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# Supply Constraints do not Explain House Price and Quantity Growth Across U.S. Cities*

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**Abstract**

The standard view of housing markets holds that the flexibility of local housing supply—shaped by factors like geography and regulation—strongly affects the response of house prices, house quantities and population to rising housing demand. 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 pattern when we expand the sample to 1980 to 2020, use different elasticity measures, and when we instrument for local housing demand. Using a general demand-and-supply framework, we show that our findings imply that constrained housing supply is relatively unimportant in explaining differences in rising house prices among U.S. cities. These results challenge the prevailing view of local housing and labor markets and suggest that easing housing supply constraints may not yield the anticipated improvements in housing affordability.

**Keywords:** house prices, housing supply, affordability, regulation, zoning, land use

**JEL Codes:** E22, J61, R21, R31, R52

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# 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]

Why is housing so expensive? The canonical view is that the elasticity of local housing supply is a major determinant of local house prices and quantities (Glaeser, Gyourko and Saks, 2005; Saiz, 2010). In response to the same shift in the demand for housing, cities with relatively more elastic housing supply will see a larger increase in the quantity of housing and a smaller increase in the price of housing compared to cities with relatively less elastic housing supply. To the extent that regulatory constraints reduce the elasticity of housing supply, relaxing these constraints will increase the elasticity of housing supply, increase housing quantities, and reduce house prices (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).

If this perspective were correct, one would expect higher income growth to cause higher house price growth and lower house quantity growth in more constrained cities relative to less constrained cities. However, using four standard measures of housing supply constraints from the literature, we find that cities measured to have more restrictive housing supply show the same growth in house prices, quantities, population and rooms per person in response to higher income growth from 2000–2020 as cities that seem less constrained. This is true across all the measures of housing constraints, if we extend our sample to cover 1980 to 2020, and if we instrument for housing demand using the plausibly exogenous increase in housing demand from pandemic-era remote work.

Interpreting our empirical approach through a demand-and-supply framework where we allow for arbitrary correlations of income growth with other shocks, we show that our results imply that housing supply constraints are quantitatively unimportant in explaining rising housing costs across U.S. cities. In the simplest case, when income growth is uncorrelated with other housing demand and supply shocks, then the same income growth will translate into more house price growth and less house quantity growth in less elastic cities. The fact that we do not find these differences in price and quantity growth would imply that

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

differences in housing supply elasticities are small and unimportant across cities. But since we do not isolate exogenous variation in our baseline analysis, we cannot rule out that income growth is correlated with other shocks.

We show that because we examine the effect of income growth on both house prices and quantities, our analysis will uncover the importance of housing supply elasticities in the cross-section even when income growth is correlated with other housing demand shocks. For example, if income growth is positively correlated with housing demand shocks in more elastic cities, then the effect of income growth on house price growth may look similar across elastic and inelastic cities. Intuitively, elastic cities that experience an increase in housing demand due to high income growth will also experience an additional increase in housing demand, so the increase in prices will be larger and more similar to inelastic cities that do not experience the additional demand shock. But the more elastic cities will then see a larger increase in housing quantities relative to the less elastic cities due to the much higher level of demand. Thus, while this correlation of income growth with housing demand shocks shrinks the difference in house price growth, it magnifies the difference in housing quantity growth. Therefore, differences in the responses of housing prices and quantities to income growth remain informative about the role of housing supply elasticities. Because our objective is to determine the relative slope of housing supply curves across cities, this argument extends to all features of the housing demand curve that are potentially heterogeneous across cities and correlated with income growth. Thus, even when we allow for arbitrary correlations with housing demand shocks, our result that income growth predicts the same house price and housing quantity growth across elastic and inelastic cities implies that differences in housing supply elasticities are small and quantitatively not important for explaining differences in house price and quantity growth.

If there is instead a positive correlation of income growth with housing supply shocks in less elastic cities, then the response of both house price and quantity growth to income growth may look similar across cities. But this explanation simply restates the claim that housing supply elasticities do not explain the variation in house price and quantity growth across cities. If increases in housing demand systematically give rise to positive supply "shocks" that dampen the impact on prices in less elastic cities, then we cannot conclude that tight housing supply accounts for differences in house price growth. By examining the comovement of growth in house prices and quantities induced by income growth, we can therefore uncover the importance of supply elasticities regardless of correlations with unobserved demand and supply shocks.

Our analysis uses four measures of housing supply constraints that have been very influential and represent the cutting edge of research in the area. These are the 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). We use the terms "housing supply constraint" and "housing supply elasticity" interchangeably to describe these measures.

In our benchmark analysis, we regress house price growth and house quantity growth on income growth, an indicator if the city's housing supply is measured as relatively less constrained, and the interaction of income growth and the constraint indicator. Total income growth, which reflects growth in both average income and population, 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 also examine a measure of the intensive margin of housing, the change in the average number of rooms per person, and find that elastic cities experience the same change in space as inelastic cities, conditional on income growth. To check if these findings are unique to the period from 2000 to 2020, we extend our sample to 1980 and find the same results when looking at growth from 1980 to 2000 or from 1980 to 2020. 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.

Considering these sets of regressions together, we can see that growth in housing prices and quantities is independent of local measures of housing supply elasticity conditional on income growth. We make this point explicitly by leveraging the comovement of prices and quantities and estimating an instrumental variable specification to recover the elasticity of housing quantities to prices. Specifically, we regress growth in housing quantities on growth in house prices interacted with an indicator for the housing supply constraint, and we instrument for house prices with growth in total income also interacted with the supply constraint indicator. Thus, we estimate an elasticity of housing quantities with respect to prices for both more and less constrained cities, which allows us to directly test if measured supply constraints affect the relationship between prices and quantities. The only threat to identification is that there are omitted shocks to the supply of housing quantities, which would be a problem for the economic meaningfulness of the constraint measures. Our estimated elasticities are all around one and, critically, are statistically and economically indistinguishable across cities measured to be relatively more or less constrained. In other words, for a given increase in prices we find that a city has the same increase in housing quantities regardless of whether or not it appears to be more or less constrained.

While we demonstrate that omitted variables do not pose a problem for our empirical approach, if our results are correct, then an exogenous shock to housing demand should cause the same house price and quantity growth across cities regardless of their measured supply elasticity. We test this prediction by exploiting the plausibly exogenous shock to housing caused by the shift towards work-from-home (WFH) during the pandemic. As demonstrated by Mondragon and Wieland (2022) and Howard, Liebersohn and Ozimek (2023), city-level exposure to the rise of remote work over the pandemic was uncorrelated with other shocks to local housing and labor markets and caused a large increase in the demand for housing. This expansion in housing demand reflected both more migration and increasing demand for space for a given population of remote workers. We use exposure to remote work as a shock to housing demand and trace out its effects on house prices and housing quantities from 2019 to 2023 where we measure quantities with the number of housing units permitted.[2] In addition to allowing us to make explicitly causal claims, this exercise is also useful because we examine a period that is out-of-sample with respect to the rest of our results.

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 the same growth in permitted units regardless of the measure of housing supply constraints. Despite these estimates coming from a different period, one of exceptional economic changes, and the distinct source of variation, we find the same results as in our baseline analysis, further validating our approach.

While we find that the interaction of income growth and the elasticity measures do not predict house price growth, the level of the elasticity measure does predict house price growth. Specifically, a lower supply elasticity predicts higher house price growth holding fixed income growth. But this prediction is not reflected in lower quantity growth as implied by the supply-centric view. The magnitude of this effect is also generally not monotonic in the measured supply elasticity. It is therefore plausible that this difference in price growth reflects differential amenity growth correlated with the measured supply elasticity (Davidoff, 2016) or even limitations in how well price indexes adjust for changes in housing quality. But even if we take this differential house price growth as a causal effect from relatively tight supply, we show that the magnitude of this effect is small. Thus, we once again conclude

[2] Our measure for housing quantities in 1980, 2000, and 2020 is taken from the Census and so is not available at the annual frequency.

that there is little evidence that differences in housing supply elasticities are quantitatively important in explaining house price and quantity growth across U.S. cities.

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

## Related Literature

Limits on housing supply are now generally agreed to be an important, if not the most important, impediment to affordable housing (Glaeser, Gyourko and Saks, 2005; Saiz, 2023).[3] Gyourko (2009), Gyourko and Molloy (2015), Glaeser and Gyourko (2018), and Molloy (2020) provide surveys of this extensive literature.[4] A common theme is that the incidence of supply tightness is not uniform across U.S. cities. Gyourko, Saiz and Summers (2008) and Gyourko, Hartley and Krimmel (2021) developed indexes of regulatory constraints that reduce supply elasticities across different metropolitan entities. Saiz (2010) recovered MSA-level elasticities that show that metros with little developable land due to geographical 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 neighborhood 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 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 Noel (2017), Gaubert (2018), and Hsieh and Moretti (2019), among others, argue that housing supply has important effects on outcomes

[3]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 zoning, and the Economic Report of the President (Council of Economic Advisers, 2024).

[4]For a seminal contribution to thinking about housing supply see DiPasquale (1999).

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 surrounding area. These estimates, by studying shifts in local housing supply, identify the shape of the local demand curve. By contrast, our approach works to identify 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. 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.

A number of other studies in the literature have also found a limited role for supply elasticities 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 makes the argument that income growth drives house prices. Davidoff (2013) shows that regions with the largest 2000 housing cycle also saw the highest growth in supply and that, conditional on demand, the amplitude of the 2000 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, 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 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. Davis and Ortalo-Magné (2011) examine data on expenditure shares on housing for renters and find that these shares are constant across MSAs, and conclude that supply elasticities will be uncorrelated with rents and prices. We show that growth in housing quantities, in addition to house price growth, is independent of local supply elasticities, and thus infer a limited role for housing supply elasticites in explaining the cross-section of U.S. city house price and quantity growth since at least 1980.

# 2 Theoretical Framework

Using a standard supply-and-demand framework for the housing market, we demonstrate that OLS regressions predicting city-level house price and quantity growth from income growth interacted with the local supply elasticity reveal the importance of supply elasticities in explaining cross-city variations in house price growth. We show that this conclusion holds regardless of the correlation of income growth with other housing supply and demand shocks.

We assume there are $i$ cities, each with a population $N_i$ where individuals receive income $y_i$ so that total income in the city is given as $Y_i = y_i N_i$ 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. Households also have some additional demand shifters $\theta_i$, 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 $\epsilon$ gives the relevant demand elasticity:[5]

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

We assume the total supply of housing $H_i^S$ is competitive and determined by an elasticity parameter $\psi_i$ and supply shocks $\widehat{\sigma}$ so that $H_i^S = P_i^{\psi_i} e^{\widehat{\sigma}_i}$. The elasticity $\psi_i$ 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

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

[5] 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 longer-run supply curve elasticity (Guren, McKay, Nakamura and Steinsson, 2021a).

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 taste shocks or from shifts in supply:

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

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 taste $\widehat{\theta}_i$ 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:

$$\widehat{H}_i = \frac{1}{1 + \frac{\epsilon_p}{\psi_i}}\left(\epsilon_y \widehat{Y}_i + \widehat{\theta}_i\right) + \frac{\frac{\epsilon_p}{\psi_i}}{1 + \frac{\epsilon_p}{\psi_i}}\widehat{\sigma}_i. \tag{2}$$

Here as $\psi_i$ 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 (1) is increasing.

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 $\Omega^H$ (high) and $\Omega^L$ (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 $\Omega^j$ 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:

$$\beta_j = \frac{\epsilon_y}{\psi_j + \epsilon_p} + \frac{1}{\psi_j + \epsilon_p} \frac{Cov(\widehat{\theta}_i - \widehat{\sigma}_i, \widehat{Y}_i | i \in \Omega^j)}{Var(\widehat{Y}_i | i \in \Omega^j)},$$
$$\gamma_j = \frac{\epsilon_y}{1 + \frac{\epsilon_p}{\psi_j}} + \frac{1}{1 + \frac{\epsilon_p}{\psi_j}} \frac{Cov(\widehat{\theta}_i + \frac{\epsilon_p}{\psi_j}\widehat{\sigma}_i, \widehat{Y}_i | i \in \Omega^j)}{Var(\widehat{Y}_i | i \in \Omega^j)}, \qquad j \in \{H, L\}.$$

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:

$$\psi_H > \psi_L \rightarrow \beta_H < \beta_L \quad \text{and} \quad \gamma_H > \gamma_L. \tag{3}$$

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 $\beta_H$ relative to the coefficient $\beta_L$ 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, $\gamma_H > \gamma_L$.

Of course, it is possible that unobserved demand shocks or supply shocks are correlated with the change in income so that the second terms do not drop out. But the effect of these factors on house prices will still run through the housing supply elasticity. So if high and low elasticity cities all have the same correlation between omitted shocks and income growth then house price growth in high elasticity cities will still exhibit a smaller correlation with income growth. And the converse will hold for housing quantities. In other words, we would still expect the regression coefficient to follow the pattern in (3), although the magnitudes would certainly be different.

Instead, there are essentially two kinds of heterogeneity that could contaminate these estimates such that the intuitive relationship between supply elasticities and regression coefficients falls apart. First, the correlation between income changes and unobserved shocks could vary across the type of city. For example, if high elasticity places have a strong correlation between income growth and other positive demand shocks, then these cities will generate a relatively high correlation between income and house price growth pushing $\beta_H$ closer to $\beta_L$. But we should then see an even stronger relation between measured housing supply elasticities and quantity growth, as the same demand shocks will push up housing quantities more in more elastic cities so that $\gamma_H >> \gamma_L$. Figure II illustrates this logic in a demand-and-supply diagram. Thus, this hypothesis is testable by looking jointly at prices and quantities.

In contrast, if income growth is positively correlated with housing supply shocks in low elasticity locations, then the estimated $\beta_L$ for house prices in these cities will be relatively low, while raising the $\gamma_L$ for housing quantities. Thus, positive housing supply shocks in low elasticity cities have the potential for making the city groups more alike in both sets of regressions. Figure III illustrates this example in a supply-and-demand diagram. But if such a correlation were empirically important then it would raise questions about the meaningfulness of the housing supply measures. If cities with relatively inelastic housing supply always experience positive housing supply shocks that offset increases in demand, then to what extent is tight housing supply driving up prices? 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. If these measures of housing market flexibility are not empirically relevant for house price dynamics because of offsetting correlations in other supply "shocks", it suggests there are important gaps in our understanding about how these elasticities matter for the price and quantity of housing.

A second kind of potentially problematic heterogeneity would not be in the correlations with unobserved shocks, but in the underlying elasticities $\epsilon_y$ and $\epsilon_p$. For example, if individuals in cities with relatively inelastic housing supply have a lower income elasticity of demand for housing or if they are relatively more price sensitive, then the income growth will have a relatively smaller effect on house prices. But if the correlation between elasticities is such as to reduce the disparities in house price growth in low and high supply elasticity cities ($\beta_L \approx \beta_H$), then it will exacerbate the differences in housing quantity growth between them ($\gamma_H >> \gamma_L$). Again, this explanation is testable by jointly examining housing prices and quantities.

We lean on these simple relationships to quantify the extent to which local measures of housing supply elasticity matter for housing affordability dynamics. Specifically, we estimate the following regressions

$$\widehat{P}_i = \alpha + \beta_1 \widehat{Y}_i + \beta_2 \mathbb{I}_i(\text{Less Constrained}) + \beta_3 \widehat{Y}_i \times \mathbb{I}_i(\text{Less Constrained}) + e_i \tag{4}$$

$$\widehat{H}_i = \delta + \gamma_1 \widehat{Y}_i + \gamma_2 \mathbb{I}_i(\text{Less Constrained}) + \gamma_3 \widehat{Y}_i \times \mathbb{I}_i(\text{Less Constrained}) + v_i$$

The coefficients of interest are $\beta_3$ and $\gamma_3$, 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 above, $\beta_3 = \beta_H - \beta_L$ 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.

An analogous strategy is to directly estimate the implied differences in housing supply elasticities from the comovement of house prices with house quantities induced by income growth. Specifically, we regress the change in house quantities on the change in house prices instrumented by the change in total income for both high and low elasticity cities,

$$\widehat{H}_i = \kappa_j + \theta_j \check{P}_i + w_i,$$
$$\widehat{P}_i = \alpha_j + \beta_j \widehat{Y}_i + e_i, \qquad i \in \Omega^j,\ j \in \{H, L\}$$

where $\check{P}$ is instrumented price changes.

The IV estimator, using the definitions in (1) and (2) and rearranging, is simply

$$\theta_j = \psi_j + \frac{Cov(\sigma_i, \widehat{Y}_i | i \in \Omega^j)}{Cov(\widehat{P}_i, \widehat{Y}_i | i \in \Omega^j)}, \qquad i \in \Omega^j,\ j \in \{H, L\} \tag{5}$$

The IV estimator reinforces that when we jointly examine the response of housing quantities and prices to income growth, then the only threat to identification is that the correlation of income growth with supply shocks differs across low and high elasticity cities. But, as we explained above, if our estimates of $\theta_j$ are similar across cities because low elasticity cities consistently experience positive supply shocks correlated with income growth then this calls into question whether tight housing supply explains house price growth in the cross-section. All other sources of variation, such as demand shocks or elasticities correlated with income growth, do not pose a problem for estimating the slope of the supply curve (and are in fact valid variation) because they only change how much housing demand changes, which is normalized in the IV.

In summary, our theoretical framework shows that simple regressions help quantify the importance of local supply in shaping the cross-section of house price and quantity growth. Specifically, we show that if differences in local supply are quantitatively important, then we should see such differences in OLS regression of house price and quantity growth on income growth interacted with measures of the supply elasticity. Similarly, the estimated housing supply elasticity from an IV regression of house quantities on house prices instrumented by income growth should be much lower in cities deemed to have constrained supply than in cities deemed to have less constrained supply. We next describe our data sources and then estimate these 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.[6] Finally, we use the 2012 measure of the land share of value from Davis et al. (2021) at the county level and then aggregate them to the MSA-level with population weights.[7] 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 personal income estimates from the BEA and then aggregate them to the MSA level.[8] We use the broad measure "all persons from all sources" in a geography during a calendar year.[9]

We rely on two measures of house prices. 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, 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.[10]

[6] 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.

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

[8] Available for download at https://apps.bea.gov/regional/zip/CAINC1.zip.

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

[10] 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

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.

Finally, we use exposure to remote work as a shock to local housing demand. Mondragon and Wieland (2022) 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 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

relevant measure of house price growth is price growth net of changes in construction costs. Saiz (2023) 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.

appears inconsistent with the view that supply constraints have held back housing quantities.

# 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 infer the extent to which variation in the elasticity of housing supply is important in explaining house price and quantity growth in the cross-section.

## 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.

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 indeed the case by plotting the total annualized growth in housing quantities against the same measures of housing constraints. These results are much less clear. All of the measures but the building share of land value are at least weakly negatively correlated with housing quantities. But 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 was explained by variation in the growth of housing quantities.

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.[11] 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. As discussed in Section 2, for the same growth in housing demand MSAs with less constrained housing markets should show relatively less growth in house prices compared to MSAs with more constrained housing markets. This is not what we find. Instead, across every measure, we find that house prices for more- and less-constrained cities have the same slope with respect to changes in income. To the extent that changes in income reflect different demand conditions, these pictures show that none of the measures of supply constraints translate into relatively less house price growth.

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. We discuss this gap in more detail in Section 4.5, where we argue that it is both quantitatively small and unlikely to reflect a causal impact of the supply elasticity on house prices.

The fact that supply constraints do not seem to affect the relationship between income and house price growth is not consistent with the logic of how housing supply affects house prices given in Equation (1). 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 case, it may be the case that migration causes price-to-income ratios to be equalized so that local housing supply elasticities will have

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

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 ($\epsilon_p$) being very large in Equation (1).[12] 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 there is evidence that housing constraints affect the relationship between growth 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 local labor market models are correct, 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.

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, affect house price and house quantity growth. We next confirm this insight in regression form and then show that it is a robust conclusion.

## 4.2 Regression Results

We estimate various regressions along the lines of (4), where we create an indicator for a city being less constrained if the relevant measure is above the sample median (again, all variables have been constructed so that a larger value indicates the city is relatively unconstrained). The coefficient of interest is the interaction of total income growth with the indicator for being less constrained and where standard theory predicts this coefficient should be negative for house prices and positive for housing quantities. 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).

[12] Another implication of this perspective is that the elasticity of supply ($\psi_i$) 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 (2).

Table II reports the results for house prices where panel A uses the Corelogic house price index and panel B uses the median home value. Total income growth is strongly correlated with house price growth: a one percentage point increase in total income growth predicts a 60 basis point increase in house price growth. Most importantly, the interaction term with the housing supply elasticity is essentially zero and statistically insignificant for both measures of house prices and across all measures of the elasticity. In other words, the correlation between house price growth and total income growth is the same across cities regardless of the measured constraints on housing supply. We again see that less constrained areas tend to have less house price growth on average (although this result is not robust across all specifications), which we discuss in detail in Section 4.5.

Table III changes the outcome variable to housing quantity growth. Panel A uses at 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 have a slight positive effect on growth in housing units and population. Even taking this small effect at face value, note that Table II showed that there is essentially no effect on prices as one would expect from a supply-centric view. 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. Thus, while less constrained places tend to show less price growth on average, we find no evidence for relatively more growth in housing quantities in less constrained areas for any of the constraint measures.

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. But this correlation is completely unaffected by the measure of housing constraints. Given a level of income growth, having a housing market that is 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 matter in the way standard theory posits. To summarize this point we estimate instrumental variable specifications along the lines of (5), 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 to just differential correlations between supply shocks and income growth.

Table IV 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. 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 to be able to say with any precision that less regulated cities have a meaningfully different response in the quantity of housing units. Table V 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 Conditioning on a Housing Demand Shock

We believe our analysis is particularly attractive because, as we lay out in Section 2, we do not require exogenous variation in housing demand to determine whether differences in housing supply elasticities across U.S. cities are quantitatively important for explaining differences in house price growth.

But if we had such exogenous variation, it should also show that higher housing demand causes equally large house price and quantity growth across U.S. cities, similar to our baseline analysis. We now test this claim using the shift to working from home shock in Mondragon and Wieland (2022), who show that it is a plausibly exogenous shock to local housing demand. Specifically, we construct an indicator for having above-median exposure to WFH, identified using the employment share of WFH from 2015-2019 which is strongly correlated with the increase in WFH over the pandemic. We then interact this indicator with each of the indicators for being less constrained (above median). Whereas standard theory predicts that the less constrained cities experience less house price growth and more house quantity growth given the same WFH shock, our previous results predict that these locations should see similar house price and quantity growth.

Table VI reports the results where we look at growth from 2019 to 2023, the most recent year for which we have all the total income growth. In panel A we put total income growth as the outcome to check if growth in more- and less-constrained cities load equally on the WFH shocks. We actually see some evidence that growth is higher in places that are less constrained according to the Baum-Snow and Han elasticity and the regulatory index, implying there is some heterogeneity in the treatment effect. This is not informative about the role of supply constraints in the housing market, but instead helps scale 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, in fact has the wrong sign but that might primarily reflect the additional income growth shown in Panel A. Finally, Panel C looks at the cumulative growth in the number of units permitted.[13] 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.

First, these estimates show that the increase in housing demand due to WFH had a large effect on permit growth, about three times larger than that on house prices. This larger response relative to the change in total housing is intuitive since permits represent the response of housing investment, which is smaller and more volatile than the overall stock of housing. Critically, these estimates show that none of the constraint measures had any affect on quantity of permits issued in response to the increase in housing demand. Even in cities with relatively lenient regulatory environments and where house price growth was actually rather high, there is no evidence of a larger response in permits. In fact, the sign on the interaction of WFH with the regulatory constraint has the wrong sign, although the estimate is very imprecise.

In short, we show that even in an episode that is out of sample and where we have isolated plausibly exogenous variation, these measures of housing constraints do not affect the relative growth of house prices and house quantities across cities. Once again we 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 show robustness exercises that continue to show that income growth has the same effect on 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 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

[13]Since permits are quite volatile we calculate the cumulative growth in permits by summing all permits from 2020 to 2023 and comparing that to the sum of permits issued from 2016 to 2019 and then annualizing that growth rate.

relevant when demand is not increasing. 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.

One important question is if the results that we document are unique to the years 2000 to 2020. In Table IX 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 VIII 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 III 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 IX 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 be subject to some measurement error in this earlier sample.

Table X 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 IX, panel B shows that the less constrained cities actually had less population growth for a given level of income growth. So while the comovement of prices and quantities is in line with the supply-centric view, low growth in population and high growth in prices is happening in the less constrained cities—the opposite of what that 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). 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. Table A1 reports the results for house prices and Table A2 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 the 1980 to 2020 (Table A3 and Table A4) and 1980 to 2000 (Table A5 and Table A6) subsamples. None of these estimates show robust evidence that housing supply constraints matter as they should according to the supply-centric view.

Glaeser and Gyourko (2005) show that housing supply should be relatively inelastic as demand falls. In other words, 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 distribution of total income growth and re-run our baseline analysis. The price results are reported in Table XI and finds broadly the same results, although some interaction estimates now have the wrong sign. Table XII 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.

Finally, we check if our results are caused by cities of a certain size. While it would be unexpected 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. 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 (4) within each of these subsamples and report the interaction term.

Panels A and B of Table A8 show that our baseline finding that supply constraints do not matter for how income growth translates into house price growth holds 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 A9). Thus, we do not find evidence that measurement error in constraints for small cities is confounding our results.

## 4.5 Residual Importance 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 (1) and (2)). 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 a statistically significant level effect of supply constraints on house price growth holding fixed income growth. We now argue that this effect is quantitatively small and unlikely to reflect a causal effect from the supply elasticity on house price growth.

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 XIII 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 XIV 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.[14] This suggests that the house price effect

[14]We do see more evidence of a relationship with the change in rooms per person in this table, but this

captured by the supply elasticities is not actually due to restrictive supply. Furthermore when we estimate the regression using quartiles in Table A1, 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.

# 5 Conclusion

This paper revisits the standard view that housing supply constraints significantly influence local house price and quantity growth. We estimate how shifts in income growth and remote work exposure translate into changes in housing prices and quantities across U.S. cities with varying housing supply elasticities. Contrary to prevailing beliefs and influential policy narratives, our empirical results consistently demonstrate that higher income growth predicts similar growth in house prices, housing quantities, population, and living space per person across more and less housing constrained cities.

Through the lens of a standard demand-and-supply equilibrium housing model, in which we allow for arbitrary correlations of income growth with other housing demand or supply shocks, our estimates imply that differences in housing supply elasticities across U.S. cities are small and quantitatively not important for explaining differences in house price and quantity growth. Our findings challenge the consensus that relaxing regulatory constraints would substantially lower housing prices and meaningfully expand housing quantities. This research thus calls for a reevaluation of our understanding of housing supply, echoing the call by DiPasquale (1999) more than 25 years ago, and of policy prescriptions that hope to improve housing affordability primarily through the relaxation of housing regulations.

effect is not particularly robust as it is not present in our baseline results Table III.

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# Figures

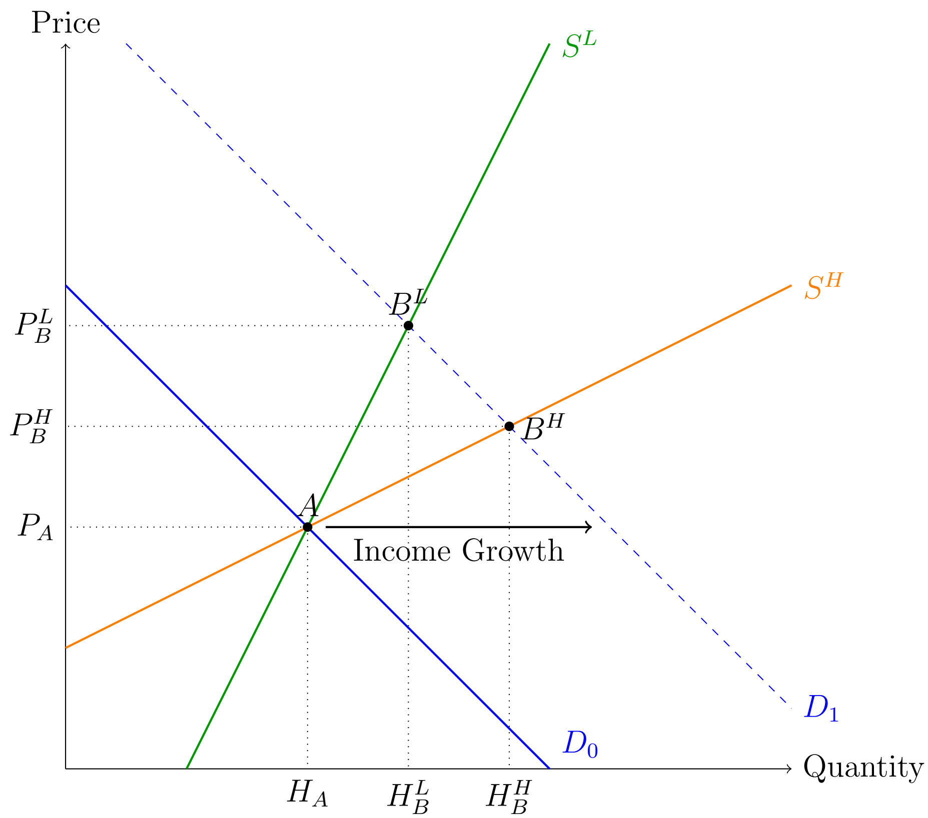



FIGURE I
The Differential Effect of Income Growth on House Prices and Quantities When Supply Elasticities Differ Across Cities

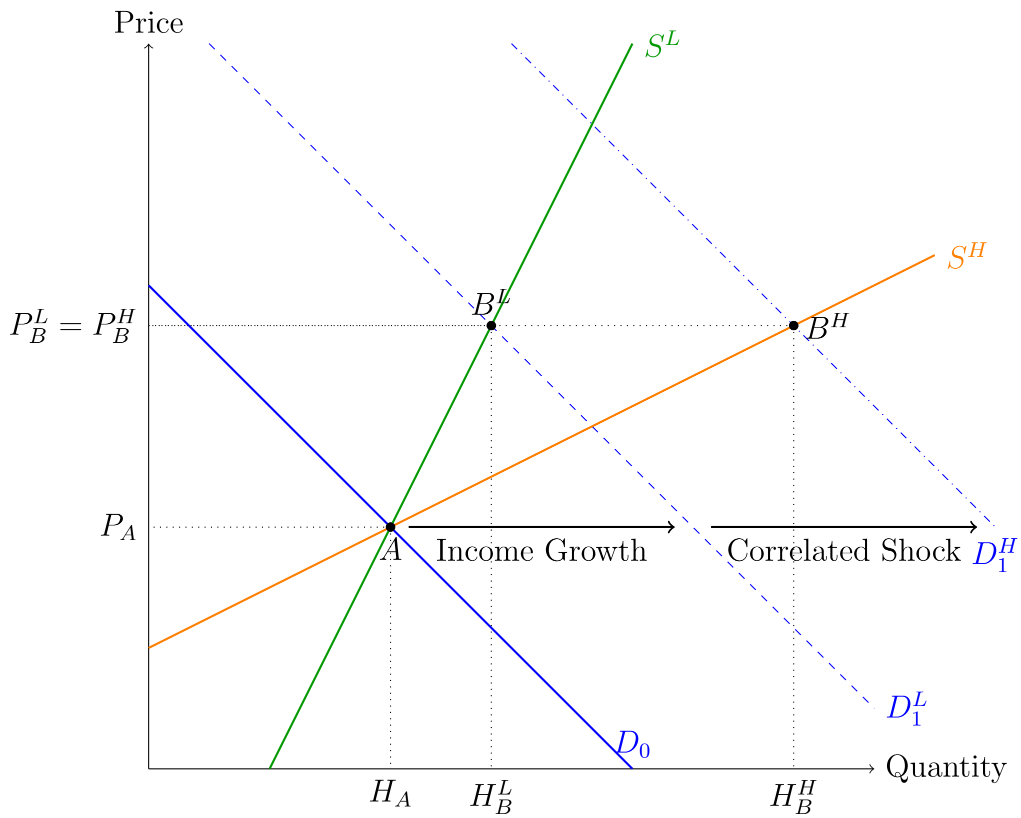



FIGURE II
The Differential Effect of Income Growth on House Prices and Quantities When Demand Shocks Are Positively Correlated With Income Growth in More Elastic Cities

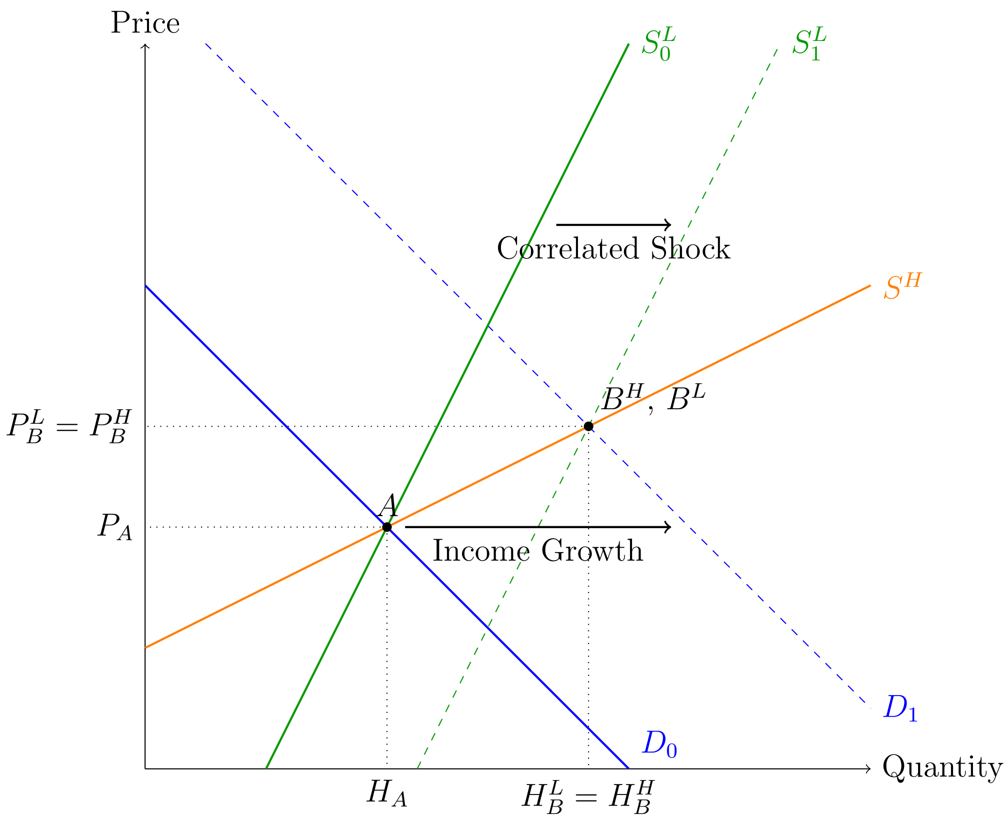
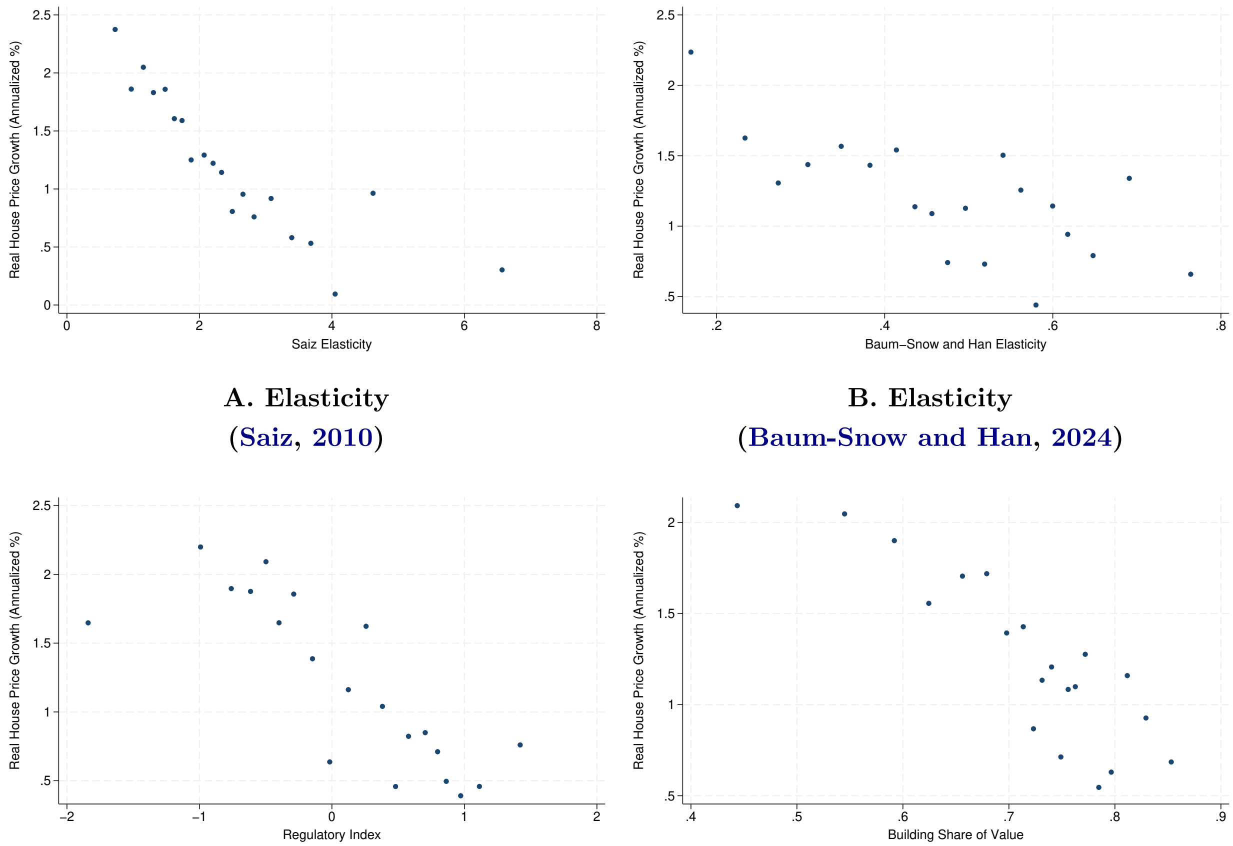



FIGURE III
The Differential Effect of Income Growth on House Prices and Quantities When Supply Shocks Are Positively Correlated With Income Growth in Less Elastic Cities




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

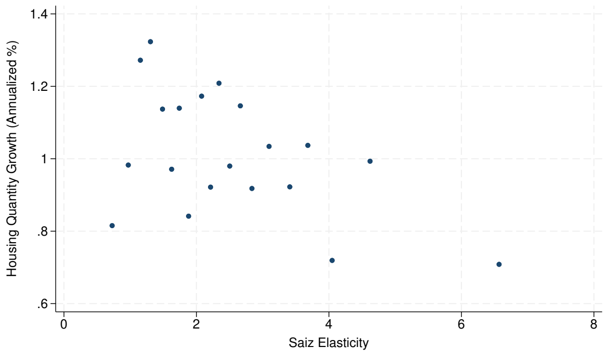
**B. Elasticity**
**(Baum-Snow and Han, 2024)**

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

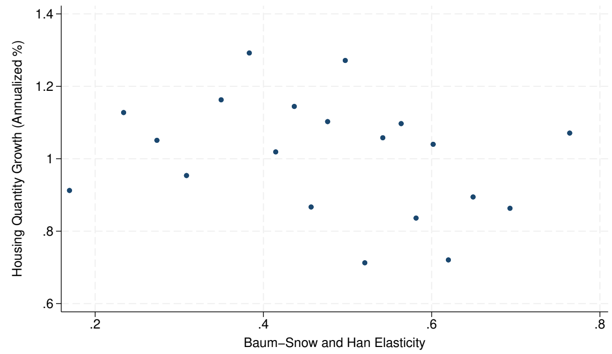
**D. Building Share of Value**
**(Davis et al., 2021)**

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

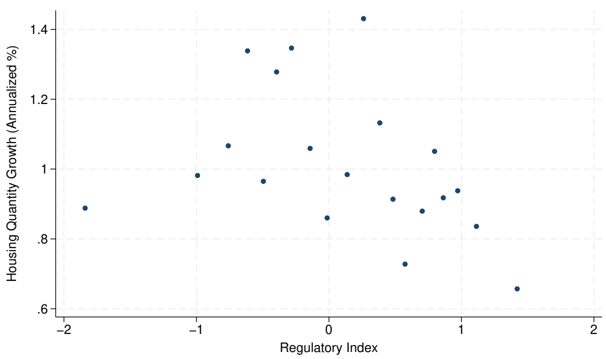
Note.—This figure splits MSAs into ventiles of each measure of housing constraints and then reports the mean growth in real house prices. We multiply the regulatory index by minus one so that regulations are becoming more relaxed as it increases. We calculate building share of value by subtracting the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



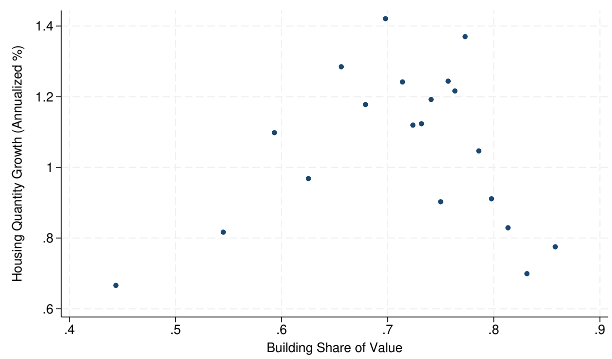

**A. Elasticity**
**(Saiz, 2010)**




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



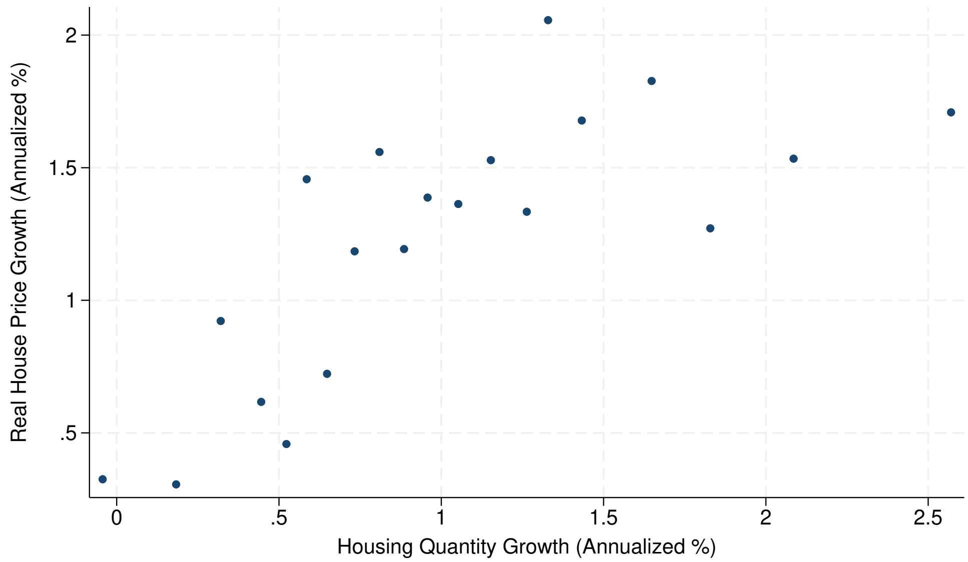

**C. Regulatory Index**
**(Gyourko et al., 2008)**




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

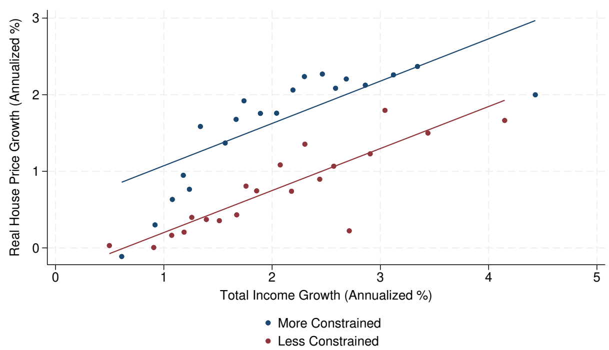
FIGURE V
Housing Quantity Growth and Housing Constraints (2000-2020)

NOTE.—This figure splits MSAs into ventiles of each measure of housing constraints and then reports the mean growth in real house prices. 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.

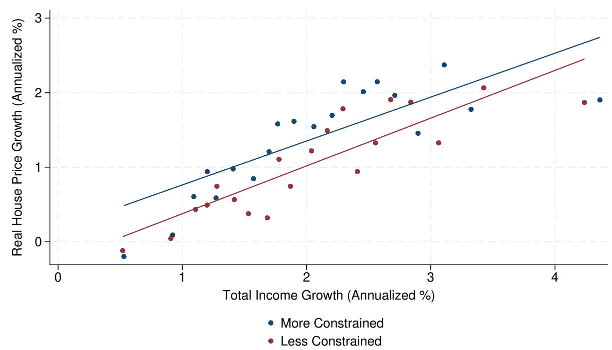



NOTE.—This figure splits MSAs into ventiles of house quantity growth and then reports the mean growth of real house prices within each bin.

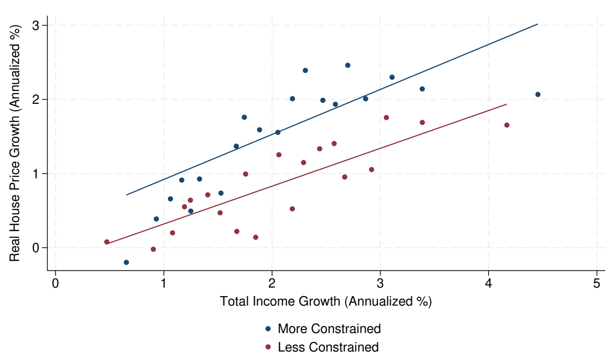
FIGURE VI
House Price and Quantity Growth (2000-2020)



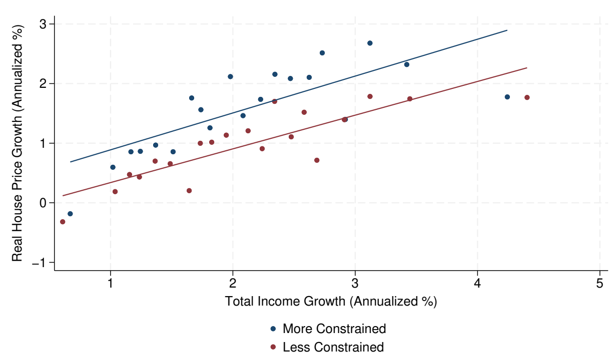

**A. Elasticity**
**(Saiz, 2010)**




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




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

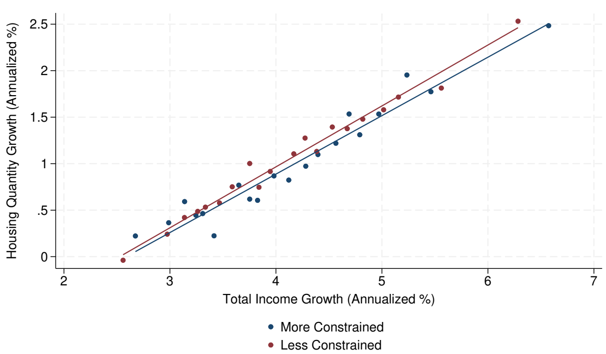



**D. Land Share of Value**
**(Davis et al., 2021)**

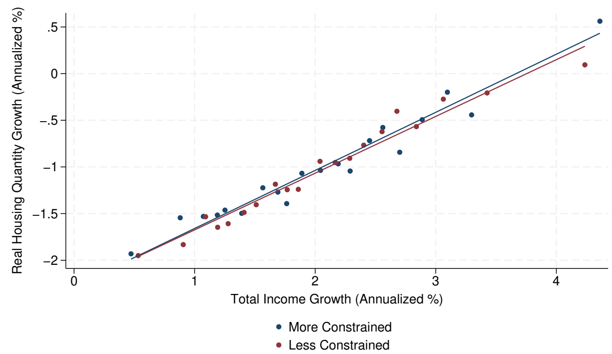
FIGURE VII

House Price and Income Growth

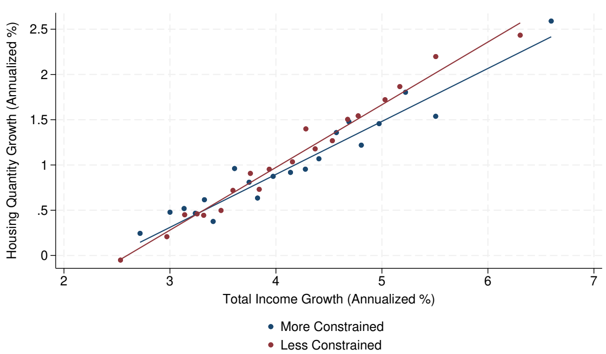
NOTE.—This figure splits MSAs into groups above and below the relevant measure of local housing markets and then reports the mean growth of real house prices and total income for ventiles of each group. The lines give the linear fit within each group.



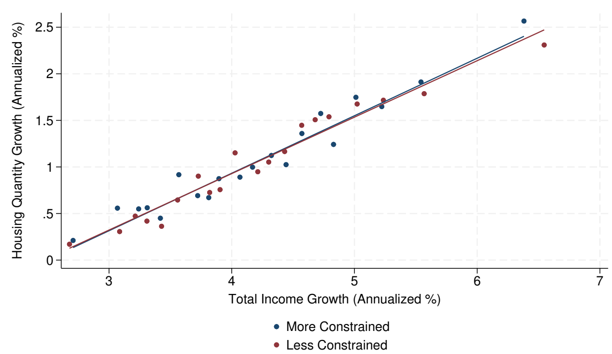

**A. Elasticity**
**(Saiz, 2010)**




**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.

# Tables

TABLE I

Summary Statistics

| | Observations | Mean | SD | 25th Pct | 50th Pct | 75th Pct |
|---|---|---|---|---|---|---|
| *Panel A. 2000-2020* | | | | | | |
| Real House Price Growth (Annualized %) | 321 | 1.22 | 1.05 | 0.47 | 1.21 | 1.97 |
| Real Median House Value Growth (Annualized %) | 321 | 1.44 | 1.00 | 0.77 | 1.36 | 2.22 |
| Real Total Income Growth (Annualized %) | 323 | 4.18 | 0.93 | 3.45 | 4.09 | 4.76 |
| 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 | 0.70 | 1.26 |
| Change in Average Rooms per Person | 321 | 0.47 | 0.20 | 0.33 | 0.47 | 0.59 |
| *Panel B. 1980-2020* | | | | | | |
| Real House Price Growth (Annualized %) | 321 | 0.99 | 0.87 | 0.40 | 0.92 | 1.51 |
| Real Median House Value Growth (Annualized %) | 321 | 1.13 | 0.67 | 0.66 | 1.08 | 1.57 |
| Real Total Income Growth (Annualized %) | 323 | 5.41 | 1.01 | 4.73 | 5.33 | 6.00 |
| House Quantity Growth (Annualized %) | 322 | 1.26 | 0.75 | 0.72 | 1.18 | 1.67 |
| Population Growth (Annualized %) | 323 | 0.97 | 0.85 | 0.35 | 0.94 | 1.49 |
| Change in Average Rooms per Person | 163 | 0.87 | 0.25 | 0.68 | 0.87 | 1.04 |
| *Panel C. 1980-2000* | | | | | | |
| Real House Price Growth (Annualized %) | 321 | 0.77 | 1.26 | -0.13 | 0.62 | 1.44 |
| Real Median House Value Growth (Annualized %) | 323 | 0.81 | 0.89 | 0.26 | 0.79 | 1.27 |
| Real Total Income Growth (Annualized %) | 323 | 6.65 | 1.32 | 5.72 | 6.61 | 7.44 |
| 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 | 0.43 | 0.12 | 0.36 | 0.44 | 0.51 |

*Notes*: This table reports summary statistics for key variables in the analysis for three distinct samples. See the text for more details.

TABLE II

# House Price Growth (2000-2020)

| | (1) Saiz | (2) BS-H | (3) WRLURI | (4) Building |
|---|---|---|---|---|
| *Panel A. Real House Price Growth (Annualized %)* | | | | |
| Less Constrained × Income Growth | -0.038 | 0.070 | -0.053 | -0.043 |
| | (0.122) | (0.111) | (0.118) | (0.116) |
| Income Growth | 0.581*** | 0.591*** | 0.591*** | 0.630*** |
| | (0.104) | (0.080) | (0.093) | (0.089) |
| Less Constrained | -0.759*** | -0.498** | -0.580** | -0.501* |
| | (0.273) | (0.240) | (0.262) | (0.257) |
| R2 | 0.47 | 0.35 | 0.42 | 0.37 |
| Number of Observations | 268 | 308 | 268 | 306 |
| *Panel B. Real Median House Value Growth (Annualized %)* | | | | |
| Less Constrained × Income Growth | 0.044 | -0.090 | -0.102 | 0.066 |
| | (0.122) | (0.118) | (0.122) | (0.123) |
| Income Growth | 0.580*** | 0.713*** | 0.664*** | 0.601*** |
| | (0.106) | (0.094) | (0.101) | (0.098) |
| Less Constrained | -0.673** | -0.108 | -0.201 | -0.499* |
| | (0.260) | (0.247) | (0.263) | (0.264) |
| R2 | 0.47 | 0.41 | 0.43 | 0.38 |
| 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 III
## House Quantity Growth (2000-2020)

| | (1) Saiz | (2) BS-H | (3) WRLURI | (4) Building |
|---|---|---|---|---|
| *Panel A. Housing Quantities Growth (Annualized %)* | | | | |
| Less Constrained × Income Growth | 0.015 | -0.029 | 0.100** | -0.023 |
| | (0.048) | (0.050) | (0.050) | (0.053) |
| Income Growth | 0.649*** | 0.642*** | 0.604*** | 0.636*** |
| | (0.034) | (0.030) | (0.034) | (0.033) |
| Less Constrained | 0.044 | 0.028 | -0.118 | 0.042 |
| | (0.092) | (0.095) | (0.096) | (0.102) |
| 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 | -0.007 | -0.011 | 0.083 | -0.004 |
| | (0.054) | (0.054) | (0.055) | (0.057) |
| Income Growth | 0.760*** | 0.721*** | 0.712*** | 0.712*** |
| | (0.043) | (0.034) | (0.038) | (0.039) |
| Less Constrained | 0.037 | -0.067 | -0.131 | -0.016 |
| | (0.108) | (0.103) | (0.107) | (0.111) |
| 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 | 0.019 | 0.027 | 0.022 | -0.003 |
| | (0.024) | (0.022) | (0.023) | (0.023) |
| Income Growth | -0.060*** | -0.060*** | -0.058*** | -0.042*** |
| | (0.016) | (0.016) | (0.016) | (0.016) |
| Less Constrained | 0.042 | 0.027 | 0.066 | 0.075 |
| | (0.052) | (0.048) | (0.050) | (0.049) |
| R2 | 0.11 | 0.10 | 0.15 | 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 IV

## 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 | 1.117*** | 1.087*** | 1.023*** | 1.009*** |
| | (0.204) | (0.170) | (0.191) | (0.165) |
| Less Constrained × Price Growth | 1.220*** | 0.924*** | 1.308*** | 1.039*** |
| | (0.169) | (0.122) | (0.177) | (0.153) |
| Less Constrained | 0.933** | 0.519* | 0.555 | 0.566* |
| | (0.380) | (0.274) | (0.355) | (0.301) |
| Chi-Squared Test P-value | 0.70 | 0.43 | 0.27 | 0.89 |
| CD F-stat | 54.04 | 58.23 | 53.82 | 63.99 |
| Number of Observations | 268 | 308 | 268 | 306 |
| *Panel B. Real Median Home Value Growth (Annualized %)* | | | | |
| More Constrained × Price Growth | 1.119*** | 0.901*** | 0.913*** | 1.060*** |
| | (0.205) | (0.128) | (0.155) | (0.184) |
| Less Constrained × Price Growth | 1.058*** | 0.979*** | 1.245*** | 0.919*** |
| | (0.112) | (0.144) | (0.143) | (0.131) |
| Less Constrained | 0.798** | 0.138 | 0.066 | 0.559 |
| | (0.387) | (0.272) | (0.321) | (0.351) |
| Chi-Squared Test P-value | 0.79 | 0.69 | 0.11 | 0.53 |
| CD F-stat | 53.50 | 81.89 | 59.25 | 53.36 |
| 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 V

## 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) | (0.336) |
| 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 | 0.903** | 0.032 | 0.077 | 0.553 |
| | (0.432) | (0.288) | (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 VI

## Effect of Work from Home Shock (2019-2023)

| | Saiz | | BS-H | | WRLURI | | Building | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| *Panel A. Real Total Income Growth (Annualized %)* | | | | | | | | |
| High WFH × Less Constrained | | -0.368 | | 0.606** | | 1.102*** | | 0.253 |
| | | (0.271) | | (0.279) | | (0.297) | | (0.289) |
| High WFH | 0.959*** | 1.203*** | 0.855*** | 0.643*** | 0.959*** | 0.529*** | 0.828*** | 0.730*** |
| | (0.137) | (0.187) | (0.128) | (0.172) | (0.137) | (0.199) | (0.127) | (0.171) |
| Less Constrained | | 0.314* | | -0.051 | | -0.214 | | -0.060 |
| | | (0.164) | | (0.166) | | (0.187) | | (0.160) |
| R2 | 0.15 | 0.16 | 0.12 | 0.15 | 0.15 | 0.21 | 0.12 | 0.12 |
| Number of Observations | 269 | 269 | 310 | 310 | 269 | 269 | 308 | 308 |
| *Panel B. Real House Price Growth (Annualized %)* | | | | | | | | |
| High WFH × Less Constrained | | -0.085 | | 0.682 | | 1.237** | | 0.328 |
| | | (0.552) | | (0.500) | | (0.545) | | (0.568) |
| High WFH | 0.792*** | 0.656 | 0.958*** | 0.819** | 0.792*** | 0.141 | 1.042*** | 0.814** |
| | (0.267) | (0.429) | (0.250) | (0.325) | (0.267) | (0.379) | (0.254) | (0.403) |
| Less Constrained | | -0.379 | | 0.206 | | -0.667* | | -0.300 |
| | | (0.394) | | (0.329) | | (0.353) | | (0.392) |
| R2 | 0.03 | 0.04 | 0.05 | 0.06 | 0.03 | 0.05 | 0.05 | 0.05 |
| Number of Observations | 268 | 268 | 308 | 308 | 268 | 268 | 306 | 306 |
| *Panel C. Cumulative Permit Growth (Annualized %)* | | | | | | | | |
| High WFH × Less Constrained | | 0.489 | | 1.869 | | -0.805 | | 2.681 |
| | | (1.622) | | (1.755) | | (1.514) | | (1.811) |
| High WFH | 3.668*** | 4.011*** | 2.856*** | 2.883*** | 3.668*** | 4.755*** | 3.181*** | 2.991** |
| | (0.860) | (1.063) | (0.863) | (1.030) | (0.860) | (1.077) | (0.866) | (1.214) |
| Less Constrained | | 1.187 | | 1.594 | | 2.168** | | 1.321 |
| | | (1.114) | | (1.218) | | (1.087) | | (1.304) |
| R2 | 0.07 | 0.08 | 0.04 | 0.06 | 0.07 | 0.08 | 0.04 | 0.08 |
| Number of Observations | 257 | 257 | 299 | 299 | 257 | 257 | 296 | 296 |

This table reports estimates of total income growth (panel A), house price growth (panel B), and permit growth (panel B) regressed on an indicator for above median exposure to WFH, an indicator for being less constrained (above median), and the interaction of the two indicators. 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

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 | -0.067 | 0.085 | -0.039 | -0.088 |
| | (0.090) | (0.088) | (0.087) | (0.091) |
| Income Growth | 0.193*** | 0.203*** | 0.194*** | 0.250*** |
| | (0.071) | (0.065) | (0.067) | (0.069) |
| Less Constrained | -0.478* | -0.536** | -0.492** | -0.275 |
| | (0.251) | (0.232) | (0.237) | (0.251) |
| R2 | 0.22 | 0.13 | 0.20 | 0.17 |
| Number of Observations | 268 | 308 | 268 | 306 |
| *Panel B. Real Median House Value Growth (Annualized %)* | | | | |
| Less Constrained × Income Growth | 0.082 | 0.107 | 0.075 | -0.012 |
| | (0.072) | (0.074) | (0.076) | (0.075) |
| Income Growth | 0.264*** | 0.290*** | 0.270*** | 0.305*** |
| | (0.062) | (0.060) | (0.064) | (0.062) |
| Less Constrained | -0.672*** | -0.513*** | -0.576*** | -0.382* |
| | (0.197) | (0.193) | (0.201) | (0.207) |
| R2 | 0.41 | 0.33 | 0.37 | 0.35 |
| Number of Observations | 267 | 309 | 267 | 307 |

This table reports estimates of house price growth (panel A) and medan 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 VIII
# House Quantity Growth (1980-2020)

| | (1) Saiz | (2) BS-H | (3) WRLURI | (4) Building |
|---|---|---|---|---|
| *Panel A. Housing Quantities Growth (Annualized %)* | | | | |
| Less Constrained × Income Growth | -0.001 | 0.015 | 0.025 | 0.052 |
| | (0.036) | (0.037) | (0.040) | (0.039) |
| Income Growth | 0.730*** | 0.713*** | 0.715*** | 0.705*** |
| | (0.031) | (0.030) | (0.029) | (0.026) |
| Less Constrained | 0.146* | 0.098 | 0.078 | 0.009 |
| | (0.084) | (0.086) | (0.090) | (0.094) |
| $R2$ | 0.88 | 0.87 | 0.88 | 0.86 |
| Number of Observations | 268 | 309 | 268 | 307 |
| *Panel B. Population Growth (Annualized %)* | | | | |
| Less Constrained × Income Growth | -0.031 | -0.034 | -0.003 | 0.076* |
| | (0.041) | (0.040) | (0.045) | (0.042) |
| Income Growth | 0.849*** | 0.840*** | 0.831*** | 0.796*** |
| | (0.035) | (0.033) | (0.034) | (0.027) |
| Less Constrained | 0.134 | 0.085 | 0.024 | -0.108 |
| | (0.098) | (0.094) | (0.105) | (0.100) |
| 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 | -0.014 | 0.050 | -0.015 | -0.014 |
| | (0.040) | (0.037) | (0.036) | (0.039) |
| Income Growth | -0.093*** | -0.132*** | -0.082*** | -0.110*** |
| | (0.025) | (0.023) | (0.028) | (0.025) |
| Less Constrained | 0.128 | -0.064 | 0.191* | 0.082 |
| | (0.100) | (0.091) | (0.097) | (0.099) |
| R2 | 0.21 | 0.21 | 0.27 | 0.20 |
| 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 IX
## 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 | -0.015 | 0.042 | -0.075 | -0.105 |
| | (0.115) | (0.115) | (0.113) | (0.115) |
| Income Growth | -0.006 | 0.056 | 0.033 | 0.106 |
| | (0.086) | (0.092) | (0.091) | (0.086) |
| Less Constrained | -0.446 | -0.487 | -0.266 | -0.170 |
| | (0.385) | (0.362) | (0.377) | (0.375) |
| R2 | 0.04 | 0.03 | 0.04 | 0.05 |
| Number of Observations | 268 | 308 | 268 | 306 |
| *Panel B. Real Median House Value Growth (Annualized %)* | | | | |
| Less Constrained × Income Growth | 0.221*** | 0.232*** | 0.144 | 0.088 |
| | (0.084) | (0.083) | (0.089) | (0.091) |
| Income Growth | 0.139** | 0.159** | 0.164** | 0.184*** |
| | (0.060) | (0.063) | (0.064) | (0.060) |
| Less Constrained | -0.969*** | -0.886*** | -0.741*** | -0.754*** |
| | (0.265) | (0.260) | (0.274) | (0.285) |
| R2 | 0.22 | 0.21 | 0.21 | 0.23 |
| Number of Observations | 269 | 310 | 269 | 308 |

This table reports estimates of house price growth (panel A) and medan 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 X

## House Quantity Growth (1980-2000)

| | (1) Saiz | (2) BS-H | (3) WRLURI | (4) Building |
|---|---|---|---|---|
| *Panel A. Housing Quantities Growth (Annualized %)* | | | | |
| Less Constrained × Income Growth | -0.071 | -0.005 | 0.019 | 0.053 |
| | (0.045) | (0.048) | (0.051) | (0.049) |
| Income Growth | 0.701*** | 0.661*** | 0.656*** | 0.646*** |
| | (0.036) | (0.040) | (0.037) | (0.033) |
| Less Constrained | 0.351*** | 0.268** | 0.067 | 0.076 |
| | (0.128) | (0.136) | (0.143) | (0.143) |
| R2 | 0.80 | 0.77 | 0.79 | 0.76 |
| Number of Observations | 268 | 309 | 268 | 307 |
| *Panel B. Population Growth (Annualized %)* | | | | |
| Less Constrained × Income Growth | -0.118*** | -0.093** | 0.010 | 0.041 |
| | (0.045) | (0.045) | (0.053) | (0.052) |
| Income Growth | 0.803*** | 0.783*** | 0.735*** | 0.734*** |
| | (0.035) | (0.037) | (0.037) | (0.032) |
| Less Constrained | 0.349** | 0.292** | -0.126 | 0.002 |
| | (0.142) | (0.139) | (0.166) | (0.156) |
| R2 | 0.81 | 0.78 | 0.80 | 0.77 |
| Number of Observations | 269 | 310 | 269 | 308 |
| *Panel C. Change in Average Rooms per Person* | | | | |
| Less Constrained × Income Growth | -0.010 | 0.011 | -0.022 | 0.001 |
| | (0.021) | (0.017) | (0.018) | (0.017) |
| Income Growth | -0.025** | -0.037*** | -0.019 | -0.034*** |
| | (0.010) | (0.011) | (0.012) | (0.012) |
| Less Constrained | 0.059 | -0.042 | 0.099* | -0.016 |
| | (0.060) | (0.052) | (0.056) | (0.055) |
| R2 | 0.11 | 0.09 | 0.12 | 0.09 |
| 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 XI

## 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) | (0.360) | (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*** | -0.500 | -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 medan 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 XII

## 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) | (0.158) |
| 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 | 0.043 | 0.048 | 0.006 |
| | (0.034) | (0.030) | (0.032) | (0.031) |
| Income Growth | -0.046** | -0.051** | -0.055** | -0.031 |
| | (0.021) | (0.021) | (0.022) | (0.022) |
| Less Constrained | -0.007 | -0.023 | -0.010 | 0.042 |
| | (0.084) | (0.075) | (0.080) | (0.076) |
| R2 | 0.06 | 0.06 | 0.10 | 0.03 |
| 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 XIII

## Implied 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 | -0.262*** | -1.729*** | -0.470*** | -3.875*** |
| | (0.064) | (0.294) | (0.060) | (0.452) |
| Income Growth | 0.544*** | 0.624*** | 0.549*** | 0.610*** |
| | (0.057) | (0.055) | (0.054) | (0.057) |
| Share of SF-Houston Gap | 0.0724 | 0.0157 | 0.0882 | 0.1813 |
| R2 | 0.44 | 0.39 | 0.45 | 0.43 |
| Number of Observations | 268 | 308 | 268 | 306 |
| *Panel B. Real Median House Value Growth (Annualized %)* | | | | |
| Elasticity Measure | -0.170*** | -1.438*** | -0.344*** | -2.407*** |
| | (0.046) | (0.315) | (0.055) | (0.633) |
| Income Growth | 0.593*** | 0.658*** | 0.590*** | 0.636*** |
| | (0.059) | (0.056) | (0.056) | (0.062) |
| Share of SF-Houston Gap | 0.1428 | 0.0391 | 0.1963 | 0.3516 |
| R2 | 0.44 | 0.44 | 0.46 | 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 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 XIV

## Implied 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 | 0.021 | -0.019 | 0.057*** | 0.479*** |
| | (0.014) | (0.122) | (0.021) | (0.180) |
| Income Growth | 0.657*** | 0.627*** | 0.660*** | 0.626*** |
| | (0.024) | (0.027) | (0.024) | (0.028) |
| Share of SF-Houston Gap | 0.0002 | -0.0000 | 0.0003 | 0.0007 |
| R2 | 0.79 | 0.77 | 0.80 | 0.77 |
| Number of Observations | 269 | 310 | 269 | 308 |
| *Panel B. Population Growth (Annualized %)* | | | | |
| Elasticity Measure | 0.007 | -0.241* | 0.031 | 0.409** |
| | (0.015) | (0.130) | (0.026) | (0.198) |
| Income Growth | 0.756*** | 0.716*** | 0.760*** | 0.713*** |
| | (0.027) | (0.027) | (0.027) | (0.029) |
| 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 | 0.017 | 0.339*** | 0.051*** | 0.514*** |
| | (0.011) | (0.072) | (0.018) | (0.104) |
| Income Growth | -0.051*** | -0.044*** | -0.048*** | -0.044*** |
| | (0.012) | (0.011) | (0.012) | (0.011) |
| Share of SF-Houston Gap | 0.0966 | 0.0612 | 0.1994 | 0.5286 |
| R2 | 0.08 | 0.13 | 0.11 | 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 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.

# Appendix

# Appendix Tables

TABLE A1

## House Price Growth (2000-2020): Quartiles

| | (1) Saiz | (2) BS-H | (3) WRLURI | (4) Building |
|---|---|---|---|---|
| *Panel A. Real House Price Growth (Annualized %)* | | | | |
| Qtl 2 Constraint | -0.549 | -0.514 | -0.757** | -0.628 |
| | (0.468) | (0.347) | (0.376) | (0.393) |
| Qtl 3 Constraint | -1.028*** | -0.887** | -1.091*** | -0.861** |
| | (0.379) | (0.351) | (0.354) | (0.406) |
| Qtl 4 Constraint | -1.161*** | -0.630* | -0.964*** | -0.714* |
| | (0.389) | (0.378) | (0.358) | (0.374) |
| Qtl 2 Constraint × Income Growth | 0.032 | 0.018 | 0.106 | 0.027 |
| | (0.205) | (0.162) | (0.165) | (0.183) |
| Qtl 3 Constraint × Income Growth | 0.047 | 0.165 | 0.128 | -0.001 |
| | (0.162) | (0.166) | (0.166) | (0.179) |
| Qtl 4 Constraint × Income Growth | -0.050 | 0.000 | -0.092 | -0.092 |
| | (0.169) | (0.173) | (0.162) | (0.172) |
| Income Growth | 0.528*** | 0.579*** | 0.500*** | 0.624*** |
| | (0.138) | (0.131) | (0.127) | (0.139) |
| R2 | 0.51 | 0.38 | 0.47 | 0.41 |
| Number of Observations | 268 | 308 | 268 | 306 |
| *Panel B. Real Median Home Value Growth (Annualized %)* | | | | |
| Qtl 2 Constraint | -0.409 | -0.523 | -0.728* | -0.501 |
| | (0.479) | (0.420) | (0.404) | (0.440) |
| Qtl 3 Constraint | -1.069** | -0.636 | -0.652* | -0.516 |
| | (0.425) | (0.400) | (0.385) | (0.426) |
| Qtl 4 Constraint | -0.797* | -0.131 | -0.622* | -0.926** |
| | (0.420) | (0.396) | (0.353) | (0.394) |
| Qtl 2 Constraint × Income Growth | -0.014 | 0.038 | 0.068 | 0.070 |
| | (0.216) | (0.195) | (0.181) | (0.197) |
| Qtl 3 Constraint × Income Growth | 0.140 | 0.087 | 0.025 | 0.011 |
| | (0.181) | (0.186) | (0.180) | (0.185) |
| Qtl 4 Constraint × Income Growth | -0.019 | -0.215 | -0.116 | 0.181 |
| | (0.183) | (0.184) | (0.168) | (0.178) |
| Income Growth | 0.558*** | 0.691*** | 0.595*** | 0.573*** |
| | (0.162) | (0.164) | (0.142) | (0.154) |
| 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 A2

# House Quantity Growth (2000-2020): Quartiles

| | (1) Saiz | (2) BS-H | (3) WRLURI | (4) Building |
|---|---|---|---|---|
| *Panel A. Housing Quantity Growth (Annualized %)* | | | | |
| Qtl 2 Constraint | -0.021 | -0.011 | -0.050 | -0.131 |
| | (0.148) | (0.119) | (0.158) | (0.124) |
| Qtl 3 Constraint | 0.009 | 0.083 | -0.177 | 0.095 |
| | (0.135) | (0.150) | (0.173) | (0.113) |
| Qtl 4 Constraint | 0.098 | -0.043 | -0.171 | -0.072 |
| | (0.110) | (0.110) | (0.154) | (0.164) |
| Qtl 2 Constraint × Income Growth | 0.046 | 0.027 | 0.071 | 0.164*** |
| | (0.074) | (0.060) | (0.075) | (0.059) |
| Qtl 3 Constraint × Income Growth | 0.057 | -0.023 | 0.152* | 0.025 |
| | (0.066) | (0.080) | (0.089) | (0.054) |
| Qtl 4 Constraint × Income Growth | -0.004 | -0.006 | 0.142* | 0.066 |
| | (0.053) | (0.056) | (0.075) | (0.094) |
| Income Growth | 0.634*** | 0.628*** | 0.558*** | 0.560*** |
| | (0.040) | (0.038) | (0.066) | (0.039) |
| R2 | 0.80 | 0.78 | 0.80 | 0.79 |
| Number of Observations | 269 | 310 | 269 | 308 |
| *Panel B. Population Growth (Annualized %)* | | | | |
| Qtl 2 Constraint | -0.125 | -0.091 | -0.062 | -0.192 |
| | (0.179) | (0.134) | (0.172) | (0.145) |
| Qtl 3 Constraint | -0.093 | -0.076 | -0.208 | -0.012 |
| | (0.147) | (0.159) | (0.175) | (0.118) |
| Qtl 4 Constraint | 0.079 | -0.158 | -0.157 | -0.126 |
| | (0.137) | (0.118) | (0.165) | (0.168) |
| Qtl 2 Constraint × Income Growth | 0.103 | 0.042 | 0.056 | 0.199*** |
| | (0.089) | (0.068) | (0.081) | (0.070) |
| Qtl 3 Constraint × Income Growth | 0.082 | 0.012 | 0.133 | 0.072 |
| | (0.070) | (0.085) | (0.089) | (0.056) |
| Qtl 4 Constraint × Income Growth | -0.022 | 0.011 | 0.104 | 0.080 |
| | (0.066) | (0.058) | (0.081) | (0.094) |
| Income Growth | 0.718*** | 0.699*** | 0.676*** | 0.621*** |
| | (0.052) | (0.042) | (0.065) | (0.043) |
| 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 | 0.109 | 0.183*** | 0.166** | 0.017 |
| | (0.067) | (0.064) | (0.074) | (0.067) |
| Qtl 3 Constraint | 0.161** | 0.158** | 0.206*** | 0.129* |
| | (0.076) | (0.067) | (0.079) | (0.071) |
| Qtl 4 Constraint | 0.072 | 0.087 | 0.134* | 0.015 |
| | (0.082) | (0.077) | (0.073) | (0.069) |
| Qtl 2 Constraint × Income Growth | -0.005 | -0.049 | -0.051 | 0.033 |
| | (0.029) | (0.031) | (0.034) | (0.030) |
| Qtl 3 Constraint × Income Growth | -0.013 | -0.005 | -0.031 | -0.018 |
| | (0.034) | (0.031) | (0.036) | (0.030) |
| Qtl 4 Constraint × Income Growth | 0.031 | 0.006 | 0.008 | 0.064** |
| | (0.037) | (0.035) | (0.034) | (0.032) |
| Income Growth | -0.050** | -0.034 | -0.023 | -0.058** |
| | (0.025) | (0.025) | (0.027) | (0.023) |
| R2 | 0.15 | 0.14 | 0.17 | 0.13 |
| 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 A3

## 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 | -0.520 | -0.679* | -0.773** | -0.802* |
| | (0.434) | (0.390) | (0.391) | (0.411) |
| Qtl 3 Constraint | -0.703* | -1.152*** | -0.949** | -0.599 |
| | (0.388) | (0.402) | (0.396) | (0.416) |
| Qtl 4 Constraint | -1.097*** | -0.859** | -0.962** | -0.597 |
| | (0.377) | (0.402) | (0.421) | (0.439) |
| Qtl 2 Constraint × Income Growth | 0.025 | 0.080 | 0.092 | 0.018 |
| | (0.141) | (0.138) | (0.136) | (0.144) |
| Qtl 3 Constraint × Income Growth | -0.017 | 0.249* | 0.080 | -0.062 |
| | (0.128) | (0.144) | (0.139) | (0.144) |
| Qtl 4 Constraint × Income Growth | 0.002 | 0.099 | -0.024 | -0.179 |
| | (0.134) | (0.148) | (0.154) | (0.160) |
| Income Growth | 0.117 | 0.120 | 0.102 | 0.228* |
| | (0.105) | (0.123) | (0.120) | (0.124) |
| R2 | 0.29 | 0.17 | 0.26 | 0.27 |
| Number of Observations | 268 | 308 | 268 | 306 |
| *Panel B. Real Median Home Value Growth (Annualized %)* | | | | |
| Qtl 2 Constraint | -0.624* | -0.622* | -0.447 | -0.675* |
| | (0.376) | (0.332) | (0.341) | (0.372) |
| Qtl 3 Constraint | -0.931** | -1.178*** | -0.683** | -0.628* |
| | (0.361) | (0.308) | (0.327) | (0.380) |
| Qtl 4 Constraint | -1.141*** | -0.728** | -1.074*** | -0.806** |
| | (0.357) | (0.298) | (0.322) | (0.373) |
| Qtl 2 Constraint × Income Growth | 0.077 | 0.083 | 0.024 | 0.079 |
| | (0.124) | (0.117) | (0.122) | (0.128) |
| Qtl 3 Constraint × Income Growth | 0.126 | 0.296*** | 0.071 | 0.007 |
| | (0.118) | (0.109) | (0.117) | (0.132) |
| Qtl 4 Constraint × Income Growth | 0.149 | 0.098 | 0.164 | 0.043 |
| | (0.123) | (0.110) | (0.119) | (0.136) |
| Income Growth | 0.189* | 0.211** | 0.231** | 0.255** |
| | (0.107) | (0.095) | (0.103) | (0.117) |
| 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 A4

## House Quantity Growth (1980-2020): Quartiles

| | (1) Saiz | (2) BS-H | (3) WRLURI | (4) Building |
|---|---|---|---|---|
| *Panel A. Housing Quantity Growth (Annualized %)* | | | | |
| Qtl 2 Constraint | 0.130 | 0.321* | 0.354** | -0.031 |
| | (0.163) | (0.166) | (0.162) | (0.120) |
| Qtl 3 Constraint | 0.252* | 0.340** | 0.348** | 0.126 |
| | (0.143) | (0.160) | (0.164) | (0.135) |
| Qtl 4 Constraint | 0.283* | 0.291* | 0.257 | -0.136 |
| | (0.151) | (0.170) | (0.158) | (0.135) |
| Qtl 2 Constraint × Income Growth | 0.018 | -0.038 | -0.084 | 0.110** |
| | (0.064) | (0.065) | (0.064) | (0.045) |
| Qtl 3 Constraint × Income Growth | -0.003 | -0.031 | -0.055 | 0.058 |
| | (0.053) | (0.064) | (0.066) | (0.054) |
| Qtl 4 Constraint × Income Growth | -0.028 | -0.018 | -0.008 | 0.166*** |
| | (0.062) | (0.069) | (0.064) | (0.058) |
| Income Growth | 0.740*** | 0.752*** | 0.779*** | 0.654*** |
| | (0.050) | (0.059) | (0.054) | (0.040) |
| R2 | 0.89 | 0.88 | 0.89 | 0.89 |
| Number of Observations | 268 | 309 | 268 | 307 |

| | (1) Saiz | (2) BS-H | (3) WRLURI | (4) Building |
|---|---|---|---|---|
| *Panel B. Population Growth (Annualized %)* | | | | |
| Qtl 2 Constraint | 0.051 | 0.309* | 0.197 | -0.058 |
| | (0.183) | (0.164) | (0.168) | (0.118) |
| Qtl 3 Constraint | 0.103 | 0.297** | 0.153 | 0.077 |
| | (0.163) | (0.146) | (0.165) | (0.135) |
| Qtl 4 Constraint | 0.300* | 0.271* | 0.167 | -0.300** |
| | (0.171) | (0.152) | (0.154) | (0.129) |
| Qtl 2 Constraint × Income Growth | 0.027 | -0.065 | -0.063 | 0.109** |
| | (0.072) | (0.067) | (0.066) | (0.045) |
| Qtl 3 Constraint × Income Growth | 0.005 | -0.078 | -0.043 | 0.063 |
| | (0.061) | (0.061) | (0.067) | (0.053) |
| Qtl 4 Constraint × Income Growth | -0.080 | -0.085 | -0.053 | 0.189*** |
| | (0.069) | (0.062) | (0.063) | (0.057) |
| Income Growth | 0.849*** | 0.889*** | 0.875*** | 0.745*** |
| | (0.057) | (0.052) | (0.051) | (0.035) |
| R2 | 0.90 | 0.90 | 0.90 | 0.91 |
| Number of Observations | 269 | 310 | 269 | 308 |

| | (1) Saiz | (2) BS-H | (3) WRLURI | (4) Building |
|---|---|---|---|---|
| *Panel C. Change in Average Rooms per Person* | | | | |
| Qtl 2 Constraint | -0.040 | 0.089 | 0.347** | -0.013 |
| | (0.142) | (0.124) | (0.171) | (0.142) |
| Qtl 3 Constraint | 0.146 | 0.032 | 0.462** | 0.047 |
| | (0.164) | (0.127) | (0.178) | (0.161) |
| Qtl 4 Constraint | 0.109 | -0.082 | 0.374** | 0.089 |
| | (0.127) | (0.141) | (0.172) | (0.129) |
| Qtl 2 Constraint × Income Growth | 0.029 | -0.009 | -0.095 | 0.030 |
| | (0.054) | (0.049) | (0.062) | (0.052) |
| Qtl 3 Constraint × Income Growth | -0.011 | 0.048 | -0.101 | 0.004 |
| | (0.060) | (0.046) | (0.062) | (0.059) |
| Qtl 4 Constraint × Income Growth | -0.010 | 0.043 | -0.053 | 0.008 |
| | (0.051) | (0.057) | (0.065) | (0.051) |
| Income Growth | -0.101*** | -0.122*** | -0.013 | -0.123*** |
| | (0.032) | (0.033) | (0.055) | (0.038) |
| R2 | 0.22 | 0.25 | 0.30 | 0.22 |
| 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 A5

# 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 | -0.507 | -0.905 | -0.431 | -0.736 |
| | (0.620) | (0.663) | (0.627) | (0.607) |
| Qtl 3 Constraint | -0.704 | -1.279* | -0.395 | -0.263 |
| | (0.586) | (0.651) | (0.619) | (0.637) |
| Qtl 4 Constraint | -1.194** | -1.027 | -0.594 | -0.704 |
| | (0.588) | (0.657) | (0.651) | (0.611) |
| Qtl 2 Constraint × Income Growth | 0.015 | 0.113 | -0.027 | -0.070 |
| | (0.169) | (0.197) | (0.187) | (0.176) |
| Qtl 3 Constraint × Income Growth | 0.028 | 0.211 | -0.084 | -0.168 |
| | (0.162) | (0.190) | (0.180) | (0.189) |
| Qtl 4 Constraint × Income Growth | 0.084 | 0.109 | -0.077 | -0.166 |
| | (0.181) | (0.201) | (0.201) | (0.188) |
| Income Growth | -0.080 | -0.061 | 0.031 | 0.116 |
| | (0.129) | (0.171) | (0.158) | (0.153) |
| R2 | 0.07 | 0.06 | 0.07 | 0.14 |
| Number of Observations | 268 | 308 | 268 | 306 |
| *Panel B. Real Median Home Value Growth (Annualized %)* | | | | |
| Qtl 2 Constraint | -0.962** | -0.934** | 0.262 | -0.875** |
| | (0.417) | (0.448) | (0.460) | (0.411) |
| Qtl 3 Constraint | -1.193*** | -1.688*** | -0.207 | -1.207*** |
| | (0.410) | (0.442) | (0.448) | (0.434) |
| Qtl 4 Constraint | -1.917*** | -1.406*** | -1.056** | -1.326*** |
| | (0.445) | (0.440) | (0.459) | (0.490) |
| Qtl 2 Constraint × Income Growth | 0.174 | 0.154 | -0.130 | 0.084 |
| | (0.113) | (0.129) | (0.135) | (0.118) |
| Qtl 3 Constraint × Income Growth | 0.238** | 0.400*** | -0.044 | 0.128 |
| | (0.115) | (0.130) | (0.135) | (0.129) |
| Qtl 4 Constraint × Income Growth | 0.444*** | 0.326** | 0.252* | 0.182 |
| | (0.137) | (0.134) | (0.140) | (0.175) |
| Income Growth | 0.020 | 0.027 | 0.246** | 0.124 |
| | (0.096) | (0.109) | (0.114) | (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 A6
# House Quantity Growth (1980-2000): Quartiles

| | (1) Saiz | (2) BS-H | (3) WRLURI | (4) Building |
|---|---|---|---|---|
| *Panel A. Housing Quantity Growth (Annualized %)* | | | | |
| Qtl 2 Constraint | 0.391* | 0.613** | -0.009 | 0.025 |
| | (0.223) | (0.269) | (0.266) | (0.230) |
| Qtl 3 Constraint | 0.722*** | 0.791*** | 0.076 | 0.126 |
| | (0.209) | (0.268) | (0.261) | (0.231) |
| Qtl 4 Constraint | 0.580** | 0.668** | -0.001 | 0.119 |
| | (0.239) | (0.272) | (0.260) | (0.277) |
| Qtl 2 Constraint × Income Growth | -0.043 | -0.072 | 0.033 | 0.086 |
| | (0.068) | (0.085) | (0.081) | (0.069) |
| Qtl 3 Constraint × Income Growth | -0.134** | -0.123 | 0.025 | 0.090 |
| | (0.063) | (0.085) | (0.084) | (0.072) |
| Qtl 4 Constraint × Income Growth | -0.110 | -0.050 | 0.064 | 0.078 |
| | (0.085) | (0.088) | (0.085) | (0.101) |
| Income Growth | 0.747*** | 0.740*** | 0.638*** | 0.610*** |
| | (0.059) | (0.079) | (0.069) | (0.061) |
| R2 | 0.80 | 0.80 | 0.79 | 0.78 |
| Number of Observations | 268 | 309 | 268 | 307 |
| *Panel B. Population Growth (Annualized %)* | | | | |
| Qtl 2 Constraint | 0.432* | 0.570** | -0.407 | -0.023 |
| | (0.227) | (0.254) | (0.331) | (0.231) |
| Qtl 3 Constraint | 0.632*** | 0.763*** | -0.429 | 0.245 |
| | (0.212) | (0.245) | (0.328) | (0.243) |
| Qtl 4 Constraint | 0.647*** | 0.635** | -0.355 | -0.110 |
| | (0.227) | (0.251) | (0.314) | (0.275) |
| Qtl 2 Constraint × Income Growth | -0.101 | -0.099 | 0.101 | 0.078 |
| | (0.064) | (0.076) | (0.089) | (0.066) |
| Qtl 3 Constraint × Income Growth | -0.177*** | -0.204*** | 0.096 | 0.026 |
| | (0.061) | (0.075) | (0.095) | (0.070) |
| Qtl 4 Constraint × Income Growth | -0.196** | -0.148* | 0.051 | 0.083 |
| | (0.079) | (0.079) | (0.088) | (0.103) |
| Income Growth | 0.866*** | 0.865*** | 0.663*** | 0.700*** |
| | (0.053) | (0.068) | (0.079) | (0.053) |
| R2 | 0.81 | 0.79 | 0.81 | 0.78 |
| Number of Observations | 269 | 310 | 269 | 308 |
| *Panel C. Change in Average Rooms per Person* | | | | |
| Qtl 2 Constraint | -0.076 | 0.043 | 0.144* | 0.022 |
| | (0.075) | (0.079) | (0.085) | (0.086) |
| Qtl 3 Constraint | -0.007 | -0.034 | 0.244*** | -0.035 |
| | (0.086) | (0.067) | (0.084) | (0.092) |
| Qtl 4 Constraint | 0.077 | -0.013 | 0.128 | 0.013 |
| | (0.084) | (0.083) | (0.085) | (0.079) |
| Qtl 2 Constraint × Income Growth | 0.020 | -0.014 | -0.028 | -0.005 |
| | (0.020) | (0.026) | (0.024) | (0.025) |
| Qtl 3 Constraint × Income Growth | 0.014 | 0.012 | -0.051** | 0.004 |
| | (0.026) | (0.020) | (0.024) | (0.027) |
| Qtl 4 Constraint × Income Growth | -0.037 | -0.001 | -0.029 | 0.001 |
| | (0.029) | (0.026) | (0.027) | (0.023) |
| Income Growth | -0.035** | -0.031** | 0.002 | -0.031 |
| | (0.015) | (0.013) | (0.018) | (0.019) |
| R2 | 0.14 | 0.10 | 0.18 | 0.10 |
| 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 A7

## 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 | -0.156** | -1.673*** | -0.298** | -1.353* |
| | (0.069) | (0.488) | (0.120) | (0.785) |
| Income Growth | 1.124*** | 1.183*** | 1.126*** | 1.183*** |
| | (0.086) | (0.075) | (0.086) | (0.079) |
| Share of SF-Houston Gap | 0.0101 | 0.0035 | 0.0132 | 0.0158 |
| R2 | 0.56 | 0.58 | 0.56 | 0.56 |
| Number of Observations | 268 | 308 | 268 | 306 |
| *Panel B. Real Median House Value Growth (Annualized %)* | | | | |
| Elasticity Measure | -0.010 | -1.186* | 0.004 | 1.570 |
| | (0.088) | (0.640) | (0.134) | (1.020) |
| Income Growth | 1.153*** | 1.131*** | 1.160*** | 1.179*** |
| | (0.105) | (0.094) | (0.107) | (0.097) |
| Share of SF-Houston Gap | 0.0015 | 0.0055 | -0.0004 | -0.0420 |
| R2 | 0.44 | 0.44 | 0.44 | 0.42 |
| 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 A8
# Effects By Population (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 | 0.157 | -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 | 0.095*** | -0.012 | -0.012 | -0.013 | 0.010 | -0.016 | 0.017 | -0.034 |
| | (0.036) | (0.028) | (0.035) | (0.028) | (0.041) | (0.031) | (0.035) | (0.028) |
| R2 | 0.12 | 0.25 | 0.04 | 0.26 | 0.05 | 0.34 | 0.04 | 0.20 |
| 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 A9

## 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 (Annualized %)* | | | | | | | | |
| Less Constrained × Income Growth | 0.066 | 0.017 | 0.011 | -0.005 | 0.084* | -0.028 | 0.039 | -0.045 |
| | (0.051) | (0.044) | (0.046) | (0.041) | (0.047) | (0.049) | (0.047) | (0.039) |
| R2 | 0.04 | 0.25 | 0.01 | 0.19 | 0.05 | 0.36 | 0.01 | 0.14 |
| 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.