Housing Speculation and Housing Cycles

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ABSTRACT

In contrast to the conventional wisdom that supply elasticity in housing markets attenuates price cycles, we document in the recent U.S. housing cycle a hump-shaped pattern with respect to supply elasticity in both the housing price increase during the boom period of 2004 to 2006 and the price drop during the bust period of 2007 to 2009. We also find that the rise in investment home purchases during the boom, which were likely made by homebuyers unfamiliar with local housing market conditions, were particularly large in areas with intermediate elasticities. Furthermore, these investment home purchases also led to large quantities of housing supply during the boom in these areas, which resulted in an overhang problem that amplified the subsequent housing price bust.

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Conventional wisdom posits that areas with more inelastic housing supplies have more pronounced price increases during booms, while more elastic areas have more dramatic supply increases. The mechanism behind these monotonic relationships is intuitive: in inelastic areas, where the housing supply is constrained, prices adjust to accommodate demand shocks during booms, while in elastic areas, upward pressure on housing prices induces more building to keep prices equal to marginal cost. Consistent with this conventional wisdom, Glaeser, Gyourko, and Saiz (2008), for instance, find that supply elasticity has significant explanatory power for housing booms historically, but very little correlation with busts.

As noted by Glaeser (2013) and other commentators, however, during the recent U.S. housing cycle in the 2000s, some areas such as Las Vegas and Phoenix experienced more dramatic housing price booms and busts, despite their relatively elastic housing supply, compared to areas with more inelastic supply, such as New York and Los Angeles. Different cities in the U.S. experienced largely synchronized price booms and busts during this period, even though the magnitudes of the cycle varied across cities. Figure 1 displays the real house price indices for the U.S. and three cities, New York, Las Vegas, and Charlotte, from 2000 to 2010. According to Saiz's (2010) widely used measure of supply elasticity, the elasticity measures for New York, Las Vegas, and Charlotte are 0.76, 1.39, and 3.09, respectively.

The national housing market experienced a significant boom and bust cycle in the 2000s with the national home price index increasing over 60 percent from 2000 to 2006 and then falling back to the 2000 level through 2010. New York, which has severe geographic constraints and building regulations, had a real housing price appreciation of more than 80 percent during the boom, and then declined by over 25 percent during the bust. Charlotte, with its vast reserves of developable land and few building restrictions, had an almost flat real housing price level throughout this decade. Sitting in between New York and Charlotte, Las Vegas, with its intermediate supply elasticity, experienced the most pronounced price expansion of over 120 percent during the boom, and the most dramatic price drop of over 50 percent during the bust.

Are Las Vegas and Phoenix unique in experiencing these dramatic housing cycles despite their relatively elastic housing supply? These cities are currently viewed as outliers in the literature rather than evidence of a more nuanced relationship in the recent U.S. housing cycle between housing price variance and supply elasticity. To answer this question, we systematically

examine the cross-section of the booms and busts experienced by different zip codes in the 2000s. By regressing the housing price increase over the boom period of 2004 to 2006 and the price drop in the bust period of 2007 to 2009 on Saiz's elasticity measure, we find a hump-shaped relationship between the magnitudes of the housing price booms and busts experienced by different zip codes and their supply elasticity. This is in contrast to the monotonically decreasing relationship commonly perceived in the literature. Furthermore, this hump-shaped relationship between housing supply and housing cycles is difficult to reconcile with conventional theories of housing supply and demand.

To help understand this puzzle, we examine the roles played by investment home purchases and housing supply during the boom. Our analysis is motivated by the micro-level evidence of Chico and Mayer (2015) and Case, Shiller, and Thompson (2015). Chinco and Mayer (2015) highlight the importance of speculators for understanding the housing price boom and bust cycles in 21 cities including Las Vegas, Miami, and Phoenix, while Case, Shiller, and Thompson (2015) provide survey evidence that home buyers underappreciated the ability of the housing supply to respond to demand in the recent cycle. Speculation in the housing market became a national phenomenon in the low interest rate environment of the mid-2000s, with non-owner-occupied home purchases contributing to 30% of all home purchases during the boom in some cities such as Las Vegas.

Since investment homebuyers may not be well-informed about local housing market conditions, these speculators may be more susceptible to neglecting the supply response during booms. This underappreciation of the supply-side of the housing market is likely to be most severe in areas with intermediate supply elasticities, where it is more difficult to disentangle the impact of supply and demand in driving housing price appreciation. This is a key economic mechanism illustrated by the theory of Gao, Sockin, and Xiong (2015). This mechanism would also lead to an increase in housing supply that is most pronounced at intermediate supply elasticities.

Consistent with this mechanism, we find that, similar to the house price boom and bust cycles, there is also a non-monotonic pattern in the fraction of non-owner-occupied home (secondary home) purchases during the boom period of 2004 to 2006 across zip codes with different supply elasticities. The highest level of purchases occurred in zip codes with intermediate supply

elasticities, as opposed to zip codes with either the most elastic or inelastic housing supplies. Furthermore, we find that zip codes with a greater share of non-owner-occupied home purchases during the boom period of 2004 to 2006 also experienced larger price increases during the boom, and larger price drops in the bust period of 2007 to 2009. These correlations suggest a connection between investment home purchases and the housing cycle.

How did home buyer speculation impact the housing cycle? Our analysis highlights an important transmission channel through housing supply. First, there is also a hump-shaped pattern in the housing supply increase during the boom period of 2004 to 2006, as measured by new building permits, across zip codes with different elasticities. In addition, zip codes with a larger share of non-owner-occupied home purchases during the boom period also experienced larger increases in housing supply. These two findings suggest that housing speculation may have contributed to the housing cycle by inducing more building in zip codes with intermediate elasticities.

While Glaeser, Gyourko, and Saiz (2008) find a lack of correlation between housing supply elasticity and housing price busts historically, we document a positive correlation across zip codes between the housing supply increase during the boom period of 2004 to 2006 and the house price drop during the bust period of 2007 to 2009. This indicates that, contrary to conventional wisdom, supply elasticity has significant explanatory power for the magnitude of the housing price bust in the recent cycle. Though this correlation may merely reflect a supply overhang problem in which building during the boom exacerbated the house price drop during the bust, the underlying mechanism may be more subtle. To the extent that builders and home buyers should have rationally anticipated at the time of the boom the future price impact of the housing supply response in the event of a future bust, this correlation suggests that home buyers may not have fully appreciated the supply overhang problem.

Finally, we also find that controlling for the increase in housing supply reduces the non-monotonicity in the housing price drop during the bust period with respect to supply elasticity. Taken together, our findings point to an important role played by housing speculation in inducing largest housing supply increases and most pronounced price cycles in zip codes with intermediate supply elasticities.

Our paper contributes to the empirical housing literature by uncovering a hump-shaped relationship between recent housing cycles, non-owner occupied home purchases, and supply elasticity. In contrast with the common intuition that a more elastic housing supply mitigates house price volatility, a small, growing literature has documented that some relatively unconstrained areas recently experienced more pronounced house price boom-bust cycles, for example Davidoff (2013), Glaeser (2013), and Nathanson and Zwick (2015). None of these papers, however, examine this non-monotonic cross-sectional variation of house prices systematically or highlight the importance of the supply increase during the boom for the price drop during the bust. Gao (2013) also documents this puzzling phenomenon for prices and non-owner occupied home purchases across the U.S. housing market, but instead rationalizes it with the time-to-build feature and over-building behavior of the housing supply side and extrapolative expectations on the demand side.

In addition, the existing literature has emphasized the importance of accounting for home buyers' expectations (and in particular extrapolative expectations) in understanding dramatic housing boom and bust cycles, e.g., Case and Shiller (2003), Glaeser, Gyourko, and Saiz (2008), and Piazzesi and Schneider (2009). More recently, however, Glaeser (2013) and Case, Shiller, and Thompson (2015) have highlighted the importance of incorrect beliefs about housing supply for understanding home buyer behavior. Our work links these observations to the recent U.S. housing cycle through the channel of investment home purchases.

This paper is organized as follows. Section I describes the data used in the analysis. Section II summarizes the puzzling phenomenon of a non-monotonic pattern in the house price increase during the boom period and in the house price drop during the bust period of the recent U.S. housing cycle. We analyze non-owner-occupied home purchases in Section III and housing supply in Section IV. Section V concludes the paper.

I. Data Description

Table 1 provides summary statistics for a set of variables used in our analysis. We investigate the recent U.S. housing boom and bust cycle and focus on 2004 to 2006 as the boom period and

2007 to 2009 as the bust period.[1] Accordingly, we annualize the changes in house prices and fundamental factors in 2004 to 2006 and in 2007 to 2009.

Our house price data come from the Case-Shiller Home Price indices. We use zip code level price index data for our empirical tests. Case-Shiller Home Price Indices are constructed from repeated house sales in the sample. We deflate the Case-Shiller home price indices with the Consumer Price Index (CPI) from the Bureau of Labor Statistics. The annualized real house price change has a mean of 8.95% during the boom period across the zip codes in our sample, and a mean of -13.2% during the bust period.

For housing supply elasticity, we employ the widely used elasticity measure constructed by Saiz (2010). This elasticity measure reflects the difficulty in house building and focuses on geographic constraints by defining undevelopable land for construction as terrain with a slope of 15 degrees or more and areas lost to bodies of water including seas, lakes, and wetlands. This measure provides an exogenous measure of price elasticity of supply, with a lower value if an area is more geographically restricted. Saiz's measure is available for 269 Metropolitan Statistical Areas (MSAs). By matching zip codes with MSAs, our sample includes 4136 zip codes for which we have data on both house prices and supply elasticity available from 2000 to 2010. Although the sample covers only 11 percent of the number of counties and 10 percent of the number of zip codes, it represents 53 percent of the U.S. population in 2000. In this sample, the Saiz elasticity measure has a mean of 1.443 and standard deviation of 0.722.

To measure supply side activities, we use building permits from the U.S. Census Bureau, which conducts a survey in permit-issuing places all over the U.S. Compared with other construction-related measures including housing starts and housing completions, building permits have detailed county level information. In addition, building permits are issued before housing starts and therefore can predict price trends in a timely manner. Unfortunately, the Census Bureau does not provide building permit data at the zip code level. To carry out our analysis at the zip code level, we project this series at the county level onto the zip code level by allocating an equal fraction of the new building permits in a given county across its zip codes. Specifically, we construct the measure of new housing supply during the boom period as the

[1] Haughwout, Peach, Sporn and Tracy (2012) identify the boom period as 2000 to 2006 and the bust period as 2007 to 2010 in their analysis. We focus on a subset of these intervals. Glaeser (2013) also identifies 2006, when the Case-Shiller Index peaked in April, as the turning point in the recent cycle.

building permits issued from 2004 to 2006 relative to the existing housing units in 2000 that we collect from 2000 U.S. census data. This measure has a mean of 0.0494 across the zip codes in our sample and a substantial standard deviation of 0.0491.[2]

We collect fundamental factors at zip code level from various sources. Annual population and annual per capita income at zip code level are available from the Internal Revenue Service (IRS). The IRS does not, however, provide data in 2003. We thus use the data in 2002 and 2006 to calculate the changes during the boom period. These two variables at the county level are from the Bureau of Economic Analysis. Annual total employment, annual payroll, the number of establishments at the zip code level are from the Zip Code Business Patterns database. We include both residents' income and annual payroll from the employers because, as argued by Mian and Sufi (2009), residents in a certain area do not necessarily work in the same place that they live. The annualized population change in 2003-06 has a mean of 2.21% and a large standard deviation of 6.43%. The annualized population change in 2007-09 has a mean of 1.91% and again a large standard deviation of 6.46%. The annualized per capita income change has a mean of 1.57% in 2003-06 and -3.74% in 2007-09, which is consistent with the severe economic recession during the bust period. The annualized employment change has a mean of 2.76% in 2003-06 and -2.57% in 2007-09, which is also consistent with the severe recession during the bust period. Similarly, the annualized real payroll change has a mean of 3.26% in 2003-06 and -3.26% in 2007-09.

We include several variables on credit conditions at the zip code level to control for the well-known credit expansion during the recent housing boom. The main resource for this data is the Home Mortgage Disclosure Act data set (HMDA). HMDA is a comprehensive individual mortgage application and origination data set in the U.S. We use mortgages originated for home purchases and link the lender institutions in the HUD subprime home lender list to the HMDA data and identify the mortgages issued to the subprime households. As the HUD subprime home lender list ends in 2005, we then use the fraction of subprime mortgage originations in 2005 as the share of low quality loans at the zip code and county level during the boom cycle. This

[2] We find similar results if we instead measure the increase in housing supply by the change in the fraction of employment in residential construction from the County Business Patterns dataset. Since an employee need not work in the same zip code, or even the same county, in which she lives, we prefer to use new building permits as our measure of housing supply.

fraction has a mean of 19.4% and standard deviation of 13.2%. The HMDA dataset also marks whether a mortgage application is denied by the lender, the originated mortgage is sold to the government sponsored entities (GSEs), and whether the mortgage is sold for securitization purposes. We consequently can also control for the mortgage denial rate, the share of mortgage sold to GSEs, the mortgages sold for securitizations in 2005 at zip code level.[3] The mortgage denial rate has a mean of 13.5%, the fraction of GSE mortgage has a mean of 20.4%, and the fraction of securitized mortgages has a mean of 18.8%.

The HMDA dataset also discloses the owner occupancy for each individual mortgage: whether the mortgage is for primary residence or other non-owner occupied purposes. We aggregate the HMDA data to the zip code level and calculate the fraction of mortgage origination for non-owner-occupied home purchase purposes in the total mortgage origination as our measure of the share of secondary home purchases. The fraction of non-owner-occupied home purchases in 2004-06 has a mean of 13.5% and standard deviation of 10.8%.

II. Non-monotonicity in Housing Cycles across Supply Elasticity

In this section, we document a non-monotonic pattern in the recent U.S. housing cycle across zip codes with different supply elasticities. We highlight that the housing price expansion during the boom period and the housing price contraction during the bust period both exhibit hump-shaped patterns across supply elasticity.

We first classify the zip codes in our sample into three groups based on Saiz's elasticity measure, each with the same population as measured by the 2000 U.S. Census. Panel A of Figure 2 plots the average price expansion and contraction experienced by each group during the housing cycle. It shows that the middle group has the most pronounced housing cycle, with its price expansion during the boom being substantially more pronounced than that of the inelastic group, and its price contraction during the bust slightly greater than that of the inelastic group.

Most studies that examine housing cycle and supply elasticity focus on the contrast between the most inelastic and the most elastic regions of the US. As such, they do not notice the nuanced non-monotonicity that our analysis highlights. As shown in Panel B of Figure 2, if one instead

[3] We control these variables only in 2005 as we use the subprime mortgage fraction in 2005. The results hold if we choose these controls in 2004 to 2006.

sorts counties into three groups, each with an equal number of zip codes, the average housing price increase in the boom period of 2004 to 2006 and drop in the bust period of 2007 to 2009 monotonically decreases across the inelastic, intermediate elastic, and elastic groups. The population, however, is unevenly distributed across these three groups, with the inelastic group having more than half of the total population according to the 2000 U.S. Census. This is consistent with the observation that inelastic areas tend to be densely populated. As the inelastic group pools together a large fraction of the population, there might be substantial heterogeneity between counties within the inelastic group. As evidence of this, both New York and Las Vegas fall into this inelastic group. While New York remains in the inelastic group when grouping instead with equal populations, Las Vegas now falls into the middle group.

We next systematically examine the cross-section of the booms and busts experienced by different zip codes in the 2000s to show that that the monotonically decreasing relationship between the magnitude of housing cycles and supply elasticity is more fragile than commonly perceived. We have 4136 zip codes with both observations of Case-Shiller price index and Saiz's elasticity measure. We also add various controls of economic fundamentals and credit conditions into our analysis, including state fixed effects and clustered standard errors at the MSA level. Different from the simple group analysis using zip code level data, we introduce quadratic terms of Saiz's elasticity measure. Specifically, we regress annualized real house price changes during the boom (and bust) period on both linear and quadratic terms of the elasticity measure and report the results in Table 2.

During the boom period of 2004 to 2006, the coefficient of the linear term is positive with marginal significance while the coefficient of the quadratic term is significantly negative, both without and with controls. The fitted quadratic function is a parabola that opens downwards. The maximum of the parabola lies at the elasticity measure of 1.541 without controls and 1.563 with controls. Several of the control variables also have significant coefficients. The price change during the boom is positively correlated with both annualized population change and annualized per capita income change in the same period, which represent the strength of local economic fundamentals, and with the annualized change in number of establishments in this period, a measure of the supply side activity. The price change during the boom is also positively correlated with the fraction of subprime mortgages, mortgage denial rate, and fraction of GSE

mortgages in 2005, consistent with the argument advanced by Mian and Sufi (2009) that a credit expansion to subprime households was a key driver of the housing boom.

During the bust period of 2007 to 2009, the coefficient in Table 2 is significantly negative for the linear term while it is significantly positive for the quadratic term. The parabola of the fitted quadratic function opens upwards. The minimum of the parabola lies at the elasticity measure of 1.477 without controls and 1.604 with controls in the regressions.[4] The price change during the bust period is also negatively correlated with the fraction of subprime mortgages in 2005, confirming a reversal of the price boom caused by the subprime credit expansion, and positively correlated with the annualized per capita income in 2007 to 2009, a measure of local economic strength.

Figure 3 illustrates the fitted line of the quadratic functions after regressing the annualized real house price change in 2004 to 2006 on the linear and quadratic terms of elasticity measure and controls, together with scatters of 25 zip code groups clustered by supply elasticity and de-trended by the controls in the same figure. This figure graphically illustrates a hump-shaped relationship between the price increases and supply elasticity. Similarly, Figure 4 shows the fitted line of bust period (2007 to 2009) regression and the scatter plot of 25 zip code groups, demonstrating the U-shaped curve between the price drop and supply elasticity. Both figures show that the areas with intermediate elasticity (between 1 and 2 of Saiz's elasticity measure) exhibit the most significant boom and bust cycles.[5]

These non-monotonic patterns of housing booms and busts in the recent U.S. cycle challenge conventional wisdom on the role of supply elasticity. In contrast to a monotonically decreasing pattern in price booms, housing price increases from 2004 to 2006 exhibit a hump-shaped pattern across supply elasticity. More strikingly, the recent cycle also displays a U-shaped pattern in the housing price drops from 2007 to 2009 across supply elasticity. Existing supply-side mechanisms suggest supply elasticity has no explanatory power for housing price busts.

[4] In Internet Table 1, we demonstrate that a linear regression of the housing price boom and bust on Saiz's elasticity measure has insignificant coefficients. In accordance with conventional wisdom, the coefficient is negative, though small, during the boom period. Interestingly, the coefficient is larger and positive for the bust period.

[5] In Figures 1 and 2 of the Internet Appendix, we plot the fitted lines and de-trended data for two semi-parametric regression specifications as robustness checks. The first estimates a fractional polynomial, while the second employs 25 dummy variables for different elasticity buckets**.** Both demonstrate the non-monotonic pattern found with the quadratic regressions for the recent cycle.

Consistent with this intuition, Glaeser, Gyourko, and Saiz (2008) find little correlation historically between supply elasticity and housing price busts. Consequently, this non-monotonic pattern for the bust period is puzzling and outside the scope of conventional theories.

III. Housing Speculation

How can one explain this puzzling non-monotonic pattern in the housing price cycles with respect to supply elasticity? As we highlight in the introduction, the recent housing cycle saw widespread speculation by home buyers who purchased housing for investment purposes. In this section, we explore the potential link between housing cycles and speculation in the housing market.

We construct the fraction of non-owner-occupied home purchases at the zip code level from the HMDA dataset. The HMDA has comprehensive coverage for mortgage applications and originations in the US, and we use mortgage originations as our measure of home purchases. Since the HMDA dataset also identifies owner occupancy for each individual mortgage, we calculate the fraction of mortgage originations for non-owner occupied homes in total originations as our measure of the share of non-owner occupied home purchases.

Figure 5 depicts the fraction of non-owner-occupied home purchases for the U.S. and three cities, New York, Las Vegas, and Charlotte, from 2000 to 2010. Non-owner-occupied home purchases represent a sizable fraction of mortgage originations, comprising 15.31% of all new originations in the US at the peak in 2005. While non-owner-occupied home purchases capture both secondary home and investment home purchases, the behavior of this series is consistent with speculation in investment homes, which became a national phenomenon in the low interest rate environment of the mid-2000s. Furthermore, evidence at the micro level in Chinco and Mayer (2015) suggests that speculation by investment home buyers played an important role in the dramatic housing price boom and bust cycles in 21 cities including Las Vegas, Miami, and Phoenix. We indirectly test this insight on the national cross-section of US zip codes. Among the three cities, Las Vegas has the highest fraction of non-owner-occupied home purchases, which rises from a level 17.77% in 2000 to 29.41% in 2005 and then drops down to 17.77% in 2008. New York has the lowest fraction, which, while having a synchronous rise and fall, remains below 7% during this period.

A. Non-monotonicity in Non-owner-occupied Home Purchases

We first present evidence on a non-monotonic pattern in non-owner-occupied home purchases. Like before, we classify the zip codes in our sample into three groups based on Saiz's elasticity measure, each with the same population as measured by the 2000 U.S. Census. Panel A of Figure 6 plots the average fraction of non-owner-occupied home purchases by each group during the housing boom period of 2004-06. Interestingly, it shows another non-monotonic pattern across the three groups---the middle group has the highest fraction of 17.88%, while the inelastic group has the lowest fraction of 11.69%.

Panel B of Figure 6 again shows that the typical sorting of zip codes into three groups, each with an equal number of zip codes, would mask this nuanced non-monotonic pattern. According to this sorting, the inelastic group has the highest fraction of 16.03% non-owner-occupied home purchases during the boom, while the middle group has a slightly smaller fraction of 15.52%.

To systematically establish this non-monotonic pattern, we regress the fraction of non-owner-occupied home purchases in 2004-06 on the linear and quadratic terms of Saiz's elasticity measure, together with a list of control variables. Table 3 reports the coefficient estimates. The coefficient of the quadratic term is significantly negative, with or without the control variables. As the linear term is significantly positive, the fitted quadratic function is a parabola that opens downwards. The maximum of the parabola lies at the elasticity measure of 2.49 without controls and 2.48 with controls. Several of the control variables also have significant coefficients. In particular, the coefficient of fraction of subprime mortgages in 2005 is significantly negative, suggesting that non-owner-occupied home purchases are more concentrated in non-subprime areas and thus not driven by the subprime credit expansion. The coefficient of annualized per capita income change in 2004-06 is significantly positive, suggesting that the non-owner-occupied home purchases are positively correlated with local economic fundamentals.

Figure 7 illustrates the fitted line of the quadratic functions after regressing the fraction of non-owner-occupied home purchases in 2004 to 2006 on the linear and quadratic terms of elasticity measure and controls, together with scatters of 25 zip code groups clustered by supply elasticity and de-trended by the controls in the same figure. This figure graphically illustrates a

hump-shaped pattern in the fraction of non-owner-occupied home purchases during the boom period of 2004 to 2006 of the recent US housing cycle with respect to supply elasticity. [6]

B. Housing Speculation and Price Cycle

Is the non-monotonic pattern in housing speculation related to that observed in housing cycles across zip codes from Section II? In this subsection, we document a positive link between investment home purchases and housing cycles as evidence of a potential relationship between them.

Table 4 reports the results from regressing the annualized real house price changes during the boom period of 2004 to 2006 and the bust period of 2007 to 2009 on the fraction of non-owner-occupied home purchases in 2004 to 2006, together with a list of control variables that we have used in the housing price regressions reported in Table 2. Panel A shows that the coefficient on the fraction of non-owner-occupied home purchases is positive and significant during the boom period, with and without including the control variables, while Panel B shows that the coefficient is negative and significant during the bust period, again with and without the control variables. The coefficients of the control variables are similar to those reported in Table 2.

We emphasize that while the regression results reported in Table 4 highlight a positive correlation between home buyer speculation and housing cycles, they are not evidence of a causal relationship. To the extent that the fraction of non-owner-occupied home purchases in 2004 to 2006 also exhibits a non-monotonic pattern with respect to supply elasticity, the positive cross-sectional correlations of the fraction of non-owner-occupied home purchases with the price increase during the boom and the price decrease during the bust suggest that housing speculation offers a promising direction to explore.

IV. Housing Supply and Cycles

How would housing speculation affect housing cycles? In this section, we describe and present evidence of such a mechanism. During the boom period of a housing cycle, the rising prices would induce optimism among potential home buyers about prices rising further. In

[6] Internet Figure 3 demonstrates that this non-monotonic pattern is robust to two semi-parametric specifications: regressing the change in the share of non-owner occupied home purchases on 25 elasticity dummies and fitting it with fractional polynomials.

particular, the micro-level evidence provided by Chinco and Mayer (2015) suggests that rising prices tend to attract investment from out-of-town home buyers. The buying pressure of investment-home buyers would further push up the house prices in the area, which in turn would motivate builders to build more houses. While the housing speculation can absorb the increased housing supply during the boom, the increased supply would eventually flow back to the market during the bust when investment home buyers unwind their investments. As a result, there would be a supply overhang, which would exacerbate the price decline during the bust.

This mechanism implies two key predictions for us to examine in the data: First, we expect housing supply during the boom period to be positively correlated with non-owner-occupied home purchases across zip codes. Second, we expect the price decline during the bust also to be positively correlated with housing supply during the boom. This implies that zip codes with a larger housing supply increase during the boom would experience more severe price declines during the bust.

The first prediction is not unique to this mechanism. Even if investment-home buyers have rational expectations, one would expect a positive correlation between housing supply and investment-home purchases as both variables are positively correlated with the local economic fundamentals and house prices. Housing speculation with rational expectations, however, would not give the second prediction. If home buyers have rational expectations, they should anticipate, at the time of the boom, the overhang effect of housing supply when the cycle reverses itself. Thus, one should not expect the price decline during the bust to be correlated with housing supply during the boom. Thus, by systematically examining these two predictions, we can shed some light on how housing speculation affects the housing cycle.

Important to our mechanism is the interaction between home buyer expectations and housing supply elasticity. Irrational expectations, such as trend-chasing, alone cannot generate these hump-shaped patterns. As highlighted by Glaeser, Gyourko, and Saiz (2008), irrational expectations, including extrapolative expectations, and an elastic housing supply give rise to a monotonically decreasing relationship between supply elasticity and housing price variance, and a monotonically increasing relationship between supply elasticity and the increase in housing supply during the boom. This occurs because a more elastic housing supply mutes the price impact of a positive shock to home buyer expectations but leads to overbuilding. Consequently,

our results provide evidence of a more nuanced role for supply elasticity in shaping home buyer expectations.

To continue our analysis at the zip code level, we construct a measure of housing supply from the Census Bureau's New Building Permits, which is available only at the county level. Specifically, we project this series onto the zip code level by allocating an equal fraction of the new building permits in a given county across its zip codes. [7]

Figure 8 depicts the annual building permits granted in 2000 to 2010 relative to the number of housing units in 2000 for the U.S. and three cities, New York, Las Vegas, and Charlotte. At the national level, the annual building permits has a modest increase from 1.05% in 2000 to 1.45% in 2005 and then a substantial drop to 0.38% in 2009. As one would expect, New York has a tight housing supply, with the annual building permits staying at a flat level of less than 0.4% throughout this decade. Interestingly, among the three cities, Las Vegas has the most dramatic rise and fall in its annual building permits---rising from 2.03% in 2000 to a level above 5% in 2005 and 2006 and then dropping to 0.50% in 2009, well synchronized with the cycles in the house prices and the fraction of non-owner-occupied home purchases.

A. Non-monotonicity

We first compare housing supply during the boom period of 2004 to 2006 across zip codes with different elasticities. Like before, we classify the zip codes in our sample into three groups based on Saiz's elasticity measure, each with the same population as measured by the 2000 U.S. Census. Panel A of Figure 9 depicts the average annual building permits in 2004 to 2006 relative the number of housing units in 2000. It shows yet another non-monotonic pattern across the three groups---the middle group has the highest level of 6.20%, slightly higher than the elastic group with a level of 5.96%, while the inelastic group has the lowest level of just 3.27%.

Interestingly, Panel B of Figure 9 again shows that the typical sorting of zip codes into three groups, each with an equal number of zip codes, would mask this nuanced non-monotonic pattern. According to this sorting, the elastic group has the highest level of housing supply of 6.66% during the boom, while the middle group has 5.56% and the inelastic group 4.94%.

[7] In Tables 2 and 3 of the Internet Appendix, we show that our results for housing supply are robust to instead allocating new building permits at the county level to zip codes according to the fraction of the housing supply in each zip code in 2000 and to the fraction of employment in residential construction in 2000.

To systematically establish this non-monotonic pattern, we regress housing supply in 2004-06 on the linear and quadratic terms of Saiz's elasticity measure, together with a list of control variables. Table 4 reports the coefficient estimates. The coefficient of the quadratic term is significantly negative, with or without the control variables. As the linear term is significantly positive, the fitted quadratic function is a parabola that opens downwards. The maximum of the parabola lies at the elasticity measure of 2.21 without controls and 2.23 with controls. Several of the control variables also have significant coefficients. In particular, the coefficients of annualized population change and annualized employment change in 2004 to 2006 are significantly positive, consistent with the basic intuition that housing supply rising with local housing market fundamentals.

Figure 10 illustrates the fitted line of the quadratic functions after regressing the housing supply in 2004 to 2006 on the linear and quadratic terms of elasticity measure and controls, together with scatters of 25 zip code groups clustered by supply elasticity and de-trended by the controls in the same figure. This figure graphically illustrates a hump-shaped pattern in the housing supply during the boom period of the recent U.S. housing cycle with respect to supply elasticity. Taken together, the housing supply during the boom period of 2004 to 2006 also exhibits a non-monotonic pattern with respect to supply elasticity.

B. Housing Supply and Speculation

Next, we examine the cross-sectional correlation between housing supply and housing speculation during the boom period. Table 6 reports the results from regressing housing supply, measured by the average building permits in 2004 to 2006 relative to the number of housing units in 2000, on the fraction of non-owner-occupied home purchases in 2004 to 2006, together with a list of control variables, which we have previously used in the housing supply regression of Table 5. The coefficient on the fraction of non-owner-occupied home purchases is positive and significant, with and without including the control variables. This result indicates that during the boom period, the fraction of non-owner-occupied home purchases is positively correlated with housing supply across zip codes. This positive correlation is consistent with the first prediction we discussed earlier. It also suggests that the non-monotonic pattern in housing supply during the boom period with respect to supply elasticity is indeed related to the non-monotonic pattern in non-owner-occupied home purchases.

C. Supply Overhang

Finally, we examine whether the housing supply during the boom is correlated with the house price decline during the bust. While Glaeser, Gyourko, and Saiz (2008) find only a weak correlation between supply elasticity and house price busts, we demonstrated in Section II that housing price busts exhibited a hump-shaped pattern across supply elasticity in the recent US housing cycle. To test whether the supply increase during the boom period of 2004 to 2006 led to a supply overhang problem that can help explain this non-monotonic relationship, we regress the annualized real housing price drop from 2007 to 2009 on the housing supply in 2004 to 2006, as well as linear and quadratic terms of Saiz's elasticity measure and a list of other control variables.

Table 7 reports the regression results. Column (1) reports a negative and significant correlation between the supply in the boom period and the price change in the bust period with the state fixed effects, MSA-level clustered standard errors, and control variables. With one percentage increase of building permits relative to the number of housing units in 2000, the house price drops by 33 basis points annually during the bust period. This significant correlation confirms the presence of supply overhang.

Furthermore, columns (2) and (3) give an even more striking result that the non-monotonicity exhibited by the Saiz's elasticity measure in explaining the housing price bust in 2007 to 2009 is mitigated by the inclusion of the housing supply during the boom period of 2004 to 2006. Specifically, the coefficients on the quadratic terms on Saiz's elasticity measure are no longer significant, suggesting that the hump-shaped pattern across supply elasticity is related to the increase in housing supply during the boom.

Taken together, Table 7 shows that the housing supply during the boom has significant explanatory power for the housing price drop across supply elasticity during the bust period. This provides evidence that housing speculation contributed to a supply overhang problem in the recent housing cycle. This overhang problem is important for understanding the non-monotonicity in the housing price increase during the boom period and the housing price drop during the bust period.

V. Conclusion

In this paper, we document that, in contrast to conventional wisdom, both the housing price expansion during the boom period of 2004 to 2006 and the price contraction during the bust period of 2007 to 2009 exhibited hump-shaped patterns across supply elasticity in the recent U.S. housing cycle. This hump-shaped pattern is also present in the fraction of non-owner occupied home purchases and in the increase in housing supply, as measured by new building permits, during the boom period. To help explain these puzzling observations, we demonstrate that the fraction of non-owner occupied home purchases, intended to capture the upward pressure on supply from investment home buyers, is positively correlated with the change in housing supply across zip codes during the boom. We then provide evidence that this change in housing supply can help explain why supply elasticity has explanatory power for the housing price drop across zip codes during the bust. Our results suggest that supply overhang brought about by investment home buyers may have played an important role in the recent cycle. Our analysis provides evidence of a new amplification mechanism for home buyer expectations, specifically those of investment home buyers, to explain housing cycles.

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Figure 1: Case-Shiller Home Price Index

This figure plots the Case-Shiller home price index for the U.S. and three cities, New York, Las Vegas, and Charlotte. The price index is deflated by the CPI and normalized to 100 in 2000.

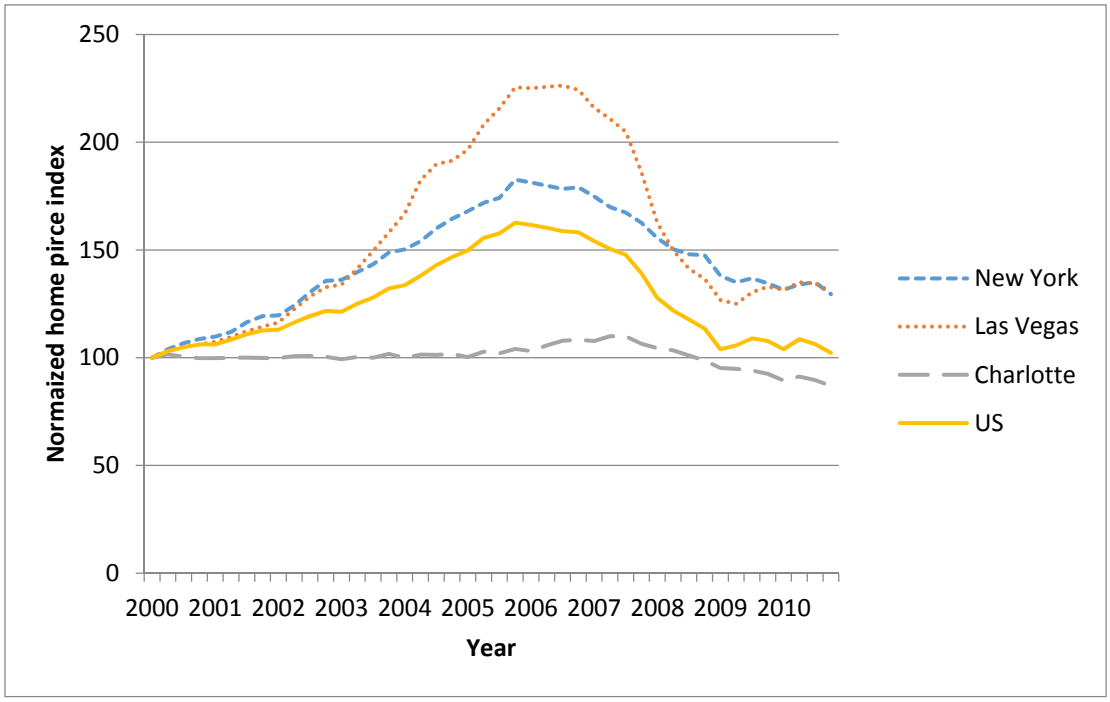
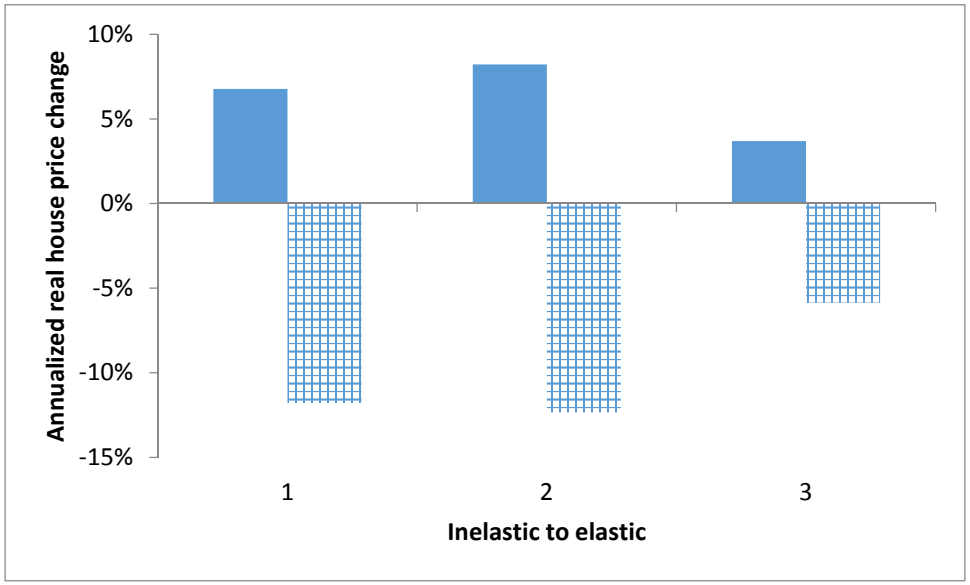


Figure 2: Housing Cycle across Three Elasticity Groups

This figure is constructed from sorting the zip codes in the U.S. into three groups based on Saiz's (2010) housing supply elasticity measure. It depicts the average housing price expansion (the annualized real house price change) during the boom period of 2004-2006 and the average housing price contraction (the annualized real house price change) during the bust period of 2007-2009 in each of the groups.

Panel A: Groups with Equal Population as measured by the 2000 U.S. Census



Panel B: Groups with Equal Number of Zip Codes

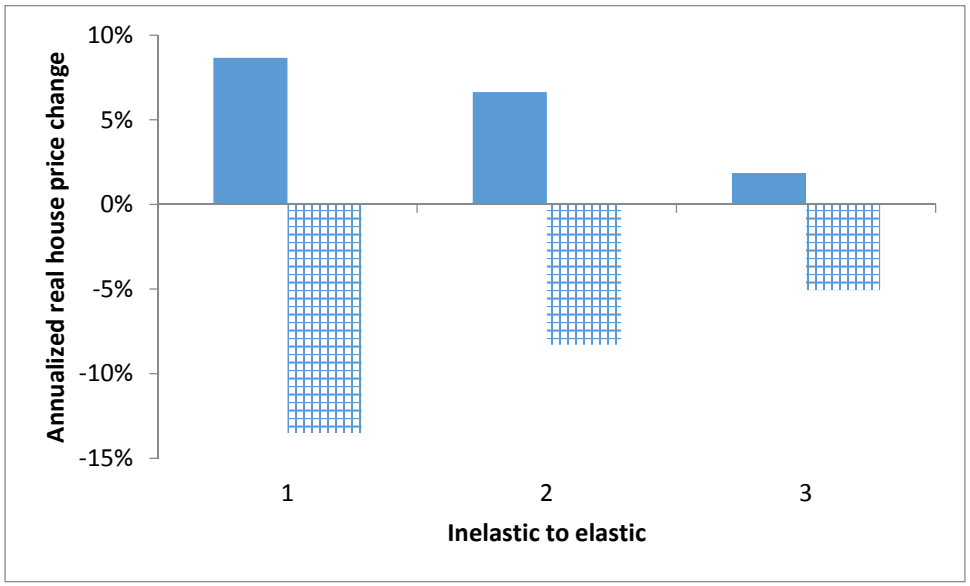


Figure 3: Quadratic Regression of Annualized Real House Price Change in 2004-06

This figure presents the annualized real house price change in 2004-2006 across supply elasticity. The fitted line is computed from a quadratic regression on supply elasticity and linear in controls, i.e., regression (2) in Table 2. The scatters are 25 zip code groups clustered by elasticity and de-trended by the controls.

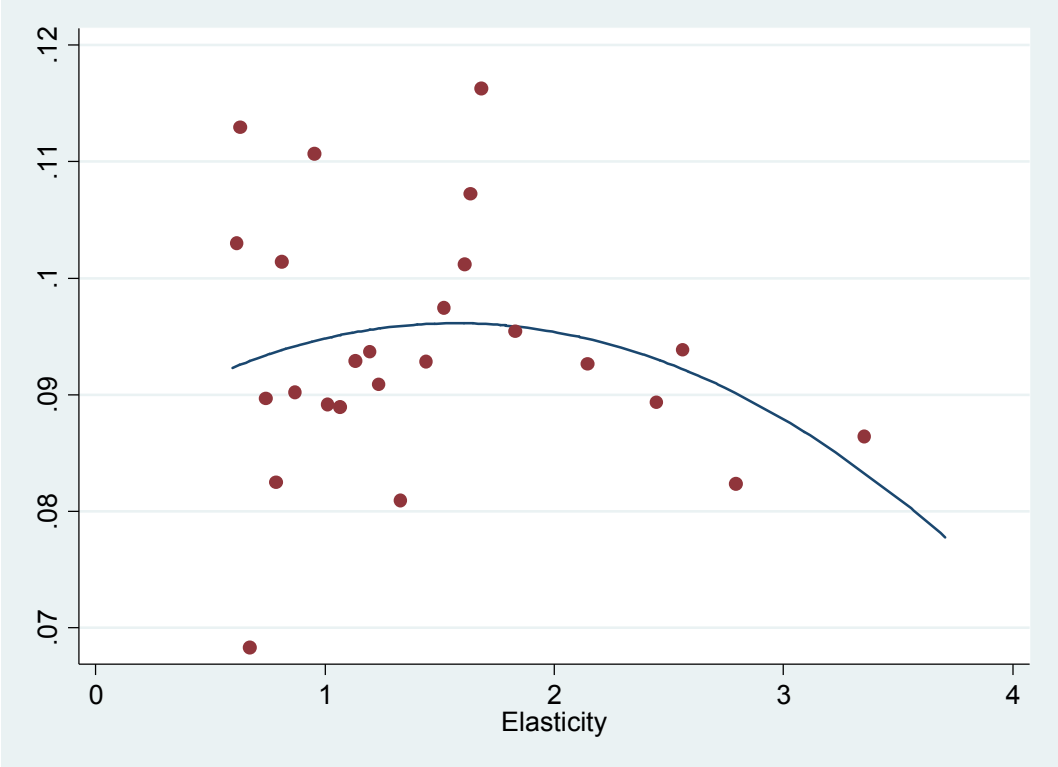


Figure 4: Quadratic Regression of Annualized Real House Price Change in 2007-09

This figure presents the annualized real house price change in 2007-2009 across supply elasticity. The fitted line is computed from a quadratic regression on supply elasticity and linear in controls, i.e., regression (4) in Table 2. The scatters are 25 zip code groups clustered by elasticity and de-trended by the controls.

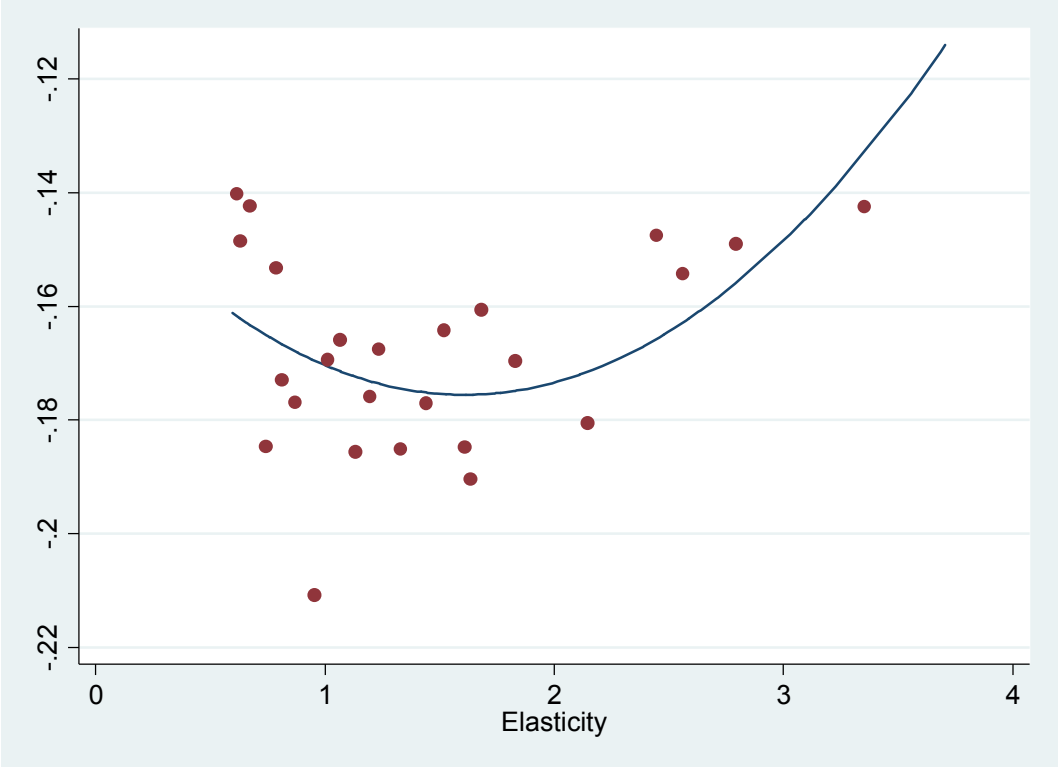


Figure 5: Fraction of Non-Owner-Occupied Home Purchases

This figure plots the share of non-owner-occupied home purchases for the U.S. and three cities, New York, Las Vegas, and Charlotte. The fraction of non-owner-occupied home purchases in each city is computed from the "Home Mortgage Disclosure Act" data set.

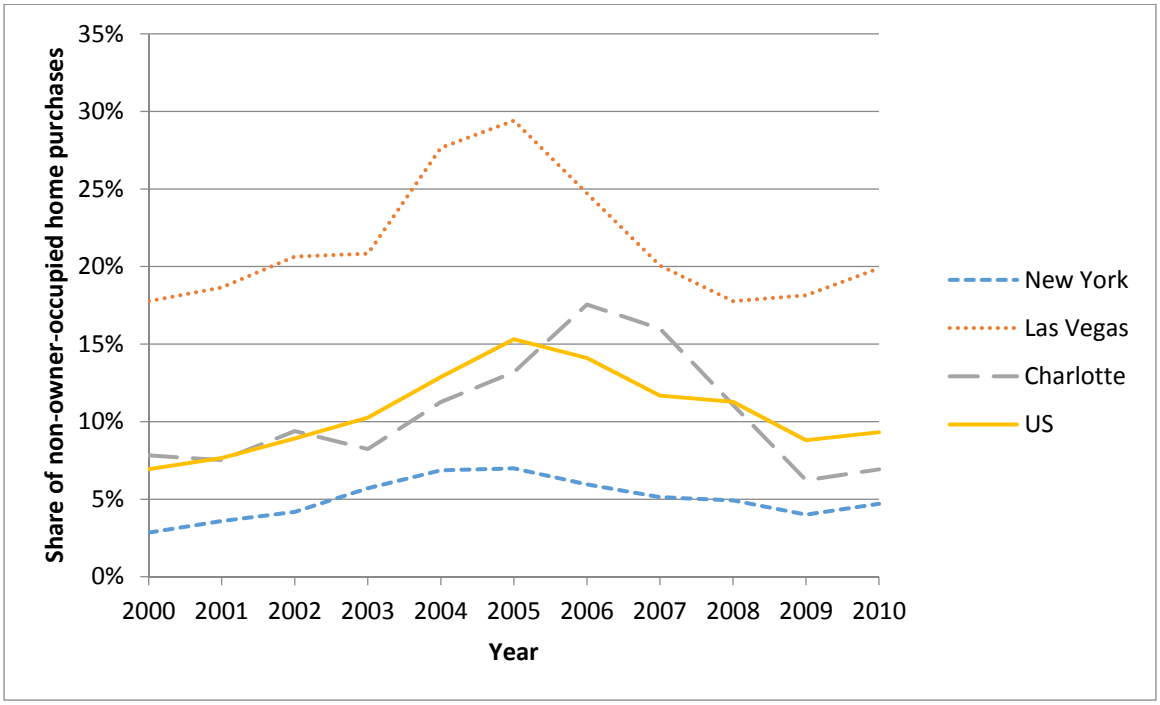
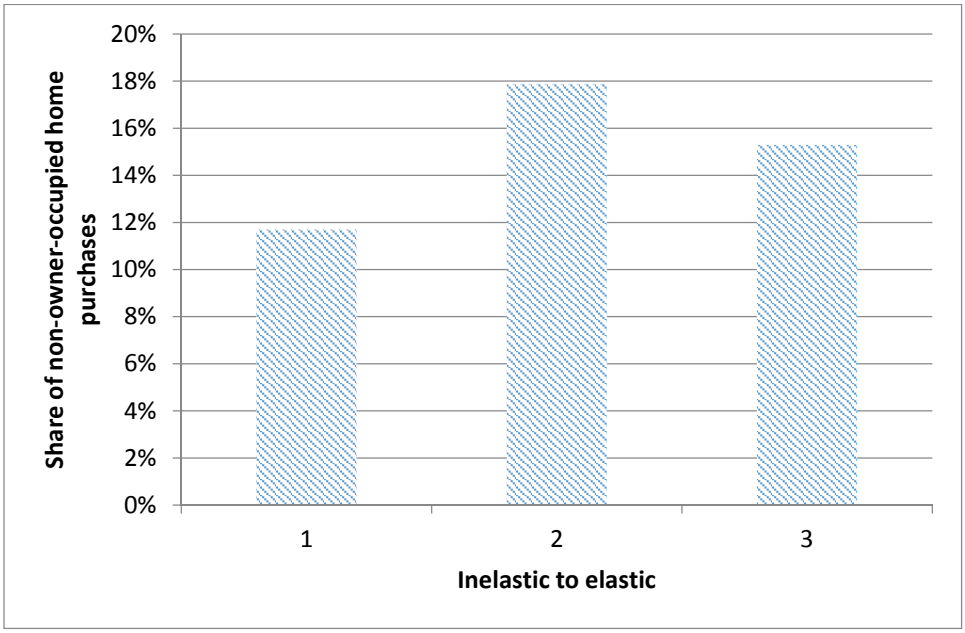


Figure 6: Fraction of Non-Owner-Occupied Home Purchases in 2004-06 across Elasticity Groups

This figure is constructed from sorting the zip codes in the U.S. into three groups based on Saiz's (2010) housing supply elasticity measure. It depicts the fraction of non-owner occupied home purchases during the boom period of 2004-06 in each of the groups. The fraction of non-owner-occupied home purchases in each county is computed from the "Home Mortgage Disclosure Act" data set.

Panel A: Groups with Equal Population as measured by the 2000 U.S. Census



Panel B: Groups with Equal Number of Zip Codes

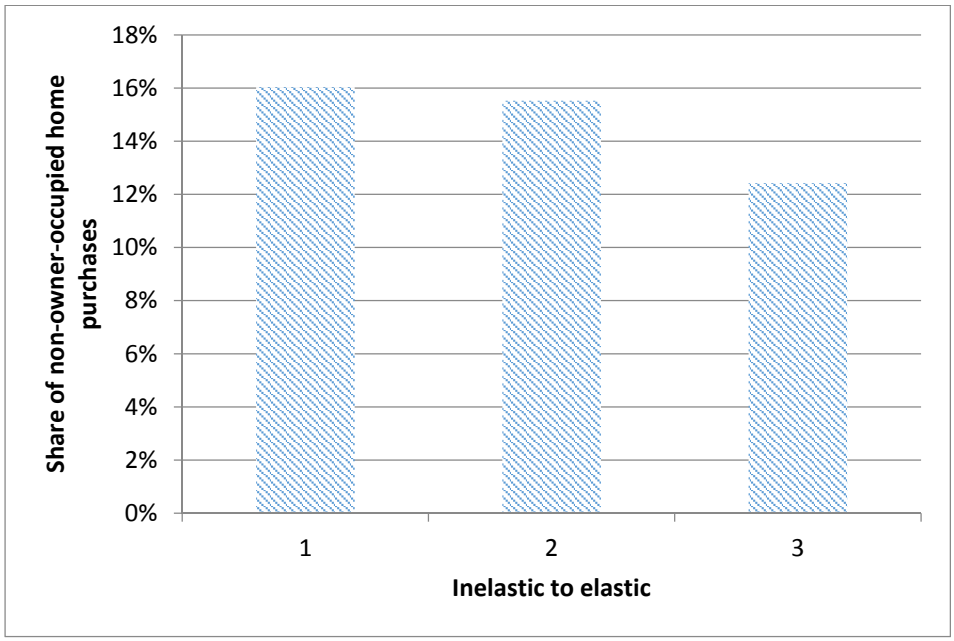


Figure 7: Quadratic Regression of Fraction of Non-Owner-Occupied Home Purchases in 2004-06

This figure depicts the fraction of non-owner-occupied home purchases in 2004-06 across supply elasticity. The fitted line is computed from a quadratic regression on supply elasticity and linear in controls. The scatters are 25 zip code groups clustered by supply elasticity and de-trended by the controls.

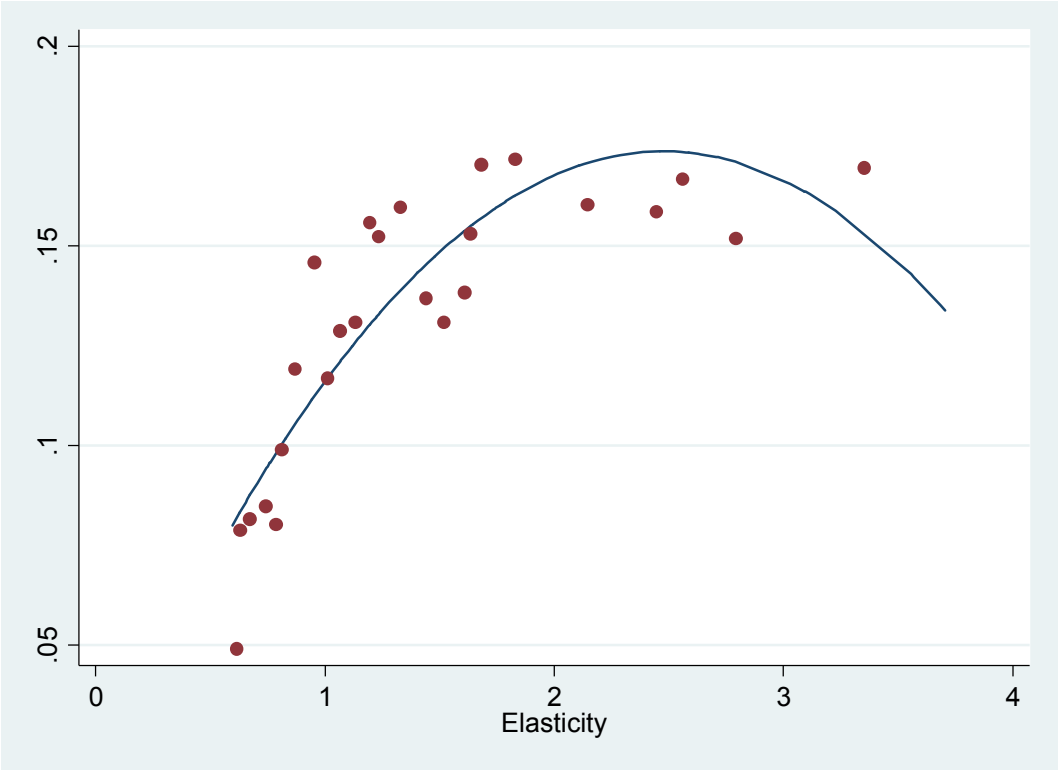


Figure 8: Housing Supply

This figure depicts building permits in 2000 to 2010 relative to the housing units in 2000 for the U.S. and three cities, New York, Las Vegas, and Charlotte.

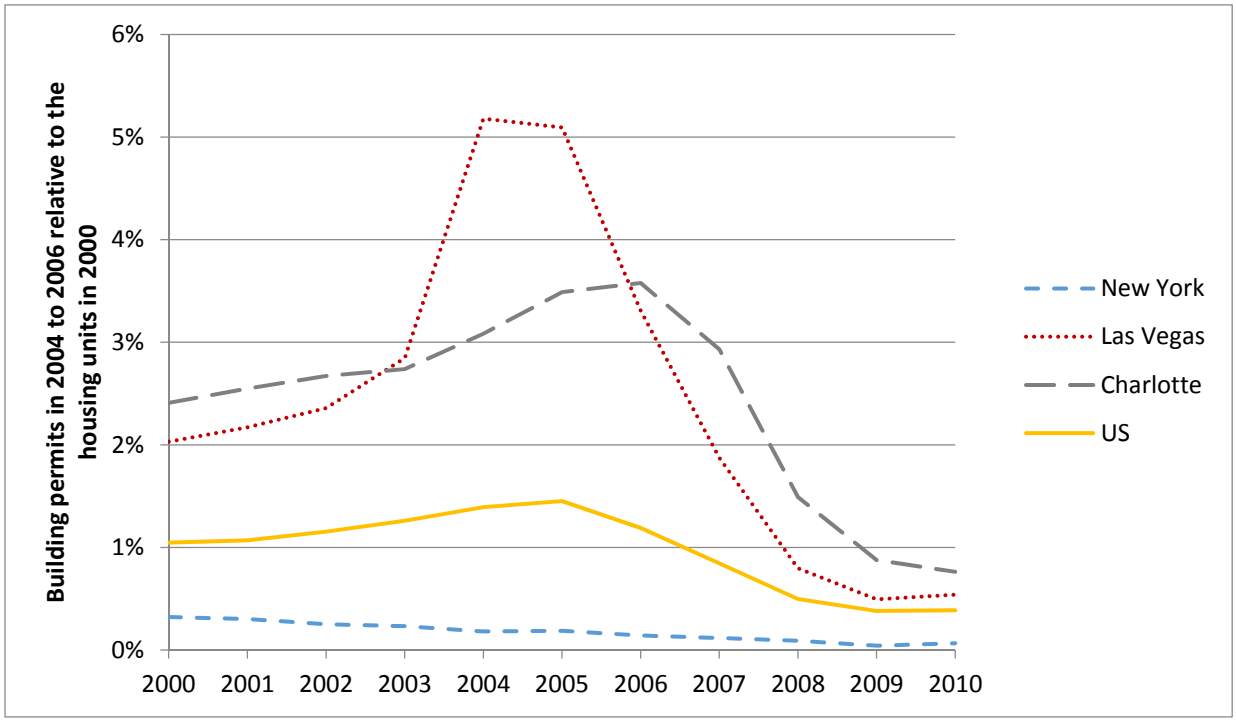
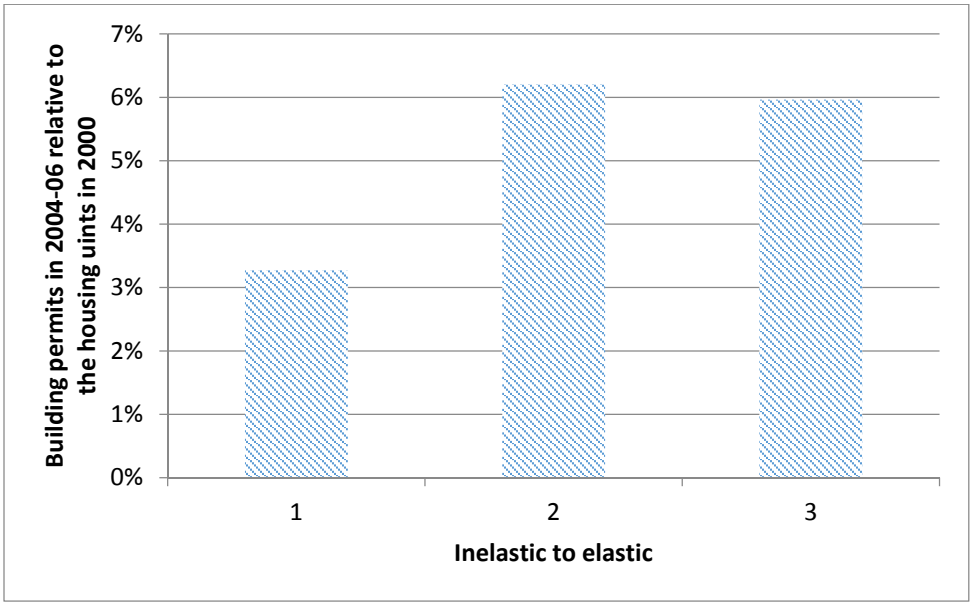


Figure 9: Housing Supply in 2004-06 across Elasticity Groups

This figure is constructed from sorting the zip codes in the U.S. into three groups based on Saiz's (2010) housing supply elasticity measure. It depicts the average annual building permits in 2004 to 2006 relative to the number of housing units in 2000 in each of the groups.

Panel A: Groups with Equal Population as measured by the 2000 U.S. Census



Panel B: Groups with Equal Number of Zip Codes

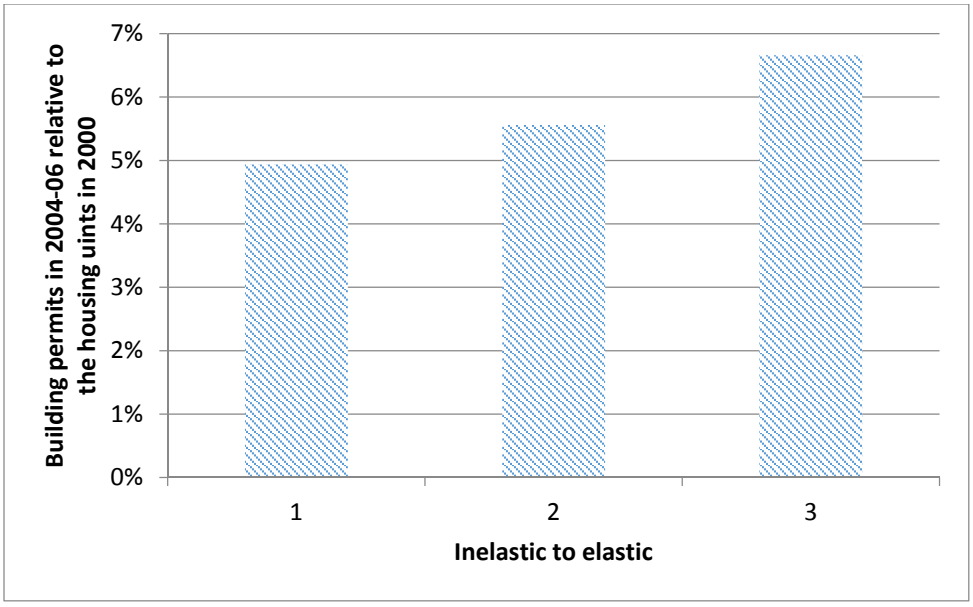


Figure 10: Quadratic Regression of Housing Supply in 2004-06 across Supply Elasticity

This figure depicts average building permits in 2004-06 relative to the number of housing units in 2000 across supply elasticity. The fitted line is computed from a quadratic regression on supply elasticity and linear in controls. The scatters are 25 zip code groups clustered by supply elasticity and de-trended by the controls.

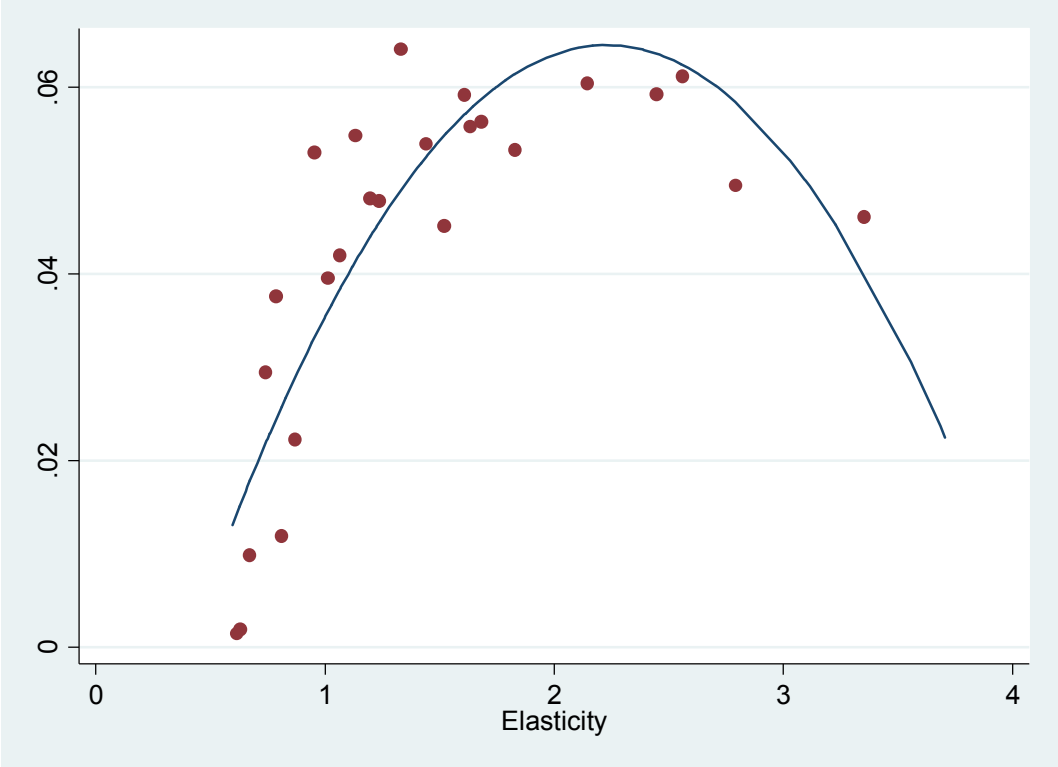


Table 1: Summary Statistics for the Zip Code Level Sample

VARIABLES	N	mean	sd
Saiz's elasticity measure	4,136	1.443	0.722
Annualized real house price change in 2004-06	4,136	0.0895	0.0641
Annualized real house price change in 2007-09	4,136	-0.132	0.0902
Fraction of non-owner-occupied home purchases in 2004-06	3,975	0.135	0.108
Building permits in 2004-06 relative to 2000 housing units	4,136	0.0494	0.0491
Annualized population change in 2003-06	4,093	0.0221	0.0643
Annualized population change in 2007-09	4,130	0.0191	0.0646
Annualized per capita income change in 2003-06	4,093	0.0157	0.0327
Annualized per capita income change in 2007-09	4,130	-0.0374	0.0337
Annualized employment change in 2004-06	3,942	0.0276	0.0600
Annualized employment change in 2007-09	3,924	-0.0257	0.0552
Annualized real payroll change in 2004-06	3,942	0.0326	0.0684
Annualized real payroll change in 2007-09	3,924	-0.0326	0.0695
Annualized change in no. of establishments in 2004-06	3,942	0.0242	0.0346
Annualized change in no. of establishments in 2007-09	3,924	-0.0112	0.0264
Fraction of subprime mortgages in 2005	3,975	0.194	0.132
Mortgage denial rate in 2005	3,975	0.135	0.0521
Fraction of GSE mortgages in 2005	3,975	0.204	0.104
Fraction of securitized mortgages in 2005	3,975	0.188	0.0752

Table 2: Housing Boom and Bust during the Recent Cycle

This table presents coefficient estimates from regressing the annualized real house price change in 2004-2006 (housing boom period) and in 2007-2009 (housing bust period) on the linear term and quadratic terms of Saiz's elasticity, and a list of control variables. Standard errors are clustered at MSA level and t-stats are reported in parentheses. ***, **, * indicate coefficient estimates statistically distinct from 0 at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)
	Annualized real house price change in 2004-06		Annualized real house price change in 2007-09	
Saiz's elasticity	0.0123	0.0126*	-0.0381**	-0.0449**
	(1.54)	(1.76)	(-1.98)	(-2.55)
Saiz's elasticity squared	-0.00399*	-0.00403**	0.0129**	0.0140**
	(-1.78)	(-2.08)	(2.52)	(2.19)
Annualized population change in		0.0931**		
2004-06		(2.27)		
Annualized per capita income		0.288***		
change in 2004-06		(5.57)		
Annualized employment change in		0.00640		
2004-06		(0.42)		
Annualized real payroll change in		0.00180		
2004-06		(0.18)		
Annualized change in no. of		0.0745**		
establishments in 2004-06		(2.19)		
Fraction of subprime mortgages in		0.143***		-0.320***
2005		(8.99)		(-10.34)
Mortgage denial rate in 2005		0.0563**		0.106***
		(2.10)		(2.63)
Fraction of GSE mortgages in		0.0673**		-0.0133
2005		(2.45)		(-0.34)
Fraction of securitized mortgages		0.0246		0.0191
In 2005		(0.87)		(0.40)
Annualized population change in				-0.0956
2007-09				(-1.20)
Annualized per capita income				0.219***
change in 2007-09				(4.10)
Annualized employment change in				0.00130
2007-09				(0.05)

Annualized real payroll change in 2007-09				0.0258 (1.46)
Annualized change in no. of establishments in 2007-09				0.0232 (0.51)
Constant	0.152***	0.0862***	-0.201***	-0.139***
	(5.99)	(3.84)	(-4.07)	(-3.59)
State fixed effect	Yes	Yes	Yes	Yes
Observations	4136	3941	4136	3923
R-squared	0.813	0.863	0.645	0.779

Table 3: Fraction of Non-Owner-Occupied Home Purchases in 2004-06

This table presents coefficient estimates from regressing the fraction of non-owner-occupied home purchases in 2004-06 on the linear and quadratic terms of Saiz's elasticity measure, and a list of control variables. Standard errors are clustered at MSA level and t-stats are reported in parentheses. ***, **, * indicate coefficient estimates statistically distinct from 0 at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)
	Fraction of Non-Owner-Occupied Home Purchases in 2004-06	
Saiz's elasticity	0.0952***	0.131***
	(3.91)	(5.44)
Saiz's elasticity squared	-0.0191***	-0.0264***
	(-3.24)	(-4.26)
Fraction of subprime mortgages in 2005		-0.200***
		(-3.89)
Mortgage denial rate in 2005		0.601***
		(6.92)
Fraction of GSE mortgages in 2005		-0.0821*
		(-1.74)
Fraction of securitized mortgages in 2005		0.210***
		(3.48)
Annualized population change in 2004-06		-0.152
		(-1.59)
Annualized per capita income change in 2004-06		0.330**
		(2.46)
Annualized employment change in 2004-06		-0.0461
		(-1.09)
Annualized real payroll change in 2004-06		0.0519
		(1.46)
Annualized change in no. of establishments in 2004-06		-0.393***
		(-4.74)
Constant	0.121***	0.0115
	(4.73)	(0.36)
State fixed effect	Yes	Yes
Observations	3975	3941
R-squared	0.353	0.435

Table 4: Non-Owner-Occupied Home Purchases and Price Cycle

This table reports coefficient estimates from regressing the change in real house price in 2004-06 (Panel A) and in 2007-09 (Panel B) on the fraction of non-owner-occupied home purchases in 2004-06, and a list of control variables. Standard errors are clustered at MSA level and t-stats are reported in parentheses. ***, **, * indicate coefficient estimates statistically distinct from 0 at the 1%, 5%, and 10% levels, respectively.

Panel A: Housing price changes in 2004 to 2006

	(1)	(2)
	Annualized real house price change in 2004-06	
Fraction of Non-Owner-Occupied Home Purchases in 2004-06	0.0454***	0.0513***
	(2.77)	(3.72)
Fraction of subprime mortgages in 2005		0.153***
		(8.68)
Mortgage denial rate in 2005		0.0236
		(0.84)
Fraction of GSE mortgages in 2005		0.0660**
		(2.52)
Fraction of securitized mortgages in 2005		0.0159
		(0.58)
Annualized population change in 2003-06		0.0974**
		(2.31)
Annualized per capita income change in 2003-06		0.271***
		(5.38)
Annualized employment change in 2004-06		0.00857
		(0.57)
Annualized real payroll change in 2004-06		0.000529
		(0.05)
Annualized change in number of establishments in 2004-06		0.0997***
		(2.84)
Constant	0.149***	0.0877***
	(13.50)	(5.49)
State fixed effect	Yes	Yes
Observations	3975	3941
R-squared	0.814	0.865

Panel B: Housing price changes in 2007 to 2009

	(1)	(2)
	Annualized real house price change in 2007-09	
Fraction of Non-Owner-Occupied Home Purchases in 2004-06	-0.0213*	-0.0289**
	(-1.83)	(-2.25)
Fraction of subprime mortgages in 2005		-0.325***
		(-9.04)
Mortgage denial rate in 2005		0.131***
		(2.86)
Fraction of GSE mortgages in 2005		-0.0145
		(-0.35)
Fraction of securitized mortgages in 2005		0.0235
		(0.47)
Annualized population change in 2007-09		-0.130*
		(-1.67)
Annualized per capita income change in 2007-09		0.207***
		(3.90)
Annualized employment change in 2007-09		-0.00168
		(-0.07)
Annualized real payroll change in 2007-09		0.0317*
		(1.85)
Annualized change in no. of establishments in 2007-09		0.0204
		(0.42)
Constant	-0.222***	-0.169***
	(-6.94)	(-5.72)
State fixed effect	Yes	Yes
Observations	3975	3923
R-squared	0.635	0.772

Table 5: Housing Supply during the Boom Period

This table reports coefficient estimates from regressing building permits in 2004-06 relative to the number of housing units in 2000 on the linear and quadratic terms of Saiz's elasticity measure, and a list of control variables. Standard errors are clustered at MSA level and t-stats are reported in parentheses. ***, **, * indicate coefficient estimates statistically distinct from 0 at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)
	Building permits in 2004-06 relative to the number of housing units in 2000	
Saiz's elasticity	0.0995***	0.0859***
	(5.24)	(5.41)
Saiz's elasticity	-0.0225***	-0.0193***
squared	(-4.60)	(-4.75)
Fraction of subprime		0.0114
mortgages in 2005		(0.63)
Mortgage denial rate		-0.0111
in 2005		(-0.43)
Fraction of GSE mortgages		0.0228
in 2005		(1.00)
Fraction of securitized		0.0190
mortgages in 2005		(1.01)
Annualized population		0.265***
change in 2004-06		(4.58)
Annualized per capita income change in		0.0387
2004-06		(0.70)
Annualized employment change in		0.0527***
2004-06		(2.78)
Annualized real payroll		0.00807
change in 2004-06		(0.50)
Annualized change in no. of		
establishments		0.169***
in 2004-06		(4.22)
Constant	-0.0112	-0.0312
	(-0.61)	(-1.61)
State fixed effect	Yes	Yes
Observations	4063	3875
R-squared	0.450	0.526

Table 6: Housing Supply and Non-Owner Occupied Home Purchases during the Boom

This table reports coefficient estimates from regressing the average building permits in 2004-06 relative to the number of housing units in 2000 on the fraction of non-owner occupied home purchases in 2004-06, and a list of control variables. Standard errors are clustered at MSA level and t-stats are reported in parentheses. ***, **, * indicate coefficient estimates statistically distinct from 0 at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)
	Building permits in 2004-06 relative to the housing units in 2000	
Fraction of Non-Owner-Occupied Home Purchases in 2004-06	0.0398*	0.0808***
	(1.79)	(3.86)
Fraction of subprime mortgages in 2005		0.0342
		(1.45)
Mortgage denial rate in 2005		-0.0600*
		(-1.89)
Fraction of GSE mortgages in 2005		0.0711***
		(3.16)
Fraction of securitized mortgages in 2005		-0.0157
		(-0.74)
Annualized population change in 2003-06		0.315***
		(5.20)
Annualized per capita income change in 2003-06		-0.0257
		(-0.46)
Annualized employment change in 2004-06		0.0551***
		(2.94)
Annualized real payroll change in 2004-06		0.0232
		(1.40)
Annualized change in no. of establishments in 2004-06		0.175***
		(3.57)
Constant	0.0804***	0.0413***
	(12.57)	(2.94)
State fixed effect	Yes	Yes
Observations	3908	3875
R-squared	0.373	0.487

Table 7: Housing Supply during the Boom and House Price Change during the Bust

This table reports coefficient estimates from regressing the annualized real house price change in 2007-2009 (housing bust period) on building permits in 2004-06 relative to the 2000 housing units, the linear term and quadratic terms of Saiz's elasticity, and a list of control variables. Standard errors are clustered at MSA level and t-stats are reported in parentheses. ***, **, * indicate coefficient estimates statistically distinct from 0 at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)
	Annualized real house price change in 2007-09		
Saiz's elasticity		-0.00866	-0.0146
		(-0.23)	(-0.54)
Saiz's elasticity squared		0.00639	0.00724
		(0.80)	(1.26)
Building permits in 2004-06 relative to the	-0.327***	-0.305***	-0.327***
housing units in 2000	(-4.08)	(-2.69)	(-4.12)
Annualized population change in 2007-09	-0.107		-0.0927
	(-1.42)		(-1.20)
Annualized per capita income change in 2007-09	0.210***		0.203***
	(4.64)		(4.80)
Annualized employment change in 2007-09	0.00706		0.0108
	(0.30)		(0.47)
Annualized real payroll change in 2007-09	0.0129		0.00664
	(0.76)		(0.39)
Annualized change in no. of establishments	0.0524		0.0555
in 2007-09	(1.29)		(1.40)
Fraction of subprime mortgages in 2005	-0.312***		-0.316***
	(-11.08)		(-11.54)
Mortgage denial rate in 2005	0.0934**		0.0871**
	(2.36)		(2.20)
Fraction of GSE mortgages in 2005	0.0139		-0.00296
	(0.42)		(-0.09)
Fraction of securitized mortgages in 2005	0.0252		0.0329
	(0.54)		(0.73)
Constant	-0.148***	-0.202***	-0.145***
	(-5.26)	(-4.22)	(-4.08)
State fixed effect	Yes	Yes	Yes
Observations	3923	4136	3923
R-squared	0.789	0.659	0.794