BGR. Our baseline *BGR* is based on shocks to the number of mortgage origination of lenders in a given MSA. Our findings remain qualitatively the same if we compute lender-specific shocks to the volume of mortgage origination at the MSA level.¹³

In order to investigate whether our results also hold for higher levels of aggregation, we aggregate the HMDA-data at the lender-state level and re-run the baseline model for the aggregate mortgage, house price, and employment growth (Table 7). This reduces the number of observations to 1,225. At the state level, the effect of the lender-market specific shocks remain statistically significant for mortgage and house price growth and explain about 9% of the aggregate variation. For employment, the *BGR* accounts for about 5% of the variation in the most parsimonious model (Column (3)). However, it does not seem to matter much for employment in the models including house prices in Columns (4) to (5).

Further robustness tests. Since developments of house prices and other variables can be closely related within states, we check whether the significance of our baseline effects is affected when clustering standard errors at the state instead of the MSA level. Compared to Columns (1) to (3) in Table 3, the statistical significance of the effect of the *BGR* remains at the 1%-level with state-level clustering, while the standard error increases somewhat compared to the specification in Column (4), such that the effect on employment is a little weaker in a statistical sense.

Next, we investigate whether our findings are robust to the inclusion of lagged house prices in the baseline models. Lagged house prices are positively and significantly linked to all of our three outcome variables. Still, including lagged house prices does not drown out the granular effects of the mortgage market.

Finally, we address the issue that if a lender that enters the *BGR* has acquired another lender in a given year, the HMDA files show the originated loans from the acquired lender as new loans from the acquiring entity. This ‘accounting shock’ does not reflect the actual loan

standard deviation of the granular residual that now comprises the shock and the predicted market shares from the first-stage regression.

¹³The regression tables are available upon request.

origination of the surviving lender, which might bias our results. To rule out that mergers and acquisitions affect our results, we drop all cases of mergers and acquisitions and run our baseline regression with the *BGR* containing only information from non-merging entities. Our results for mortgage and house price growth are unaffected by this adjustment. At the same time, the effect of the *BGR* on employment becomes weaker.

4.4 Granular Effects from Non-Bank Mortgage Lenders

Given the recent increase in the mortgage origination share of the less regulated non-bank mortgage lenders, we now investigate the relative importance granular effects from banks and non-bank mortgage lenders. Table 8 reports the regression results based on Equation (10), where we analyze granular effects separately for bank and non-bank mortgage lenders.¹⁴ Regarding mortgage and house price growth, the estimations reveal statistically significant and positive coefficients for both *BGRs* (Column (1)). Hence, idiosyncratic shocks from both traditional mortgage banks and shadow banks translate into mortgage origination and house price movements at the MSA level. The *BGR* for depository lenders (BGR^{bank}) shows larger point estimates compared to the *BGR* for shadow banks (BGR^{shadow}). However, the Wald test p-value of 0.06 suggests that the two estimated coefficients are not statistically different. In terms of economic significance, the variation in depository banking granularity explains 5-6% of the variation in mortgage and house price growth. In contrast, the variation in shadow bank granularity explains 2-5% of this variation.

Despite the significant link between the weighted mortgage supply shocks from the non-bank sector and growth in mortgage origination and house prices, these shocks seem to matter less for the employment dynamics though (Columns (3) to (5)). The *BGR* computed for depository mortgage lenders retains its positive and statistically significant effect. Hence, lender-specific mortgage supply shocks from banks drive the results observed above (Table 3) and translate into the economy beyond the housing market, whereas lender-specific shocks from the shadow sector play less of a role in this respect.

When looking at subcategories of loans, namely home purchase loans and refinance loans, this pattern prevails. Shocks to mortgages supplied by banks are generally more closely related to aggregate outcomes than shocks to mortgages supplied by non-banks. Interestingly, for refinancing loans, the effects of shocks from both parts of the financial sector are statistically

¹⁴Note that for our granular residual calculations, we define the top 20% for banks and non-banks separately.

significant and somewhat similar in their economic impact. Shocks to refinance loans tend to translate into aggregate mortgage origination and house prices, but only weakly affect employment; both through banks and non-bank mortgage lenders. If refinance loans do not exert as much pressure on aggregate demand as home purchase loans, this might rationalize the lack of real effects.

An explanation for the somewhat weaker effect of shocks to shadow banks, especially on the real side of the economy, can be the lower concentration in the non-bank mortgage market compared to concentration among depository lenders (see Figure 1). With lower concentration, the link between shocks at the micro-level and aggregate outcomes should, *ceteris paribus*, be weaker since shocks cancel out to a larger degree the less the distribution of mortgages is dominated by the largest lenders.

5 Conclusion

This paper highlights the importance of mortgage market concentration for the propagation of idiosyncratic events at level of mortgage lenders and their effect on mortgage origination, house price growth, and real economic activity. Our analysis of granular effects from the U.S. mortgage market yields four main findings.

First, mortgage origination at the MSA-level is highly concentrated. The distribution of newly issued mortgages follows a fat-tailed power law. This means that a small number of players dominate mortgage origination.

Second, idiosyncratic mortgage supply shocks impact mortgage and house price growth. The more substantial the increase in mortgage supply due to lender-specific events is, the faster house prices grow. These results are robust to several alternative model specifications.

Third, granular effects from the mortgage market are not limited to the housing market, but also affect real outcomes like employment growth. We can also show that the effects of lender-specific mortgage supply shocks on the real economy are driven by regions with higher house price growth.

Fourth, disaggregating the Banking Granular Residual for bank and non-bank mortgage lenders, we find positive and statistically significant effects for both lender types on regional mortgage origination and house price growth. However, the granular effects from non-bank lenders do not matter much for the real economy, as measured by employment growth.

Our results are essential for informing the debate on the treatment of large financial institutions. They stress that lender-specific shocks like financial innovations or unexpected managerial decisions happening to mortgage lenders with large market shares can have implications beyond the micro-level. The higher mortgage market concentration is, the easier do micro-level events spread across housing markets and finally to the real economy. In addition to indicators like mortgage growth and loan-to-value ratios, macroprudential regulation should take market shares and mortgage market concentration into account when analyzing macroeconomic stability. Moreover, given the recent rise in non-bank mortgage lenders' role in the U.S. mortgage market, our results point to the importance of monitoring both concentration and idiosyncratic shocks also in this less-regulated market segment - even if shocks at the level of non-bank lenders do not show more pronounced effects on aggregate outcomes than shocks at the level of traditional banks for now.

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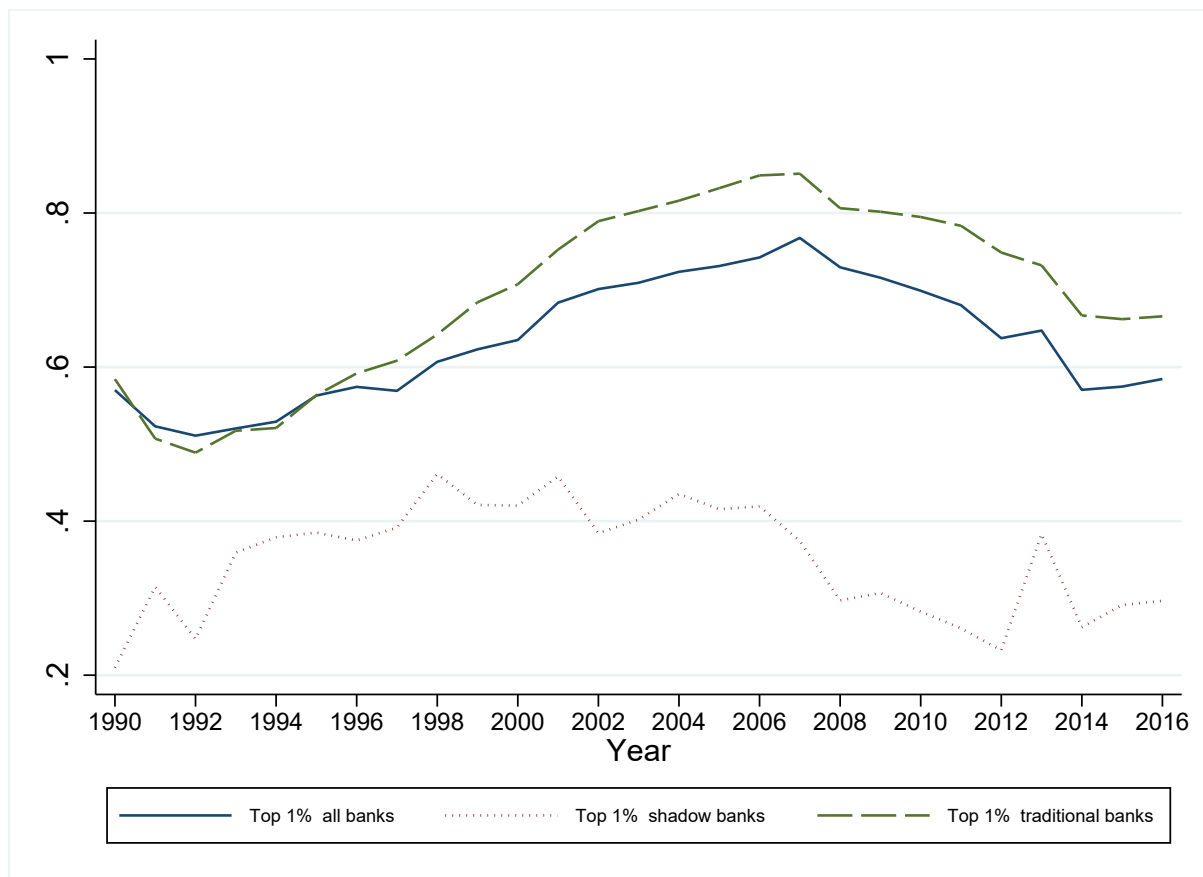
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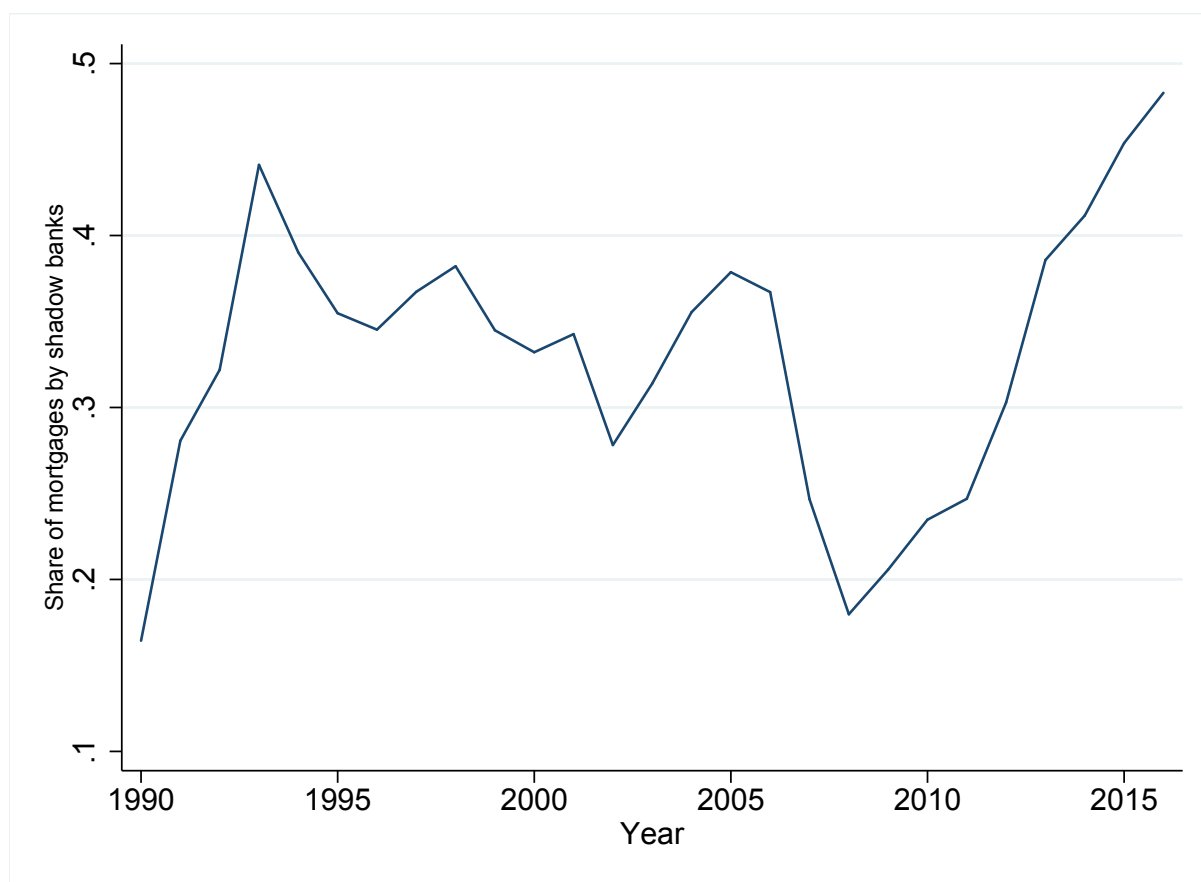
Figures and Tables

Figure 1: Mortgages of the largest lenders to total mortgage lending



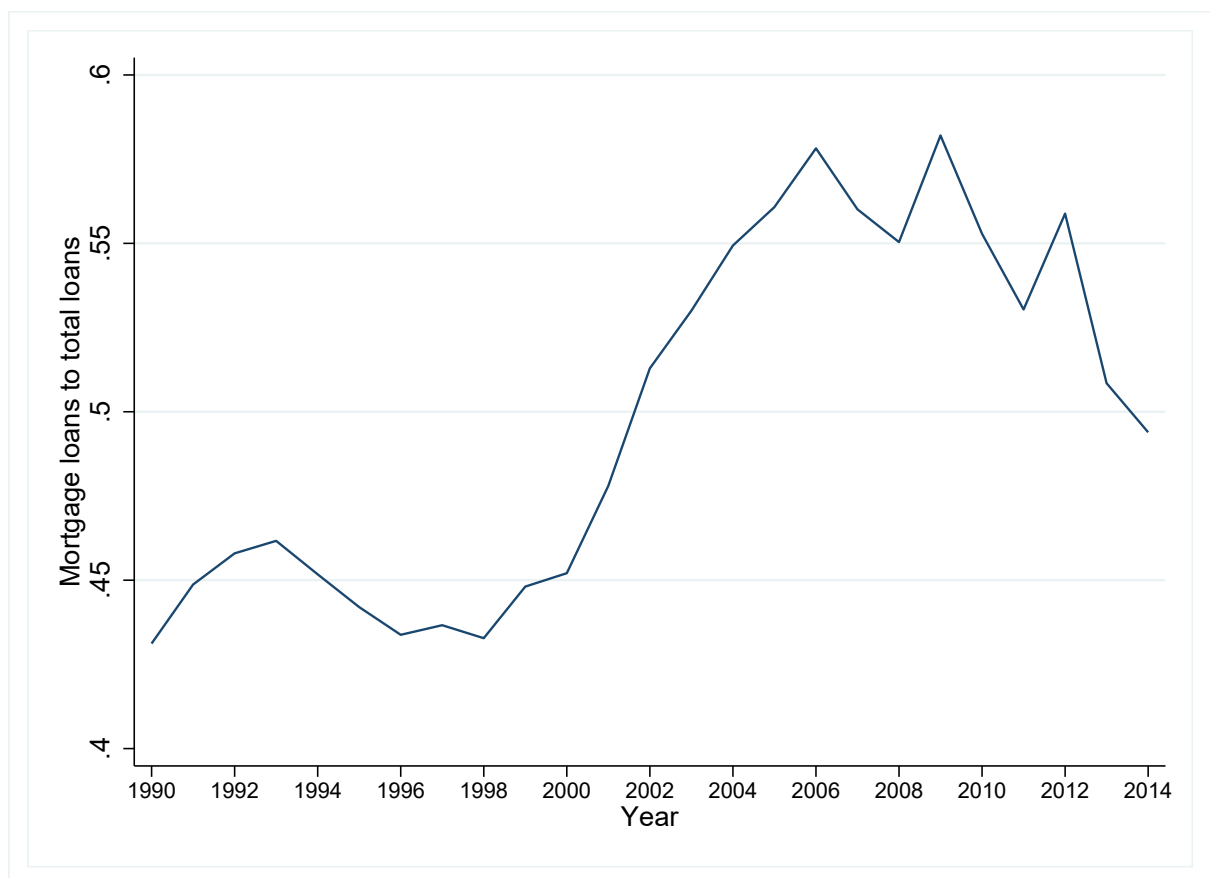
Notes: This figure illustrates the sum originated mortgages for the top 1% of (i) all banks, (ii) depository mortgage lenders, and (iii) non-depository mortgage lenders as a fraction of total newly issued mortgages in each of these categories. Data are aggregated at the U.S. level between 1990 and 2016 and come from HMDA. We identify depository institutions (traditional banks) and non-depository mortgage lenders (shadow banks) by the HMDA lender file kindly provided by Robert Avery.

Figure 2: Importance of non-bank mortgage origination



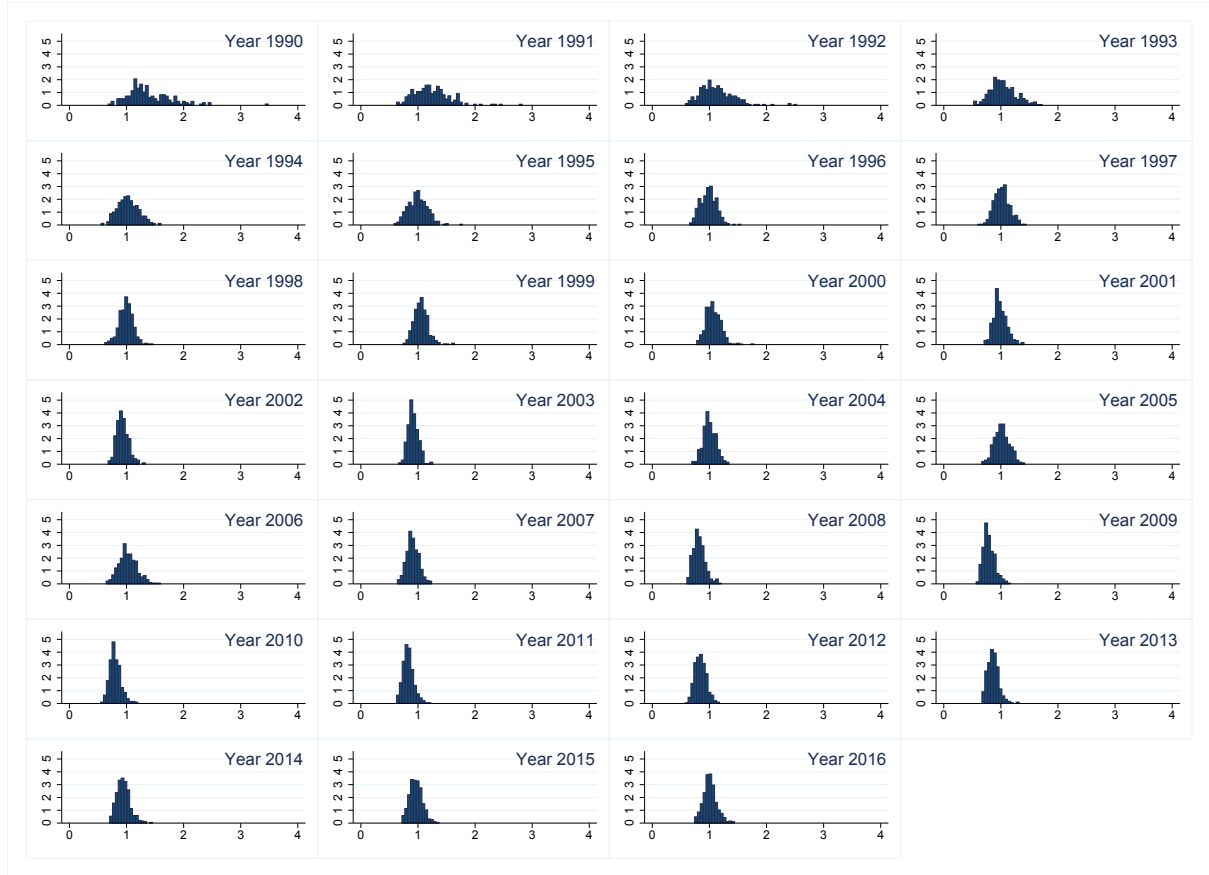
Notes: This graph shows aggregate mortgage origination by non-bank mortgage lenders to total mortgage origination based on the HMDA data.

Figure 3: U.S. mortgage loans to total loans



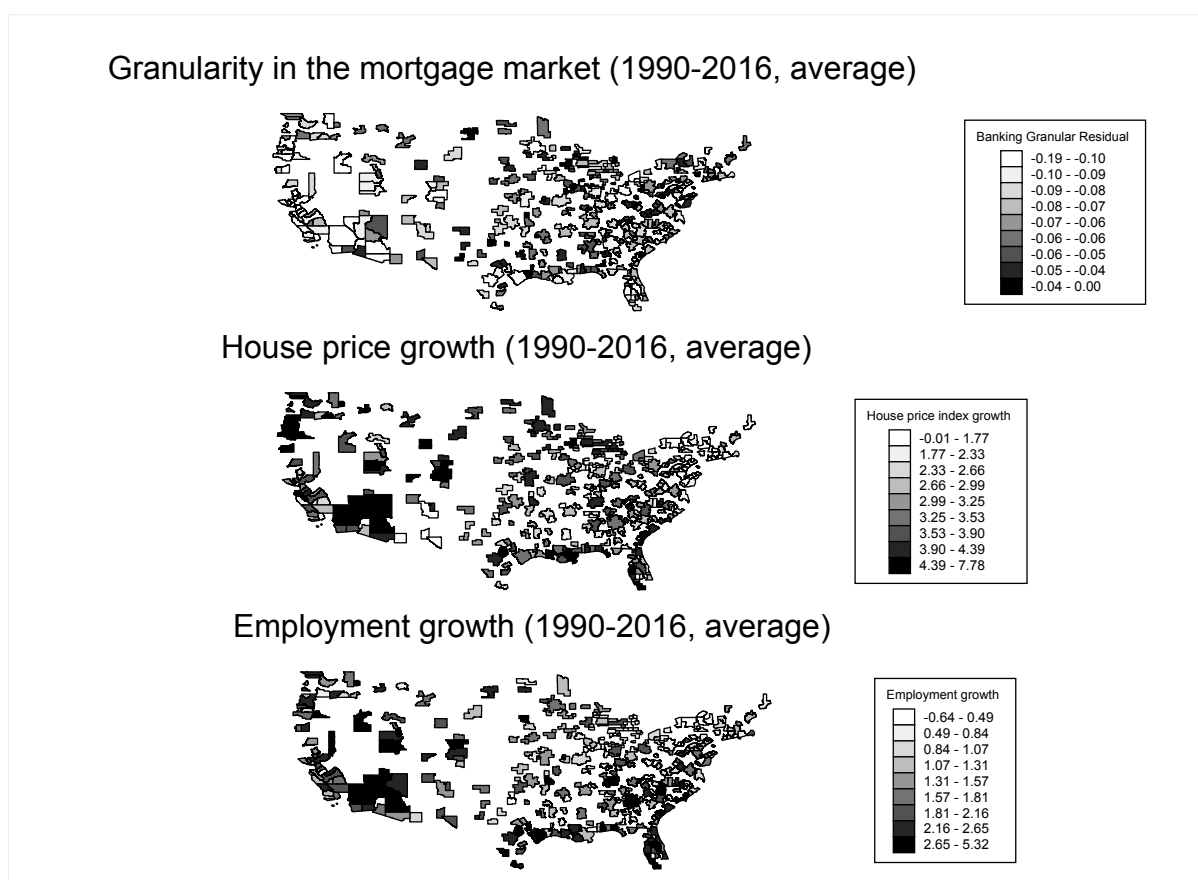
Notes: This figure plots the ratio of mortgages to total loans between 1990 and 2014. Total loans, as measured as the aggregate gross book value of total loans (before deduction of valuation reserves), and mortgages extended by the banking sector are taken from the Call Reports.

Figure 4: Histogram of estimated power-law coefficients of the mortgage size distribution



Notes: This graph shows the histogram of power-law coefficients of the distribution of newly issued mortgage loans per MSA and year. For each of the 371 MSAs in the baseline sample, we regress the log of lenders' rank (based on the number of newly issued mortgages) on the log of the number of newly issued mortgages for the top 20% of lenders. The resulting coefficient indicates whether the bank size distribution in each regional mortgage market follows a fat-tailed power law. This is the case if the absolute value is below two.

Figure 5: Regional variation in bank granularity, house price and employment growth



Notes: This figure depicts the averaged Banking Granular Residual (upper subgraph) over the period 1990-2016 across all 371 MSAs in our sample, the average house price index growth (middle subgraph) over the same period for 371 MSAs in the sample and the average firm growth (lower subgraph) over the same period for 371 MSAs in the sample.

Table 1: Variable descriptions

Variable Name	Description	Source	Label
Micro variables (lender level)			
No. of accepted mortgages	Number of newly originated mortgages. Loan purpose includes home purchase loans, home improvement loans, and refinancing loans for all property types: 1-4 family houses, manufacturing houses and multifamily houses. Number of accepted mortgages at the bank-household-year level are aggregated to the bank-MSA-year level.	HMDA	$NL_{bm,t}$
Idiosyncratic shock (MSA)	We regress the log differences of newly originated mortgages on bank-year fixed effects and MSA-year fixed effects: $\Delta \ln(NL_{bm,t}) = \alpha_b + \delta_{m,t} + \tilde{\epsilon}_{bm,t}$. The residual from this regression is the bank-market specific idiosyncratic shock.	HMDA	$\tilde{\epsilon}_{bm,t}$
Idiosyncratic shock (common)	We regress the log differences of newly originated mortgages on bank fixed effects and MSA-year fixed effects: $\Delta \ln(NL_{bm,t}) = \alpha_b + \delta_{m,t} + \tilde{\epsilon}_{bm,t}$. The residual from this regression is the bank specific idiosyncratic shock.	HMDA	$\epsilon_{bm,t}$
Bank size	Log of total assets.	FFIEC	$Size_{b,t}$
Return on assets	The ratio of net income to total assets.	FFIEC	$RoA_{b,t}$
Distance	The distance in thousand miles between the MSA where the bank's headquarters is located and the county where the bank is granting mortgages.	NBER	$distance_{bm,t}$
Macro variables (MSA-level)			
Banking Granular Residual	The idiosyncratic shocks (MSA/common) are weighted by the market share in mortgage origination of the respective lender. Summing up across the top-20 lenders in MSA m in year t yields the $BGR_{m,t}$.	HMDA	$BGR_{m,t}$
BGR (banks)	Calculation as above, except that we only consider depository institutions which we identify by the HMDA lender file from Robert B. Avery.	HMDA	$BGR_{m,t}^{banks}$
BGR (shadow)	Calculation as with the conventional BGR, except that we only consider non-depository institutions that we identify by the HMDA lender file. Shadow banks do not take deposits which makes them exempt from a large amount of regulatory oversight (Buchak et al., 2018)	HMDA	$BGR_{m,t}^{shadow}$
Aggregate mortgage growth	Log differences of newly originated mortgages at the MSA-year level	HMDA	$\hat{Y}_{m,t}$
House price index	The monthly Freddie Mac House Price Index (FHPI) captures prices of one-family and townhome properties according to the repeat transactions methodology. It is based on loans purchased either by Freddie Mac or Fannie Mae. We convert the monthly index to annual frequency by taking the median.	Freddie Mac	House Prices
Employment growth	Growth (% change from preceding period) of employment	BEA	EMP
Income p. c. growth	Growth (% change from preceding period) of per capita personal income, in current dollars (not adjusted for inflation).	BEA	Income (p.c.) growth
Population growth	Population growth (% change from preceding period) based on Census Bureau population estimates.	BEA	Population growth
Deregulation	The index captures interstate branching restrictions for commercial banks. It takes on values between zero (most restrictive states) and four (least restrictive states).	Rice and Strahan (2010)	$LIB_{ms,t}$

Table 2: Summary statistics for the regression sample

	Obs.	Mean	Std.Dev.	Med.	Min	Max
Lender-level variables (HMDA)						
No. of accepted mortgages	784,097	475.65	1518.79	143.00	3.00	135435.00
Growth rate accepted mortgages	692,530	0.39	1.11	0.18	-4.87	10.20
Idiosyncratic shock (MSA)	692,282	0.15	0.76	0.03	-5.13	9.48
Idiosyncratic shock (common)	692,495	0.28	1.07	0.06	-4.45	10.03
Banks market share	784,097	1.19	2.05	0.50	0.01	71.05
Return on assets	380,502	1.08	1.68	1.11	-27.90	39.29
Bank size	449,980	16.24	2.58	16.43	6.68	24.57
Deregulation	778,366	2.31	1.62	3.00	0.00	4.00
Distance	134,962	0.64	0.69	0.37	0.01	5.07
MSA-level variables (HMDA)						
BGR (MSA)	8,841	-0.070	0.135	-0.065	-2.496	0.910
BGR (common)	8,841	-0.103	0.182	-0.098	-2.125	0.813
BGR ^{banks} (MSA)	8,507	-0.072	0.156	-0.062	-1.711	1.141
BGR ^{banks} (common)	8,507	-0.109	0.195	-0.089	-1.439	0.754
BGR ^{shadow} (MSA)	7,756	-0.074	0.130	-0.064	-3.133	0.671
BGR ^{shadow} (common)	7,756	-0.121	0.185	-0.111	-3.281	0.742
MSA-level variables (BEA)						
Aggregate mortgage growth	8,841	9.493	34.421	8.113	-274.320	205.919
House price growth	8,841	2.699	5.999	2.950	-53.440	35.413
Employment growth	8,841	1.276	2.155	1.369	-15.437	18.340
Income p.c. growth	8,841	3.652	3.049	3.800	-31.900	50.900
Population growth	8,841	1.052	1.193	0.900	-25.000	11.500

Notes: This table reports summary statistics for the baseline regression sample. The sample includes all U.S. metropolitan statistical areas for which mortgage, house price, and employment data is available for the period 1990-2016, and where at least 30 lenders are active per year. $BGR(MSA)$ is the Banking Granular Residual as computed in equation (7), based on lender-market-specific shocks. $BGR(common)$ is based on the idiosyncratic shocks that include a lender-specific component common to all MSAs a lender is active in as presented in equation (6).

Table 3: Lender-MSA-specific mortgage supply shocks and aggregate outcomes

	(1) MORTG	(2) HP	(3) EMP	(4) EMP	(5) EMP
BGR (MSA)	16.922*** (3.57)	2.366*** (0.35)	0.480*** (0.12)	0.314*** (0.12)	0.121 (0.14)
Income p.c. growth	0.596*** (0.12)	0.425*** (0.06)	0.235*** (0.03)	0.205*** (0.03)	0.206*** (0.03)
L.Income p.c. growth	0.382*** (0.11)	0.321*** (0.05)	0.093*** (0.01)	0.070*** (0.01)	0.070*** (0.01)
Population growth	3.853*** (0.63)	1.329*** (0.21)	0.725*** (0.05)	0.631*** (0.04)	0.628*** (0.04)
L.Population growth	0.839** (0.39)	0.763*** (0.09)	0.020 (0.04)	-0.034 (0.04)	-0.032 (0.04)
House price growth				0.070*** (0.01)	0.078*** (0.01)
House price growth \times BGR					0.074** (0.03)
Obs.	8,841	8,841	8,841	8,841	8,841
MSAs	371	371	371	371	371
Adj. R-Sq	0.73	0.55	0.65	0.66	0.66

Notes: This table reports fixed effects regressions of the log change in mortgage origination (MORTG), house prices (HP), and employment (EMP) on the *BGR* based on market-specific idiosyncratic shocks at the lender level. MSA fixed effects and year dummies are included in all regressions. Standard errors are robust to heteroskedasticity and are clustered at the MSA-level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 4: Lender-specific mortgage supply shocks and aggregate outcomes

	(1) MORTG	(2) HP	(3) EMP	(4) EMP	(5) EMP
BGR (common)	34.274*** (3.46)	6.097*** (0.65)	0.683*** (0.14)	0.261** (0.12)	0.233* (0.12)
Income p.c. growth	0.487*** (0.11)	0.405*** (0.06)	0.233*** (0.03)	0.205*** (0.03)	0.205*** (0.03)
L.Income p.c. growth	0.350*** (0.10)	0.315*** (0.05)	0.092*** (0.01)	0.071*** (0.01)	0.070*** (0.01)
Population growth	3.486*** (0.60)	1.263*** (0.20)	0.717*** (0.05)	0.630*** (0.04)	0.629*** (0.04)
L.Population growth	0.871** (0.37)	0.769*** (0.09)	0.020 (0.04)	-0.033 (0.04)	-0.033 (0.04)
House price growth				0.069*** (0.01)	0.074*** (0.01)
House price growth \times BGR					0.022 (0.01)
Obs.	8,841	8,841	8,841	8,841	8,841
MSAs	371	371	371	371	371
Adj. R-Sq	0.74	0.57	0.65	0.66	0.66

Notes: This table reports fixed effects regressions of the log change in mortgage origination (MORTG), house prices (HP), and employment (EMP) on the *BGR* based on lender-specific idiosyncratic shocks including a lender-specific component common to all the lender's destination markets. MSA fixed effects and year dummies are included in all regressions. Standard errors are robust to heteroskedasticity and are clustered at the MSA-level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 5: First stage, prediction of market shares

	(1)	(2)
	Market share	Market share
Deregulation	-0.006*** (0.0021)	-0.057*** (0.0054)
Deregulation \times Distance		0.059*** (0.0052)
Distance		-0.334*** (0.0168)
Personal income p.c. change	0.002** (0.0008)	0.003*** (0.0009)
Population change	-0.022*** (0.0044)	-0.005 (0.0044)
Bank size	0.124*** (0.0042)	0.238*** (0.0086)
Return on assets	0.004*** (0.0005)	0.011*** (0.0008)
Obs.	1,270,924	435,454
States	371	371
Adj. R-Sq	0.31	0.21

Notes: This table reports regression results for the prediction of market shares as presented in equation (11). *Marketshare* are the shares of each lender's mortgage origination in total mortgage origination in a given MSA and year. *Deregulation* is the deregulation index described in the main text, and *Distance* reflects the distance between a lender's headquarters and the market (MSA) where the lender originates the mortgage loan. Standard errors are robust to heteroskedasticity and are clustered at the MSA-level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 6: Instrumental variable regressions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	MORTG	HP	EMP	EMP	EMP	MORTG	HP	EMP	EMP	EMP
BGR (MSA, LIB)	0.902*** (0.0829)	0.108*** (0.0288)	0.029*** (0.0063)	0.022*** (0.0058)	0.021*** (0.0061)					
BGR (MSA, LIB \times distance)						0.539*** (0.0821)	0.024 (0.0254)	0.007 (0.0059)	0.005 (0.0057)	0.002 (0.0064)
Income p.c. growth	0.583*** (0.1266)	0.430*** (0.0628)	0.227*** (0.0275)	0.198*** (0.0261)	0.198*** (0.0261)	0.583*** (0.1269)	0.430*** (0.0629)	0.227*** (0.0275)	0.197*** (0.0261)	0.197*** (0.0261)
L.Income p.c. growth	0.368*** (0.1020)	0.319*** (0.0536)	0.091*** (0.0144)	0.069*** (0.0128)	0.069*** (0.0129)	0.378*** (0.1049)	0.321*** (0.0543)	0.092*** (0.0146)	0.069*** (0.0129)	0.070*** (0.0130)
Population growth	3.259*** (0.5611)	1.371*** (0.2322)	0.726*** (0.0525)	0.631*** (0.0442)	0.631*** (0.0442)	3.467*** (0.5570)	1.399*** (0.2337)	0.733*** (0.0528)	0.636*** (0.0443)	0.636*** (0.0441)
L.Population growth	0.937*** (0.3467)	0.829*** (0.1010)	0.033 (0.0396)	-0.024 (0.0364)	-0.024 (0.0365)	0.770** (0.3329)	0.808*** (0.1006)	0.027 (0.0392)	-0.029 (0.0361)	-0.029 (0.0362)
House price growth				0.069*** (0.0073)	0.069*** (0.0073)				0.070*** (0.0074)	0.069*** (0.0075)
House price growth \times BGR (MSA, LIB)				0.000 (0.0008)						
House price growth \times BGR (MSA, LIB \times distance)									0.002 (0.0010)	
Obs.	8,507	8,507	8,507	8,507	8,507	8,507	8,507	8,507	8,507	8,507
MSAs	371	371	371	371	371	371	371	371	371	371
Adj. R-Sq	0.77	0.56	0.65	0.67	0.67	0.77	0.55	0.65	0.67	0.67

Notes: This table presents the second stage instrumental variable (IV) estimations. In columns (1) - (5), the potentially endogenous part of the BGR, that is, the market shares in mortgage origination at the MSA level, are instrumented with an index of branching deregulation (LIB), and the lender-specific variables presented in Table 5. Columns (6) - (10) show the results when also considering distance between lenders' headquarters and the MSA mortgages are originated in. MSA fixed effects and year dummies are included in all regressions. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 7: State level regressions

	(1) MORTG	(2) HP	(3) EMP	(4) EMP	(5) EMP
BGR (state)	28.076*** (4.67)	4.293*** (1.14)	0.717** (0.30)	0.474 (0.29)	0.543 (0.35)
Income p.c. growth	1.350** (0.55)	0.551*** (0.12)	0.221*** (0.02)	0.190*** (0.02)	0.190*** (0.02)
L.Income p.c. growth	0.348 (0.54)	0.645*** (0.10)	0.167*** (0.02)	0.130*** (0.02)	0.130*** (0.02)
Population growth	3.565** (1.59)	0.868 (0.57)	0.724*** (0.26)	0.675*** (0.24)	0.675*** (0.24)
L.Population growth	-0.461 (1.43)	0.052 (0.55)	-0.369* (0.19)	-0.372** (0.17)	-0.373** (0.17)
House price growth				0.056*** (0.01)	0.054*** (0.01)
House price growth \times BGR (state)					-0.024 (0.05)
Obs.	1,225	1,225	1,225	1,225	1,225
States	49	49	49	49	49
Adj. R-Sq	0.81	0.64	0.82	0.84	0.84

Notes: This table presents the results for estimations at the state level. The *BGR* is based on shocks at the lender level that are specific to destination markets. State fixed effects and year dummies are included in all regressions. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 8: Lender-MSA-specific effects from the bank and non-bank mortgage origination

	(1) MORTG	(2) HP	(3) EMP	(4) EMP	(5) EMP
BGR ^{bank}	12.758*** (2.20)	2.146*** (0.36)	0.378*** (0.12)	0.235* (0.12)	0.105 (0.14)
BGR ^{shadow}	11.260*** (2.88)	1.114*** (0.37)	0.255* (0.13)	0.181 (0.13)	0.173 (0.13)
Income p.c. growth	0.548*** (0.12)	0.425*** (0.06)	0.217*** (0.03)	0.189*** (0.03)	0.189*** (0.03)
L.Income p.c. growth	0.398*** (0.10)	0.319*** (0.05)	0.092*** (0.01)	0.071*** (0.01)	0.071*** (0.01)
Population growth	3.372*** (0.56)	1.435*** (0.25)	0.728*** (0.05)	0.633*** (0.04)	0.632*** (0.04)
L.Population growth	1.132*** (0.30)	0.901*** (0.10)	0.050 (0.04)	-0.010 (0.04)	-0.007 (0.04)
House price growth				0.066*** (0.01)	0.071*** (0.01)
House price growth \times BGR ^{bank}					0.049** (0.02)
House price growth \times BGR ^{shadow}					-0.002 (0.03)
Obs.	7,753	7,753	7,753	7,753	7,753
MSAs	371	371	371	371	371
Adj. R-Sq	0.80	0.57	0.66	0.68	0.68
p-value (bank=nonbank)	0.61	0.062	0.54	0.77	0.73

Notes: This table shows the panel regression of macroeconomic outcomes on the Banking Granular Residual based on depository institutions (BGR^{bank}) and on non-depository institutions (BGR^{shadow}). Lender types are identified with the HMDA lender file kindly by Robert B. Avery. MSA fixed effects and year dummies are included in all regressions. Robust standard errors in parentheses and clustered at MSA-level, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.