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SUPPLY CONSTRAINTS DO NOT EXPLAIN HOUSE PRICE AND QUANTITY GROWTH ACROSS U.S. CITIES

Schuyler Louie
John A. Mondragon
Johannes Wieland

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Supply Constraints do not Explain House Price and Quantity Growth Across U.S. Cities
Schuyler Louie, John A. Mondragon, and Johannes Wieland
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ABSTRACT

The standard view of housing markets holds that differences in the flexibility of local housing supply—shaped by factors like geography and regulation—explain differences in how house price and quantity growth respond to rising demand across U.S. cities. However, from 2000 to 2020, we find that higher income growth predicts the same growth in house prices, housing quantity, and population regardless of a city's estimated housing supply elasticity. We find the same results when we examine rents, expand the sample to 1980 to 2020, use different elasticity measures, use per capita income or population growth instead of total income growth, and when exploiting a variety of plausibly exogenous variation in local housing demand. Using a general demand-and-supply framework, we show that these results imply that estimated housing supply constraints are unimportant in explaining differences in rising house prices among U.S. cities. Our conclusions challenge the prevailing view of local housing and labor markets and suggest that relaxing regulatory housing supply constraints may not materially affect housing affordability.

Schuyler Louie
University of California, Irvine
schuyljl@uci.edu

John A. Mondragon
Federal Reserve Bank of San Francisco
john.mondragon@sf.frb.org

Johannes Wieland
University of California, San Diego
Department of Economics
and NBER
jfwieland@ucsd.edu

1 Introduction

> "Rent, considered as the price paid for the use of the land, is naturally the highest which the tenant can afford to pay in the actual circumstances of the land." – Adam Smith (1776)

> "The rent is too damn high." – Jimmy McMillan (2010)[1]

In this paper we ask: do measured differences in housing supply elasticities explain differences in house price growth and housing quantity growth across U.S. cities since 2000? Our answer: no.[2]

The canonical view for why housing has become so expensive, particularly in some cities, is that these cities have relatively inelastic housing supply, leading to greater increases in housing prices rather than quantities (Glaeser, Gyourko and Saks, 2005; Saiz, 2010). Specifically, the response of city i's housing supply growth $\widehat{H}_i^S$ to local house price growth $\widehat{P}_i$, is given by the supply function

$$\widehat{H}_i^S = \psi_i \widehat{P}_i + \widehat{\sigma}_i \tag{1}$$

where $\psi_i > 0$ is the city-specific elasticity of housing supply and $\widehat{\sigma}_i$ is a housing supply shock (a change in quantity not caused by changing prices).[3] Cities with elastic housing supply (high ψ) will increase housing production as demand starts to push prices up, while cities with inelastic housing supply (low ψ) will increase production less for the same increase in demand. As a result, there will be less housing and it will be more expensive in relatively inelastic cities, compared to elastic cities where housing will be relatively abundant and cheap (see Figure I). To the extent that regulatory constraints reduce a city's housing supply elasticity ψ_i, relaxing these policies will moderate house price growth through increased growth in housing quantities (Gyourko, Saiz and Summers, 2008; Saiz, 2023). The 2024 Economic Report of the President devotes an entire chapter to arguing that constrained housing supply is the main impediment to affordable housing and advocating for relaxing regulatory constraints (Council of Economic Advisers, 2024, Ch. 4) and a vast body of work has documented evidence in support of this logic (Molloy, 2020).

Using four standard measures of housing supply elasticities/constraints from the literature, we find that in response to higher income growth from 2000–2020 cities measured as having more-elastic housing supply show the same growth in house prices, quantities, popula-

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[1] As quoted in the October 18th, 2010 New York gubernatorial debate. See here.

[2] We have provided a FAQ to respond to common questions and comments. See Louie et al. (2025a).

[3] We abuse terminology somewhat by using "city" and "MSA" interchangeably, but the basic units of analysis in this paper are MSAs or Metropolitan Statistical Areas.

tion, rents, commuting times, and rooms per person as cities measured as having less-elastic housing supply. This is true across all the measures of housing constraints that we use, if we extend our sample to cover 1980 to 2020, if we separate income growth into per capita income growth or population growth, and if we use plausibly exogenous changes in housing demand caused by standard instruments or exposure to pandemic-era work-from-home. In short, existing estimates of housing supply constraints do not explain differences in house price growth and housing quantity growth across cities.

Although the majority of our estimates are explicitly non-causal, in Section 2 we provide four arguments that they accurately reflect negligible differences in actual housing supply elasticities across cities as captured by these measures. First, if city income growth is uncorrelated with city supply shocks $\widehat{\sigma}_i$, then our estimates identify the true group-specific supply elasticities ψ_j, where $j \in \{L, H\}$ denotes the inelastic (L) and elastic (H) cities.[4] Intuitively, income growth will move house prices and quantities along the group-specific supply curve $\widehat{H}_i = \psi_j \widehat{P}_i$ and thereby identify the group-specific supply elasticity ψ_j from the co-movement of quantities and prices.[5] Even if population growth, and therefore income growth, responds differently to demand shocks in inelastic and elastic cities because of their different supply elasticities, this does not threaten identification as house prices and quantities continue to comove along the group-specific supply curve.[6] Of course, it is well known that any variation in house price or quantity driven by demand identifies the supply elasticity (Angrist and Krueger, 2001; Saiz, 2010).

Second, if supply shocks $\widehat{\sigma}_i$ are correlated with income growth, our estimates still reflect relative differences in supply elasticities, provided this correlation is uniform across cities. The comovement of house price growth and quantity growth conditional on income growth will then identify the supply elasticity ψ_j and a bias term, with the size of the bias corresponding to the correlation between supply shocks and income growth. If those supply shocks are equally important in inelastic and elastic cities, our estimates will still identify the relative supply elasticity $\psi_H - \psi_L$ across cities as the bias is "differenced" out. So even in this case the presence of unobserved supply shocks is not a problem for our analysis. However, a plausible prior derived from a standard housing production function actually suggests that supply shocks should be less important in inelastic areas, consistent with the notion that

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[4] Grouping the data into more and less elastic cities is consistent with Glaeser, Gyourko and Saks (2006) and Ganong and Shoag (2017), among others.

[5] If the supply elasticity ψ is heterogeneous within each group, then the pooled estimate has a heterogeneous treatment effect interpretation (Louie, Mondragon and Wieland, 2025b).

[6] Therefore, the claim by Furth (2025), Wiebe (2025) and others that identification fails because population growth depends on supply elasticities is incorrect. In Louie et al. (2025b) and Louie, Mondragon and Wieland (2025c) we provide comprehensive and self-contained replies to Wiebe (2025) and Furth (2025) respectively and we illustrate this point in a standard spatial equilibrium model in Appendix A1 (second section).

quantities vary less in these markets. This prior implies that our estimates should be biased towards finding even larger differences in supply elasticities when they exist. In order for our estimates to obscure genuine differences in supply elasticities, supply shocks would instead need to be more correlated with income growth in cities classified as inelastic.

Third, even if one is willing to assume that supply shocks are more strongly correlated with income growth in inelastic cities, our results could only be explained by a highly specific scenario—one that contradicts conventional wisdom about housing supply elasticities. Specifically, the stronger correlation could occur either because supply shocks are more positively correlated with labor demand shocks or because supply shocks are relatively more important in inelastic cities. Within a standard spatial equilibrium framework (Moretti, 2011), the hypothesis that supply shocks are relatively more important implies additional correlations that are clearly rejected by the data: it predicts substantial differences in how house prices and quantities comove with per capita income growth in more- and less-elastic cities. But the correlations between both house price and quantity growth with per capita income growth are indistinguishable across the groups of cities, clearly rejecting this hypothesis. Therefore, the only remaining scenario is that supply shocks systematically correlate more strongly with labor demand shocks in inelastic cities. Under this scenario, inelastic cities experiencing substantial per capita income growth (such as San Francisco) would need to consistently achieve relative productivity improvements in construction compared to elastic cities with similar per capita income growth (such as Austin), precisely offsetting any genuine elasticity differences. We are unaware of any literature proposing such a specific scenario persisting over decades. Moreover, even if such conditions held, it would actually imply that differences in supply elasticities do not explain observed variations in housing prices and quantities across cities.

Fourth, our causal estimates, derived using both well-established instrumental variables and recent remote work shocks, also show that prevailing measures of housing supply constraints do not explain differences in housing price and quantity growth across metropolitan areas. Because these instruments plausibly isolate shifts in housing demand that are uncorrelated with supply-side shocks, they are not subject to the deus ex machina explanation above. The fact that these results give the same results as our non-causal estimates reinforce our interpretation of the non-causal estimates, suggesting that any genuine differences in housing supply elasticities, if present, are not adequately captured by widely used elasticity measures.

In summary, the simplest and most coherent explanation of our findings is that common metrics of housing supply elasticity do not reflect actual differences in housing supply elasticities across cities, either because genuine differences are negligible or because they are not captured by existing metrics. Critically, our results do not imply that supply "doesn't matter." Instead, our framework assumes the fundamental and correct premise that exogenous expansions in housing supply will expand quantities and reduce prices; equivalently, we assume that supply curves slope up and demand curves slope down at the MSA level.[7] What we evaluate is if measures that ought to reflect the relative slopes of supply curves have the expected effects on housing market dynamics as demand increases. Therefore, our findings do not imply that shifts in housing supply will have no effects on prices or quantities. Rather we conclude that these measures of housing supply constraints do not reflect the relative slopes of housing supply curves across cities.

We next describe our results in more detail. Our empirical analysis uses four measures of housing supply constraints which have been very influential or represent the cutting edge of research in the area. These are the seminal supply elasticity from Saiz (2010), a supply elasticity from Baum-Snow and Han (2024), the Wharton Residential Land Use Regulation Index (WRLURI) from Gyourko, Saiz and Summers (2008), and the land share of value from Davis, Larson, Oliner and Shui (2021) (Section 3). We use the terms "housing supply constraint" and "housing supply elasticity" interchangeably to describe these measures.

In our benchmark analysis in Section 4, we regress house price growth and house quantity growth on total income growth, an indicator if the city's housing supply is measured as relatively less constrained (more elastic), and the interaction of income growth and the constraint indicator. We use total income growth to capture the net of changes in both average income and population as both margins reflect housing demand, but we also examine each component separately and find the same results.[8] Total income growth is strongly correlated with growth in house prices, but the interaction of income growth with the constraint is economically and statistically insignificant across all of the measures. In other words, higher income growth predicts the same increase in house price growth in cities measured to be more or less constrained. We turn to housing quantities and find the same results: income growth is strongly correlated with growth in the number of housing units and growth in population, but this correlation is not affected by any of the measures of housing supply constraints. We make this point explicit by leveraging the comovement of prices and quantities and estimating an instrumental variable specification to recover the elasticities of housing quantities to prices for more- and less-constrained cities. Our estimated elasticities are all around one

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[7] The level of aggregation matters. It is almost certainly the case that geographic or regulatory constraints affect supply curves at the level of the census tract, for example. But our results show that this does not imply similar effects at the city or MSA level, which is consistent with Baum-Snow (2023), Figure 4. Thanks to Michael Wiebe for pointing this out.

[8] Total income growth need not be a comprehensive measure of housing demand. For our purposes it need only be correlated with housing demand.

and, critically, are statistically and economically indistinguishable across cities measured to be relatively more or less constrained.

As discussed above, if these results are explained by a greater importance of supply shocks in inelastic cities then specifications using per capita or population growth should give different results. Instead we find that growth in per capita income and population both have identical correlations with house price and quantity growth in more- and less-constrained cities. We also examine growth in rents, the change in the average number of rooms per person, and the change in average commuting times and find that elastic and inelastic cities all exhibit the same correlation with income growth. We extend our sample to 1980 and find the same results when looking at growth from 1980 to 2000 or from 1980 to 2020. We explore finer discretizations of the constraint measures and continuous interaction models, all with the same results. The fact that measured constraints do not affect the correlations of house price or quantity growth with income growth is a robust feature of the data for at least the last 40 years from 1980 to 2020.

To maintain that supply elasticities are nevertheless different in the face of our evidence requires believing that housing supply shocks must be more positively correlated with labor demand shocks in inelastic cities. This implies that high-growth, inelastic cities have benefited from positive supply shocks that exactly nullified the impact of a lower supply elasticity. We are not aware of anyone in the literature making this claim, which is also inconsistent with the claim that supply constraints are important in explaining house price growth and housing quantity growth across cities.

A much simpler interpretation of our results is that supply elasticities are either similar across cities or genuine differences are not captured by existing measures. Our results using exogenous housing demand shock are also consistent with this view. First, we employ standard instruments from the literature (see Saiz (2010), Diamond (2016), and Chodorow-Reich, Guren and McQuade (2024) among many others), a Bartik shock and local climate measures, in our baseline sample. Using these instruments recovers estimates of average supply elasticities in line with the literature, but we find no evidence that elasticities are relatively larger in cities measured as more elastic compared to ostensibly less-elastic cities. Second, we rely on the literature documenting the effect of remote work on housing demand (Howard, Liebersohn and Ozimek, 2023; Mondragon and Wieland, 2025) and check if the shift to remote work had differential effects from 2019 to 2023 depending on the measured housing constraints. Consistent with prior research, we find that exposure to WFH caused an increase in housing demand and house prices. Critically, the increase in house prices was essentially identical regardless of whether the city was more or less constrained. Similarly, exposure to WFH caused large increases in the growth of units permitted for construction and, conditional on the same exposure to WFH, cities saw similar growth in permitted units regardless of the measure of housing supply constraints. Despite these estimates coming from an out-of-sample period of exceptional economic changes and the distinct source of variation, we find the same results as in our baseline analysis, further validating the view that supply elasticities are not truly different across cities or that actual differences are not measured well.

In short, we establish that measures of local housing supply constraints are not quantitatively important for understanding how shifts in demand translate into house price and quantity growth across U.S. cities. This finding challenges the standard view that supply constraints explain rising house prices across cities and suggests that efforts to relax measured housing constraints may have negligible effects on house prices and quantities.

Related Literature

Housing supply constraints are now generally agreed to be an important, if not the most important, impediment to affordable housing (Glaeser, Gyourko and Saks, 2005; Saiz, 2023).[9] Gyourko (2009), Gyourko and Molloy (2015), Glaeser and Gyourko (2018), and Molloy (2020) provide surveys of this extensive literature.[10] A common theme is that supply elasticities are not uniform across U.S. cities. Gyourko, Saiz and Summers (2008) and Gyourko, Hartley and Krimmel (2021) developed indexes of regulatory constraints that ostensibly reduce supply elasticities across different metropolitan entities. Saiz (2010) recovered MSA-level elasticities incorporating geographic and regulatory constraints to show that metros with little developable land due to geographic constraints from water bodies or steep terrain are the very places often deemed to have inelastic housing supply. Baum-Snow and Han (2024) estimate supply elasticities at the census tract level and trace out how the supply response across the metro area varies with geographic and regulatory constraints. Davis, Larson, Oliner and Shui (2021) use a large micro dataset to estimate the land share of value, which indicates the relative tightness of housing supply constraints, across a large variety of geographies. Additional papers estimating local housing supply constraints or elasticities in the U.S. include Green, Malpezzi and Mayo (2005), Glaeser, Gyourko and Saks (2005), Davis and Palumbo (2008), Kok, Monkkonen and Quigley (2014), Gorback and Keys (2020), Albouy and Stuart (2020), Guren, McKay, Nakamura and Steinsson (2021b), and Chodorow-Reich, Guren and

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[9] While critics of this perspective do exist, they are often ignored or dismissed (Been, Ellen and O'Regan, 2019). The broader impact of this argument is evinced by the rapid rise of the YIMBY movement, advocating for more relaxation of housing regulation like "upzoning," and the Economic Report of the President (Council of Economic Advisers, 2024). The same claims are also central to the "Abundance" diagnosis of the housing crisis. For evidence that there is not a housing shortage see McClure and Schwartz (2025).

[10] For a seminal contribution spurring the literature on housing supply see DiPasquale (1999).

McQuade (2024). For a review of international evidence on housing supply elasticities see Saiz (2023).

In addition to potentially driving up house prices, tight housing supply has been linked to pernicious effects on other important economic outcomes. Saks (2008), Paciorek (2013), Gyourko, Mayer and Sinai (2013), Ganong and Shoag (2017), Gaubert (2018), and Hsieh and Moretti (2019), among others, argue that differences in housing supply elasticities have important effects on outcomes ranging from housing market volatility to aggregate productivity. Been, Ellen and O'Regan (2019) surveys work linking supply restrictions to environmental costs, segregation, and inequality. Glaeser and Gyourko (2018) also provide a survey and discussion on the broader costs of tight housing supply.

There is a growing literature that examines the local effects of new construction on outcomes like neighborhood rents and demographic composition. Examples include Zahirovich-Herbert and Gibler (2014), Diamond and McQuade (2019), Pennington (2021) and Li (2022). Some, although not all, of these papers find evidence that new construction reduces rent growth in the affected area. These estimates, by studying shifts in local housing supply, identify the shape of the local demand curve. By contrast, our approach identifies the slopes of the city-level supply curves in more- and less-constrained cities, which is critical for understanding the extent to which supply constraints affect housing affordability. Therefore, our results are not in conflict with these papers. A more closely related body of work studies changes in zoning constraints and how this affects the supply of housing, which should be informative about how much the housing supply function is affected by regulatory constraints. This work is surveyed by Freemark (2023), who reports mixed and generally modest effects of zoning changes on housing prices or quantities, consistent with our results.[11]

A number of other studies have also found a limited role for supply elasticity differences in the cross-section of U.S. cities. Rodríguez-Pose and Storper (2020) give an influential critique of the idea that relaxing regulatory barriers is likely to improve affordability, reduce inequality, or spur growth and also make the argument that income growth drives house prices.[12] Davidoff (2013) shows that regions with the largest 2000s housing cycle also saw the highest growth in quantities and that, conditional on demand, the amplitude of the 2000s housing cycle is not larger in less-elastic cities. Davidoff (2016) further finds that cities with lower measured supply elasticity experience both higher house price and quantity growth from 1980-2012 and argues that this reflects a negative correlation of supply elasticities with demand shocks. Like Davidoff (2013, 2016) we jointly examine house prices and quantities,

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[11] Glaeser and Gyourko (2025) argue that regulatory constraints have now tightened across all metro areas, although Pendall, Lo and Wegmann (2022) find that zoning constraints have generally eased in high-growth metro areas.

[12] See also Rodríguez-Pose and Storper (2022).

and show that OLS regressions interacting income with supply elasticities can help us determine the role of supply elasticities in explaining house price and quantity growth across cities.

Howard and Liebersohn (2021) show that the effect of income growth on their newly-constructed rent index from 2000-2018 is independent of the measured housing supply elasticity, which they attribute to a high migration elasticity. Similarly, Aura and Davidoff (2008) and Anenberg and Kung (2020) use quantitative calibrated models to argue that relaxing local housing supply constraints is unlikely to significantly affect local house prices due to strong migration responses. Molloy, Nathanson and Paciorek (2022) find a weak relationship between elasticities and rents, although they argue there are large effects on prices and quantities. Davis and Ortalo-Magné (2011) examine data on expenditure shares on housing for renters and find that these shares are constant across MSAs, concluding that supply elasticities will be uncorrelated with rents and prices. We depart from most of these papers by also showing that growth in housing quantities and population, not just house price growth, is independent of local supply elasticities, and thus infer a limited role for housing supply elasticities (and so migration) in explaining the cross-section of U.S. city house price and quantity growth since at least 1980.

While we employ the standard competitive supply framework used in the vast majority of empirical and theoretical work on housing markets, there is work arguing for alternative foundations.[13] Watson and Ziv (2021) provide a theory of monopolistic production and pricing in housing markets and Watson and Ziv (2024) and Baker (2024) both document evidence of pricing power in rental markets. Because monopolistic producers take into account the curvature of demand, the link between marginal cost shifters (like regulatory costs) and price and quantity may be significantly altered. Alternatively, Murphy (2018), Murray (2020) and Lange and Teulings (2024) incorporate the real option dimension to housing supply decisions, building off of an earlier literature starting with Titman (1985). In this approach the behavior of housing production can differ fundamentally from production in the static competitive framework. Finally, evidence on the production function for housing suggests that the importance of land prices can be muted through the substitution of capital (that is, density) for land (McDonald, 1981; Thorsnes, 1997; Ahlfeldt and McMillen, 2018; Combes, Duranton and Gobillon, 2021). We do not take a stand on what direction may be most useful for understanding our results.

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[13] In his discussion (available here) of Glaeser and Gyourko (2003), O'Flaherty lays out a number of important critiques of this standard framework and related empirical approaches.

2 THEORETICAL FRAMEWORK

Using a standard demand-and-supply framework for the housing market, we demonstrate that non-causal OLS regressions predicting city-level house price and quantity growth from income growth interacted with the local supply elasticity inform whether differences in supply elasticities are important in explaining cross-city differences in house price growth and housing quantity growth.

We assume there are I cities indexed by i, each with a population L_i where individuals receive income y_i so that total income in the city is given as $Y_i = y_i L_i$ and the total quantity of housing is H_i, purchased at the price P_i. For simplicity, we assume H is a measure of total housing consumption that encompasses both the extensive and intensive margins. In our empirical work we examine measures of both margins.[14] Households also have some additional demand shifters θ_i, which can increase or decrease their demand for housing. These can be thought of as changes in the demand for amenities or changes in wealth (for example, stock market investments) that affect housing demand in the city. Therefore housing demand in the city is given by a general Marshallian demand function $H_i^D = f(Y_i, P_i, \theta_i)$. We linearize this expression to get the change in housing demand where hats indicate the percentage change and ϵ gives the relevant demand elasticity:

$$\widehat{H}_i^D = \epsilon_y \widehat{Y}_i - \epsilon_p \widehat{P}_i + \widehat{\theta}_i. \tag{2}$$

This housing demand function nests the demand functions from standard spatial equilibrium models. Consider the case in which households in location i earn y_i to spend on tradable non-housing goods c_i and nontradable housing h_i with relative price P_i. Under Cobb-Douglas preferences with housing share α_i (consistent with Davis and Ortalo-Magné, 2011), housing demand is

$$h_i = \alpha_i \frac{y_i}{P_i} \qquad \Rightarrow \qquad H_i = h_i L_i = \alpha_i \frac{Y_i}{P_i}.$$

In this model $\epsilon_y = 1$, $\epsilon_p = 1$, and $\widehat{\theta}_i = \widehat{\alpha}_i$.

Our housing housing demand function (2) does not restrict the correlations between the demand shifter $\hat{\theta}$ and prices and income in any way. Intuitively, we can allow for arbitrary correlations of residual demand $\widehat{\theta}_i$ with $\widehat{Y}_i$ and $\widehat{P}_i$ because any variation in demand that is correlated with income is valid variation for identifying relative supply curves. For this

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[14] We also explore the implications of two margins of housing consumption, which are non-trivial, in Section A2 and Louie et al. (2025c).

reason our demand function also nests intertemporal as well as spatial equilibrium models of housing demand (see Section A1).

We assume the total supply of housing H_i^S is competitive and determined by an elasticity parameter ψ_i and supply shocks σ so that $H_i^S = P_i^{\psi_i}\sigma_i$. The elasticity ψ_i reflects the flexibility of the local housing construction sector as determined by regulations, geography, and so on. We abstract from the importance of other factors like local labor costs or financing costs. Linearizing this expression gives the change in total supply as

$$\widehat{H}_i^S = \psi_i \widehat{P}_i + \widehat{\sigma}_i.$$

The differences that we consider should generally be thought of as long-differences, in practice 20 years or more. This is important in that housing construction is time consuming, so that in the short-run almost all supply curves are relatively inelastic regardless of the long-run supply curve elasticities (Guren, McKay, Nakamura and Steinsson, 2021a). The long view also justifies a stock-based supply curve relative to a flow-based supply curve (DiPasquale and Wheaton, 1994).

The housing market clears so that the total change in housing quantities is equal to the change in the supply of housing and the change in housing demand:

$$\widehat{H}_i = \widehat{H}_i^S = \widehat{H}_i^D.$$

Solving for prices gives an intuitive expression for the change in prices as a function of changes in demand coming from income and residual demand shocks or from shifts in supply:

$$\widehat{P}_i = \frac{1}{\psi_i + \epsilon_p}\left(\epsilon_y \widehat{Y}_i + \widehat{\theta}_i\right) - \frac{1}{\psi_i + \epsilon_p}\widehat{\sigma}_i. \tag{3}$$

The effect of changes in income on house prices depends on the elasticity of housing demand to income, but this effect will be mitigated to the extent that housing supply elasticities are high or if demand is very sensitive to changes in the price. Shifts in supply $\widehat{\sigma}_i$ or residual demand $\widehat{\theta}_i$ affect house prices in a similar way.

Substituting for prices into the supply equation gives a reduced form expression for the change in housing quantities:

$$\widehat{H}_i = \frac{1}{1 + \frac{\epsilon_p}{\psi_i}}\left(\epsilon_y \widehat{Y}_i + \widehat{\theta}_i\right) + \frac{\frac{\epsilon_p}{\psi_i}}{1 + \frac{\epsilon_p}{\psi_i}}\widehat{\sigma}_i. \tag{4}$$

Here as ψ_i becomes smaller (less elastic) then the denominator becomes larger, reducing the size of the quantity response at the same time that the price response in Equation (3) is increasing. These expressions nest standard local labor market/spatial equilibrium models (see Section A1).

Now assume that there are two kinds of cities, those with high supply elasticities and those with low supply elasticities and denote the respective set of cities by Ω^H (high) and Ω^L (low). We have data on house prices, quantities, and the total change in income for each city. We can estimate the relationship between changes in total income and house prices and quantities within each set of cities Ω^j using the following regression where $j \in \{H, L\}$ indicates if the city is of a high- or low-elasticity type

$$\begin{aligned}\widehat{P}_i &= \alpha_j + \beta_j \widehat{Y}_i + e_i,\\ \widehat{H}_i &= \delta_j + \gamma_j \widehat{Y}_i + v_i, \qquad i \in \Omega^j,\ j \in \{H, L\}.\end{aligned}$$

These regression within each set of cities will recover the following estimates:[15]

$$\begin{aligned}\beta_j &= \frac{\epsilon_y}{\psi_j + \epsilon_p} + \frac{1}{\psi_j + \epsilon_p}\frac{Cov_j(\widehat{\theta}_i - \widehat{\sigma}_i, \widehat{Y}_i)}{Var_j(\widehat{Y}_i)},\\ \gamma_j &= \frac{\epsilon_y}{1 + \frac{\epsilon_p}{\psi_j}} + \frac{1}{1 + \frac{\epsilon_p}{\psi_j}}\frac{Cov_j(\widehat{\theta}_i + \frac{\epsilon_p}{\psi_j}\widehat{\sigma}_i, \widehat{Y}_i)}{Var_j(\widehat{Y}_i)}, \qquad j \in \{H, L\}.\end{aligned}$$

If there is no omitted variable bias coming from unobserved demand and supply shocks then the second terms will fall out so that the regressions recover the effects of income growth on house prices and quantities as mediated by the income elasticity of demand for housing, the price elasticity of demand for housing, and the housing supply elasticity. If households across cities do not differ in their income or price elasticities, the pass-through from income growth into house prices will be lower in cities with more elastic housing supply:

$$\psi_H > \psi_L \to \beta_H < \beta_L \quad \text{and} \quad \gamma_H > \gamma_L. \tag{5}$$

Figure I illustrates this standard demand and supply logic where B^j indicates the equilibrium for each type of city after the shift in demand from the initial equilibrium. Thus, a regression of house price growth on income growth within high-elasticity cities should recover a smaller coefficient β_H relative to the coefficient β_L from the same regression of house prices on income growth within low-elasticity cities. For the regression of housing quantity growth on income growth we expect a larger response in the more elastic cities, $\gamma_H > \gamma_L$.

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[15] We simplify by assuming that elasticities within each group are constant (or uncorrelated with other variables). In theory and in extreme cases this simplification may be problematic, but in practice it makes it more likely that we are biased towards finding large differences across high- and low-elasticity cities. See Louie et al. (2025b), available here. Thanks to Michael Wiebe for pressing this point.

More generally, the ratio of the OLS estimators from the quantity and price regressions shows when co-movement of quantity and prices with income growth is informative about a city's supply elasticity,

$$\frac{\gamma_j}{\beta_j} = \psi_j + \frac{Cov_j(\widehat{\sigma}_i, \widehat{Y}_i)}{Cov_j(\widehat{P}_i, \widehat{Y}_i)}, \qquad j \in \{H, L\}. \tag{6}$$

This ratio is equivalent to the IV estimator of housing quantity growth on house price growth instrumented by income growth.

When supply shocks are uncorrelated with income growth $Cov(\widehat{\sigma}_i, \widehat{Y}_i) = 0$, then the ratio of quantity to price effects identifies the supply elasticity ψ_j. In particular, we can allow for arbitrary correlations of income with other demand shocks and arbitrary differences in the parameters of the housing demand function (2). Any variation in demand helps identify the slope of the supply curve (Angrist and Krueger, 2001; Saiz, 2010). For example, Figure II illustrates the case when high elasticity places have a relatively stronger correlation between income growth and other positive demand shocks. This correlation will generate a relatively high correlation between income and house price growth pushing β_H closer to β_L. But we should then see an even larger difference in quantities, as the same demand shocks will push up housing quantities even more in more elastic cities so that $\gamma_H >> \gamma_L$. Intuitively, any demand shock moves quantity and prices along the city-specific supply curve, so their relative movements identify the slope of the supply curve ψ_i.

When supply shocks are correlated with income, then we no longer identify a city's supply elasticity but the relative co-movement can still identify the relative supply elasticity if the bias is the same in elastic and inelastic cities:

$$\frac{\gamma_H}{\beta_H} - \frac{\gamma_L}{\beta_L} = \psi_H - \psi_L + \frac{Cov_H(\widehat{\sigma}_i, \widehat{Y}_i)}{Cov_H(\widehat{P}_i, \widehat{Y}_i)} - \frac{Cov_L(\widehat{\sigma}_i, \widehat{Y}_i)}{Cov_L(\widehat{P}_i, \widehat{Y}_i)}$$

Empirically, we find that the covariance between prices and income is nearly identical across elastic and inelastic cities $Cov_L(\widehat{\sigma}_i, \widehat{Y}_i) = Cov_H(\widehat{\sigma}_i, \widehat{Y}_i)$. Thus, if the covariance between supply shocks and income growth is also the same across cities, then comparing the co-movement of quantities and prices conditional on income across inelastic and elastic cities will identify their relative supply elasticities.

A reasonable prior about these covariances is that supply shocks are relatively more important in elastic areas, which implies that we will be biased to recovering even larger differences in supply elasticities. Assume perfect competition and a CES production function for housing $Q_i = A_i[\alpha \bar{K}_i^{\frac{\xi-1}{\xi}} + (1-\alpha)L_i^{\frac{\xi-1}{\xi}}]^{\frac{\xi}{\xi-1}}$ where A is construction productivity, $\bar{K}$ is fixed land, L is labor, and ξ is the elasticity of substitution.[16] The supply curve is then $\widehat{Q}_i = \psi_i \widehat{P}_i + (1+\psi_i)\widehat{A}_i - \psi_i \widehat{W}_i$ where the supply elasticity is $\psi_i = \xi(1-s_i^K)/s_i^K$ and $s_i^K = 1-\frac{WL}{PQ}$ is the land share. The microfounded housing supply shocks $\hat{\sigma}_i \equiv (1+\psi_i)\hat{A}_i - \psi_i \hat{W}_i$ scale with the supply elasticity, consistent with the intuitive notion that quantities will vary less in places where it is harder to build. Thus, to the extent that supply elasticities are different across cities, we expect supply shocks to be relatively more important in elastic cities, $Cov_L(\widehat{\sigma}_i, \widehat{Y}_i) < Cov_H(\widehat{P}_i, \widehat{Y}_i)$, and our estimates would be biased towards finding even larger differences in supply elasticities.

We understate the difference in supply elasticity if and only if supply shocks are more positively correlated with income growth in inelastic cities than in elastic cities, $Cov_L(\widehat{\sigma}_i, \widehat{Y}_i) > Cov_H(\widehat{P}_i, \widehat{Y}_i)$. Figure III illustrates an example in a demand-and-supply diagram, in which income growth in the inelastic city is correlated with a positive supply shock but in the elastic city there is no such correlation. The correlated positive supply shock reduces prices and increases quantities in the inelastic cities, generating housing market outcomes that are indistinguishable from those of the elastic city.

There are two possible scenarios that could generate such a correlation: supply shocks must be either more positively correlated with labor demand shocks or supply shocks must be relatively more important in inelastic cities. Through the lens of standard of a standard spatial equilibrium framework (Moretti, 2011), we can distinguish these explanations as follows. Assume the labor demand curve of a city is downward-sloping and equal to,

$$\widehat{w}_i = \widehat{Z}_i - \gamma \widehat{L}_i$$

where $\widehat{Z}_i$ is non-construction productivity and $\gamma > 0$ is the labor demand elasticity. The covariance of total income growth with the supply shock is,

$$Cov_j(\widehat{\sigma}_i, \widehat{Y}_i) = Cov_j(\widehat{\sigma}_i, \widehat{Z}_i) + (1-\gamma) Cov_j(\widehat{\sigma}_i, \widehat{L}_i)$$

The covariance in inelastic cities could be larger either because they are more correlated with labor demand shocks $\widehat{Z}_i$, or supply shocks are simply more important and endogenously explain more of the variation in population, $Cov_L(\widehat{\sigma}_i, \widehat{L}_i) > Cov_H(\widehat{\sigma}_i, \widehat{L}_i)$. Critically, these two explanations make different predictions about the covariance of supply shocks with per capita income growth,

$$Cov_j(\widehat{\sigma}_i, \widehat{w}_i) = Cov_j(\widehat{\sigma}_i, \widehat{Z}_i) - \gamma Cov_j(\widehat{\sigma}_i, \widehat{L}_i).$$

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[16] Labor can be thought of as a composite of actual labor and flexible capital inputs.

Holding fixed the covariance with labor demand shocks, if $Cov_L(\widehat{\sigma}_i, \widehat{L}_i) > Cov_H(\widehat{\sigma}_i, \widehat{L}_i)$, then supply shocks are more negatively correlated with per capita income growth. This scenario then predicts that the comovement of house price growth and housing quantity growth with per capita income growth is biased towards finding large differences in supply elasticities whenever supply shocks obscure these differences for total income growth. Note that we should observe different comovements with per capita income even when allowing for agglomeration effects, $\gamma < 0$, since per capita income growth always loads less on $Cov_j(\widehat{\sigma}_i, \widehat{L}_i)$ than total income growth. Indeed, the comovements of house prices and quantity growth with population growth is most biased towards find no difference, since by definition it loads the most on $Cov_j(\widehat{\sigma}_i, \widehat{L}_i)$. Therefore, if supply shocks are relatively more important in inelastic areas we should see this difference reflected in differences in our regressions depending if we use income growth, per capita income growth, or population growth.

Either scenario is theoretically problematic for the view that differences in supply elasticities explain house price and quantity growth across cities. Empirically, our regressions show no differences across total income, per capita income or population growth, rejecting the scenario that supply shocks are more important in inelastic cities. We therefore focus on the scenario that supply shocks are more correlated with labor demand shocks in inelastic cities. This scenario implies that inelastic cities experiencing the highest per capita income growth (e.g., San Francisco) have benefited from positive housing supply shocks relative to elastic cities experiencing the highest per capita income growth (e.g., Austin) exactly to such an extent as to obscure any underlying differences in supply elasticities. We are not aware of anyone making this knife-edge case. Furthermore, as Figure III shows, the outcomes are then observationally equivalent to the case where there is no difference in the housing supply elasticity across cities. In other words, differences in supply elasticities do not explain differences in house price growth and quantity growth across cities.

Despite the seeming implausibility of the supply shock argument, we also test this explanation by exploiting explicitly causal variation in local housing demand. First, we follow numerous papers in the literature by instrumenting for local housing demand using exposure to labor demand via a Bartik shock and measures of local climate attractiveness (see Saiz (2010), Diamond (2016), and Chodorow-Reich et al. (2024) among many others). This literature explicitly argues that these instruments are uncorrelated with local supply shocks ($Cov_j(\widehat{\sigma}_i, X_i) = 0$ where X_i is an instrument), and therefore recover the underlying housing supply elasticities ψ_j. Second, we rely on a body of work arguing that exposure to work-from-home over the pandemic induced a large and again plausibly exogenous shock to housing demand (see Howard and Liebersohn (2021) and Mondragon and Wieland (2025) among others). Here again the explicit argument is that this shift in housing demand is uncorrelated with local shocks to housing supply, as well as other shocks to demand. Thus, even if one believes the deus ex machina resolution of our results that preserves differences in supply elasticities across locations, that explanation will not apply to the results that leverage distinct sources of plausibly exogenous variation in housing demand.

In summary, our theoretical framework shows that if differences in local supply elasticities are quantitatively important, then we should see such differences in non-causal OLS regression of house price and quantity growth on income growth interacted with measures of the supply elasticity. To the extent that a differential exposure to supply shocks obscures differences in housing supply elasticities in these regressions, then this implies (1) that housing supply elasticities do not explain house prices and quantity growth across cities and (2) that differences in supply elasticities will become evident in our causal regressions.

3 Data

We rely on four influential measures of housing supply constraints from the literature. We take the elasticity estimates from Saiz (2010), which are available at the MSA level. Because of the influence of these estimates in the literature we use these MSA definitions as our baseline geography and match other data to these definitions. We also use the measures of the Wharton Residential Land Use Regulatory Index (WRLURI) by Gyourko et al. (2008), generated at the MSA-level by Saiz (2010), which capture variation in the regulatory environment across MSAs. We multiply this index by minus one so that increases in the value indicate a less restrictive regulatory environment and so, ostensibly, a more elastic housing supply function. Baum-Snow and Han (2024) provide a number of elasticities at the census tract level that can be aggregated to other geographies. We use their elasticity for the number of units as this has a strong correlation with house price growth that is consistent with expectations.[17] Finally, we use the 2012 measure of the land share of value from Davis et al. (2021) at the county level and then aggregate this to the MSA-level with population weights.[18] The share of value attributable to land arguably reflect constraints on the construction of housing (Glaeser et al., 2005), so we take one minus the land share, which we call the building share of value, so that increases in the value indicate a relatively more elastic supply function.

We measure total income (income and population) in an area using the county-level

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[17] Following guidance in the documentation dated September 2023, we use the elasticity estimated by the quadratic finite mixture model and then aggregate it to the MSA level using the formula in equation 21 and provided housing quantities.

[18] We use their "as-is" measure of land value share at the county level.

personal income estimates from the BEA and then aggregate them to the MSA level.[19] We use the broad measure “all persons from all sources” in a geography during a calendar year.[20]

We rely on several measures of housing costs. First, we use the county-level Corelogic single-family repeat-sales index and then aggregate this index to the MSA level using population weights. These data are monthly, but we convert them to annual by using the December value. Second, we use the American Community Survey (ACS) to measure the median home value and the median rent, which we aggregate from the relevant geography to the MSA level using population weights. While the median home value does not adjust for quality like the Corelogic price index, it was used in the construction of the Saiz (2010) elasticity estimates and so is a useful check on the robustness of our results.[21] Similarly, median rents are not quality adjusted, but there is no high-quality rental index with sufficient coverage across time and space.

To measure the number of housing units we rely on the Census of housing accessed via IPUMS NHGIS, which are pulled at the county level and then summed to the MSA level. We also use the ACS to measure the average number of rooms per person, although in the years before 2000 this is only available for a smaller set of MSAs due to restrictions in county identification.

We use three distinct sources of cross-sectional variation in housing demand, building off both the classic works of Saiz (2010), Diamond (2016), and cutting-edge work from Chodorow-Reich et al. (2024): a Bartik instrument for labor demand using employment growth in supersectors from 2000 to 2020 and July mean humidity and January mean temperature to measure local climate attractiveness. We select these variables because of the literature’s reliance on these and similar variables to isolate plausibly exogenous variation for housing demand and estimate housing supply elasticities.

Finally, we use exposure to remote work as a recent shock to local housing demand. Mondragon and Wieland (2025) use the ACS and measure a remote worker as someone who is employed, does not commute to work, and who does not work in agriculture or the military. They show that the share of work-from-home (WFH) in the pre-pandemic period has a strong effect on post-pandemic WFH and the demand for housing, driven by both increased

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[19] Available for download at https://apps.bea.gov/regional/zip/CAINC1.zip. Note that in this version of the paper we have updated all of our tables to use the most recent updates which include data up to 2023 and revises estimates of previous years. This results in slightly different numbers than the previous version of our paper which used the previous vintage of these data. But none of our material conclusions have changed.

[20] For more detail on this measure see here and here.

[21] One potentially important difference is that Saiz (2010) adjusts home value growth for growth in construction costs. We do not have the necessary data to make this adjustment, but it is not obvious that the relevant measure of house price growth is price growth net of changes in construction costs. Saiz (2024) describes the effects of construction costs on prices as “mechanical,” but it may still be the case that they are an important determinant of price growth.

migration and increases in housing demand by remote workers. They also document that the effect on housing demand is uncorrelated with other shocks to local markets, so it is plausibly exogenous. While this measure only directly captures workers who are fully remote, Kmetz, Mondragon and Wieland (2023) show that this measure is strongly correlated with more holistic measures of remote work such as the surveys in Barrero, Bloom and Davis (2023) and Bick, Blandin and Mertens (2023).

Table I reports summary statistics for the primary variables used in our analysis. All of the variables are in growth rates except for the change in average rooms per person, which is more easily interpreted in levels. Because the distribution of cumulative growth rates is heavily skewed over these long horizons, we annualize all of the growth rates. This makes the distributions more symmetric and improves precision, but is not necessary for our results. We also convert prices and total income growth into real values using the CPI price index. Panel A reports statistics for 2000 to 2020, our main sample of analysis, Panel B covers the longer sample from 1980 to 2020, and Panel C looks just at 1980 to 2000. Note that the number of observations in this table will not match the analysis tables as not all MSAs are populated with every constraint measure. But every MSA reported here is populated with at least one of the four measures of constraints, so this table provides a summary of all of the MSAs used in the analysis.

Just from comparing 2000 to 2020 to 1980 to 2000 we can see that the last twenty years are marked by relatively high growth in house prices, relatively less growth in total incomes, and less growth in housing quantities, all consistent with the growing perception that there is a housing affordability crisis. At the same time, the growth in housing quantities has outpaced the growth in population and the average number of rooms per person has increased, which appears inconsistent with the view that supply constraints have held back housing quantities and consistent with the argument in McClure and Schwartz (2025) that there is no evidence of a housing shortage.

4 EMPIRICAL RESULTS

In this section we estimate to what extent higher income growth predicts higher house price and lower quantity growth in U.S. cities with less elastic housing supply compared to cities with more elastic housing supply. As we explain in Section 2, these regressions allow us to quantify the importance of variation in housing supply elasticities for explaining variation in house price and quantity growth across cities.

4.1 Graphical Results

We first show the unconditional correlation between house price growth and the housing supply elasticity measures, which is strongly negative as emphasized in prior work. We then show the correlation of house quantity growth with those measures, which is also negative and inconsistent with a supply-centric story. Finally, we show graphically that higher income growth predicts the same increase in house price and quantity growth in more and less elastic cities and that the relationships between prices and quantities in general do not seem to depend on the elasticity measures.

Figure IV divides MSAs into ventiles of each measure and then plots the average annualized real house price growth from 2000 to 2020 within each bin against the average value of the constraint measure within each bin (Stepner, 2013). All of the constraint measures are adjusted so that larger values reflect less constrained, or more elastic, housing markets (see Section 3). Every measure has the expected relationship that has been repeatedly documented in the literature: cities with relatively more elastic housing markets tend to have less house price growth. The strength of the association varies across each measure, but broadly they all point to statistically and economically significant variation in house price growth across cities. For example, moving from the bottom to the top of the range of Saiz (2010) implies real house price growth goes from over 2% to less than 0.5% a year, or cumulative growth of 50% compared to 10% over 20 years.

If housing constraints are the central factor determining the growth in house prices, then housing quantities should reflect the inverse relationship. Ceteris paribus, cities with relatively unconstrained housing markets should build more housing, thus suppressing growth in house prices. Figure V checks if this is the case by plotting the total annualized growth in housing quantities against the same measures of housing constraints. The results are not consistent with this argument. All of the measures but the building share of land value are at least weakly negatively correlated with housing quantities. It is clear that none of these measures is strongly positively correlated with growth in housing quantities, as would be the case if most of the variation in house price growth were explained by variation in the growth of housing quantities (that is, explained by differential supply elasticities).

Of course, a critical step in this argument is that shocks to demand and supply are held constant when comparing cities with different elasticities. As demonstrated by Davidoff (2016) and Howard and Liebersohn (2021), local elasticity measures are strongly correlated with differences in housing demand. For example, coastal California has, in addition to restrictive zoning and difficult terrain, pleasant weather and excellent Mexican food, both of which increase housing demand.[22] Therefore, it is difficult to disentangle the effect of housing constraints from high demand.

Figure VI plots house price growth against the growth in house quantities. We see a strong positive relationship between growth in house prices and quantities: cities that experienced large growth in house prices are generally cities that experienced large growth in housing quantities, consistent with Davidoff (2013). This picture suggests that differential shifts in demand are important drivers of housing market dynamics. Of course, it does not indicate that differences in supply constraints are irrelevant, just that it is important to condition on demand when examining the effects of housing constraints on house price growth.

Figure VII takes this approach by plotting growth in house prices for each measure of housing constraints against growth in total income separately for MSAs with above and below median values of each constraint measure. Dividing cities in this way is consistent with previous work of Glaeser et al. (2006) and Ganong and Shoag (2017). As discussed in Section 2, for the same growth in housing demand MSAs with unconstrained housing markets should show relatively less growth in house prices compared to MSAs with constrained housing markets. Across every measure, we find that house prices for more- and less-constrained cities have the same slope with respect to changes in income growth. To the extent that changes in income growth reflect different demand conditions, these pictures show that none of the measures of supply constraints translate into relatively less house price growth.

The fact that supply constraints do not affect the relationship between income and house price growth is not consistent with the logic of how different housing supply elasticities affect house prices given in Equation (3). But this result could be consistent with the important class of local labor market models where migration across cities is driven by the cost of housing relative to income (Moretti, 2011). At the extreme, it is possible that migration causes price-to-income ratios to be equalized so that local housing supply elasticities will have zero effect on prices but large effects on migration and the quantity of housing (Aura and Davidoff, 2008; Howard and Liebersohn, 2021). In our framework this would be reflected as the price elasticity of demand (ϵ_p) being very large in Equation (3).[23] Alternatively, income growth may be correlated with positive housing demand shocks in more elastic cities, which would make house price growth in those cities look similar to less elastic cities. Both theories imply that income growth predicts large differences in quantity growth across more and less elastic cities.

In Figure VIII, we check if housing constraints affect the relationship between growth

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[22] The fish tacos in San Diego are particularly tasty.

[23] Another implication of this perspective is that the elasticity of supply (ψ_i) would also be very large to accommodate the changes in population driven by migration so that there is also a large quantity response in Equation (4).

in housing quantities and income growth. Since growth in total income reflects growth in population as well as growth in average income there will be a tight relationship between housing quantities and total income growth. But if the migration mechanism is important, then relatively unconstrained cities should see more growth in housing quantities for the same change in total income compared to relatively constrained cities. These figures show that this is not the case. Across all of the measures of constraints, relatively constrained cities show the same growth in housing quantities in response to higher income growth as relatively unconstrained cities. Interestingly, there is not even a gap in the average housing quantity growth across the two types of cities, which means the price gap is difficult for the standard model to reconcile (Section A2).

Through the lens of the housing demand-and-supply model in Section 2, these figures imply that differences in housing supply elasticities across cities are quantitatively not important for explaining how income growth, or housing demand growth more generally, affects differences in house price and house quantity growth. But perhaps income growth is a very specific measure of housing demand and more representative measures of housing demand show different results. To check on this concern, Figure IX plots house price growth against house quantity growth, which means that the slopes are the inverse elasticities of housing supply (Saiz, 2010), $\widehat{P}_i = 1/\psi_i \widehat{H}_i^S$, when there are no confounding supply shocks. In this case, these figures will trace out different loci for cities with high and low elasticities. These figures confirm that there is no evidence that these less constrained cities tend to have relatively higher elasticities of supply, even in the unconditional relationships between housing prices and quantities. While the Baum-Snow and Han (2024) slopes appear to be slightly distinct across the two groups of cities, the higher slope among less-constrained cities is actually the opposite of what the standard model would predict (that is, the figure suggests cities that should have more-elastic housing supply actually have less-elastic housing supply).

These results highlight that from the perspective of the standard model, it is entirely legitimate to test for differential supply elasticities by regressing prices on quantities. The only threat to identifying different supply elasticities in this way comes from differential distribution of housing supply shocks across groups of cities. However, we focus on variation correlated with income growth for several reasons. First, it is possible that even in the standard model different kinds of demand shifters will have different treatment effects on the response of housing units relative to house prices (see Section A2 and Louie et al. (2025c)). By conditioning on specific measures of demand like total income, per capita, and population growth, all of which are strongly correlated with housing market outcomes, we increase the likelihood that we will be recovering uniform treatment effects across cities. Second, by conditioning on income growth we raise the empirical hurdle in order for supply shocks to explain the irrelevance of constraint measures. If we want supply shocks to explain the unconditional correlations in Figure IX, it is necessary for supply shocks to be more important in constrained cities, which would be unexpected based on our discussion in Section 2. But if we condition on income growth it means that it must not only be true that there are more positive supply shocks in constrained cities, but also that supply shocks are more positively correlated with income growth in constrained cities. Thus, to rescue differential housing supply elasticities it is necessary to believe that the most constrained, high-growth cities actually experience the highest improvements in housing productivity. This is even less plausible than the possibility of differential likelihoods of supply shocks on average. Finally, by documenting the correlations of income growth and its components with housing market outcomes, we hope to shed light on important empirical moments that can be used to guide research on the housing market going forward.

It is also true that relatively constrained cities tend to have higher house price growth on average, as shown by the vertical gap between the two sets of cities in Figure VII and Figure IX, but no such gap exists for housing quantity growth in Figure VIII. We show in Section A2 that because this "intercept" term only exists for prices and not quantities, it is only consistent with differential supply elasticities if one assumes a set of ad hoc and implausible housing supply shocks:[24] on average supply shocks must have increased housing supply in elastic cities by one percentage point per year and reduced housing supply in inelastic cities by one percentage point per year. For comparison, the housing stock grows on average by one percentage point per year. Under this interpretation it is differences in supply shocks, not differences in supply elasticities that account for differences in house price growth and quantity growth across cities. We argue that it is more plausible that this difference in price growth reflects differential amenity growth correlated with the measured supply elasticity (Davidoff, 2016) and limitations in how well price indexes adjust for changes in housing quality or local amenity valuation, both of which will be priced in any standard housing model (Harding, Rosenthal and Sirmans, 2007; Billings, 2015; Diamond, 2016).[25] Further, in Section A3 we document that the empirical relationships between the constraint measures and price and quantity growth, conditional on income growth, range from small to nonexistent, further reinforcing our argument that these measures do not explain variation in price and quantity growth across cities.

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[24] The figures also show that low-growth cities have essentially identical—none to little—growth in house prices. This is not informative about the importance of housing supply constraints since constraints should only matter in environments with increasing demand (Glaeser and Gyourko, 2005). In our robustness checks we drop low-growth cities and find the same results.

[25] In her Spring 2025 Brookings discussion, Molloy argues that neither the ownership cost nor the rent of constant-quality housing has increased relative to the median income, consistent with large changes in housing quality.

In short, none of the figures suggest an important role for housing supply constraints in explaining house price growth and quantity growth in a way that the supply-centric view predicts. We next confirm this insight in regression form and show that it is a robust conclusion.

4.2 Regression Results

We estimate the following regressions:

$$\widehat{P}_i = \alpha + \beta_1 \widehat{Y}_i + \beta_2 \mathbb{I}_i(\text{Less Constrained}) + \beta_3 \widehat{Y}_i \times \mathbb{I}_i(\text{Less Constrained}) + e_i, \qquad (7)$$
$$\widehat{H}_i = \delta + \gamma_1 \widehat{Y}_i + \gamma_2 \mathbb{I}_i(\text{Less Constrained}) + \gamma_3 \widehat{Y}_i \times \mathbb{I}_i(\text{Less Constrained}) + v_i.$$

The coefficients of interest are β_3 and γ_3, which recover the differential response of house price growth and house quantity growth to income growth for cities that have relatively more elastic housing supply. In terms of our discussion in Section 2, $\beta_3 = \beta_H - \beta_L$ and $\gamma_3 = \gamma_H - \gamma_L$. Thus, we expect $\beta_3 < 0$ and $\gamma_3 > 0$, or that cities with relatively more elastic housing supply experience relatively less price growth and more house quantity growth for the same income growth. In contrast, we find that the coefficients are small, statistically insignificant, and often of the wrong sign, which implies that differences in housing supply are quantitatively not important for explaining differences in house price and quantity growth across cities (Section 2). In Section 4.4 we discuss the robustness of our results to more flexible discretizations or using a continuous specification.

Table II reports the results for the Corelogic house price index where panel A uses total income growth, our preferred measure of demand. Total income growth is strongly correlated with house price growth: a one percentage point increase in total income growth predicts a 50-60 basis point increase in house price growth. However, the interaction term of total income growth with the housing supply constraint indicator is essentially zero and statistically insignificant across all measures of the elasticity.

One concern might be that we are using total income growth when we should be using only growth in per capita income or only growth in population as our measures of housing demand. We show in Section A1 that total income is a legitimate measure of housing demand in standard models, and in Louie et al. (2025c) we show that it is appropriate even in a relatively non-standard model. The intuition is that our empirical approach only depends on the structure of the housing market and is independent of any assumptions about migration. Even so, by checking if the results depend on the measure of growth we can also determine if it is plausible for supply shocks to be more important in more constrained areas (see Section 2). Table II panel B shows that per capita income growth is strongly correlated with growth in house prices and this correlation is identical across more- and less-constrained MSAs for every measure of constraints. Interestingly, the correlation of per capita income growth with prices is somewhat stronger than the correlation of total income growth with prices. Panel C turns to population growth and, while the correlation between population growth and price growth is somewhat smaller, we again find that this correlation is unaffected by whether or not a city appears to be supply constrained. Table III repeats these regressions for growth in the median home value and finds the same results. There is no evidence that using total income as a regressor is affecting our results one way or another. Given these results, we use total income growth as our baseline regressor, but in Section 4.4 we repeat our quantity results using per capita and population growth as robustness checks. Importantly, the fact that all of the specifications show the same non-result is inconsistent with the hypothesis that supply shocks are more important in more constrained areas.

Table IV changes the outcome variable to housing quantity growth. Panel A uses the growth in the number of housing units and panel B uses population growth. Across all of the specifications only the regulatory index seems to slighty raise the positive effect of income growth on growth in housing units and population. Even taking this small effect at face value, the fact that Table II showed that there is essentially no effect on prices as one would expect from a supply-centric view, suggests this result is likely spurious and below we confirm that this effect disappears once we exclude low-growth cities. The Saiz, Baum-Snow and Han, and building share of value measures all have no effect on the correlation between quantities and income growth and mostly have the wrong sign. Overall, we find little to no evidence for relatively more growth in housing quantities in less constrained areas for any of the constraint measures. Similarly, the coefficient on the indicator itself is not significantly or even consistently positive. So while less-constrained cities tend to have lower house price growth on average in some specifications, they do not tend to have more growth in housing units or population, inconsistent with the basic supply-side mechanism (see Section A2).

Panel C uses the change in the average number of rooms per person as an alternative measure of housing quantity outcomes. If housing markets are responding on the intensive margin (for example, larger homes) more than the extensive margin (more homes) then this variable should capture some of the differential response. Here total income growth is negatively correlated with the change in rooms per person, suggesting that cities that are growing become more crowded or less spacious, perhaps as households opt to live closer to certain amenities associated with higher density. But this correlation is completely unaffected by the measure of housing constraints. Given a level of income growth, having a housing market that is ostensibly more or less constrained does not affect the quantity of housing per person.

Together these results show that neither prices nor quantities exhibit the kind of differential correlation with income growth that we would expect if housing supply constraints are actually different across these groups. To summarize this point, we estimate instrumental variable specifications along the lines of (6), where we interact growth in house prices with the indicator for being less constrained and then instrument for that variable with total income growth interacted with the same indicator. This allows us to estimate the supply elasticity directly and focuses the threats to identification on just differential correlations between supply shocks and income growth.

Table V reports estimates for growth in the quantity of housing with panel A using the house price index and panel B using the median home value. The coefficients on price growth give the estimated elasticities of housing quantity with respect to price growth for each type of city. We report the Chi-squared test for rejecting the hypothesis that the estimated elasticities across more- and less-constrained cities are the same. We also report the first-stage F-statistics for each group of cities when estimated separately to explicitly verify that instrument is strongly correlated with house price growth. In none of the specifications can we reject that the elasticities are equal at standard levels of significance. Only the regulatory index displays a lower supply elasticity in more constrained cities that is at least somewhat economically meaningful. But the difference in the relationship is simply quantitatively too small and imprecise to be able to say that less regulated cities have a meaningfully different response in the quantity of housing units, and robustness checks below show that this estimate is not robust to dropping low-growth cities.

Table A1 runs the regressions replacing housing unit growth with population growth and finds essentially the same results. We do not find any evidence that supply constraints are economically or statistically significant determinants of variation in the growth of house prices relative to house quantities.

4.3 Evidence from Plausibly Exogenous Variation in Housing Demand

We argue that our analysis is particularly attractive because we do not require exogenous variation in housing demand to evaluate if differences in housing supply elasticities across U.S. cities explain differences in house price and quantity growth (Section 2). But exogenous variation can help distinguish between the explanation that supply elasticities are not different, at least as conventionally measured, and the alternative that differentially correlated supply shocks render actual differences in supply elasticities uninformative about city house price and quantity growth. We distinguish between these explanations using two distinct approaches. First, we use three standard instruments for housing demand to re-estimate our housing supply elasticities. As explained in Section 3, these are a Bartik instrument for labor demand, July humidity, and January temperature. Second, we exploit the shock to housing demand due to the shift to work-from-home from Mondragon and Wieland (2025), who show that it is a plausibly exogenous shock to local housing demand. Both of these exercises recover little difference in supply elasticities across cities, consistent with our non-causal evidence. In addition to providing plausibly exogenous variation, these shocks are useful because we do not condition on changes in total income, per capita, or population growth, allowing us to sidestep any concerns about how those variables may be affecting our analysis.

Table VI presents the results using the standard instruments. In six of the eight specifications it is the more-constrained cities that are estimated to have more elastic housing supply functions, with an economically large and statistically-significant difference for column two of panel A. These results are the opposite of the standard view. While the estimates using the regulatory index point in the standard direction, these results again disappear after dropping low-growth cities. Therefore, even when using standard approaches to isolating housing demand that do not rely at all on our measures of income growth we find that supply elasticities do not appear to be different across cities. These regressions return elasticities that are generally lower than what we find using total income growth as an instrument, which is consistent with supply shocks biasing the OLS estimates of the supply elasticity upward. For our purposes it is sufficient to document that these elasticity estimates do not suggest that standard measures of housing supply constraints help explain house price or quantity growth across cities.

In our second exercise, we construct a measure of exposure to the rise of WFH over the pandemic, the the employment share of WFH from 2015-2019, which Mondragon and Wieland (2025) show is strongly correlated with the increase in WFH over the pandemic and plausibly exogenous. We then interact this measure with each of the indicators for being less constrained (above median). We measure outcomes from 2019 to 2023, the most recent year for which we can measure total income growth.

Because this is a single shock, we present the reduced form results in Table VII. In panel A we put total income growth as the outcome to check if growth in more- and less-constrained cities loads equally on the WFH shock. We see some evidence that growth is higher in places that are less regulated, implying there is some heterogeneity in the treatment effect. This heterogeneous treatment effect is not informative about the role of supply constraints in the housing market, but it is important for scaling the demand shock across these different cities. Panel B turns to house prices and finds that remote work does increase house prices, but there is no evidence that house prices grew less in cities that were less constrained. The one statistically significant estimate, on the regulatory constraint, has the wrong sign.

Finally, panel C looks at the cumulative growth in the number of units permitted.[26] We use permitted units instead of actual units because the quantity of housing measure we use in other specifications is only available in census years. These estimates show that the increase in housing demand due to WFH had a large effect on permit growth, about two to three times larger than that on house prices. This larger response is intuitive since permits represent the response of housing investment, which is smaller and more volatile than the overall stock of housing. The interaction terms are all positive, sometimes with large coefficients, but the standard errors are far too large to distinguish these estimates from zero. These large coefficients on the interactions are actually due to outliers as quantile regressions, which are less sensitive to outliers than OLS regression, are reported in Table A2 and show that these estimates largely disappear. Critically, none of the measures gives the expected set of coefficients showing relatively less house price growth and relatively more permitting growth in elastic cities in response to the shift in demand.

In short, even when using exogenous variation the measures of housing constraints do not affect the relative growth of house prices and house quantities across cities. We again conclude that differences in housing supply elasticities are quantitatively unimportant for explaining differences in house price and house quantity growth.

4.4 Robustness

In this section we provide robustness exercises that continue to show that income growth has the same relationship with house price growth and housing quantity growth irrespective of the measured local supply elasticity. First, we extend the sample to 1980-2020. Second, we look at just the 1980-2000 subsample. Third, we use quartiles of the housing constraint measure rather than a binary indicator to check if we are obscuring effects in parts of the distributions of constraint measures. Fourth, we use continuous interaction models. Fifth, we exclude cities that are not growing or growing very slowly to make sure we are not biasing the results since housing supply constraints should not be relevant when demand is not increasing or declining. Sixth, we examine growth in rents instead of house prices. Seventh, we examine changes in commuting times. Eighth, we examine housing quantities again but using variation in per capita income growth or in population growth to again address concerns that total income growth somehow biases our results. Finally, we check if our results are being driven by small cities. All of these results show that our finding is a robust feature of the data since at least 1980.

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[26] Since permits are quite volatile we calculate the cumulative growth in permits by summing all permits from 2021 to 2023 and comparing that to the sum of permits issued from 2017 to 2019 and then annualize that growth rate.

One important question is if the results that we document are unique to the years 2000 to 2020. In Table VIII we extend the sample to 1980 and run the reduced form price regressions. We still find that the constraints have no effect on the correlation between house prices and income growth. Table IX turns to housing quantities and finds the same result: local constraints have no meaningful effect on the correlation between income growth and growth in housing quantities. Even the small effect of regulatory constraints on quantity growth found in Table IV is not present in these estimates. The longer sample confirms that there is little evidence that housing supply constraints explain variation in housing quantity growth or house price growth at least since 1980.

A related concern might be that the supply elasticities had more relevance in the period before 2000, which would correspond with much of the sample used to estimate the elasticities from Saiz (2010) and Baum-Snow and Han (2024). To test for this possibility we restrict the sample to the years from 1980 to 2000 and run the same reduced form regressions. Table A3 reports the price results. Again we find no evidence that less constrained cities experience less house price growth, instead we even find in panel B that all the measures seem to increase the correlation between income growth and house prices, some even with statistical significance. Interestingly, the two house price measures display different correlations with income growth, with the house price index seemingly uncorrelated with income growth and with the constraint measures. This is in contrast with the median home value measure, which shows the standard correlations with both income and constraints, suggesting that the price index may have large measurement error in this earlier sample.

Table A4 turns to housing quantities and again finds no evidence that the constraints are associated with more growth in housing quantities. Consistent with panel B of Table A3, panel B shows that, by some measures, less constrained cities actually had less quantity and population growth for a given level of income growth. Low growth in population and high growth in prices is happening in the less constrained cities—the opposite of what the supply-centric view predicts.

Our results so far have focused on comparing cities above and below the median of the constraints measures. If supply constraints are the single most important factor affecting housing market dynamics, then this is likely sufficient to reveal these effects. However, these constraints are measured with noise, which may make it difficult to estimate effects, and it is theoretically possible that the economically meaningful effects are only apparent at the margins of the distribution (for example, by comparing Grand Forks, ND to San Francisco, CA). It is also possible that discretizing the variable by the median reduces the statistical power of the analysis. To check for this possibility we re-run our baseline analyses, but this time we split cities into quartiles based on the measured constraints and then interact income growth with these quartiles. While the relatively small number of observations may mean this larger set of coefficients cannot be estimated precisely, it should still be capable of detecting economically important effects albeit with less precision. Table A5 reports the results for house prices and Table A6 does the same for house quantities. Once again, we find no evidence that income growth leads to lower house price growth even when comparing the most constrained quartile to the least constrained quartile. We also check this specification for prices and quantities in 1980 to 2020 (Table A7 and Table A8) and 1980 to 2000 (Table A9 and Table A10). None of these estimates show robust evidence that housing supply constraints matter as they should according to the supply-centric view and many of them feature the opposite relationship.

Though these results point overwhelmingly to the lack of any robust relationship between constraint measures and relative growth in prices or quantities, we also examine the interaction model where the constraint measures are included continuously. All of the constraint distributions but the Baum-Snow and Han elasticity are heavily skewed, which could result in continuous models being very misleading (in any direction) since they are particularly sensitive to outliers. But it would still be interesting if continuous interaction models give clear results in favor of the standard model. Table A11 presents the results for growth in house prices and median home values where we have standardized each constraint so that the coefficients can be interpreted as reflecting one standard deviation of the constraint measure, where one standard deviation is roughly equivalent to the difference in the Saiz elasticity estimates for San Francisco and Houston. All of the interaction terms have negative signs, which is consistent with the supply-centric view, but the magnitudes and precision vary wildly. The interaction on the Saiz elasticity is now statistically significant in both panels, but the economic magnitude is very small, implying that relaxing San Francisco's elasticity to Houston and assuming average growth in total incomes would reduce house prices in San Francisco by about 4%. Both the Baum-Snow and Han and building share estimates have economically larger coefficients in some specifications, but these coefficients are not mirrored in the other measure of house prices. This suggests the results are likely spurious. Additional evidence that the continuous measures are not economically important determinants of house price growth is the fact that the total amount of variation explained, given by the r-squared, changes minimally if at all when including the constraint measure as a continuous variable relative to the indicator specification (compare to Table III).

However, one concern might be that the non-normal distributions of these constraints are obscuring results that would be otherwise apparent, although our non-parametric specifications are evidence against this interpretation. To check further if this is the case, we winsorize the top and bottom of each distribution using the 5th and 95th percentiles. If extreme observations were having an undue influence on the linear specifications then this should lead to better behaved, more precise estimates. Table A12 gives the results, where we now see that there is no longer any evidence of even the tiny economic effect that was apparent in the Saiz estimate. The other estimates that were economically large in the previous table are now much smaller and the results are still not consistent across price measures. Therefore, continuous interaction models provide little evidence that these constraint measures are economically important determinants of variation in house price growth.

Table A13 reports the parallel results for measures of housing quantities. The Saiz elasticity now gives a statistically significant estimate on its interaction, but the economic magnitude is again miniscule: giving San Francisco the elasticity of Houston and assuming average income growth increases the total quantity of housing built over 20 years by about 40 basis points (in total!). We find the same positive but economically small coefficient on the regulatory index interaction as in our baseline results. The interaction term on the building share index is economically larger, although imprecisely estimated and still economically small. Table A12 applies the same winsorization as above and shows that these large estimates were spurious, with the interaction estimates now pointing to no economic difference. As with the price results, the sensitivity of these estimates to winsorization is evidence that the constraint measure distributions are heavily skewed and potentially subject to significant measurement error, suggesting that our baseline non-parametric approach is a more robust way to quantify these relationships.

Glaeser and Gyourko (2005) show that housing supply should be relatively inelastic as demand falls so that the housing supply curve is “kinked.” Therefore, areas that are declining or growing very slowly will not be informative about the mechanisms we outline in Section 2, which apply only to increases in demand. To check if such low-growth cities are biasing our results, we drop the cities in the bottom quartile of the entire distribution of total income growth and re-run our baseline analysis. The price results are reported in Table X and finds broadly the same results, although some interaction estimates now have the wrong sign. Table XI reports the quantity effects and again we find that measured constraints have no effect on the correlation with income. These results show that low-growth cities are not biasing our baseline estimates against finding large differences in supply elasticities.

It is possible that looking only at house prices may obscure important dynamics in the rental market if the purchase and rental housing markets are significantly segmented. Importantly, our quantity and population measures will capture growth across both rental and purchase markets, so this can only be a potential concern with our price measures. Table XIV panel A replaces house prices with growth in median rents in our baseline specifications and finds again that the measured constraints do not affect how income growth predicts rent growth.[27] The correlations between income and median rent growth are about two-thirds the size of those between income and median home value growth. This does suggest some differences in composition between rental and purchase markets, but importantly these relationships never vary with measured constraints.

Another outcome where housing supply may be important is in the costs of housing quality or quality of life. While we try to capture this with the change in the number of rooms per person, another important outcome is how much time workers spend commuting to their jobs. Less regulated geographies may allow workers to live closer to their work or to efficient means of transportation, allowing them to spend less time commuting. Panel B of Table XIV uses the ACS to compute the change in the average commute time among employed individuals in each MSA.[28] Changes in commuting time are essentially uncorrelated with any of our explanatory variables, so it is not surprising that we also find that the relationship between income growth and commuting times is the same in more- and less-constrained MSAs.[29]

Finally, we check if our results are caused by cities of a certain size. While it would be unexpected and theoretically puzzling for supply elasticities to only matter in cities of a certain size, it is possible that these constraints are measured with more measurement error in relatively small cities. Additionally, if small cities have disproportionally high income growth and a low supply elasticity, then this would cause attenuation bias in our estimates of the effects of supply constraints on the correlation with income. To check for this possibility we split each of the elasticity samples into small and large cities based on the median city size and then we construct new indicators of being less constrained based on the median constraint value within each of these subsamples. We then estimate our baseline regressions in (7) within each of these subsamples and report the interaction term.

Panels A and B of Table A15 show that our baseline findings hold true in both small and large cities. Among housing quantity outcomes, only the Wharton regulatory index displays a small positive effect for both small and large cities, similar to our baseline results. But like our baseline result, that effect disappears once we drop low-growth cities (Table A16). Thus, we do not find evidence that measurement error in constraints or some kind of size-effect is confounding our results.

To summarize this section, across a wide variety of regression specifications we find little

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[27] We use median rents from the ACS because there is no high-quality rental index with sufficient coverage in earlier years in our sample.

[28] We use the average instead of the median commuting time as these survey responses exhibit a large amount of rounding to a few salient answers (for example, 30 minutes), leading the distribution of median commuting times to be sparse and non-smooth.

[29] The growth rate of commuting times behaves similarly.

to no evidence that differences in housing supply elasticities explain differences in house price or growth.

5 Conclusion

This paper revisits the standard view that local housing supply constraints explain differences in local house price and quantity growth. We estimate how shifts in income growth and exogenous housing demand shocks translate into changes in house prices and quantities across U.S. cities measured to be more or less constrained in their housing supply. Contrary to prevailing beliefs and influential policy narratives, our empirical results consistently show that higher income growth predicts similar growth in house prices, rents, housing quantities, population, and living space per person across more and less housing constrained cities. These results imply that differences in housing supply elasticities across U.S. cities are quantitatively not important for explaining differences in house price and quantity growth. Instead, our evidence suggests that housing supply functions are broadly similar across most metro areas despite very different regulatory and geographic environments, challenging the consensus that relaxing regulatory constraints would substantially expand housing quantities and lower prices.

These results thus call for a reevaluation of our understanding of housing markets and housing supply, echoing the call by DiPasquale (1999) more than 25 years ago. We think there are a number of potentially fruitful directions going forward. First, the fact that per capita income growth is strongly correlated with price growth but barely correlated with quantity growth points to multiple margins of housing consumption, namely consumption of quality (or amenities) as well as the consumption of units of a given quality. We are pursuing this direction and give examples of this framework in Section A2 and Louie et al. (2025c). In this kind of framework, growth in per capita incomes will raise prices because richer households have more income to spend on high-value housing, but this income growth need not induce any growth in units since richer households do not want to consume additional units of housing in the same city. In fact, unevenly distributed income growth may even reduce population growth if the price growth of local services (including housing) caused by income growth at the top prices out lower-income households. So frameworks that only include one margin of housing demand and supply may be obscuring critical mechanisms in the housing market.

A second promising avenue that we are pursuing focuses on differences in the labor market and labor supply across metro areas. From 2000 to 2020, real house prices in San Francisco grew annually by about 2.4%, compared to 1% for Houston, while at the same time real per capita income in San Francisco grew by 2.2% and just 0.8% in Houston. The growth of incomes relative to prices was identical in these two very different cities, consistent with identical housing supply elasticities. So then why did average incomes increase so much in San Francisco despite low population growth, while in Houston average wages effectively stagnated and population growth was relatively high? From the perspective of standard labor market models, these patterns point to fundamental differences in labor supply. Some cities, like San Francisco, are home to high-productivity jobs where top workers are very difficult to recruit, thus resulting in very high wages.[30] Other cities may also be home to high-productivity industries, but if appropriately-skilled workers in these industries are relatively more plentiful so that labor supply is relatively higher, then there will tend to be less growth in average incomes and more growth in employment and so population. These mechanisms reinforce the core insight of local labor market models, which is that housing and labor markets are fundamentally connected, and indicate that productivity and wage growth may be the most important factors for understanding housing market trends.

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[30] At the time of writing there are reports that Mark Zuckerberg is offering compensation of up to $100 million dollars to top AI engineers within their first year of employment.

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FIGURES

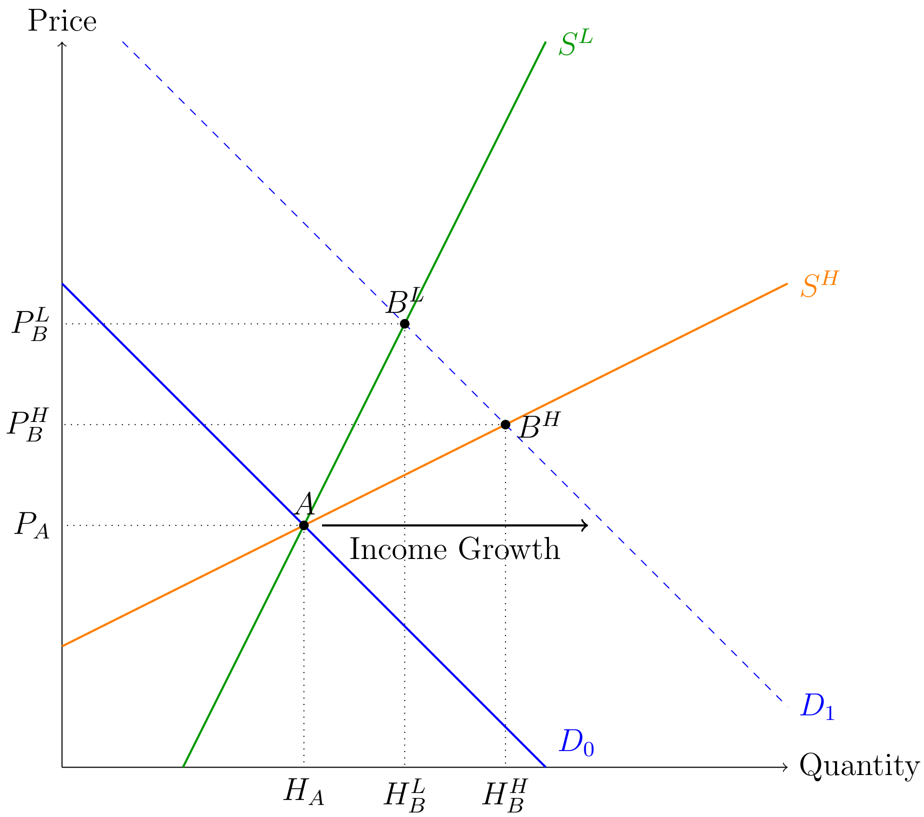


FIGURE I
The Differential Effect of Income Growth on House Prices and Quantities When Supply Elasticities Differ Across Cities

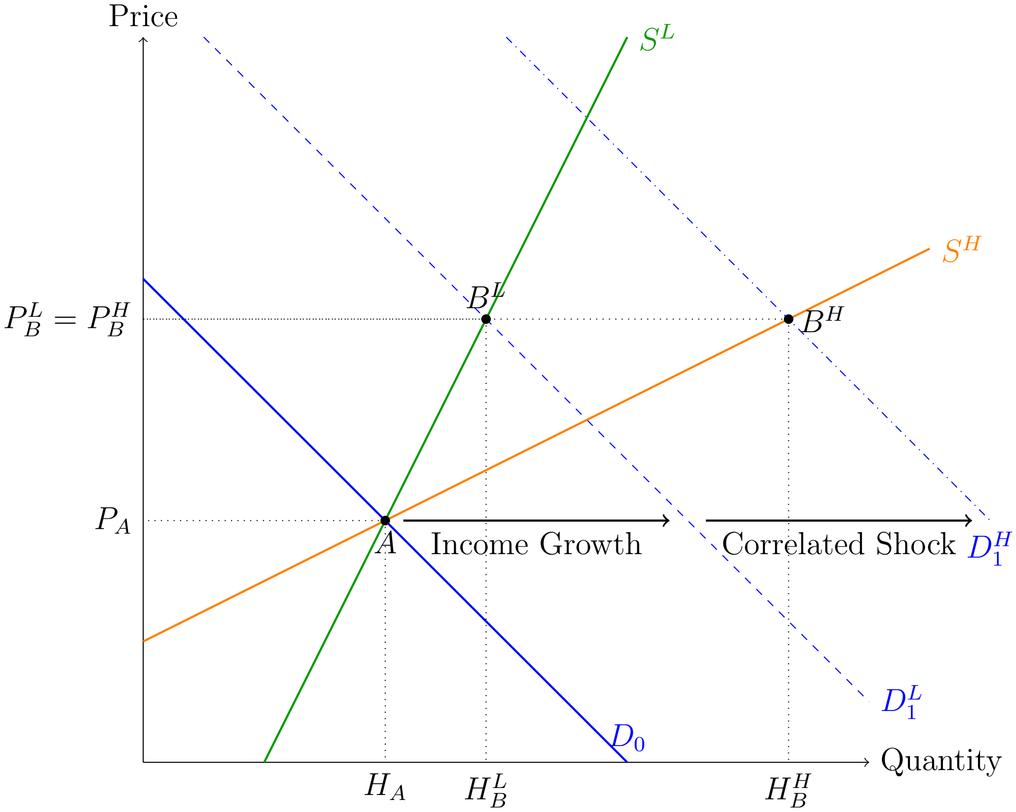


FIGURE II
The Differential Effect of Income Growth on House Prices and Quantities When Demand Shocks Are Positively Correlated With Income Growth in More Elastic Cities

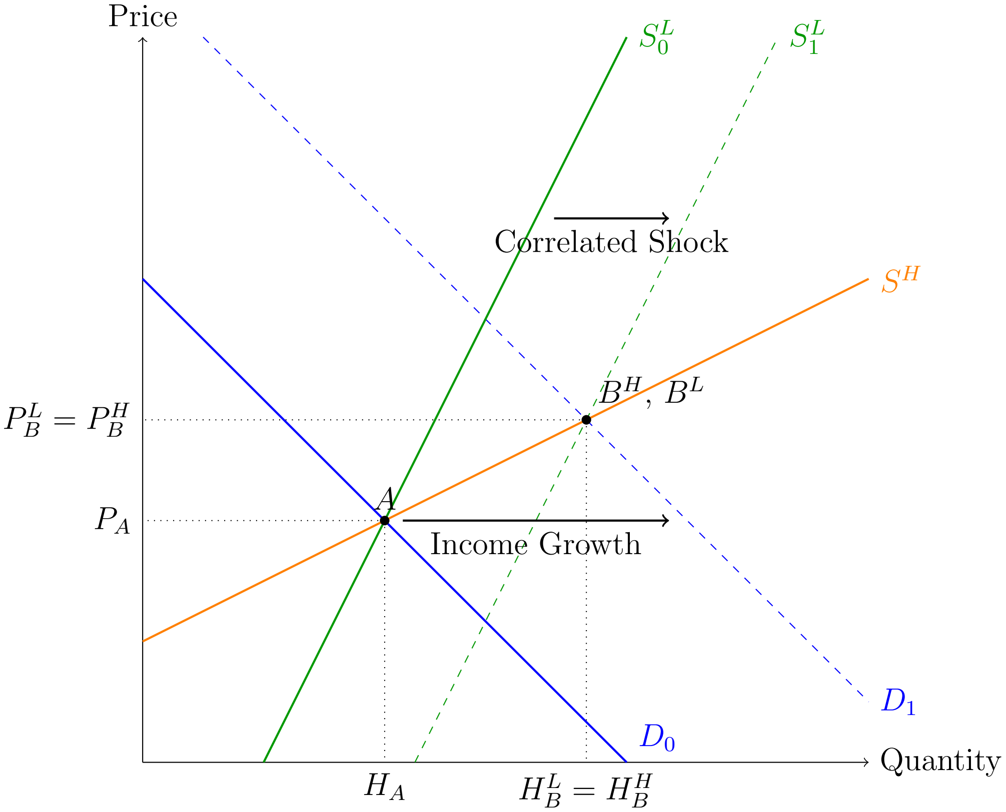
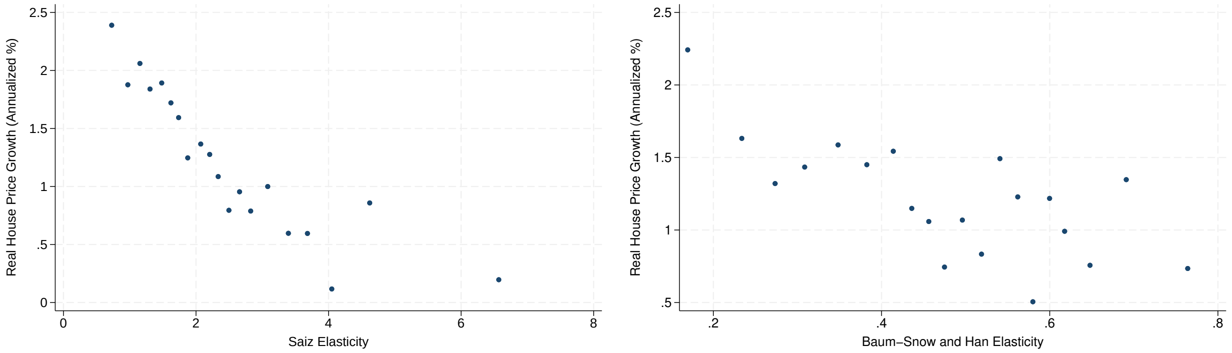
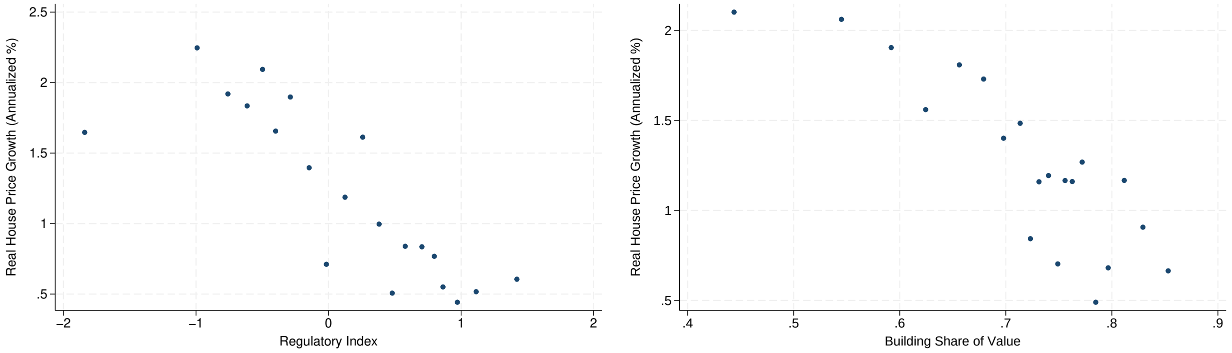


FIGURE III
The Differential Effect of Income Growth on House Prices and Quantities When Supply Shocks Are Positively Correlated With Income Growth in Less Elastic Cities



A. Elasticity
(**Saiz, 2010**)

B. Elasticity
(**Baum-Snow and Han, 2024**)

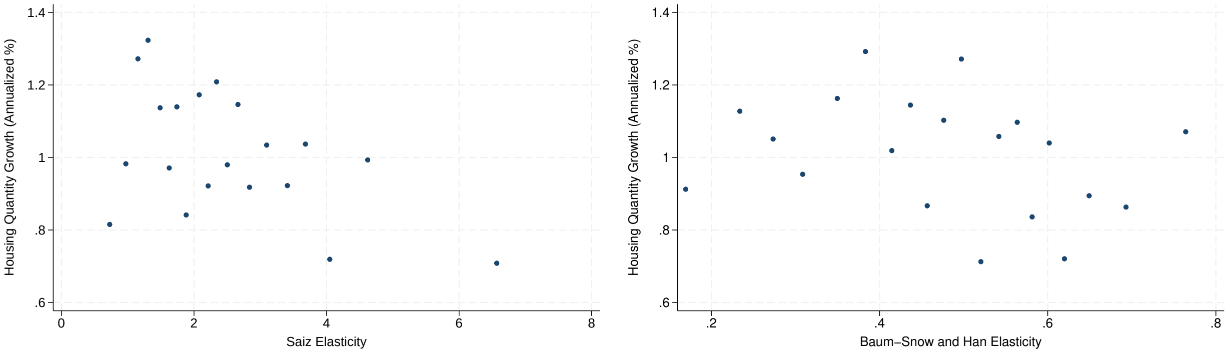


C. Regulatory Index
(**Gyourko et al., 2008**)

D. Building Share of Value
(**Davis et al., 2021**)

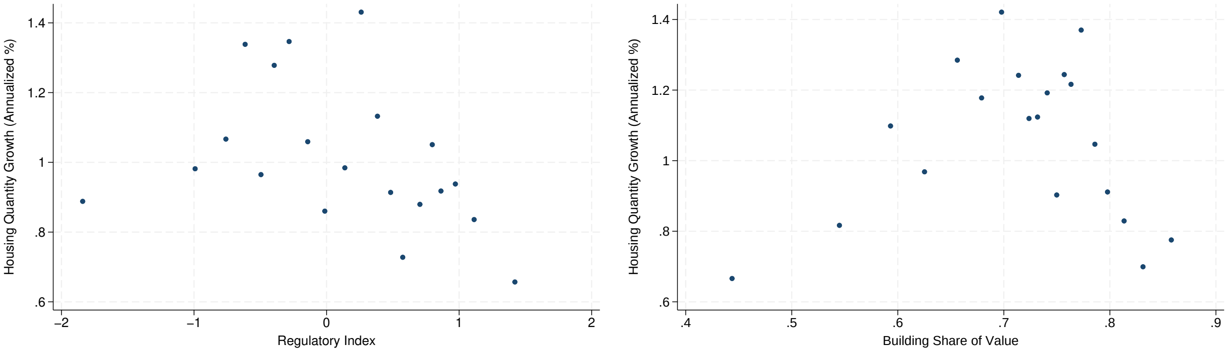
FIGURE IV
House Price Growth and Housing Constraints (2000-2020)

Note.—This figure splits MSAs into ventiles of each measure of housing constraints and then reports the mean growth in real house prices. We multiply the regulatory index by minus one so that regulations are becoming more relaxed as it increases and we calculate the building share of value by subtracting the land share of value from one.



A. Elasticity (Saiz, 2010)

B. Elasticity (Baum-Snow and Han, 2024)



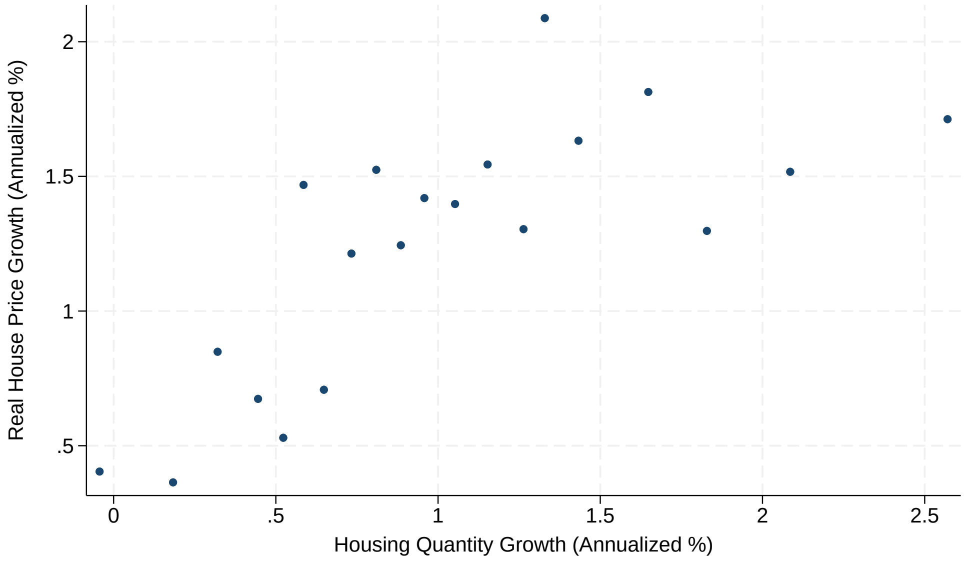
C. Regulatory Index (Gyourko et al., 2008)

D. Building Share of Value (Davis et al., 2021)

FIGURE V

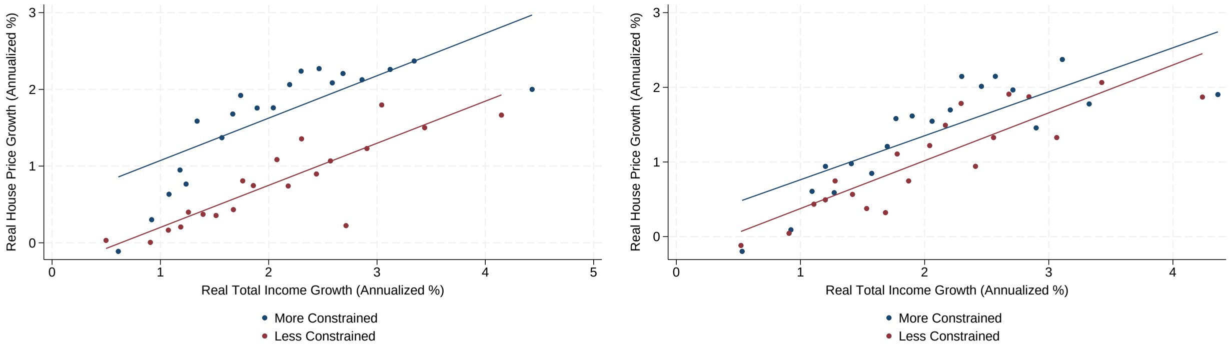
Housing Quantity Growth and Housing Constraints (2000-2020)

NOTE.—This figure splits MSAs into ventiles of each measure of housing constraints and then reports the mean growth of housing units. We multiply the regulatory index by minus one so that regulations are becoming more relaxed as it increases. We calculate building share of value by subtracting the land share of value from one.



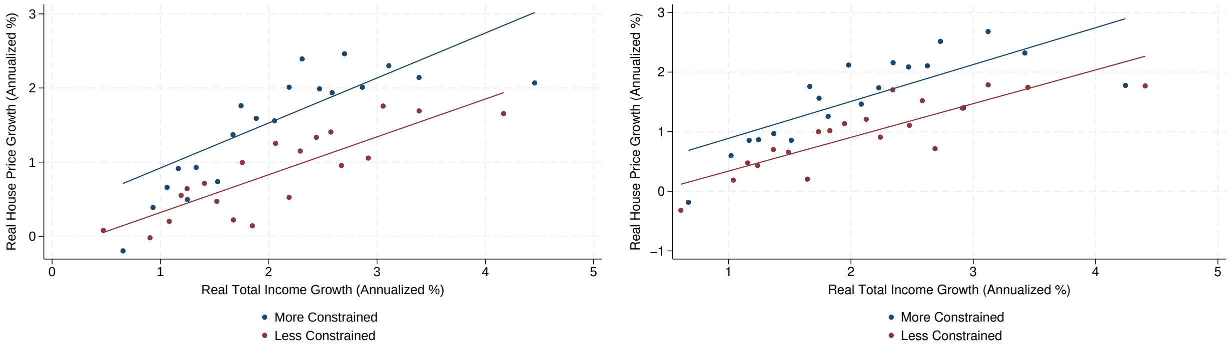
Note.—This figure splits MSAs into ventiles of house quantity growth and then reports the mean growth of real house prices against the mean growth of housing quantities within each bin.

FIGURE VI
House Price and Quantity Growth (2000-2020)



A. Elasticity
(**Saiz, 2010**)

B. Elasticity
(**Baum-Snow and Han, 2024**)

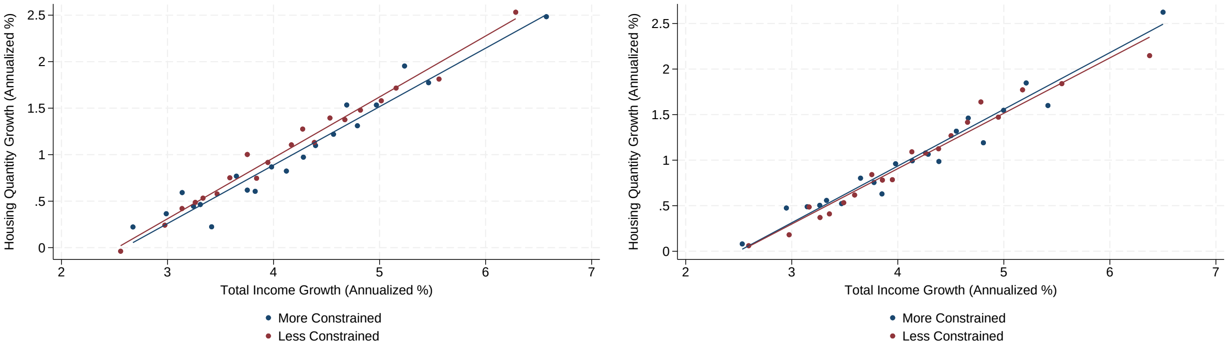


C. Regulatory Index
(**Gyourko et al., 2008**)

D. Land Share of Value
(**Davis et al., 2021**)

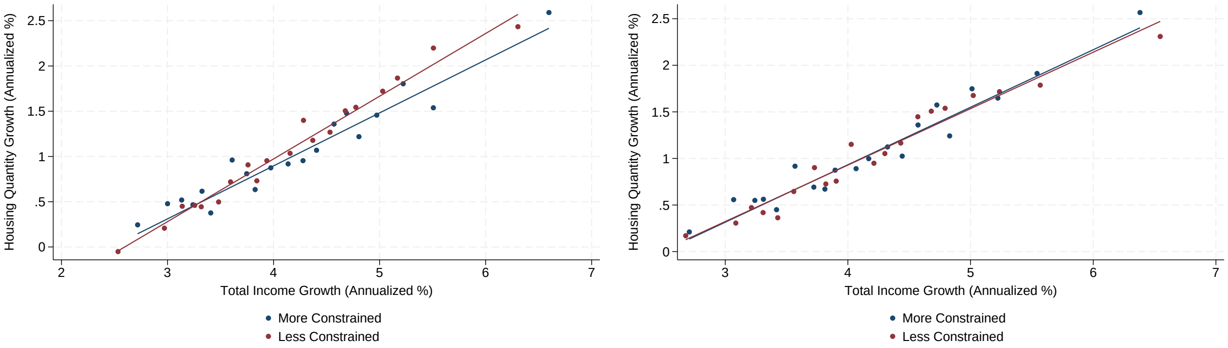
FIGURE VII
House Price and Income Growth

Note.—This figure splits MSAs into groups above and below the relevant measure of local housing markets and then reports the mean growth of real house prices and total income for ventiles of each group. The lines give the linear fit within each group.



A. Elasticity
(**Saiz, 2010**)

B. Elasticity
(**Baum-Snow and Han, 2024**)



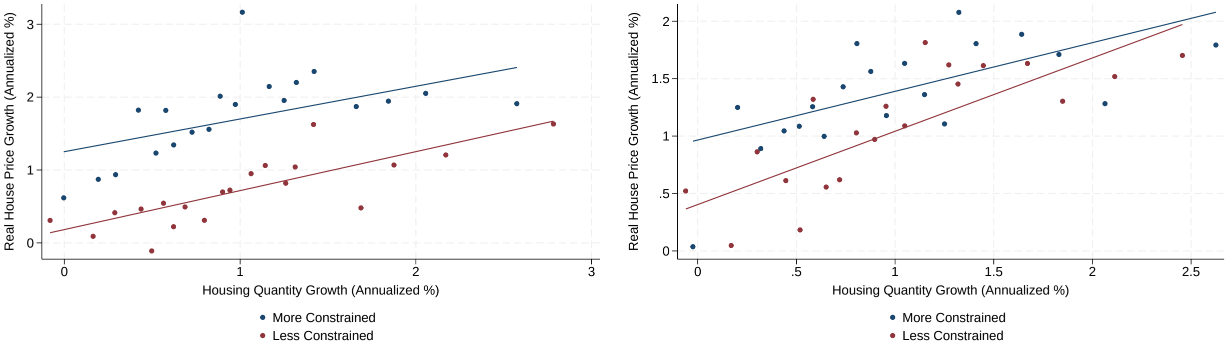
C. Regulatory Index
(**Gyourko et al., 2008**)

D. Land Share of Value
(**Davis et al., 2021**)

FIGURE VIII

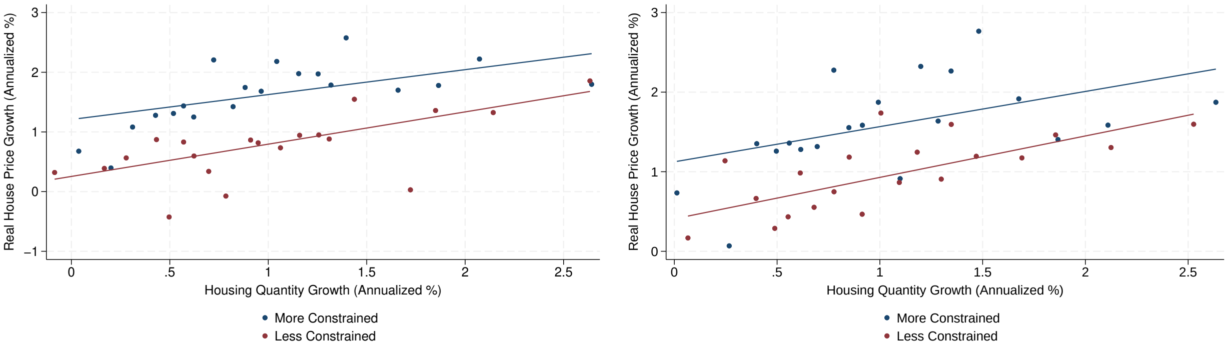
House Quantity and Income Growth (2000-2020)

NOTE.—This figure splits MSAs into groups above and below the relevant measure of local housing markets and then reports the mean growth of housing units and total income within ventiles of each group. The lines give the linear fit within each group.



A. Elasticity
(Saiz, 2010)

B. Elasticity
(Baum-Snow and Han, 2024)



C. Regulatory Index
(Gyourko et al., 2008)

D. Land Share of Value
(Davis et al., 2021)

FIGURE IX
House Quantity and Real House Price Growth (2000-2020)

NOTE.—This figure splits MSAs into groups above and below the relevant measure of local housing markets and then reports the mean growth of real house prices and housing units within ventiles of each group. The lines give the linear fit within each group. Note that the slopes of these curves are the inverse elasticities of housing supply.

TABLES

TABLE I
SUMMARY STATISTICS

	Observations	Mean	SD	25th Pct	50th Pct	75th Pct
Panel A. 2000-2020						
Real House Price Growth (Annualized %)	321	1.23	1.04	0.46	1.18	1.98
Real Median House Value Growth (Annualized %)	321	1.44	1.00	0.77	1.36	2.22
Real Rent Growth (Annualized %)	321	0.95	0.64	0.50	0.90	1.45
Real Total Income Growth (Annualized %)	323	2.06	0.91	1.32	1.98	2.64
House Quantity Growth (Annualized %)	323	1.01	0.65	0.54	0.91	1.37
Population Growth (Annualized %)	323	0.81	0.74	0.26	0.71	1.26
Change in Average Rooms per Person	321	0.33	0.17	0.22	0.34	0.44
Panel B. 1980-2020						
Real House Price Growth (Annualized %)	321	0.97	0.91	0.28	0.90	1.55
Real Median House Value Growth (Annualized %)	321	1.13	0.67	0.66	1.08	1.57
Real Rent Growth (Annualized %)	163	1.06	0.55	0.61	1.02	1.47
Real Total Income Growth (Annualized %)	323	2.50	0.98	1.82	2.44	3.08
House Quantity Growth (Annualized %)	322	1.26	0.75	0.72	1.18	1.67
Population Growth (Annualized %)	323	0.98	0.86	0.34	0.94	1.50
Change in Average Rooms per Person	163	0.56	0.25	0.38	0.58	0.75
Panel C. 1980-2000						
Real House Price Growth (Annualized %)	321	0.71	1.32	-0.22	0.60	1.46
Real Median House Value Growth (Annualized %)	323	0.81	0.89	0.26	0.79	1.27
Real Rent Growth (Annualized %)	163	1.07	0.75	0.67	1.20	1.46
Real Total Income Growth (Annualized %)	323	2.95	1.26	2.05	2.91	3.71
House Quantity Growth (Annualized %)	322	1.51	0.93	0.85	1.44	1.95
Population Growth (Annualized %)	323	1.14	1.06	0.38	1.03	1.77
Change in Average Rooms per Person	163	0.24	0.17	0.14	0.27	0.36

This table reports summary statistics for the primary variables in our analysis across all cities with at least one constraint measure. See the text for more details.

TABLE II
House Price Growth (2000-2020)

Panel A. Total Income Growth

Less Constrained × Income Growth	-0.004	0.052	-0.097	-0.053
	(0.120)	(0.111)	(0.119)	(0.113)
Income Growth	0.553***	0.589***	0.607***	0.619***
	(0.098)	(0.078)	(0.094)	(0.089)
Less Constrained	-0.868***	-0.438*	-0.504*	-0.496**
	(0.262)	(0.237)	(0.262)	(0.246)
R2	0.48	0.34	0.42	0.37
Number of Observations	268	308	268	306

Panel B. Per Capita Income Growth

Less Constrained × Per Capita Income Growth	0.158	-0.162	-0.218	-0.222
	(0.253)	(0.248)	(0.268)	(0.232)
Per Capita Income Growth	0.984***	1.284***	1.139***	1.252***
	(0.178)	(0.187)	(0.163)	(0.170)
Less Constrained	-1.120***	-0.263	-0.492	-0.381
	(0.335)	(0.328)	(0.354)	(0.312)
R2	0.41	0.27	0.34	0.32
Number of Observations	268	308	268	306

Panel C. Population Growth (Annualized %)

Less Constrained × Population Growth	0.061	0.117	-0.001	0.067
	(0.130)	(0.131)	(0.137)	(0.139)
Population Growth	0.460***	0.498***	0.494***	0.483***
	(0.102)	(0.090)	(0.107)	(0.110)
Less Constrained	-0.992***	-0.401**	-0.788***	-0.677***
	(0.158)	(0.158)	(0.168)	(0.166)
R2	0.38	0.20	0.32	0.24
Number of Observations	268	308	268	306

This table reports estimates of house price growth regressed on total income growth (panel A), per capita income growth (panel B), or population growth (panel C) and an indicator for an MSA having an above-median constraint measure (less constrained), and the interaction of the indicator with the respective growth measure. Each column uses a different measure of housing constraints where column 1 uses the elasticity from Saiz (2010), column 2 uses an elasticity from Baum-Snow and Han (2024), column 3 uses the regulation index Gyourko et al. (2008), and column 4 uses the land share of value Davis et al. (2021). See the text for more details.

TABLE III
Median Home Value Growth (2000-2020)

Panel A. Total Income Growth

Less Constrained × Income Growth	0.047	-0.089	-0.101	0.068
	(0.120)	(0.119)	(0.121)	(0.124)
Income Growth	0.577***	0.715***	0.663***	0.603***
	(0.104)	(0.094)	(0.099)	(0.099)
Less Constrained	-0.674***	-0.112	-0.205	-0.500*
	(0.254)	(0.244)	(0.258)	(0.262)
R2	0.47	0.41	0.43	0.38
Number of Observations	267	309	267	307

Panel B. Per Capita Income Growth

Less Constrained × Per Capita Income Growth	0.057	-0.266	-0.388	0.002
	(0.257)	(0.277)	(0.263)	(0.265)
Per Capita Income Growth	1.010***	1.298***	1.199***	1.103***
	(0.198)	(0.222)	(0.214)	(0.207)
Less Constrained	-0.728**	-0.110	-0.022	-0.424
	(0.335)	(0.352)	(0.353)	(0.341)
R2	0.32	0.26	0.28	0.25
Number of Observations	267	309	267	307

Panel C. Population Growth (Annualized %)

Less Constrained × Population Growth	0.176	-0.061	0.024	0.183
	(0.132)	(0.124)	(0.132)	(0.143)
Population Growth	0.502***	0.709***	0.580***	0.533***
	(0.110)	(0.092)	(0.105)	(0.117)
Less Constrained	-0.798***	-0.217	-0.533***	-0.533***
	(0.154)	(0.149)	(0.161)	(0.165)
R2	0.36	0.28	0.31	0.25
Number of Observations	267	309	267	307

This table reports estimates of house price growth regressed on total income growth (panel A), per capita income growth (panel B), or population growth (panel C) and an indicator for an MSA having an above-median constraint measure (less constrained), and the interaction of the indicator with the respective growth measure. Each column uses a different measure of housing constraints where column 1 uses the elasticity from Saiz (2010), column 2 uses an elasticity from Baum-Snow and Han (2024), column 3 uses the regulation index Gyourko et al. (2008), and column 4 uses the land share of value Davis et al. (2021). See the text for more details.

TABLE IV
House Quantity Growth (2000-2020)

	(1) Saiz	(2) BS-H	(3) WRLURI	(4) Building
Panel A. Housing Quantities Growth (Annualized %)				
Less Constrained × Income Growth	0.027	-0.015	0.110^{**}	-0.012
	(0.046)	(0.048)	(0.049)	(0.050)
Income Growth	0.642^{***}	0.635^{***}	0.597^{***}	0.630^{***}
	(0.033)	(0.030)	(0.034)	(0.032)
Less Constrained	0.026	-0.001	-0.133	0.018
	(0.089)	(0.090)	(0.093)	(0.095)
R2	0.79	0.77	0.80	0.76
Number of Observations	269	310	269	308
Panel B. Population Growth (Annualized %)				
Less Constrained × Income Growth	0.002	0.001	0.091^{*}	0.005
	(0.052)	(0.051)	(0.053)	(0.054)
Income Growth	0.755^{***}	0.717^{***}	0.709^{***}	0.710^{***}
	(0.041)	(0.034)	(0.037)	(0.038)
Less Constrained	0.027	-0.088	-0.137	-0.032
	(0.104)	(0.098)	(0.104)	(0.104)
R2	0.81	0.80	0.82	0.78
Number of Observations	269	310	269	308
Panel C. Change in Average Rooms per Person				
Less Constrained × Income Growth	0.017	0.003	0.004	-0.013
	(0.018)	(0.018)	(0.018)	(0.019)
Income Growth	-0.055^{***}	-0.043^{***}	-0.046^{***}	-0.031^{**}
	(0.012)	(0.013)	(0.012)	(0.014)
Less Constrained	0.020	0.072^{*}	0.070^{*}	0.090^{**}
	(0.040)	(0.039)	(0.039)	(0.041)
R2	0.11	0.11	0.13	0.08
Number of Observations	267	309	267	307

This table reports estimates of house quantity growth (panel A) and population growth (panel B), and the change in average rooms per person (panel C) regressed on total income growth, an indicator for an MSA having an above-median constraint measure (less constrained), and the interaction of the two. Each column uses a different measure of housing constraints where column 1 uses the elasticity from Saiz (2010), column 2 uses an elasticity from Baum-Snow and Han (2024), column 3 uses the regulation index Gyourko et al. (2008), and column 4 uses the land share of value Davis et al. (2021). See the text for more details.

TABLE V

Housing Supply Elasticity Estimates (2000-2020)

	(1) Saiz	(2) BS-H	(3) WRLURI	(4) Building
Panel A. Real House Price Growth (Annualized %)				
More Constrained × Price Growth	1.161***	1.078***	0.984***	1.018***
	(0.216)	(0.168)	(0.183)	(0.170)
Less Constrained × Price Growth	1.216***	0.965***	1.383***	1.088***
	(0.175)	(0.133)	(0.201)	(0.159)
Less Constrained	1.058***	0.447	0.443	0.547*
	(0.405)	(0.280)	(0.356)	(0.313)
Chi-Squared Test P-value	0.84	0.60	0.14	0.76
F-stat More Constrained	31.63	56.74	41.70	48.41
F-stat Less Constrained	64.92	66.03	48.12	65.23
Number of Observations	268	308	268	306
Panel B. Real Median Home Value Growth (Annualized %)				
More Constrained × Price Growth	1.112***	0.888***	0.905***	1.047***
	(0.204)	(0.127)	(0.154)	(0.183)
Less Constrained × Price Growth	1.064***	0.985***	1.251***	0.922***
	(0.113)	(0.142)	(0.145)	(0.129)
Less Constrained	0.778**	0.108	0.045	0.534
	(0.386)	(0.270)	(0.321)	(0.349)
Chi-Squared Test P-value	0.84	0.61	0.10	0.57
F-stat More Constrained	30.53	57.69	44.37	37.14
F-stat Less Constrained	111.82	74.86	66.61	81.47
Number of Observations	267	309	267	307

This table reports estimates of house quantity growth regressed on house price growth (panel A) and median home value growth (panel B), where price growth is interacted with an indicator for being less constrained (above median). We instrument for house price growth with growth in total income interacted with the same constraint indicator. Each column uses a different measure of housing constraints where column 1 uses the elasticity from Saiz (2010), column 2 uses an elasticity from Baum-Snow and Han (2024), column 3 uses the regulation index Gyourko et al. (2008), and column 4 uses the land share of value Davis et al. (2021). See the text for more details.

TABLE VI
HOUSING SUPPLY ELASTICITY ESTIMATES WITH ALTERNATIVE INSTRUMENTS (2000-2020)

	(1) Saiz	(2) BS-H	(3) WRLURI	(4) Building
Panel A. Real House Price Growth (Annualized %)				
More Constrained × Price Growth	0.694***	0.636***	0.479***	0.526***
	(0.132)	(0.120)	(0.098)	(0.097)
Less Constrained × Price Growth	0.513***	0.309***	0.811***	0.452***
	(0.126)	(0.107)	(0.190)	(0.107)
Less Constrained	0.741***	0.491**	0.044	0.349*
	(0.242)	(0.197)	(0.219)	(0.179)
Chi-Squared Test P-value	0.32	0.04	0.12	0.60
F-stat More Constrained	15.66	18.58	21.09	17.53
F-stat Less Constrained	17.22	13.29	8.20	19.21
Number of Observations	268	308	268	304
Panel B. Real Median Home Value Growth (Annualized %)				
More Constrained × Price Growth	0.532***	0.503***	0.398***	0.502***
	(0.100)	(0.086)	(0.080)	(0.096)
Less Constrained × Price Growth	0.550***	0.435***	0.701***	0.444***
	(0.093)	(0.107)	(0.107)	(0.089)
Less Constrained	0.277	0.175	-0.219	0.211
	(0.197)	(0.185)	(0.180)	(0.185)
Chi-Squared Test P-value	0.90	0.62	0.02	0.65
F-stat More Constrained	23.76	27.80	23.24	19.71
F-stat Less Constrained	20.47	12.83	24.13	30.07
Number of Observations	267	309	267	305

This table reports estimates of house quantity growth regressed on house price growth (panel A) and median home value growth (panel B), where price growth is interacted with an indicator for being less constrained (above median). We instrument for house price growth with average July humidity, January temperature, and an employment Bartik shock all interacted with the same constraint indicator. Each column uses a different measure of housing constraints where column 1 uses the elasticity from Saiz (2010), column 2 uses an elasticity from Baum-Snow and Han (2024), column 3 uses the regulation index Gyourko et al. (2008), and column 4 uses the land share of value Davis et al. (2021). See the text for more details.

TABLE VII

Effect of Work from Home Shock

	Saiz		BS-H		WRLURI		Building	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. Total Income Growth (Annualized %)								
WFH Shock × Less Constrained		0.082		0.146		0.325***		0.024
		(0.115)		(0.098)		(0.115)		(0.104)
WFH Shock	0.437***	0.455***	0.407***	0.366***	0.437***	0.357***	0.381***	0.408***
	(0.056)	(0.083)	(0.050)	(0.078)	(0.056)	(0.078)	(0.048)	(0.074)
Less Constrained		-0.017		-0.290		-0.812*		0.132
		(0.460)		(0.388)		(0.443)		(0.404)
R2	0.25	0.26	0.22	0.24	0.25	0.30	0.20	0.21
Number of Observations	269	269	310	310	269	269	308	308
Panel B. House Price Growth (Annualized %)								
WFH Shock × Less Constrained		0.122		0.110		0.633***		0.203
		(0.228)		(0.213)		(0.232)		(0.229)
WFH Shock	0.344***	0.252	0.401***	0.401**	0.344***	0.086	0.449***	0.375**
	(0.116)	(0.161)	(0.108)	(0.162)	(0.116)	(0.162)	(0.107)	(0.157)
Less Constrained		-0.770		0.081		-2.382***		-0.751
		(0.917)		(0.825)		(0.893)		(0.902)
R2	0.05	0.05	0.06	0.07	0.05	0.08	0.08	0.08
Number of Observations	268	268	308	308	268	268	306	306
Panel C. Cumulative Permit Growth (Annualized %)								
WFH Shock × Less Constrained		0.747		0.886		0.168		1.331
		(0.793)		(0.710)		(0.708)		(0.834)
WFH Shock	1.006***	0.951*	0.842**	0.623	1.006***	1.096*	0.841**	0.873*
	(0.373)	(0.501)	(0.368)	(0.468)	(0.373)	(0.566)	(0.387)	(0.522)
Less Constrained		-1.547		-1.447		0.602		-1.715
		(3.069)		(2.889)		(2.964)		(3.375)
R2	0.04	0.05	0.02	0.04	0.04	0.04	0.02	0.06
Number of Observations	269	269	310	310	269	269	308	308

This table reports estimates of total income growth (panel A), house price growth (panel B), and permit growth (panel B) regressed on a measure of exposure to WFH, an indicator for being less constrained (above median), and the interaction of the two. Each column uses a different measure of housing constraints where column 1 uses the elasticity from Saiz (2010), column 2 uses an elasticity from Baum-Snow and Han (2024), column 3 uses the regulation index Gyourko et al. (2008), and column 4 uses the land share of value Davis et al. (2021). See the text for more details.

TABLE VIII

House Price Growth (1980-2020)

	(1) Saiz	(2) BS-H	(3) WRLURI	(4) Building
Panel A. Real House Price Growth (Annualized %)				
Less Constrained × Income Growth	-0.083	0.121	-0.035	-0.091
	(0.093)	(0.088)	(0.092)	(0.093)
Income Growth	0.222***	0.212***	0.211***	0.266***
	(0.073)	(0.066)	(0.072)	(0.073)
Less Constrained	-0.465*	-0.597**	-0.548**	-0.292
	(0.258)	(0.234)	(0.249)	(0.256)
R2	0.23	0.14	0.21	0.17
Number of Observations	268	308	268	306
Panel B. Real Median House Value Growth (Annualized %)				
Less Constrained × Income Growth	0.084	0.110	0.077	-0.011
	(0.072)	(0.074)	(0.076)	(0.075)
Income Growth	0.265***	0.292***	0.271***	0.307***
	(0.062)	(0.060)	(0.063)	(0.062)
Less Constrained	-0.673***	-0.517***	-0.579***	-0.385*
	(0.196)	(0.190)	(0.199)	(0.205)
R2	0.41	0.33	0.38	0.35
Number of Observations	267	309	267	307

This table reports estimates of house price growth (panel A) and median home value growth (panel B) regressed on total income growth, an indicator for an MSA having an above-median constraint measure (less constrained), and the interaction of the two. Each column uses a different measure of housing constraints where column 1 uses the elasticity from Saiz (2010), column 2 uses an elasticity from Baum-Snow and Han (2024), column 3 uses the regulation index Gyourko et al. (2008), and column 4 uses the land share of value Davis et al. (2021). See the text for more details.

TABLE IX
House Quantity Growth (1980-2020)

	(1) Saiz	(2) BS-H	(3) WRLURI	(4) Building
Panel A. Housing Quantities Growth (Annualized %)				
Less Constrained × Income Growth	-0.002	0.017	0.025	0.050
	(0.035)	(0.037)	(0.039)	(0.039)
Income Growth	0.732***	0.714***	0.716***	0.707***
	(0.031)	(0.030)	(0.029)	(0.025)
Less Constrained	0.148*	0.091	0.078	0.010
	(0.083)	(0.085)	(0.088)	(0.092)
R2	0.88	0.87	0.88	0.86
Number of Observations	268	309	268	307
Panel B. Population Growth (Annualized %)				
Less Constrained × Income Growth	-0.032	-0.033	-0.005	0.075*
	(0.040)	(0.040)	(0.044)	(0.041)
Income Growth	0.853***	0.843***	0.835***	0.800***
	(0.034)	(0.032)	(0.033)	(0.026)
Less Constrained	0.141	0.080	0.030	-0.106
	(0.095)	(0.093)	(0.103)	(0.098)
R2	0.90	0.90	0.90	0.89
Number of Observations	269	310	269	308
Panel C. Change in Average Rooms per Person				
Less Constrained × Income Growth	-0.013	0.045	0.001	-0.029
	(0.036)	(0.035)	(0.035)	(0.039)
Income Growth	-0.098***	-0.136***	-0.096***	-0.103***
	(0.026)	(0.024)	(0.029)	(0.026)
Less Constrained	0.159*	0.021	0.164*	0.185*
	(0.092)	(0.085)	(0.094)	(0.095)
R2	0.25	0.28	0.29	0.24
Number of Observations	140	159	140	158

This table reports estimates of house quantity growth (panel A) and population growth (panel B), and the change in average rooms per person (panel C) regressed on total income growth, an indicator for an MSA having an above-median constraint measure (less constrained), and the interaction of the two. Each column uses a different measure of housing constraints where column 1 uses the elasticity from Saiz (2010), column 2 uses an elasticity from Baum-Snow and Han (2024), column 3 uses the regulation index Gyourko et al. (2008), and column 4 uses the land share of value Davis et al. (2021). See the text for more details.

TABLE X

HOUSE PRICE GROWTH WITHOUT LOW GROWTH CITIES (2000-2020)

	(1) Saiz	(2) BS-H	(3) WRLURI	(4) Building
Panel A. Real House Price Growth (Annualized %)				
Less Constrained × Income Growth	0.375***	0.202	0.148	0.158
	(0.119)	(0.136)	(0.140)	(0.131)
Income Growth	0.156**	0.354***	0.328***	0.333***
	(0.079)	(0.089)	(0.098)	(0.101)
Less Constrained	-1.944***	-0.853**	-1.185***	-1.089***
	(0.297)	(0.343)	(0.361)	(0.333)
R2	0.45	0.18	0.32	0.26
Number of Observations	197	231	197	239
Panel B. Real Median House Value Growth (Annualized %)				
Less Constrained × Income Growth	0.392***	0.049	-0.032	0.334**
	(0.135)	(0.171)	(0.156)	(0.167)
Income Growth	0.211**	0.518***	0.462***	0.321**
	(0.104)	(0.127)	(0.125)	(0.129)
Less Constrained	-1.660***	-0.501	-0.406	-1.243***
	(0.341)	(0.421)	(0.395)	(0.418)
R2	0.36	0.24	0.24	0.25
Number of Observations	196	231	196	238

This table reports estimates of house price growth (panel A) and median home value growth (panel B) regressed on total income growth, an indicator for an MSA having an above-median constraint measure (less constrained), and the interaction of the two. Each column uses a different measure of housing constraints where column 1 uses the elasticity from Saiz (2010), column 2 uses an elasticity from Baum-Snow and Han (2024), column 3 uses the regulation index Gyourko et al. (2008), and column 4 uses the land share of value Davis et al. (2021). See the text for more details.

TABLE XI
House Quantity Growth without Low Growth Cities (2000-2020)

	(1) Saiz	(2) BS-H	(3) WRLURI	(4) Building
Panel A. Housing Quantities Growth (Annualized %)				
Less Constrained × Income Growth	-0.050	-0.090	0.067	-0.096
	(0.070)	(0.072)	(0.071)	(0.071)
Income Growth	0.698***	0.680***	0.635***	0.688***
	(0.050)	(0.041)	(0.045)	(0.046)
Less Constrained	0.242	0.212	-0.012	0.259
	(0.156)	(0.162)	(0.161)	(0.159)
R2	0.71	0.68	0.72	0.69
Number of Observations	197	231	197	239
Panel B. Population Growth (Annualized %)				
Less Constrained × Income Growth	-0.072	-0.039	0.055	-0.045
	(0.080)	(0.076)	(0.077)	(0.077)
Income Growth	0.788***	0.731***	0.723***	0.739***
	(0.065)	(0.048)	(0.051)	(0.056)
Less Constrained	0.231	0.027	-0.038	0.113
	(0.185)	(0.174)	(0.176)	(0.176)
R2	0.73	0.71	0.73	0.70
Number of Observations	197	231	197	239
Panel C. Change in Average Rooms per Person				
Less Constrained × Income Growth	0.036	0.012	0.015	-0.004
	(0.025)	(0.024)	(0.025)	(0.025)
Income Growth	-0.052***	-0.038**	-0.044***	-0.029
	(0.015)	(0.017)	(0.016)	(0.019)
Less Constrained	-0.031	0.045	0.039	0.060
	(0.065)	(0.063)	(0.064)	(0.064)
R2	0.06	0.07	0.08	0.04
Number of Observations	196	231	196	238

This table reports estimates of house quantity growth (panel A) and population growth (panel B), and the change in average rooms per person (panel C) regressed on total income growth, an indicator for an MSA having an above-median constraint measure (less constrained), and the interaction of the two. Each column uses a different measure of housing constraints where column 1 uses the elasticity from Saiz (2010), column 2 uses an elasticity from Baum-Snow and Han (2024), column 3 uses the regulation index Gyourko et al. (2008), and column 4 uses the land share of value Davis et al. (2021). See the text for more details.

TABLE XII
HOUSE QUANTITY GROWTH AND PER CAPITA INCOME GROWTH (2000-2020)

	(1) Saiz	(2) BS-H	(3) WRLURI	(4) Building
Panel A. Housing Quantities Growth (Annualized %)				
Less Constrained × Per Capita Income Growth	0.308	-0.030	0.189	0.110
	(0.226)	(0.193)	(0.232)	(0.187)
Per Capita Income Growth	0.093	0.309**	0.140	0.212
	(0.183)	(0.148)	(0.152)	(0.137)
Less Constrained	-0.459	-0.084	-0.333	-0.207
	(0.283)	(0.244)	(0.285)	(0.240)
R2	0.03	0.04	0.03	0.03
Number of Observations	269	310	269	308
Panel B. Population Growth (Annualized %)				
Less Constrained × Per Capita Income Growth	0.335	-0.015	0.131	0.175
	(0.249)	(0.211)	(0.265)	(0.207)
Per Capita Income Growth	0.070	0.312**	0.151	0.173
	(0.202)	(0.152)	(0.162)	(0.147)
Less Constrained	-0.572*	-0.168	-0.343	-0.311
	(0.316)	(0.273)	(0.327)	(0.270)
R2	0.03	0.04	0.03	0.03
Number of Observations	269	310	269	308
Panel C. Change in Average Rooms per Person				
Less Constrained × Per Capita Income Growth	0.079	-0.000	0.024	0.002
	(0.050)	(0.045)	(0.052)	(0.046)
Per Capita Income Growth	-0.096***	-0.058*	-0.063**	-0.039
	(0.028)	(0.034)	(0.030)	(0.033)
Less Constrained	-0.034	0.086	0.057	0.063
	(0.063)	(0.058)	(0.063)	(0.058)
R2	0.07	0.08	0.09	0.05
Number of Observations	267	309	267	307

This table reports estimates of house quantity growth (panel A) and population growth (panel B), and the change in average rooms per person (panel C) regressed on per capita income growth, an indicator for an MSA having an above-median constraint measure (less constrained), and the interaction of the two. Each column uses a different measure of housing constraints where column 1 uses the elasticity from Saiz (2010), column 2 uses an elasticity from Baum-Snow and Han (2024), column 3 uses the regulation index from Gyourko et al. (2008), and column 4 uses the land share of value from Davis et al. (2021). See the text for more details.

TABLE XIII
HOUSE QUANTITY GROWTH AND POPULATION GROWTH (2000-2020)

	(1) Saiz	(2) BS-H	(3) WRLURI	(4) Building
Panel A. Housing Quantities Growth (Annualized %)				
Less Constrained × Population Growth	0.033	-0.019	0.031	-0.008
	(0.025)	(0.024)	(0.027)	(0.025)
Population Growth	0.840***	0.876***	0.838***	0.867***
	(0.017)	(0.019)	(0.021)	(0.020)
Less Constrained	0.025	0.057***	0.022	0.018
	(0.023)	(0.022)	(0.024)	(0.024)
R2	0.95	0.95	0.95	0.94
Number of Observations	269	310	269	308
Panel B. Change in Average Rooms per Person				
Less Constrained × Population Growth	-0.006	0.005	-0.002	-0.024
	(0.022)	(0.021)	(0.021)	(0.021)
Population Growth	-0.046***	-0.047***	-0.045***	-0.032**
	(0.015)	(0.013)	(0.015)	(0.015)
Less Constrained	0.064**	0.072***	0.086***	0.083***
	(0.025)	(0.023)	(0.024)	(0.024)
R2	0.09	0.10	0.12	0.08
Number of Observations	267	309	267	307

This table reports estimates of house quantity growth (panel A) and the change in average rooms per person (panel B) regressed on population growth, an indicator for an MSA having an above-median constraint measure (less constrained), and the interaction of the two. Each column uses a different measure of housing constraints where column 1 uses the elasticity from Saiz (2010), column 2 uses an elasticity from Baum-Snow and Han (2024), column 3 uses the regulation index from Gyourko et al. (2008), and column 4 uses the land share of value from Davis et al. (2021). See the text for more details.

TABLE XIV

Median Rent Growth and Change in Commuting Times (2000-2020)

Panel A. Real Rent Growth (Annualized %)

Less Constrained × Income Growth	-0.015	0.033	-0.009	-0.084
	(0.081)	(0.081)	(0.082)	(0.084)
Income Growth	0.315***	0.332***	0.316***	0.375***
	(0.062)	(0.054)	(0.062)	(0.058)
Less Constrained	-0.378**	-0.267	-0.281*	-0.120
	(0.169)	(0.162)	(0.170)	(0.171)
R2	0.34	0.28	0.29	0.29
Number of Observations	267	309	267	307

Panel B. Change in Average Commute Times

Less Constrained × Income Growth	-0.147	-0.036	-0.132	-0.020
	(0.242)	(0.226)	(0.241)	(0.242)
Income Growth	0.185	0.204	0.165	0.178
	(0.177)	(0.168)	(0.185)	(0.175)
Less Constrained	0.498	0.202	0.255	0.354
	(0.549)	(0.520)	(0.551)	(0.565)
R2	0.01	0.01	0.00	0.01
Number of Observations	267	309	267	307

This table reports estimates of real rent growth (panel A) and changes in average commuting times (panel B) regressed on total income growth, an indicator for an MSA having an above-median constraint measure (less constrained), and the interaction of the two. Each column uses a different measure of housing constraints where column 1 uses the elasticity from Saiz (2010), column 2 uses an elasticity from Baum-Snow and Han (2024), column 3 uses the regulation index from Gyourko et al. (2008), and column 4 uses the land share of value from Davis et al. (2021). See the text for more details.

APPENDIX

A1 Model Appendix

Here we show that the housing demand curve in Section 2 nests both a dynamic housing model, as well as spatial equilibrium housing model. We also show that the standard spatial equilibrium/local labor markets model validates our use of total income as an explanatory regressor.

A1.1 Dynamic Housing Model

Consider an infinitely lived representative household that chooses sequences of non–housing consumption $\{C_{it}\}$ and next–period housing stock $\{H_{i,t+1}\}$ to maximize expected intertemporal utility

$$\max_{\{C_{it},H_{i,t+1}\}} E_0 \sum_{t=0}^{\infty} \beta^t \Big[(1-\alpha)\ln C_{it} + \alpha \ln H_{it}\Big],$$

subject to the flow budget constraint

$$A_{i,t+1} = (1+r_t)\big[A_{it} + Y_{it} - P_{it}\{H_{i,t+1} - (1-\delta)H_{it}\} - C_{it}\big],$$

where A_{it} is the stock of risk–free assets, r_t the real interest rate, Y_{it} labor income in location i, P_{it} the real price of one unit of housing services, and δ is the depreciation rate of housing.

Let λ_{it} be the Lagrange multiplier on the budget constraint. The intertemporal budget constraint is

$$A_{it} = \sum_{s=0}^{\infty} \frac{C_{i,t+s} + P_{i,t+s}\{H_{i,t+1+s} - (1-\delta)H_{i,t+s}\} - Y_{i,t+s}}{\prod_{k=1}^{s}(1+r_k)}$$

The First Order Conditions are

$$\begin{aligned} \text{(i) Consumption:} \quad & \lambda_{it} = \frac{1-\alpha}{C_{it}}, \\ \text{(ii) Consumption Euler:} \quad & \lambda_{it} = \beta(1+r_t)E_t\lambda_{i,t+1}, \\ \text{(iii) Housing Euler:} \quad & \frac{\alpha}{H_{i,t+1}} = P_{it}\lambda_t - \beta E_t\left[(1-\delta)P_{i,t+1}\lambda_{t+1}\right], \end{aligned}$$

We combine the two Euler equations,

$$\frac{\alpha}{H_{i,t+1}} = \lambda_t \left[P_{it} - \frac{(1-\delta)P_{i,t+1}}{1+r_t}\right]$$

$$
\begin{aligned}
\frac{1}{H_{i,t+1}} &= \frac{1-\alpha}{\alpha C_{it}}\left[P_{it} - \frac{(1-\delta)P_{i,t+1}}{1+r_t}\right] \\
H_{i,t+1} &= C_{it}\frac{\alpha}{1-\alpha}\left[P_{it} - \frac{(1-\delta)P_{i,t+1}}{1+r_t}\right]^{-1} \\
H_{i,t+1+s} &= C_{i,t+s}\frac{\alpha}{1-\alpha}\left[P_{i,t+s} - \frac{(1-\delta)P_{i,t+1+s}}{1+r_{t+s}}\right]^{-1} \\
H_{i,t+1+s} &= C_{it}\beta^s\prod_{k=1}^{s}(1+r_{t+k})\frac{\alpha}{1-\alpha}\left[P_{i,t+s} - \frac{(1-\delta)P_{i,t+1+s}}{1+r_{t+s}}\right]^{-1}
\end{aligned}
$$

Log-linearizing this equation around a steady-state yields,

$$
-\hat{H}_{i,t+1} = \hat{\lambda}_{it} + \frac{1+r}{r+\delta}\hat{P}_{it} - \frac{1-\delta}{r+\delta}E_t\hat{P}_{i,t+1} + \frac{1-\delta}{r+\delta}\hat{r}_t
$$

We next solve for $\hat{\lambda}$. Combining the Euler equations and consumption FOC with the intertemporal budget constraint yields,

$$
C_{it} = \alpha(1-\beta)\left[A_{it} + (1-\delta)P_{it}H_{it} + \sum_{s=0}^{\infty}\frac{Y_{i,t+s}}{\prod_{k=1}^{s}(1+r_k)}\right]
$$

Log-linearizing around a steady state with zero assets, $P_{it}=1$, and $\beta(1+r)=1$ yields,[31]

$$
\hat{C}_{it} = \alpha(1-\beta)\hat{A}_{it} + \alpha(1-\beta)(1-\delta)\frac{C}{H}(\hat{P}_{it}+\hat{H}_{it}) + \alpha(1-\beta)\frac{Y}{C}\sum_{s=0}^{\infty}\beta^s\hat{Y}_{i,t+s} - \alpha\beta\frac{Y}{C}\sum_{s=0}^{\infty}\beta^s\hat{r}_{t+s}
$$

Combine with the housing demand equation:

$$
\begin{aligned}
\hat{H}_{i,t+1} = &-\underbrace{\left[\frac{1+r}{r+\delta} - \alpha(1-\beta)(1-\delta)\frac{C}{H}\right]}_{=\epsilon_p}\hat{P}_{it} + \underbrace{\alpha(1-\beta)\frac{Y}{C}}_{=\epsilon_y}\hat{Y}_{it} \\
&+ \underbrace{\alpha(1-\beta)\frac{Y}{C}\sum_{s=1}^{\infty}\beta^s\hat{Y}_{i,t+s} - \alpha\beta\frac{Y}{C}\sum_{s=0}^{\infty}\beta^s\hat{r}_{t+s} + \frac{1-\delta}{r+\delta}E_t\hat{P}_{i,t+1} - \frac{1-\delta}{r+\delta}\hat{r}_t}_{=\theta_{1it}} \\
&+ \underbrace{\alpha(1-\beta)[\hat{A}_{it} + (1-\delta)\frac{C}{H}\hat{H}_{it}]}_{=\theta_{2it}}
\end{aligned}
$$

---

[31] In steady state $C = \frac{(1-\alpha)(r+\delta)}{\alpha\delta(1+r)+(1-\alpha)(r+\delta)}Y$ and $H = \frac{\alpha(1+r)}{\alpha\delta(1+r)+(1-\alpha)(r+\delta)}Y$.

where the last two terms are both demand shocks, so that the entire expression is a special case of the demand equation in Section 2.

A1.2 Spatial Equilibrium Housing Model

Housing Demand

Assume that households in city i consume a non-housing good c and housing h (for an extension of this model that incorporated multiple margins of housing consumption see Louie et al. (2025c)). Household utility in city i is given by the Cobb-Douglas function (Davis and Ortalo-Magné, 2011)

$$U_i = (1-\alpha)\log(c_i) + \alpha\log(h_i).$$

Given a wage w_i and a city-specific cost of housing p_i, the budget constraint is $c_i + p_i h_i = w_i$. This implies that the per capita demand for housing is simply

$$h_i^D = \frac{\alpha w_i}{p_i}.$$

Let total population in city i be L_i. Then aggregate housing demand in that city is equal to

$$H_i^D = h_i^D L_i = \frac{\alpha w_i L_i}{p_i} = \frac{\alpha Y_i}{p_i} \tag{8}$$

where Y_i is total income in city i.

The linearized housing demand function for location i is therefore,

$$\widehat{H}_i = \underbrace{1}_{=\epsilon_y} \times \widehat{Y}_i - \underbrace{1}_{=\epsilon_p} \times \widehat{p}_i$$

which is a special case of the demand equation in Section 2. We next add the supply and labor market blocks to this model in order to show that the structural relationships between total income and housing market outcomes are appropriate empirical objects to quantify housing supply elasticities.

Housing Supply

The total supply of housing is given by the following supply function with city-specific elasticity ψ_i

$$H_i^S = p_i^{\psi_i}. \tag{9}$$

Labor Market

All workers provide one unit of labor so that there is no intensive margin of labor, but the number of workers depends on the real wage offered. For simplicity, assume there is some outside option (such as another region) so that if real wages are too low, more workers will simply take their outside option and leave the region. The labor supply curve is then given by the following where η is the labor supply elasticity between regions

$$L_i^s = \left(\frac{w_i}{p_i^\alpha}\right)^\eta.$$

Output (apart from housing) has the following production function with productivity shocks Z_i

$$Y_i = Z_i L_i^\gamma$$

So the total number of workers or population demanded is given as

$$w_i = Z_i \gamma (L_i^D)^{\gamma-1}.$$

We do not solve for the total distribution of workers across locations as this is irrelevant for the questions at hand, but such a clearing condition across regions could be easily imposed.

Equilibrium

Equilibrium in the housing market means the total quantity of housing will match the total housing demand,

$$H_i^S = H_i^D = H_i. \tag{10}$$

Labor supply must equal labor demand

$$L_i^D = L_i^S = L_i. \tag{11}$$

We can linearize and re-arrange these conditions along with the equations above to get the following linearized equilibrium conditions, where hats represent deviations from the approximation point

$$\begin{aligned}
\widehat{h}_i &= \widehat{w}_i - \widehat{p}_i, \\
\psi_i \widehat{p}_i &= \widehat{H}_i, \\
\widehat{H}_i &= \widehat{h}_i + \widehat{L}_i, \\
\widehat{w}_i - \widehat{Z}_i &= (\gamma - 1)\widehat{L}_i, \\
\widehat{L}_i &= \eta(\widehat{w}_i - \alpha \widehat{p}_i).
\end{aligned}$$

It is straightforward to derive the relationships between prices and quantities and wages and total income growth, defined as $\widehat{Y}_i = \widehat{w}_i + \widehat{L}_i$.

$$\widehat{p}_i = \frac{1+\eta}{1+\alpha\eta+\psi_i}\widehat{w}_i, \tag{12}$$

$$\widehat{p}_i = \frac{1}{1+\psi_i}\widehat{Y}_i, \tag{13}$$

$$\widehat{H}_i = \psi_i \frac{1+\eta}{1+\alpha\eta+\psi_i}\widehat{w}_i, \tag{14}$$

$$\widehat{H}_i = \psi_i \frac{1}{1+\psi_i}\widehat{Y}_i. \tag{15}$$

Thus, simple regressions of prices or quantities on wage growth (per capita income) or total income growth will be straightforward functions of housing and labor supply elasticities and housing's expenditure share.[32] In fact, the total income specifications are *simpler* than the per capita specifications because they incorporate the endogenous response of population growth to housing supply's effects on prices. This means the resulting coefficients depend *only* on the supply elasticities. This is because (13) and (15) depend only on the supply curve (9) and the within-city housing demand curve (8), and are independent of the specific migration model. That is, these results are robust to any model of inter-city migration! Models with more general demand-side features will therefore give similar results.[33]

The intuition is simple: the fact that housing supply elasticities mediate population growth through differential price growth implies that the relationships between price and

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[32] If groups of low and high elasticity cities have heterogeneous elasticities within each group, then this does not pose an issue for identification but instead gives our estimates a heterogeneous treatment effect interpretation (Louie et al., 2025b).

[33] For example, with non-homothetic CES preferences, aggregate housing demand is $\widehat{H}_i^D = -\epsilon_p \widehat{p}_i + \epsilon_Y \widehat{Y}_i$, which combined with the supply equation yields the equilibrium prices and quantities $\widehat{p}_i = \frac{\epsilon_Y}{\epsilon_p + \psi_i}\widehat{Y}_i$ and $\widehat{H}_i = \psi_i \frac{\epsilon_Y}{\epsilon_p+\psi_i}\widehat{Y}_i$, see Section 2 (equations 1 and 2 with shocks set to zero).

quantity growth and total income growth will be observably different. That is, the same population growth should lead to *more* price growth and *less* quantity growth in relatively inelastic areas *because* population growth is a function of housing supply elasticities.

Note that the labor demand function is not actually needed for these derivations. This points to a broader result that the relationships between housing market outcomes and measures of housing demand really only depend on the structure of the housing market (the local supply elasticity) and the structure of housing demand (incomes and labor supply).

A2 Understanding the Correlation of Measured Constraints with Prices

The central claim of the supply-centric view of housing is that differently sloped supply curves explain differential growth in prices and quantities. We document that the interaction of income growth and supply constraints does not predict differential growth in prices or quantities, which is inconsistent with this view. However, in some of our results, especially the estimates using the Saiz elasticity, we do find a correlation between prices and constraints, with less-constrained cities appearing to have less price growth. We call this correlation the "intercept" term for brevity. In Section A3, we document that linear specifications suggest that this intercept is actually economically small and that there is no correlation with quantities, thus concluding that this price correlation does not validate the standard view. Nevertheless, the reader may still harbor discomfort about how the relatively large intercept term in some specifications can be consistent with our central claim that differential supply constraints do not explain differential price and quantity growth.

We first demonstrate that this term is not evidence of different supply elasticities, but rather must point to large *shifts* in housing supply in more elastic cities. Intuitively, if supply elasticities are truly higher in cities that appear less constrained, then the differential price growth implies differential growth in housing quantities. However, there is no correlation between estimated elasticities and growth in quantities, and this fact can only be reconciled in the standard model by shifts in housing supply. The average shift in housing supply implied by the elasticity estimates and the standard framework is extremely large, equivalent to average growth in housing quantities overall. This implies that without these shifts in housing supply, overall growth in housing quantities would have been *essentially zero* in less-constrained cities.

We think these shifts in supply are problematic explanations of the data for a number of reasons. First, shifts in supply functions are not the central argument for why cities with elastic housing supply functions have lower prices and higher quantities. Instead the argument is that more- and less-elastic supply functions explain more and less growth in house prices and quantities, but that mechanism cannot explain these intercepts. Second, these implied shifts are far too large to be plausible, or at least they would imply enormous improvements in construction productivity that have not been documented.[34] Finally, this explanation requires a kind of epicyclic combination of shocks to supply: supply shocks uncorrelated with income growth must be *positively* correlated with elasticities to explain

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[34] Such magnitudes would be well beyond the trends discussed in Goolsbee and Syverson (2023) and those documented by Sveikauskas, Rowe and Mildenberger (2018).

the intercept term, but it must also be the case that supply shocks correlated with income growth are *negatively* correlated with elasticities in order to explain our estimates of the interaction terms. It is unclear why the productivity of housing construction would have the opposite correlation with elasticities conditional on whether or not there is income growth present and to the best of our knowledge no theory with this kind of implication has been proposed in the literature. Therefore, we conclude this explanation is implausible.

Instead of these shifts in supply, we suggest that this term likely points to differential growth in the pricing of the underlying quality of housing, where quality is broadly understood as reflecting differences in physical characteristics such as an updated kitchen as well as local amenities such as a pleasant climate or wealthy neighbors. If house prices are not perfectly adjusted for quality, so that the valuation of differences in both physical and amenity quality are captured in standard house price indexes, then this intercept term is easily explained by differential growth in housing quality. Intuitively, an increase in the demand for housing quality may then increase prices, but actually have no effect on the demand or supply of housing units, which would generate the intercept terms we find.

We believe this is a very plausible explanation of the intercept term. It is well-known that house price indexes are not, and likely cannot, be perfectly adjusted for differences in the quality of physical features and amenities across cities (Harding et al., 2007; Billings, 2015; Diamond, 2016) and that cities considered to be inelastic are also likely to have attractive amenities (Davidoff, 2016).[35] Additionally, our estimates show that per capita income growth is strongly correlated with growth in prices while it has no correlation with growth in the number of housing units (see Table II and Table XII), consistent with the discussion above. Therefore, if cities measured to be relatively inelastic actually are more exposed to increases in the demand for high-quality, high-amenity housing due to, for example, booming tech industry valuations that are not perfectly reflected in measured income growth, then this intercept term is exactly what one would expect to observe.

We next walk through the decomposition of the intercept term if we assume that the supply elasticities are truly different, then we make a simple extension to our standard framework to introduce a quality margin and show that how this can explain the intercept term without rerlying on implausible shifts in supply terms.

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[35] Imagine that state-level funding improves for a school in a neighborhood. The improvement in school quality will translate into higher prices in the neighborhood, but quality-adjusted indexes will not correct for any of this change in the quality of local amenities.

A2.1 Decomposing the Intercept Term

We start with the reduced form solutions to the demand and supply, equations (3) and (4):

$$\widehat{P}_i = \frac{1}{\psi_i + \epsilon_p}(\epsilon_y \widehat{Y}_i + \hat{\theta}_i) - \frac{1}{\psi_i + \epsilon_p}\widehat{\sigma}_i,$$
$$\widehat{H}_i = \frac{1}{1 + \frac{\epsilon_p}{\psi_i}}(\epsilon_y \widehat{Y}_i + \widehat{\theta}_i) + \frac{\frac{\epsilon_p}{\psi_i}}{1 + \frac{\epsilon_p}{\psi_i}}\widehat{\sigma}_i.$$

The intercept terms we want to understand come from the following regressions, reproduced from Section 2:

$$\widehat{P}_i = \alpha + \beta_1 \widehat{Y}_i + \beta_2 \mathbb{I}_i(\text{Less Constrained}) + \beta_3 \widehat{Y}_i \times \mathbb{I}_i(\text{Less Constrained}) + e_i, \tag{A1}$$
$$\widehat{H}_i = \delta + \gamma_1 \widehat{Y}_i + \gamma_2 \mathbb{I}_i(\text{Less Constrained}) + \gamma_3 \widehat{Y}_i \times \mathbb{I}_i(\text{Less Constrained}) + v_i.$$

The coefficients β_2 and γ_2 give the relative growth in prices and quantities for more elastic cities ($j = H$), conditional on growth in income, relative to more constrained cities. So the two intercept terms can be decomposed into the following

$$\beta_2 = E\left[\frac{1}{\psi_H + \epsilon_p}(\epsilon_y \widehat{Y}_i + \widehat{\theta}_i) - \frac{1}{\psi_H + \epsilon_p}\widehat{\sigma}_i \middle| \widehat{Y} = 0, j = H\right] - \underbrace{E\left[\widehat{P}_i | \widehat{Y} = 0, j = L\right]}_{=\alpha},$$
$$\gamma_2 = E\left[\frac{1}{1 + \frac{\epsilon_p}{\psi_H}}(\epsilon_y \widehat{Y}_i + \widehat{\theta}_i) + \frac{\frac{\epsilon_p}{\psi_H}}{1 + \frac{\epsilon_p}{\psi_H}}\widehat{\sigma}_i \middle| \widehat{Y} = 0, j = H\right] - \underbrace{E\left[\widehat{H}_i \middle| \widehat{Y} = 0, j = L\right]}_{=\delta}.$$

These expressions can be reduced to the following where, we simplify the notation so that $E[\widehat{\theta}_i | \widehat{Y}, j = H] \equiv E[\widehat{\theta}_{iYH}]$ and substitute in the constant terms from (A1):

$$\beta_2 + \alpha = \frac{1}{\psi_H + \epsilon_p}(E[\widehat{\theta}_{iYH}] - E[\widehat{\sigma}_{iYH}]),$$
$$\gamma_2 + \delta = \frac{1}{1 + \frac{\epsilon_p}{\psi_H}}(E[\widehat{\theta}_{iYH}] + \frac{\epsilon_p}{\psi_H}E[\widehat{\sigma}_{iYH}]).$$

Given estimates of the intercept terms α, δ, β_2, and γ_2, we have two equations in two unknowns: the conditional expectations of demand and supply shocks. We can then solve for the conditional expectation of supply shocks in more elastic cities as a function of the supply elasticity and the estimates, where the demand shocks drop out

$$E[\widehat{\sigma}_{iYH}] = \underbrace{\gamma_2 + \delta}_{\text{actual quantity growth}} - \underbrace{\psi_H(\beta_2 + \alpha),}_{\text{quantity growth implied by price growth}} \tag{A2}$$

This expression is nothing other than the supply function $\widehat{H}_i = \psi_i \widehat{P}_i + \sigma_i$ re-written in terms of the empirical estimates. So the conditional supply shocks are implied by the difference between realized growth in quantities and the growth in quantities consistent with the realized growth in prices and the supply elasticity. Thus, if there were positive growth in quantities, but no average price growth, then we would have to infer that less-constrained cities experienced positive supply shocks. Similarly, if the change in quantities was exactly what would be expected given the price growth and the average supply elasticity, then expected supply shocks would be zero and these intercepts would be strong evidence for the standard view of housing markets. Notice that we do not need to make any assumptions about the price or income elasticities as these demand-side factors merely rescale the demand shocks that move prices around.

Empirically, we estimate that $\psi_H = 3.56$ (Saiz, 2010), $\beta_2 = -0.868$, $\gamma_2 = 0.031$, , $\alpha = 0.52$ and $\delta = -0.34$ which implies that $E[\widehat{\sigma}_{iYH}] \approx 0.93$. This implies that if less-constrained cities truly have high elasticity on average, then their observed price and quantity growth implies that less constrained cities experienced positive shocks to housing supply equivalent to a little less than 1% annualized increase in housing quantities over 20 years (that is, about 20% over 20 years).

Similarly, in less elastic cities, the average supply shock is

$$E[\widehat{\sigma}_{iYL}] = \delta - \psi_L \alpha. \tag{A3}$$

Given an average $\psi_L = 1.51$ (Saiz, 2010), we obtain $E[\widehat{\sigma}_{iYL}] \approx -1.12$. Thus, more constrained cities experienced negative shocks to housing supply equivalent to a -1% annualized growth in housing quantities.

As we discussed above, there are a number of potential concerns with this explanation. First, the magnitude of this shock-driven growth is extraordinarily large. If relatively inelastic cities had not had such unfortunate supply shocks, then their growth in housing units would have been *double* the national average *despite* their low supply elasticity. Under this interpretation, it is unfortunate negative supply shocks, *not a low supply elasticity*, that is accounting for low unit growth in inelastic cities. Similarly, the supply shocks in less constrained cities are equivalent to the *average growth* in housing quantities across the entire sample, as well as the average within the sample of less constrained cities (see Table I). Therefore, these estimates imply that exogenous shifts in housing supply, not high elasticities, were responsible for *all* of the realized growth in housing quantities in elastic cities on average. Even if we thought the average elasticity in the less-constrained group was much smaller, say 2.5, it would still imply supply shocks equivalent to 50% of the realized growth in housing quantities. In fact, we would need to assume the elasticity is about 1, 50% lower than the average estimated elasticity in the *more* constrained cities, in order for the intercept term to be consistent with estimated elasticities. This is simply too large to be credible. Setting aside these particular magnitudes, the central issue is that this intercept term requires differential supply shocks because there is no correlation between the elasticity measures and quantities. This is a fact that is fundamentally difficult to reconcile with differential supply elasticities in these groups of cities.

Second, these housing supply shocks *must* have the opposite correlation with supply elasticities as the correlation of supply shocks and elasticities necessary to explain the intercept results. That is, supply shocks must be more positively correlated with income growth in inelastic cities in order for the interaction term to be identical across cities. But here it must be the case that supply shocks uncorrelated with income growth (because it is conditioned out) are positively correlated with elasticities. It is unclear what economic mechanism would generate these patterns and, to the best of our knowledge, none has been proposed. Finally, it is important to point out that the standard argument is not that more elastic cities experience more positive productivity shocks to construction, but that their supply function is, over the long run, more elastic. That argument cannot explain the intercept terms.

A2.2 Alternative Explanation

Instead of relying on implausible supply shocks to supply curves, we introduce a simple and realistic extension of our basic framework in Section 2 to provide a plausible explanation of the intercept term. First, we assume that there are two margins of housing consumption: the number of housing units u, and the quality of those housing units q. So the total quantity of housing produced and consumed is $H_i = q_i u_i$. Similarly, let P_i be the total price of housing, which is here the product of the prices for quality and units $P_i = P_{q,i} P_{u,i}$. Then the percentage change in the price of housing is given as $\widehat{p}_i = \widehat{p}_{q,i} + \widehat{p}_{u,i}$. Critically, we assume that we cannot perfectly observe housing quality. Even repeat-sales indexes will only imperfectly adjust for maintenance or renovations and they will not adjust at all for differences in amenities or amenity valuation. So in practice changes in the total price will reflect changes in the prices of both housing units and quality.

We then expand the demand side to reflect demand for quality and quantity by breaking apart total income into its components: per capita income y and population L. We assume, consistent with our estimates, that changes in per capita income do not affect the demand for the number of units and that changes in population do not affect the demand for quality, consistent with our empirical results (see Table II, Table XII, and Table XIII).[36] Total

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[36] We do not expect that these patterns would always be true as changes in per capita income can affect

housing demand and demand for each of the components is given by the following where $\theta_i \equiv \theta_{q,i} + \theta_{u,i}$

$$\begin{aligned}
\widehat{q}_i^D + \widehat{u}_i^D &= \epsilon_y \widehat{y}_i + \epsilon_L \widehat{L}_i - \epsilon_p \widehat{p}_i + \theta_i, \\
\widehat{q}_i^D &= \epsilon_y \widehat{y}_i - \epsilon_{p,q} \widehat{p}_{q,i} + \theta_{q,i}, \\
\widehat{u}_i^D &= \epsilon_n \widehat{N}_i - \epsilon_{p,u} \widehat{p}_{u,i} + \theta_{u,i}.
\end{aligned}$$

The supply side has a parallel structure with distinct supply curves for the quality and number of units. If there are no supply shocks then we have the following

$$\begin{aligned}
\widehat{q}_i^S &= \psi_{q,i} \widehat{p}_{q,i}, \\
\widehat{u}_i^S &= \psi_{u,i} \widehat{p}_{u,i}.
\end{aligned}$$

Equilibrium in each market is straightforward.

What is necessary to generate the intercept term in this extended framework? First, it must be the case that we cannot perfectly adjust prices for physical and amenity quality, so we only observe the total change in price. Then this framework will generate an intercept term whenever there are changes in the demand *for quality* that are correlated with measured constraints. This would be consistent with the arguments in Davidoff (2013) and Davidoff (2016), where features thought to make supply inelastic, like oceans or mountains, are also amenities attractive to high-income households.

We illustrate what happens if there is an unobserved increase in the demand for quality in Figure A1. The shift in the demand for quality will increase the price and quantity of quality, but it will have no effect on the demand for units, and so it will not affect the price of units or the number of units. But, if we draw the equilibrium in units using the total price, then it will appear *as if* there is a vertical shift in the equilibrium, with prices increasing but no change in the number of units. So if there is some residual change in demand that is positively correlated with measures of constraints, for example if rich people prefer living in coastal areas or near other rich people, then the intercept term will easily appear in a way that is consistent with our empirical results.

Notice that this argument rests primarily on the fact that price indexes cannot perfectly adjust for quality and that constraint measures may be correlated with unobserved demand for quality. Actual supply curves do not need to shift for this explanation. Therefore, we argue that the intercept 1) cannot be evidence of differential supply elasticities, and 2) may be additional evidence of the primary role of demand in driving variation in prices across

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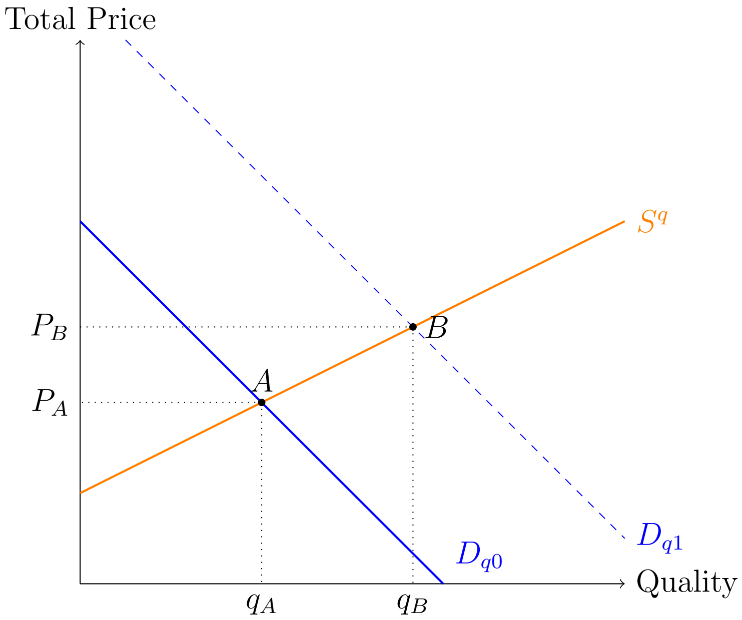
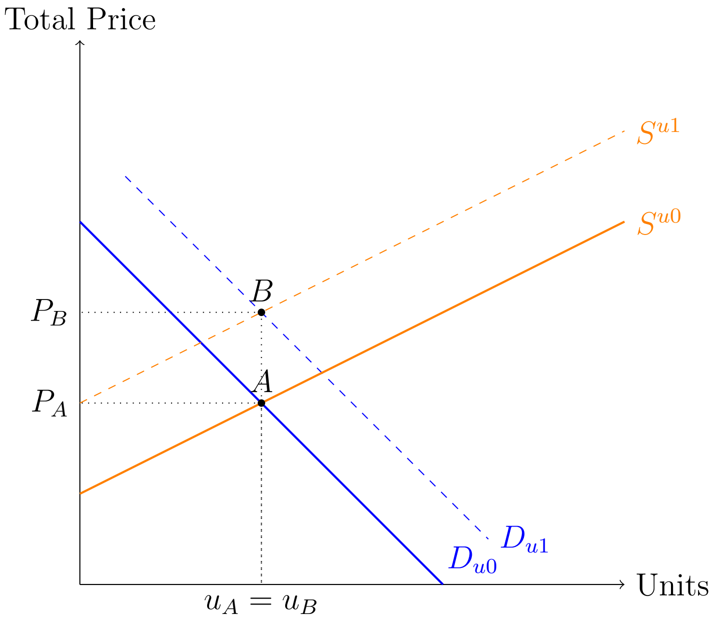
household formation at certain levels of income.

housing markets.



A. Market for Quality



B. Market for Units

FIGURE A1
Intercept Effect Due to Imperfect Quality Measurement

A3 Residual Effects of Housing Supply Elasticity

Our main focus has been on how price growth and quantity growth is explained by the interaction between supply constraints and income growth because that is where our housing market model predicts supply constraints will matter (Equations (3) and (4)). In practice, these interactions are always small and insignificant, implying a minor role for supply constraints in explaining how housing market dynamics respond to rising housing demand. However, in our house price figures (Figure VII) and regressions (Table II) we do find in some specifications a statistically significant relationship between the indicator for less-constrained locations and house price growth holding fixed income growth. In this appendix, we argue that the relationship between the constraint measures and price and quantity growth ranges from small to nonexistent.

To quantify the role of supply constraints, we regress growth in house prices and quantities on growth in total income and each of the constraint measures. By conditioning on income growth we will be absorbing any demand and supply shocks correlated with income growth. Table A17 reports the estimates for house price growth. To help quantify the economic magnitudes, we also report the share of the gap in price growth between San Francisco and Houston explained by the constraint effect since these two cities are often used to represent polar opposites of housing supply conditions. Every constraint enters with a negative and statistically significant effect on house price growth. But as the calculations demonstrate, the economic magnitudes tend to be quite modest with the exception of building share of value and the regulatory index in panel B. However, this appears to reflect the fact that both of these constraints are measured after 2000, which is the start of our sample, with the regulatory constraints being measured around 2004 and the building share of value being measured in 2012. To demonstrate this, we re-run this specification just using the years 2012 to 2020 (chosen to match the land share data measurement year) and find that these constraints explain none of the variation in price growth over that period. Therefore, even setting aside potential endogeneity of the constraint measures, we conclude that there is little evidence that adjusting these constraints would have meaningfully changed house price dynamics.

Of course, house prices are only one side of the mechanism, we should also expect these constraints to affect growth in housing quantities. Table A18 reports these estimates. Panels A and B look at growth in units and population and find no evidence that these elasticities have any effect conditional on the change in total income. In no specification does changing the elasticity shrink the gap between San Francisco and Houston by even one percentage point, and at times the sign is actually incorrect.[37] This suggests that the house price effect captured by the supply elasticities is not actually due to constrained supply. Furthermore when we estimate the regression using quartiles in Table A5, the house price effects are not monotonic in the housing supply elasticity. Thus, we suspect that the house price effect reflects a failure of the exclusion restriction for the housing supply elasticity. In Section A2 we show that these intercept terms are actually inconsistent with the standard model unless one is willing to assume extremely large, ad hoc shocks to supply. Instead we argue that they are more plausibly explained by differences in the demand for amenities.

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[37] We do see more evidence of a relationship with the change in rooms per person in this table, but this effect is not particularly robust as it is not present in our baseline results Table IV.

A4 Appendix Tables

TABLE A1

POPULATION ELASTICITY ESTIMATES (2000-2020)

	(1) Saiz	(2) BS-H	(3) WRLURI	(4) Building
Panel A. Real House Price Growth (Annualized %)				
More Constrained × Price Growth	1.367^{***}	1.217^{***}	1.168^{***}	1.147^{***}
	(0.241)	(0.170)	(0.192)	(0.181)
Less Constrained × Price Growth	1.381^{***}	1.120^{***}	1.567^{***}	1.260^{***}
	(0.193)	(0.150)	(0.233)	(0.171)
Less Constrained	1.219^{***}	0.421	0.527	0.568^{*}
	(0.454)	(0.298)	(0.386)	(0.337)
Chi-Squared Test P-value	0.96	0.67	0.19	0.65
CD F-stat	54.36	58.06	47.54	63.04
Number of Observations	268	308	268	306
Panel B. Real Median Home Value Growth (Annualized %)				
More Constrained × Price Growth	1.309^{***}	1.003^{***}	1.073^{***}	1.180^{***}
	(0.227)	(0.126)	(0.161)	(0.197)
Less Constrained × Price Growth	1.207^{***}	1.142^{***}	1.415^{***}	1.065^{***}
	(0.124)	(0.159)	(0.171)	(0.139)
Less Constrained	0.904^{**}	0.032	0.076	0.553
	(0.433)	(0.289)	(0.350)	(0.377)
Chi-Squared Test P-value	0.70	0.49	0.15	0.63
CD F-stat	53.81	84.53	59.70	55.02
Number of Observations	267	309	267	307

This table reports estimates of population growth regressed on house price growth (panel A) and median home value growth (panel B), where price growth is interacted with an indicator for being less constrained (above median). We instrument for house price growth with growth in total income interacted with the same constraint indicator. Each column uses a different measure of housing constraints where column 1 uses the elasticity from Saiz (2010), column 2 uses an elasticity from Baum-Snow and Han (2024), column 3 uses the regulation index Gyourko et al. (2008), and column 4 uses the land share of value Davis et al. (2021). See the text for more details.

TABLE A2

Effect of Work from Home Shock: Quantile Regressions

	Saiz		BS-H		WRLURI		Building	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A. Total Income Growth (Annualized %)								
WFH Shock × Less Constrained		0.053		0.014		0.220*		-0.134
		(0.131)		(0.124)		(0.117)		(0.129)
WFH Shock	0.477***	0.545***	0.424***	0.463***	0.477***	0.425***	0.400***	0.475***
	(0.062)	(0.075)	(0.059)	(0.086)	(0.062)	(0.075)	(0.057)	(0.079)
Less Constrained		0.325		0.340		-0.297		0.653
		(0.513)		(0.506)		(0.476)		(0.516)
R2								
Number of Observations	269	269	310	310	269	269	308	308
Panel B. House Price Growth (Annualized %)								
WFH Shock × Less Constrained		-0.164		-0.109		0.439*		0.023
		(0.284)		(0.222)		(0.246)		(0.248)
WFH Shock	0.248**	0.348**	0.369***	0.439***	0.248**	0.084	0.424***	0.399***
	(0.108)	(0.164)	(0.098)	(0.154)	(0.108)	(0.158)	(0.097)	(0.151)
Less Constrained		0.478		1.027		-1.698*		-0.192
		(1.114)		(0.906)		(0.998)		(0.994)
R2								
Number of Observations	268	268	308	308	268	268	306	306
Panel C. Cumulative Permit Growth (Annualized %)								
WFH Shock × Less Constrained		-0.112		0.245		-0.556		0.732
		(0.765)		(0.730)		(0.742)		(0.851)
WFH Shock	1.432***	1.432***	1.357***	1.075**	1.432***	1.652***	1.260***	1.120**
	(0.326)	(0.440)	(0.310)	(0.507)	(0.326)	(0.477)	(0.308)	(0.520)
Less Constrained		2.531		0.887		4.245		-0.359
		(2.999)		(2.978)		(3.008)		(3.405)
R2								
Number of Observations	269	269	310	310	269	269	308	308

This table reports quantile regression estimates of total income growth (panel A), house price growth (panel B), and permit growth (panel B) regressed on a measure of exposure to WFH, an indicator for being less constrained (above median), and the interaction of the two. Each column uses a different measure of housing constraints where column 1 uses the elasticity from Saiz (2010), column 2 uses an elasticity from Baum-Snow and Han (2024), column 3 uses the regulation index Gyourko et al. (2008), and column 4 uses the land share of value Davis et al. (2021). See the text for more details.

TABLE A3

HOUSE PRICE GROWTH (1980-2000)

	(1) Saiz	(2) BS-H	(3) WRLURI	(4) Building
Panel A. Real House Price Growth (Annualized %)				
Less Constrained × Income Growth	-0.092	0.071	-0.076	-0.133
	(0.120)	(0.112)	(0.116)	(0.117)
Income Growth	0.058	0.078	0.056	0.148*
	(0.092)	(0.093)	(0.093)	(0.090)
Less Constrained	-0.229	-0.538	-0.346	-0.108
	(0.400)	(0.359)	(0.381)	(0.383)
R2	0.04	0.04	0.05	0.06
Number of Observations	268	308	268	306
Panel B. Real Median House Value Growth (Annualized %)				
Less Constrained × Income Growth	0.225***	0.236***	0.149*	0.092
	(0.084)	(0.083)	(0.089)	(0.092)
Income Growth	0.137**	0.157**	0.161**	0.182***
	(0.061)	(0.063)	(0.064)	(0.060)
Less Constrained	-0.980***	-0.898***	-0.756***	-0.768***
	(0.265)	(0.260)	(0.274)	(0.284)
R2	0.22	0.21	0.21	0.22
Number of Observations	269	310	269	308

This table reports estimates of house price growth (panel A) and median home value growth (panel B) regressed on total income growth, an indicator for an MSA having an above-median constraint measure (less constrained), and the interaction of the two. Each column uses a different measure of housing constraints where column 1 uses the elasticity from Saiz (2010), column 2 uses an elasticity from Baum-Snow and Han (2024), column 3 uses the regulation index Gyourko et al. (2008), and column 4 uses the land share of value Davis et al. (2021). See the text for more details.

TABLE A4
HOUSE QUANTITY GROWTH (1980-2000)

	(1) Saiz	(2) BS-H	(3) WRLURI	(4) Building
Panel A. Housing Quantities Growth (Annualized %)				
Less Constrained × Income Growth	-0.076*	-0.010	0.014	0.048
	(0.045)	(0.048)	(0.051)	(0.049)
Income Growth	0.709***	0.668***	0.665***	0.653***
	(0.036)	(0.039)	(0.037)	(0.032)
Less Constrained	0.364***	0.279**	0.084	0.088
	(0.127)	(0.135)	(0.142)	(0.142)
R2	0.80	0.78	0.80	0.76
Number of Observations	268	309	268	307
Panel B. Population Growth (Annualized %)				
Less Constrained × Income Growth	-0.123***	-0.098**	0.004	0.037
	(0.044)	(0.045)	(0.053)	(0.052)
Income Growth	0.811***	0.791***	0.744***	0.741***
	(0.034)	(0.037)	(0.037)	(0.032)
Less Constrained	0.361**	0.300**	-0.111	0.011
	(0.141)	(0.139)	(0.165)	(0.155)
R2	0.81	0.79	0.81	0.77
Number of Observations	269	310	269	308
Panel C. Change in Average Rooms per Person				
Less Constrained × Income Growth	-0.017	0.020	-0.036*	-0.012
	(0.022)	(0.020)	(0.022)	(0.022)
Income Growth	-0.032**	-0.054***	-0.023	-0.038**
	(0.015)	(0.015)	(0.018)	(0.017)
Less Constrained	0.143**	-0.011	0.191***	0.076
	(0.070)	(0.067)	(0.073)	(0.073)
R2	0.19	0.15	0.19	0.12
Number of Observations	140	159	140	158

This table reports estimates of house quantity growth (panel A) and population growth (panel B), and the change in average rooms per person (panel C) regressed on total income growth, an indicator for an MSA having an above-median constraint measure (less constrained), and the interaction of the two. Each column uses a different measure of housing constraints where column 1 uses the elasticity from Saiz (2010), column 2 uses an elasticity from Baum-Snow and Han (2024), column 3 uses the regulation index Gyourko et al. (2008), and column 4 uses the land share of value Davis et al. (2021). See the text for more details.

TABLE A5

HOUSE PRICE GROWTH (2000-2020): QUARTILES

	(1)	(2)	(3)	(4)
	Saiz	BS-H	WRLURI	Building
Panel A. Real House Price Growth (Annualized %)				
Qtl 2 Constraint	-0.468	-0.544	-0.690*	-0.552
	(0.439)	(0.336)	(0.372)	(0.392)
Qtl 3 Constraint	-1.093***	-0.864**	-1.019***	-0.840**
	(0.367)	(0.339)	(0.352)	(0.394)
Qtl 4 Constraint	-1.185***	-0.566	-0.767**	-0.633*
	(0.400)	(0.388)	(0.364)	(0.358)
Qtl 2 Constraint × Income Growth	0.008	0.029	0.085	-0.015
	(0.195)	(0.159)	(0.165)	(0.184)
Qtl 3 Constraint × Income Growth	0.078	0.161	0.096	-0.016
	(0.159)	(0.165)	(0.165)	(0.178)
Qtl 4 Constraint × Income Growth	-0.058	-0.020	-0.191	-0.152
	(0.174)	(0.175)	(0.164)	(0.171)
Income Growth	0.516***	0.572***	0.532***	0.633***
	(0.135)	(0.130)	(0.127)	(0.140)
R2	0.52	0.37	0.47	0.41
Number of Observations	268	308	268	306
Panel B. Real Median Home Value Growth (Annualized %)				
Qtl 2 Constraint	-0.417	-0.491	-0.705*	-0.456
	(0.466)	(0.419)	(0.394)	(0.439)
Qtl 3 Constraint	-1.069**	-0.619	-0.645*	-0.516
	(0.414)	(0.404)	(0.373)	(0.424)
Qtl 4 Constraint	-0.804*	-0.126	-0.602*	-0.889**
	(0.409)	(0.397)	(0.346)	(0.396)
Qtl 2 Constraint × Income Growth	-0.010	0.023	0.059	0.048
	(0.213)	(0.196)	(0.178)	(0.199)
Qtl 3 Constraint × Income Growth	0.143	0.081	0.024	0.008
	(0.178)	(0.190)	(0.177)	(0.187)
Qtl 4 Constraint × Income Growth	-0.014	-0.220	-0.127	0.167
	(0.180)	(0.187)	(0.167)	(0.183)
Income Growth	0.554***	0.701***	0.600***	0.585***
	(0.159)	(0.167)	(0.140)	(0.156)
R2	0.49	0.45	0.48	0.40
Number of Observations	267	309	267	307

This table reports estimates of house price growth (panel A) and median home value growth (panel B) regressed on total income growth, quartiles of the constraint measure, and the interaction of income growth with each quartile. Each column uses a different measure of housing constraints where column 1 uses the elasticity from Saiz (2010), column 2 uses an elasticity from Baum-Snow and Han (2024), column 3 uses the regulation index Gyourko et al. (2008), and column 4 uses the land share of value Davis et al. (2021). See the text for more details.

TABLE A6
House Quantity Growth (2000-2020): Quartiles

	(1) Saiz	(2) BS-H	(3) WRLURI	(4) Building
Panel A. Housing Quantity Growth (Annualized %)				
Qtl 2 Constraint	-0.031	-0.025	-0.053	-0.138
	(0.140)	(0.116)	(0.156)	(0.120)
Qtl 3 Constraint	-0.008	0.035	-0.188	0.074
	(0.130)	(0.141)	(0.168)	(0.111)
Qtl 4 Constraint	0.067	-0.068	-0.193	-0.112
	(0.108)	(0.107)	(0.152)	(0.152)
Qtl 2 Constraint × Income Growth	0.050	0.034	0.073	0.168***
	(0.070)	(0.060)	(0.075)	(0.058)
Qtl 3 Constraint × Income Growth	0.067	0.002	0.160*	0.033
	(0.065)	(0.076)	(0.087)	(0.054)
Qtl 4 Constraint × Income Growth	0.014	0.006	0.156**	0.088
	(0.052)	(0.056)	(0.075)	(0.089)
Income Growth	0.624***	0.617***	0.549***	0.552***
	(0.038)	(0.038)	(0.066)	(0.038)
R2	0.80	0.78	0.80	0.79
Number of Observations	269	310	269	308
Panel B. Population Growth (Annualized %)				
Qtl 2 Constraint	-0.115	-0.099	-0.043	-0.179
	(0.169)	(0.130)	(0.169)	(0.139)
Qtl 3 Constraint	-0.089	-0.111	-0.197	-0.016
	(0.141)	(0.150)	(0.170)	(0.114)
Qtl 4 Constraint	0.068	-0.173	-0.158	-0.150
	(0.133)	(0.115)	(0.164)	(0.156)
Qtl 2 Constraint × Income Growth	0.101	0.046	0.050	0.195***
	(0.084)	(0.067)	(0.080)	(0.067)
Qtl 3 Constraint × Income Growth	0.086	0.032	0.134	0.074
	(0.068)	(0.080)	(0.087)	(0.054)
Qtl 4 Constraint × Income Growth	-0.011	0.021	0.110	0.098
	(0.065)	(0.057)	(0.080)	(0.089)
Income Growth	0.715***	0.692***	0.676***	0.619***
	(0.051)	(0.042)	(0.065)	(0.042)
R2	0.82	0.80	0.82	0.81
Number of Observations	269	310	269	308
Panel C. Change in Average Rooms per Person				
Qtl 2 Constraint	0.069	0.153***	0.194***	-0.020
	(0.052)	(0.053)	(0.062)	(0.055)
Qtl 3 Constraint	0.070	0.168***	0.207***	0.107*
	(0.057)	(0.055)	(0.067)	(0.055)
Qtl 4 Constraint	0.065	0.134**	0.180***	0.044
	(0.061)	(0.061)	(0.065)	(0.056)
Qtl 2 Constraint × Income Growth	-0.000	-0.039	-0.079***	0.043*
	(0.022)	(0.025)	(0.027)	(0.024)
Qtl 3 Constraint × Income Growth	0.013	-0.023	-0.057*	-0.010
	(0.026)	(0.025)	(0.030)	(0.023)
Qtl 4 Constraint × Income Growth	0.009	-0.013	-0.036	0.036
	(0.028)	(0.028)	(0.030)	(0.025)
Income Growth	-0.050***	-0.022	0.007	-0.051***
	(0.017)	(0.020)	(0.024)	(0.017)
R2	0.13	0.14	0.15	0.12
Number of Observations	267	309	267	307

This table reports estimates of house quantity growth (panel A) and population growth (panel B), and the change in average rooms per person (panel C) regressed on total income growth, quartiles of the constraint measure, and the interaction of income growth with each quartile. Each column uses a different measure of housing constraints where column 1 uses the elasticity from Saiz (2010), column 2 uses an elasticity from Baum-Snow and Han (2024), column 3 uses the regulation index Gyourko et al. (2008), and column 4 uses the land share of value Davis et al. (2021). See the text for more details.

TABLE A7

House Price Growth (1980-2020): Quartiles

	(1) Saiz	(2) BS-H	(3) WRLURI	(4) Building
Panel A. Real House Price Growth (Annualized %)				
Qtl 2 Constraint	-0.614	-0.689*	-0.693	-0.963**
	(0.441)	(0.401)	(0.420)	(0.419)
Qtl 3 Constraint	-0.712*	-1.196***	-0.945**	-0.755*
	(0.413)	(0.417)	(0.430)	(0.419)
Qtl 4 Constraint	-1.180***	-0.938**	-0.943**	-0.613
	(0.402)	(0.408)	(0.449)	(0.432)
Qtl 2 Constraint × Income Growth	0.048	0.077	0.055	0.066
	(0.145)	(0.142)	(0.149)	(0.150)
Qtl 3 Constraint × Income Growth	-0.031	0.268*	0.066	-0.018
	(0.138)	(0.151)	(0.152)	(0.144)
Qtl 4 Constraint × Income Growth	0.018	0.145	-0.060	-0.198
	(0.141)	(0.148)	(0.167)	(0.160)
Income Growth	0.131	0.129	0.144	0.220*
	(0.112)	(0.128)	(0.134)	(0.126)
R2	0.29	0.18	0.27	0.28
Number of Observations	268	308	268	306
Panel B. Real Median Home Value Growth (Annualized %)				
Qtl 2 Constraint	-0.627*	-0.609*	-0.455	-0.664*
	(0.372)	(0.329)	(0.339)	(0.370)
Qtl 3 Constraint	-0.932***	-1.170***	-0.691**	-0.626*
	(0.357)	(0.306)	(0.326)	(0.378)
Qtl 4 Constraint	-1.143***	-0.722**	-1.081***	-0.798**
	(0.354)	(0.296)	(0.321)	(0.370)
Qtl 2 Constraint × Income Growth	0.078	0.079	0.027	0.075
	(0.124)	(0.117)	(0.122)	(0.129)
Qtl 3 Constraint × Income Growth	0.128	0.296***	0.075	0.006
	(0.117)	(0.110)	(0.117)	(0.132)
Qtl 4 Constraint × Income Growth	0.152	0.097	0.169	0.041
	(0.123)	(0.110)	(0.120)	(0.137)
Income Growth	0.189*	0.215**	0.230**	0.260**
	(0.107)	(0.095)	(0.103)	(0.118)
R2	0.46	0.39	0.43	0.41
Number of Observations	267	309	267	307

This table reports estimates of house price growth (panel A) and median home value growth (panel B) regressed on total income growth, quartiles of the constraint measure, and the interaction of income growth with each quartile. Each column uses a different measure of housing constraints where column 1 uses the elasticity from Saiz (2010), column 2 uses an elasticity from Baum-Snow and Han (2024), column 3 uses the regulation index Gyourko et al. (2008), and column 4 uses the land share of value Davis et al. (2021). See the text for more details.

TABLE A8
House Quantity Growth (1980-2020): Quartiles

	(1) Saiz	(2) BS-H	(3) WRLURI	(4) Building
Panel A. Housing Quantity Growth (Annualized %)				
Qtl 2 Constraint	0.123	0.318*	0.364**	-0.022
	(0.159)	(0.163)	(0.161)	(0.120)
Qtl 3 Constraint	0.254*	0.329**	0.356**	0.123
	(0.141)	(0.158)	(0.162)	(0.133)
Qtl 4 Constraint	0.275*	0.281*	0.264*	-0.126
	(0.147)	(0.167)	(0.155)	(0.136)
Qtl 2 Constraint × Income Growth	0.019	-0.039	-0.088	0.105**
	(0.062)	(0.065)	(0.063)	(0.045)
Qtl 3 Constraint × Income Growth	-0.004	-0.028	-0.059	0.057
	(0.053)	(0.064)	(0.065)	(0.053)
Qtl 4 Constraint × Income Growth	-0.025	-0.016	-0.010	0.163***
	(0.060)	(0.068)	(0.062)	(0.059)
Income Growth	0.741***	0.753***	0.783***	0.658***
	(0.049)	(0.058)	(0.054)	(0.040)
R2	0.89	0.88	0.89	0.89
Number of Observations	268	309	268	307
Panel B. Population Growth (Annualized %)				
Qtl 2 Constraint	0.050	0.308*	0.219	-0.039
	(0.178)	(0.161)	(0.168)	(0.116)
Qtl 3 Constraint	0.115	0.291**	0.178	0.078
	(0.160)	(0.144)	(0.165)	(0.132)
Qtl 4 Constraint	0.299*	0.263*	0.188	-0.283**
	(0.166)	(0.151)	(0.154)	(0.130)
Qtl 2 Constraint × Income Growth	0.026	-0.066	-0.071	0.101**
	(0.070)	(0.066)	(0.066)	(0.044)
Qtl 3 Constraint × Income Growth	0.002	-0.077	-0.051	0.061
	(0.061)	(0.060)	(0.067)	(0.052)
Qtl 4 Constraint × Income Growth	-0.079	-0.084	-0.061	0.184***
	(0.067)	(0.062)	(0.062)	(0.057)
Income Growth	0.853***	0.892***	0.885***	0.752***
	(0.056)	(0.052)	(0.052)	(0.035)
R2	0.91	0.90	0.90	0.91
Number of Observations	269	310	269	308
Panel C. Change in Average Rooms per Person				
Qtl 2 Constraint	0.101	0.180	0.525***	0.059
	(0.151)	(0.124)	(0.174)	(0.150)
Qtl 3 Constraint	0.318**	0.148	0.530***	0.152
	(0.148)	(0.119)	(0.175)	(0.168)
Qtl 4 Constraint	0.152	0.092	0.473***	0.269*
	(0.123)	(0.136)	(0.175)	(0.144)
Qtl 2 Constraint × Income Growth	-0.009	-0.029	-0.151**	0.022
	(0.058)	(0.048)	(0.064)	(0.054)
Qtl 3 Constraint × Income Growth	-0.055	0.027	-0.120*	-0.005
	(0.053)	(0.042)	(0.061)	(0.062)
Qtl 4 Constraint × Income Growth	-0.002	0.024	-0.072	-0.025
	(0.045)	(0.055)	(0.066)	(0.057)
Income Growth	-0.085**	-0.113***	0.011	-0.110**
	(0.034)	(0.035)	(0.057)	(0.045)
R2	0.27	0.31	0.36	0.28
Number of Observations	140	159	140	158

This table reports estimates of house quantity growth (panel A) and population growth (panel B), and the change in average rooms per person (panel C) regressed on total income growth, quartiles of the constraint measure, and the interaction of income growth with each quartile. Each column uses a different measure of housing constraints where column 1 uses the elasticity from Saiz (2010), column 2 uses an elasticity from Baum-Snow and Han (2024), column 3 uses the regulation index Gyourko et al. (2008), and column 4 uses the land share of value Davis et al. (2021). See the text for more details.

TABLE A9

House Price Growth (1980-2000): Quartiles

	(1) Saiz	(2) BS-H	(3) WRLURI	(4) Building
Panel A. Real House Price Growth (Annualized %)				
Qtl 2 Constraint	-0.736	-0.933	-0.330	-1.052*
	(0.656)	(0.671)	(0.651)	(0.620)
Qtl 3 Constraint	-0.620	-1.357**	-0.365	-0.412
	(0.632)	(0.662)	(0.659)	(0.614)
Qtl 4 Constraint	-1.176**	-1.080*	-0.652	-0.776
	(0.588)	(0.641)	(0.675)	(0.624)
Qtl 2 Constraint × Income Growth	0.060	0.115	-0.078	0.013
	(0.180)	(0.199)	(0.198)	(0.180)
Qtl 3 Constraint × Income Growth	-0.025	0.239	-0.119	-0.142
	(0.179)	(0.195)	(0.194)	(0.182)
Qtl 4 Constraint × Income Growth	0.057	0.145	-0.106	-0.160
	(0.176)	(0.194)	(0.210)	(0.192)
Income Growth	-0.049	-0.042	0.083	0.115
	(0.139)	(0.175)	(0.172)	(0.155)
R2	0.08	0.06	0.09	0.14
Number of Observations	268	308	268	306
Panel B. Real Median Home Value Growth (Annualized %)				
Qtl 2 Constraint	-0.987**	-0.964**	0.227	-0.890**
	(0.416)	(0.446)	(0.460)	(0.409)
Qtl 3 Constraint	-1.216***	-1.718***	-0.245	-1.226***
	(0.410)	(0.440)	(0.450)	(0.432)
Qtl 4 Constraint	-1.940***	-1.435***	-1.095**	-1.348***
	(0.444)	(0.439)	(0.460)	(0.489)
Qtl 2 Constraint × Income Growth	0.181	0.163	-0.121	0.089
	(0.113)	(0.129)	(0.135)	(0.118)
Qtl 3 Constraint × Income Growth	0.245**	0.410***	-0.033	0.134
	(0.115)	(0.130)	(0.136)	(0.129)
Qtl 4 Constraint × Income Growth	0.452***	0.336**	0.264*	0.189
	(0.137)	(0.134)	(0.141)	(0.175)
Income Growth	0.014	0.019	0.237**	0.120
	(0.095)	(0.109)	(0.115)	(0.101)
R2	0.26	0.24	0.24	0.28
Number of Observations	269	310	269	308

This table reports estimates of house price growth (panel A) and median home value growth (panel B) regressed on total income growth, quartiles of the constraint measure, and the interaction of income growth with each quartile. Each column uses a different measure of housing constraints where column 1 uses the elasticity from Saiz (2010), column 2 uses an elasticity from Baum-Snow and Han (2024), column 3 uses the regulation index Gyourko et al. (2008), and column 4 uses the land share of value Davis et al. (2021). See the text for more details.

TABLE A10

House Quantity Growth (1980-2000): Quartiles

Panel A. Housing Quantity Growth (Annualized %)

	(1) Saiz	(2) BS-H	(3) WRLURI	(4) Building
Qtl 2 Constraint	0.405*	0.627**	0.022	0.040
	(0.220)	(0.264)	(0.261)	(0.227)
Qtl 3 Constraint	0.737***	0.810***	0.112	0.142
	(0.206)	(0.264)	(0.256)	(0.228)
Qtl 4 Constraint	0.605**	0.684**	0.041	0.141
	(0.235)	(0.267)	(0.255)	(0.275)
Qtl 2 Constraint × Income Growth	-0.049	-0.078	0.024	0.081
	(0.067)	(0.084)	(0.080)	(0.069)
Qtl 3 Constraint × Income Growth	-0.141**	-0.132	0.014	0.084
	(0.062)	(0.084)	(0.082)	(0.072)
Qtl 4 Constraint × Income Growth	-0.120	-0.057	0.051	0.069
	(0.084)	(0.087)	(0.083)	(0.101)
Income Growth	0.758***	0.750***	0.653***	0.619***
	(0.058)	(0.077)	(0.067)	(0.061)
R2	0.81	0.80	0.80	0.78
Number of Observations	268	309	268	307

Panel B. Population Growth (Annualized %)

	(1) Saiz	(2) BS-H	(3) WRLURI	(4) Building
Qtl 2 Constraint	0.437*	0.579**	-0.385	-0.015
	(0.224)	(0.250)	(0.328)	(0.229)
Qtl 3 Constraint	0.641***	0.776***	-0.402	0.252
	(0.210)	(0.241)	(0.326)	(0.241)
Qtl 4 Constraint	0.667***	0.645***	-0.322	-0.093
	(0.225)	(0.247)	(0.312)	(0.275)
Qtl 2 Constraint × Income Growth	-0.105*	-0.103	0.095	0.075
	(0.063)	(0.076)	(0.089)	(0.066)
Qtl 3 Constraint × Income Growth	-0.183***	-0.212***	0.088	0.022
	(0.060)	(0.074)	(0.094)	(0.070)
Qtl 4 Constraint × Income Growth	-0.205***	-0.155**	0.040	0.075
	(0.079)	(0.078)	(0.088)	(0.104)
Income Growth	0.876***	0.875***	0.675***	0.708***
	(0.052)	(0.067)	(0.079)	(0.053)
R2	0.81	0.79	0.81	0.79
Number of Observations	269	310	269	308

Panel C. Change in Average Rooms per Person

	(1) Saiz	(2) BS-H	(3) WRLURI	(4) Building
Qtl 2 Constraint	0.023	0.134	0.330***	0.144
	(0.113)	(0.105)	(0.120)	(0.129)
Qtl 3 Constraint	0.153	0.069	0.453***	0.097
	(0.114)	(0.092)	(0.111)	(0.141)
Qtl 4 Constraint	0.204*	0.068	0.318***	0.199
	(0.105)	(0.111)	(0.114)	(0.121)
Qtl 2 Constraint × Income Growth	0.008	-0.029	-0.067**	-0.022
	(0.030)	(0.032)	(0.033)	(0.036)
Qtl 3 Constraint × Income Growth	-0.010	0.002	-0.095***	-0.014
	(0.032)	(0.026)	(0.030)	(0.040)
Qtl 4 Constraint × Income Growth	-0.041	0.004	-0.058*	-0.028
	(0.031)	(0.031)	(0.033)	(0.034)
Income Growth	-0.031	-0.037*	0.024	-0.023
	(0.023)	(0.021)	(0.026)	(0.032)
R2	0.21	0.16	0.29	0.16
Number of Observations	140	159	140	158

This table reports estimates of house quantity growth (panel A) and population growth (panel B), and the change in average rooms per person (panel C) regressed on total income growth, quartiles of the constraint measure, and the interaction of income growth with each quartile. Each column uses a different measure of housing constraints where column 1 uses the elasticity from Saiz (2010), column 2 uses an elasticity from Baum-Snow and Han (2024), column 3 uses the regulation index Gyourko et al. (2008), and column 4 uses the land share of value Davis et al. (2021). See the text for more details.

TABLE A11

HOUSE PRICE GROWTH (2000-2020): CONTINUOUS

	(1) Saiz	(2) BS-H	(3) WRLURI	(4) Building
Panel A. Real House Price Growth (Annualized %)				
Elasticity Measure × Income Growth	-0.191***	-0.003	-0.103	-0.122**
	(0.071)	(0.061)	(0.077)	(0.058)
Elasticity Measure	-0.088	-0.251*	-0.187	-0.150
	(0.154)	(0.136)	(0.162)	(0.124)
Income Growth	0.533***	0.612***	0.556***	0.605***
	(0.061)	(0.055)	(0.054)	(0.057)
R2	0.49	0.37	0.45	0.44
Number of Observations	268	308	268	306
Panel B. Real Median House Value Growth (Annualized %)				
Elasticity Measure × Income Growth	-0.122**	-0.122*	-0.076	-0.048
	(0.049)	(0.063)	(0.066)	(0.083)
Elasticity Measure	-0.043	0.032	-0.129	-0.146
	(0.095)	(0.145)	(0.128)	(0.194)
Income Growth	0.593***	0.670***	0.601***	0.643***
	(0.063)	(0.059)	(0.058)	(0.066)
R2	0.46	0.45	0.46	0.41
Number of Observations	267	309	267	307

This table reports estimates of house price growth (panel A) and median home value growth (panel B) regressed on total income growth, the constraint measure, and the interaction of income growth with the constraint measure. Each column uses a different measure of housing constraints where column 1 uses the elasticity from Saiz (2010), column 2 uses an elasticity from Baum-Snow and Han (2024), column 3 uses the regulation index Gyourko et al. (2008), and column 4 uses the land share of value Davis et al. (2021). See the text for more details.

TABLE A12

House Price Growth (2000-2020): Continuous Winsorized

	(1) Saiz	(2) BS-H	(3) WRLURI	(4) Building
Panel A. Real House Price Growth (Annualized %)				
Elasticity Measure (Winsorized)				
× Income Growth	-0.078	-0.007	-0.072	-0.124**
	(0.060)	(0.061)	(0.066)	(0.055)
Elasticity Measure (Winsorized)	-0.312**	-0.234*	-0.265*	-0.149
	(0.135)	(0.136)	(0.143)	(0.115)
Income Growth	0.528***	0.613***	0.537***	0.599***
	(0.059)	(0.055)	(0.054)	(0.057)
R2	0.50	0.37	0.46	0.44
Number of Observations	268	308	268	306
Panel B. Real Median House Value Growth (Annualized %)				
Elasticity Measure (Winsorized)				
× Income Growth	-0.052	-0.124*	-0.065	-0.036
	(0.054)	(0.064)	(0.058)	(0.074)
Elasticity Measure (Winsorized)	-0.192*	0.041	-0.159	-0.178
	(0.114)	(0.145)	(0.118)	(0.163)
Income Growth	0.588***	0.671***	0.589***	0.639***
	(0.061)	(0.059)	(0.057)	(0.065)
R2	0.47	0.45	0.47	0.41
Number of Observations	267	309	267	307

This table reports estimates of house price growth (panel A) and median home value growth (panel B) regressed on total income growth, the constraint measure, and the interaction of income growth with the constraint measure where we have winsorized each constraint measure at the top and bottom 5th percentiles. Each column uses a different measure of housing constraints where column 1 uses the elasticity from Saiz (2010), column 2 uses an elasticity from Baum-Snow and Han (2024), column 3 uses the regulation index Gyourko et al. (2008), and column 4 uses the land share of value Davis et al. (2021). See the text for more details.

TABLE A13

HOUSE QUANTITY GROWTH (2000-2020): CONTINUOUS

	(1) Saiz	(2) BS-H	(3) WRLURI	(4) Building
Panel A. Housing Quantities Growth (Annualized %)				
Elasticity Measure × Income Growth	0.038***	0.013	0.070**	0.038
	(0.014)	(0.025)	(0.027)	(0.037)
Elasticity Measure	-0.029	-0.030	-0.094*	-0.028
	(0.021)	(0.045)	(0.051)	(0.064)
Income Growth	0.656***	0.627***	0.648***	0.623***
	(0.023)	(0.025)	(0.024)	(0.026)
R2	0.79	0.77	0.80	0.77
Number of Observations	269	310	269	308
Panel B. Population Growth (Annualized %)				
Elasticity Measure × Income Growth	0.024	0.018	0.057*	0.042
	(0.019)	(0.025)	(0.031)	(0.038)
Elasticity Measure	-0.025	-0.071	-0.087	-0.041
	(0.034)	(0.046)	(0.061)	(0.068)
Income Growth	0.757***	0.717***	0.751***	0.711***
	(0.026)	(0.026)	(0.027)	(0.027)
R2	0.81	0.80	0.82	0.79
Number of Observations	269	310	269	308
Panel C. Change in Average Rooms per Person				
Elasticity Measure × Income Growth	0.015*	-0.005	0.005	0.015
	(0.008)	(0.012)	(0.014)	(0.010)
Elasticity Measure	-0.012	0.062**	0.019	0.013
	(0.013)	(0.026)	(0.027)	(0.023)
Income Growth	-0.048***	-0.039***	-0.046***	-0.039***
	(0.009)	(0.009)	(0.010)	(0.009)
R2	0.09	0.15	0.11	0.11
Number of Observations	267	309	267	307

This table reports estimates of house quantity growth (panel A) and population growth (panel B), and the change in average rooms per person (panel C) regressed on total income growth, the constraint measure, and the interaction of income growth with the constraint measure. Each column uses a different measure of housing constraints where column 1 uses the elasticity from Saiz (2010), column 2 uses an elasticity from Baum-Snow and Han (2024), column 3 uses the regulation index Gyourko et al. (2008), and column 4 uses the land share of value Davis et al. (2021). See the text for more details.

TABLE A14

HOUSE QUANTITY GROWTH (2000-2020): CONTINUOUS WINSORIZED

	(1) Saiz	(2) BS-H	(3) WRLURI	(4) Building
Panel A. Housing Quantities Growth (Annualized %)				
Elasticity Measure (Winsorized) × Income Growth	0.025	0.009	0.065**	0.037
	(0.019)	(0.024)	(0.025)	(0.033)
Elasticity Measure (Winsorized)	-0.007	-0.025	-0.083*	-0.032
	(0.037)	(0.044)	(0.049)	(0.058)
Income Growth	0.657***	0.627***	0.652***	0.623***
	(0.023)	(0.025)	(0.024)	(0.026)
R2	0.79	0.77	0.80	0.77
Number of Observations	269	310	269	308
Panel B. Population Growth (Annualized %)				
Elasticity Measure (Winsorized) × Income Growth	0.006	0.014	0.052*	0.042
	(0.024)	(0.024)	(0.028)	(0.035)
Elasticity Measure (Winsorized)	0.010	-0.067	-0.082	-0.048
	(0.048)	(0.045)	(0.057)	(0.061)
Income Growth	0.758***	0.717***	0.753***	0.712***
	(0.026)	(0.026)	(0.027)	(0.027)
R2	0.81	0.80	0.82	0.79
Number of Observations	269	310	269	308
Panel C. Change in Average Rooms per Person				
Elasticity Measure (Winsorized) × Income Growth	0.013	-0.005	0.005	0.013
	(0.009)	(0.012)	(0.012)	(0.010)
Elasticity Measure (Winsorized)	-0.001	0.060**	0.028	0.018
	(0.020)	(0.025)	(0.024)	(0.022)
Income Growth	-0.046***	-0.040***	-0.043***	-0.038***
	(0.009)	(0.009)	(0.009)	(0.009)
R2	0.10	0.14	0.12	0.12
Number of Observations	267	309	267	307

This table reports estimates of house quantity growth (panel A) and population growth (panel B), and the change in average rooms per person (panel C) regressed on total income growth, the constraint measure, and the interaction of income growth with the constraint measure where we have winsorized each constraint measure at the top and bottom 5th percentiles. Each column uses a different measure of housing constraints where column 1 uses the elasticity from Saiz (2010), column 2 uses an elasticity from Baum-Snow and Han (2024), column 3 uses the regulation index Gyourko et al. (2008), and column 4 uses the land share of value Davis et al. (2021). See the text for more details.

TABLE A15

Effects By Population (2000-2020)

	Saiz		BS-H		WRLURI		Building	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Below	Above	Below	Above	Below	Above	Below	Above
Panel A. Real House Price Growth (Annualized %)								
Less Constrained × Income Growth	0.157	-0.059	-0.032	0.052	-0.062	-0.031	-0.108	-0.072
	(0.163)	(0.178)	(0.152)	(0.168)	(0.156)	(0.182)	(0.163)	(0.180)
R2	0.36	0.59	0.30	0.41	0.36	0.50	0.33	0.40
Number of Observations	134	134	154	154	134	134	153	153
Panel B. Real Median House Value Growth (Annualized %)								
Less Constrained × Income Growth	0.132	0.064	-0.207	-0.076	-0.009	0.009	0.216	-0.078
	(0.134)	(0.189)	(0.140)	(0.190)	(0.151)	(0.192)	(0.165)	(0.187)
R2	0.37	0.55	0.42	0.44	0.36	0.52	0.35	0.44
Number of Observations	134	133	155	154	134	133	154	153
Panel C. Housing Quantity Growth (Annualized %)								
Less Constrained × Income Growth	0.003	0.019	0.023	0.012	0.126**	0.204***	0.038	0.027
	(0.060)	(0.067)	(0.070)	(0.062)	(0.057)	(0.066)	(0.070)	(0.067)
R2	0.82	0.77	0.79	0.76	0.82	0.80	0.77	0.77
Number of Observations	135	134	155	155	135	134	154	154
Panel D. Population Growth (Annualized %)								
Less Constrained × Income Growth	-0.051	0.007	0.039	0.040	0.112	0.200***	0.024	0.085
	(0.072)	(0.065)	(0.069)	(0.060)	(0.071)	(0.060)	(0.077)	(0.065)
R2	0.83	0.81	0.81	0.80	0.83	0.82	0.79	0.81
Number of Observations	135	134	155	155	135	134	154	154
Panel E. Change in Average Rooms per Person (Annualized %)								
Less Constrained × Income Growth	0.053*	0.002	-0.012	-0.007	-0.004	-0.003	-0.018	-0.004
	(0.030)	(0.021)	(0.028)	(0.021)	(0.035)	(0.021)	(0.029)	(0.023)
R2	0.10	0.18	0.06	0.26	0.07	0.29	0.05	0.16
Number of Observations	134	133	155	154	134	133	154	153

This table reports the estimates of the interaction term for house price growth (panel A), median home value growth (panel B), house quantity growth (panel C), population growth (panel D), and the change in average rooms per person (panel E) regressed on total income growth, an indicator for an MSA having an above-median constraint measure (less constrained), and the interaction of the two for cities with above and below median population size in 2000. Each group of columns uses a different measure of housing constraints where columns 1-2 use the elasticity from Saiz (2010), columns 3-4 use an elasticity from Baum-Snow and Han (2024), columns 5-6 use the regulation index Gyourko et al. (2008), and columns 7-8 use the land share of value Davis et al. (2021). See the text for more details.

TABLE A16

Effects By Population without Low Growth Cities (2000-2020)

	Saiz		BS-H		WRLURI		Building	
	(1) Below	(2) Above	(3) Below	(4) Above	(5) Below	(6) Above	(7) Below	(8) Above
Panel A. Real House Price Growth (Annualized %)								
Less Constrained × Income Growth	0.406**	0.324*	0.163	0.195	0.278*	0.041	0.143	0.073
	(0.178)	(0.180)	(0.194)	(0.189)	(0.161)	(0.260)	(0.200)	(0.214)
R2	0.33	0.56	0.19	0.27	0.34	0.35	0.27	0.25
Number of Observations	99	98	116	115	99	98	120	119
Panel B. Real Median House Value Growth (Annualized %)								
Less Constrained × Income Growth	0.313*	0.433*	-0.217	0.022	-0.083	-0.044	0.422*	0.099
	(0.171)	(0.219)	(0.204)	(0.273)	(0.179)	(0.286)	(0.215)	(0.259)
R2	0.26	0.48	0.29	0.27	0.23	0.35	0.26	0.24
Number of Observations	98	98	116	115	98	98	119	119
Panel C. Housing Quantity Growth (Annualized %)								
Less Constrained × Income Growth	-0.016	-0.016	0.043	0.005	-0.003	0.125	-0.000	0.010
	(0.079)	(0.095)	(0.095)	(0.090)	(0.078)	(0.119)	(0.093)	(0.097)
R2	0.74	0.73	0.67	0.72	0.74	0.73	0.68	0.73
Number of Observations	99	98	116	115	99	98	120	119
Panel D. Population Growth (Annualized %)								
Less Constrained × Income Growth	-0.063	-0.056	0.033	0.023	0.015	0.066	0.048	0.102
	(0.084)	(0.096)	(0.094)	(0.095)	(0.089)	(0.117)	(0.106)	(0.099)
R2	0.76	0.74	0.70	0.74	0.76	0.74	0.71	0.75
Number of Observations	99	98	116	115	99	98	120	119
Panel E. Change in Average Rooms per Person								
Less Constrained × Income Growth	0.050	0.018	-0.011	0.012	0.033	-0.023	-0.017	0.001
	(0.037)	(0.038)	(0.038)	(0.029)	(0.036)	(0.042)	(0.041)	(0.032)
R2	0.05	0.16	0.02	0.17	0.04	0.27	0.02	0.11
Number of Observations	98	98	116	115	98	98	119	119

This table reports the estimates of the interaction term for house price growth (panel A), median home value growth (panel B), house quantity growth (panel C), population growth (panel D), and the change in average rooms per person (panel E) regressed on total income growth, an indicator for an MSA having an above-median constraint measure (less constrained), and the interaction of the two for cities with above and below median population size in 2000 after dropping cities with total income growth in the bottom quartile. Each group of columns uses a different measure of housing constraints where columns 1-2 use the elasticity from Saiz (2010), columns 3-4 use an elasticity from Baum-Snow and Han (2024), columns 5-6 use the regulation index Gyourko et al. (2008), and columns 7-8 use the land share of value Davis et al. (2021). See the text for more details.

TABLE A17

Residual Effects of Constraint Measures on Prices (2000-2020)

	(1) Saiz	(2) BS-H	(3) WRLURI	(4) Building
Panel A. Real House Price Growth (Annualized %)				
Elasticity Measure	-0.278***	-1.660***	-0.479***	-3.936***
	(0.070)	(0.298)	(0.061)	(0.443)
Income Growth	0.532***	0.611***	0.542***	0.594***
	(0.056)	(0.055)	(0.054)	(0.055)
Share of SF-Houston Gap	0.0754	0.0148	0.0883	0.1808
R2	0.45	0.37	0.44	0.43
Number of Observations	268	308	268	306
Panel B. Real Median House Value Growth (Annualized %)				
Elasticity Measure	-0.168***	-1.432***	-0.344***	-2.404***
	(0.046)	(0.312)	(0.055)	(0.625)
Income Growth	0.592***	0.661***	0.590***	0.638***
	(0.059)	(0.057)	(0.055)	(0.062)
Share of SF-Houston Gap	0.1417	0.0390	0.1959	0.3512
R2	0.44	0.44	0.46	0.41
Number of Observations	267	309	267	307

This table reports estimates of house price growth (panel A) and median home value growth (panel B) regressed on total income growth and the constraint measure. Each column uses a different measure of housing constraints where column 1 uses the elasticity from Saiz (2010), column 2 uses an elasticity from Baum-Snow and Han (2024), column 3 uses the regulation index Gyourko et al. (2008), and column 4 uses the land share of value Davis et al. (2021). See the text for more details.

TABLE A18

Residual Effects of Constraint Measures on Quantities (2000-2020)

	(1) Saiz	(2) BS-H	(3) WRLURI	(4) Building
Panel A. Housing Quantity Growth (Annualized %)				
Elasticity Measure	0.023	-0.015	0.057***	0.481***
	(0.014)	(0.124)	(0.021)	(0.181)
Income Growth	0.656***	0.628***	0.658***	0.627***
	(0.024)	(0.025)	(0.024)	(0.026)
Share of SF-Houston Gap	0.0002	-0.0000	0.0003	0.0007
R2	0.79	0.77	0.79	0.77
Number of Observations	269	310	269	308
Panel B. Population Growth (Annualized %)				
Elasticity Measure	0.010	-0.218*	0.034	0.433**
	(0.015)	(0.132)	(0.027)	(0.198)
Income Growth	0.757***	0.718***	0.760***	0.715***
	(0.026)	(0.026)	(0.027)	(0.028)
Share of SF-Houston Gap	0.0001	-0.0001	0.0002	0.0006
R2	0.81	0.80	0.81	0.79
Number of Observations	269	310	269	308
Panel C. Change in Average Rooms per Person				
Elasticity Measure	0.009	0.334***	0.035**	0.421***
	(0.008)	(0.062)	(0.015)	(0.090)
Income Growth	-0.048***	-0.040***	-0.045***	-0.038***
	(0.010)	(0.009)	(0.010)	(0.009)
Share of SF-Houston Gap	0.0697	0.0821	0.1860	0.5895
R2	0.08	0.15	0.11	0.11
Number of Observations	267	309	267	307

This table reports estimates of house quantity growth (panel A) and population growth (panel B), and the change in average rooms per person (panel C) regressed on total income growth and the constraint measure. Each column uses a different measure of housing constraints where column 1 uses the elasticity from Saiz (2010), column 2 uses an elasticity from Baum-Snow and Han (2024), column 3 uses the regulation index Gyourko et al. (2008), and column 4 uses the land share of value Davis et al. (2021). See the text for more details.

TABLE A19

Implied Effects of Constraint Measures on Prices (2012-2020)

	(1) Saiz	(2) BS-H	(3) WRLURI	(4) Building
Panel A. Real House Price Growth (Annualized %)				
Elasticity Measure	-0.170**	-1.751***	-0.300***	-1.826**
	(0.066)	(0.474)	(0.115)	(0.748)
Income Growth	1.112***	1.161***	1.122***	1.153***
	(0.083)	(0.071)	(0.084)	(0.076)
Share of SF-Houston Gap	0.0112	0.0037	0.0135	0.0216
R2	0.58	0.59	0.58	0.57
Number of Observations	268	308	268	306
Panel B. Real Median House Value Growth (Annualized %)				
Elasticity Measure	-0.017	-1.302**	-0.018	1.318
	(0.087)	(0.635)	(0.134)	(1.000)
Income Growth	1.144***	1.112***	1.147***	1.151***
	(0.105)	(0.097)	(0.106)	(0.098)
Share of SF-Houston Gap	0.0024	0.0060	0.0018	-0.0352
R2	0.43	0.43	0.43	0.41
Number of Observations	267	309	267	307

This table reports estimates of house price growth (panel A) and median home value growth (panel B) regressed on total income growth and the constraint measure. Each column uses a different measure of housing constraints where column 1 uses the elasticity from Saiz (2010), column 2 uses an elasticity from Baum-Snow and Han (2024), column 3 uses the regulation index Gyourko et al. (2008), and column 4 uses the land share of value Davis et al. (2021). See the text for more details.