Immigrants and The Great Divergence*

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Abstract

An extensive literature has studied the spatial sorting of workers by skill since the 1980s. This paper extends the existing literature by using Census microdata to show that geographic sorting is also nativity-biased, and that immigrant workers sort into cities with higher wages and inelastic housing supplies. I use a spatial equilibrium model to predict worker sorting across housing supply elasticity in response to changes in local labor demand. I find that local labor demand shocks are a strong predictor of the observed skill- and nativity-biased sorting when the elasticity of migration for immigrants is greater than for natives.

*I appreciate any feedback or suggestion regarding the title.

1 Introduction

One of the defining developments of the post-World War II economic landscape in the United States is the reversal of the income convergence across states that brought the South from roughly half the real per capita GDP of the Northeast to parity by the 1970s. However, in terms of per capita income, the South still lags behind the West and Northeast, and has not improved since roughly 1980. This reversal also comes with the reversal of migration trends that helped equilibrate wages across U.S. states. Prior to 1980, population flows moved workers from poor U.S. states to rich ones. Today, however, migration flows are segregated along worker skill. That is, high-skilled workers are increasingly clustering in cities with large populations of high-skilled workers, while low-skilled workers are clustering with other low-skilled workers. This divergence has coincided with an increase in the college wage premium since the 1980s, potentially driving the increasing income inequality in the United States across cities. As a consequence, migration has been less able to equilibrate wages across geographic regions.

Moretti (2013) observes that since the 1980s, cities with an increasing population share of college workers have also experienced increasing cost of living. Further, it turns out that high-skill workers increasingly choose to locate in more expensive cities than low-skill workers. He finds that in 1980 the difference in the average cost of housing between college and high school graduates was 4%, while in 2000 the difference was 14%. Over the same period, the nominal college wage premium increased 20%. While the college wage premium is rising in highly skilled metropolitan areas over time, the wages of low-skill workers are also rising in highly skilled cities - wages of low-skill occupations are higher in these cities than in less-skilled cities (Moretti (2012), Ganong and Shoag (2013)). Thus, these cities are not only attractive to high-skill workers because of high wages and desirable amenities, but are also attractive to low-skill workers. If these cities are attractive to both high- and low-skill workers, then what is driving the skill-based clustering observed in the literature?

Ganong and Shoag (2013) have linked increasing worker clustering by skill to the elasticity of housing supply. They find that housing supply constraints, driven in part by land-use regulations, in productive states can explain part of the divergence in human capital, and sheds light on how rising housing costs impact low-skill migration. They find that increasing housing supply constraints in highly productive states cause the housing supply curve to become increasingly inelastic. That is, when labor demand shocks hit a state, both low- and high-skill workers will be attracted by higher wages. However, if the supply of housing is unable to respond to increasing demand, then these labor demand shocks are converted to increases in the cost of housing - a cost that can be borne more easily by high-skill workers. Thus, an inelastic housing supply has two implications: migration is constrained, and its skill composition is biased toward high-skill workers, as the increasing college wage premium makes them less sensitive to increasing housing costs.

Further, Saks (2008) notes that, in this setting, income convergence occurs because either workers and firms are mobile: firms move to places with lower wages and workers move to places with higher wages. However, if - after a positive labor demand shock - housing price increases persist because of an inelastic housing supply, worker mobility can not effectively drive wage convergence because the migration channel for wage convergence is compromised.

Borjas (2001) and, more recently, Cadena and Kovak (2013), have demonstrated the role of immigration in equilibrating economic opportunities and insulating a region's workers from shocks to local labor markets. Borjas, in particular, demonstrates that immigrants are a special group because they have already chosen to incur the cost of migration, and are therefore sensitive to differences in economic opportunity across cities and states. That is, immigrants make up a disproportionate share of the marginal workforce – those who help equalize wages and improve labor market efficiency.

This paper attempts to link these literatures by examining whether the observable data suggests immigrants are more mobile than native workers, and thus are more willing to employ cost-of-living-reducing strategies to afford living in more productive cities with rising housing costs. As a first step to answering this hypothesis, I document four stylized facts of cities and migration across housing supply elasticities. These stylized facts show that cities with restricted housing supplies are richer and are home to larger shares of high-skill and foreign-born workers, but also have more expensive housing. Additionally, over the past 30 years these cities have experienced faster growth in the population shares of these groups, wages, and housing costs, and this faster growth in the shares of these populations is associated with migration; migration that is biased toward high-skill and foreign-born people attracted to higher wages. Richer cities among cities with less restricted housing supplies, however, appear to also be attracting migrants, but migration to these cities is biased toward low-skill and native people.

These stylized facts suggest foreign-born workers are less sensitive to housing supply restrictions than natives. To test this, I adapt the spatial general equilibrium model of Moretti (2013) to native and immigrant workers to determine the equilibrium characteristics of wages, rents, and population changes that would be consistent with a world in which the elasticity of labor of immigrants is larger than that of natives. The model implies that if immigrants have greater labor mobility than natives, more immigrants will move to cities that experience positive labor demand shocks - and, hence, positive wage shocks - than natives, even when these cities have more inelastic housing supplies that increases the cost of living in these cities. The model also predicts that natives already living in high wage, high rent cities that experience labor demand shocks will see larger increases in their wages, while natives who stay behind in low-productivity, low-wage cities experience lower wage growth. The wages of foreign-born workers, on the other hand, will grow faster in low wage, low rent cities as the local supply of these workers shrinks, and will grow slower in high wage, high rent cities due to competition from other foreign-born workers. The intuition behind this result comes from the interaction between local wages and rents, and how they influence migration decisions.

When a city receives a labor demand shock, local firms raise wages to attract new workers. Higher wages induces a migration response from workers, which in turn raises the local cost of housing, particularly if the supply of housing is already constrained. Thus, the rise in cost of living offsets some part of the rise in wages, which also reduces the migration response. Workers who are more sensitive to changes in net wage will migrate in response to a smaller change than workers who are less sensitive, that is, workers with a higher elasticity of migration will be induced to move to a new city by a relatively smaller change in that cities net wage. Immigrants may be more sensitive to changes in net wages if they have fewer ties to their current city[1], are more willing to live with family and/or other workers to reduce their cost of living, or want to maximize their earnings to send larger remittance payments to family members abroad.

I use a plausibly exogenous instrument for local labor demand shocks based on Bartik (1991), where national industry growth is constructed using changes in industry shares of gross value added between 1980 and 2010. I combine this Bartik labor demand shock together with measures of local regulatory and geographic constraints on local housing supply to estimate the equilibrium relationship between the Bartik labor demand shock and changes in the local immigrant-native population ratio, the low-skill-immigrant-native population ratio, and the high-skill population ratio, as well as on changes in the local mean wages of native and immigrants, and changes in local mean rent. Data limitations prevent a straightforward causal estimation of labor mobility across groups, but we can estimate the effect of a labor demand shock on the equilibrium outcomes across cities and housing supply elasticity (which varies how labor demand shocks influence changes in rents) to look for equilibrium changes that are consistent with the predictions of the model.

My results largely support the hypothesis that the elasticity of mobility of immigrants is larger than that of natives. I find labor demand shocks increase the wages of natives less in nonrestricted-housing-supply cities than in restricted-housing-supply cities, that the wages of foreign-born workers increase less than natives' wages in restricted- housing-supply cities, and that rents increase more in restricted-housing-supply cities in response to changes in labor demand than in nonrestricted-housing-supply cities. Further, I estimate that a 1% change in labor demand is associated with about a 3% increase in the foreign-born ratio, a 3.6% change in the low-skill-foreign-born ratio,

[1] Borjas (2001) argues that immigrant workers are likely to be more mobile than native workers because they have already made the choice to migrate from their home country, so they have fewer ties to the place in which they already live, and have demonstrated a sensitivity to economic opportunities. Additionally, the migration literature, reviewed in Greenwood (1997), has found that low-skill natives are less likely to move away from their place of birth than high-skill natives.

and a 0.75% increase in the high-skill ratio. These results are largely consistent with the prediction of the model when the elasticity of labor mobility is greater for immigrants than for natives.

2 Data

This paper uses the Integrated Public Use Microdata Series (IPUMS) (Ruggles, et al. (2010)) from the 5-percent samples of the 1980, 1990, and 2000 U.S. Decennial Census's, and the 3-percent sample of the 2009-2011 3-Year American Community Survey (ACS). The IPUMS contains sample-weighted, individual-level responses to a wide range of demographic and economic questions such as income, housing costs, household size, location of residence, migration status, and nativity (i.e., native or foreign-born). I construct two datasets from the IPUMS data: the first is a dataset of individuals grouped into cross-sections by Metropolitan Statistical Areas (MSAs), while the second dataset is a panel of sample-weighted MSA-level means constructed from the individual-level data.

This data is used to construct estimates of local wages, cost of housing, and population, as well as the nativity and skill mix of MSAs. Foreign-born workers are defined as workers who were not born in a U.S. State or territory. High-skilled workers are defined as workers having completed at least 4 years of college, while all others are low-skilled workers. Further, this data is used to compute the share of employment by indsutry in each MSA as a measure of an MSAs industrial composition, used to construct a plausibly exogenous demand shock.

My empirical strategy relies on using variation in housing supply elasticities across MSAs to capture differences in the cost of building new housing in response to migration. A variety of factors can affect the cost of building new housing in a particular city, ranging from geographic features of the land surrounding a city (such as rivers, lakes, or mountains) to regulatory constraints placed on new housing by state or local government institutions. I use two measures of housing constraints as proxies for the elasticity of the housing supply.

The first is a measure of geographic constraints from Saiz (2010) - henceforth called the Land Unavailability Index (LUI) - that captures the share of land unavailable for development within 50 km of the center of a city. Land unavailable for development is defined as land covered by a body of water or with a slope of more than 15%. As this is a measure of geographic constraints to a city's housing supply, it is fixed over time. I also use a measure of the regulatory constraints placed on a city's housing supply. This measure comes from the Wharton Residential Land-Use Regulation Index (WRLURI) constructed by Gyourko, Saiz, and Summers (2008) using the Wharton regulation survey. The WRLURI is a composite index measuring the relative degree of regulatory and administrative constraints in communities. I aggregate this index to MSAs following Saiz (2010). Components of the WRLURI index range from a Local Political Pressure Index, a Local

Zoning Approval Index, to an Approval Delay Index[2]. This measure of regulatory constraints was constructed for the year 2008 and is the only year for which the WRLURI is available.

I use these indexes of housing supply elasticity in two different ways in the analysis that follows: 1) I rank cities by their index value in ascending order, and 2) I separate cities into a group of restricted-housing-supply MSAs and a group of nonrestricted-housing-supply cities by calculating the median of each index and assigning MSAs with index values above the median a dummy variable equal to one, while all other MSAs receive a value of zero.

In addition to the measures of housing constraints, I construct plausibly-exogenous instruments for MSA-level labor demand shocks using the technique of Timothy Bartik (1991). These shocks are constructed as the growth of employment in a city as predicted by the growth of national industries weighted by the share of employment in each industry for that city. To measure the national growth rate of industries over the time period of interest, I use decadal changes in gross value added from 1980 to 2010 constructed from gross value added data by industry from the 2012 release of the EU KLEMS (O'Mahony and Timmer 2009) database. This database contains gross value added data for 34 1- to 2-digit NACE 2 industries from the United States and 10 other OECD countries.

Lastly, to capture the endogenous change in amenities as the result of productivity shocks, I construct the number of establishments per 1000 people using detailed 4-digit SIC (1979 and 1989) or 6-digit NAICS (1999 and 2009) industry data from the 1979, 1989, 1999, and 2009 County Business Patterns (CBP) by aggregating county-level establishment counts to MSAs. This measure captures the change in the number of establishments per 1000 people in each MSA across 5 industry categories: Art & Recreation, Education, Food, Retail, and Transportation[3].

The unit of analysis is the Metropolitan Statistical Area. The MSA is a somewhat problematic geographic unit, particularly because the definition of MSAs are redefined every decade by the U.S. Office of Management and Budget (OMB). Further, some MSAs are divided or combined depending on changes in population or economic linkages. Ideally, I would like to choose a geographic unit that is static over the time period of interest to remove the effect of compositional or legal changes brought about by boundary changes. However, my choice of geographic unit is mostly data-driven: housing supply elasticity data is currently only available for the 1999 definition of MSAs[4], and US Census data is available for MSAs. To address the issue of inconsistency over

[2]See Gyourko, Saiz, Summers (2008) for a detailed description of these indices and the construction of the WRLURI composite index.

[3]The Art & Recreation category includes movie theaters, museums, historical sites, zoos, and other similar establishments; the Education category includes elementary & secondary schools, junior colleges, and other colleges, universities, and professional schools; the Food category includes fast-food & traditional restaurants, grocery & convenience stores, and beverage bars (alcoholic and other); the Retail category includes clothing & shoe stores (Men's, women's, and others); and the Transportation category includes Limousine, Ambulance, and special needs services, as well as scenic & sightseeing transportation services.

[4]I am working on aggregating this municipal-level data to Commuting Zones (CZs), a time-consistent geographic

time, I have selected the subset of MSAs that are consistently identified across the 1980, 1990, and 2000 samples of the U.S. Decennial Census and the 2009-2011 3-year American Community Survey following Diamond (2016). MSAs not identified in all samples, as well as all rural areas that are not covered by any MSA in any decade, are aggregated at the state-level to a single observation per state. This method provides a balanced panel of 252 MSAs that fully covers the U.S. across four decades, for a total of 1,008 MSA-decade observations.

3 Stylized Facts of Migration and Cities

The first step toward answering the question of whether immigrants are less sensitive to restricted housing supplies than natives is to understand the relationship between housing supply elasticity and city characteristics such as population, wages, and rents. First, I will focus on establishing some key facts that differentiate restricted-housing-supply cities (cities in the upper half of the distributions of the WRLURI and LUI measures) from nonrestricted-housing-supply cities. Then I will turn to some key facts that differentiate migrants to each type of city across nativity and skill.

3.1 Cities and Housing Supply Elasticity

Panel A of Table 1 presents the results of a regression of the average wage and rent in an MSA, and the ratio of high-skill, foreign-born, and low-skill, foreign-born people in the population[5] on the ranking of MSAs by housing supply elasticity when measured using the WRLURI. The coefficients in this table are measured in units of standard deviation, that is, each coefficient corresponds to an increase in rank by one standard deviation, which is equivalent of moving from the Louisville, KY MSA (ranked 89th out of 252 MSAs) to the Salinas-Sea Side-Monterey, CA MSA (ranked 163rd).

Looking across all 5 columns, we see that all coefficients are positive and significant. Column (1) shows that a one-standard-deviation increase in WRLURI rank is associated with an increase in the mean wage by 0.738 standard deviations, or about $449 per month ($5,400 annually). Similarly, in column (2) we observe an increase in average rent by 0.872 standard deviations, or about $219 per month ($2,630 annually). This result suggests that more regulated MSAs tend to be richer and will be more attractive to migrants seeking better economic opportunities; however, these higher wages come at the cost of higher housing prices. Hence, these cities are more economically attractive in terms of earnings, but are less accessible to lower-wage (that is, less-skilled) workers.

unit that, by definition, captures local labor markets.The original data from the WRLURI is actually collected at the municipal level, which is then aggregated to the MSA level by Saiz (2010).

[5]These ratios are defined, respectively, as $\frac{\text{foreign-born population}}{\text{native population}}$, $\frac{\text{foreign-born population}^{\text{low-skill}}}{\text{native population}^{\text{low-skill}}}$, and $\frac{\text{high-skill population}}{\text{low-skill population}}$.

This fact is reflected in column (3): more heavily regulated MSAs tend to have larger shares of high-skilled workers as a one-standard-deviation increase in WRLURI ranking is associated with a 0.61 standard deviation increase in the high-skill ratio, equivalent to about a 4-percentage-point increase in the share of high-skilled workers. However, MSAs with more regulated housing supplies also tend to have larger shares of foreign-born and low-skill-foreign-born workers, columns (4) and (5) show increases in standard deviation equivalent to approximately 5.8-percentage-point and 4.4-percentage-point greater shares, respectively.

Panel B of Table 1 reports the same regressions as above, except the independent variable now ranks MSAs by Saiz's LUI, a measure of geographic restrictions on housing supply. We can see the estimates in Panel B are quite similar to those of Panel A, though the correlation with mean wage and mean rent is marginally lower when ranking MSAs by land unavailability.

The population-based dependent variables in Table 1 are ratios, and hence they increase in two ways: 1) the numerator increases, or 2) the denominator decreases. The regressions in Table 2 tell us how the numerators and denominators changed between 1980 and 2010. The dependent variables are changes in the adult population (aged 18-64; measured in numbers of people) between 1980 and 2010. The independent variables are the same as in Table 1: the ranking of MSAs by the WRLURI and the LUI in ascending order.

Table 2 shows a clear pattern: the change in the population of high-skilled natives, and low- and high-skilled foreign born, is larger in MSAs with more restricted housing supplies, while the change in the population of low-skilled native workers is larger in MSAs with less restricted housing supplies. A regression of the change in employment on the same rankings produces very similar results[6]. Hence, the high-skill, foreign-born, and low-skill-foreign-born ratios are increasing in restricted-housing-supply MSAs because the population of low-skill natives grew less than the population of the other groups (and, hence, the overall native population is growing less), while the change in the populations of high-skill natives and foreign born (both skill levels) grew much faster[7]. It is notable that these coefficients measure *net* changes in population, which includes natural increases in population as well as in- and out-migration. It is probable that low-skill natives are still moving to MSAs with restricted housing supplies, but in smaller numbers compared to the other nativity-skill groups, and compared to MSAs with less restricted housing supplies.

So far the data is showing us two broad facts:

1. MSAs with restricted housing supplies tend be richer, more expensive, and have larger shares

[6]The results are also nearly identical when including all ages in the population, rather than restricting the sample to the adult population. The results of regressions using employment instead of population and all age groups can be provided upon request.

[7]This correlation is consistent with the findings of Bound & Holzer (2000) who study the effects of labor demand shifts and population demand shifts across metropolitan areas. They find, during the 1980s, demand shifts were an important driver of migration, but that the supply response of less-educated workers was substantially lower relative to more-educated workers.

of high-skill and foreign-born persons, and

2. Changes in the population of high-skill natives, and high- and low-skill foreign-born between 1980 and 2010 are increasing in restricted-housing-supply MSAs, while the population of low-skill natives grew much slower or shrunk in these cities.

These two facts speak to changes in the populations of MSAs across housing supply elasticity by nativity and skill level. However, these changes occur over a relatively long time period - 30 years - and thus could reflect a difference in intergenerational changes in the education level of MSAs across housing supply elasticity, rather than a flow of people. That is, a similar pattern across MSAs could be observed if the children of low-skill workers in restricted-housing-supply MSAs became high-skill workers in these same cities during the 2000s, while the children of low-skill workers in less restricted MSAs remained low-skill workers and did not move. In this case, migration would not be a strong predictor of future shares of high-skill, foreign-born, or low-skill-foreign-born workers.

Table 3 presents the results of regressions of the shares of high-skill, foreign-born, low-skill-foreign-born workers, and the MSA mean wage and rent, on lagged values of the number of in-migrants to an MSA and whether the MSA has a restricted housing supply. The number of in-migrants to an MSA is measured using a question from the Decennial Census and ACS asking about the respondents location 5 years ago (1 year ago in the case of the ACS)[8]. Panel A reports the results when housing supply elasticity is estimated using the WRLURI, while the results in Panel B measure housing supply elasticity using the LUI.

Column (1) in both panels A and B show us that lagged in-migration has little relationship with the high-skill ratio in MSAs without restricted housing supplies. However, this is not true in MSAs with restricted housing supplies: the relationship between in-migrants and the share of high-skill workers is significantly steeper among restricted-housing-supply MSAs. For example, a one-standard-deviation increase in lagged in-migration among restricted-housing-supply MSAs - according to the WRLURI - is associated with a share of high-skill workers 0.782 standard deviations larger on average, or about 6 percentage points. Results are quite similar across columns (2)-(5) and across both panels: the relationship between lagged migration and each dependent variable is significantly stronger among restricted-housing-supply MSAs regardless of the measure of housing supply elasticity used. This evidence supports the hypothesis that the facts highlighted in Tables 1 and 2 are at least partly driven by migration rather than changes in educational attainment

[8]The coding of this variable is insufficient to distinguish between people who moved within an MSA from people who moved within a state but not within an MSA. To address this, I only count respondents who reported either living in a different state or living abroad 5 years ago (or 1 year ago in the ACS). Hence, the independent variable as calculated is likely a significant underestimation of the true number of in-migrants, especially for MSAs in relatively large states such as California.

over time.

3.2 Migration and Cities

Thus far, I have established that there are significant differences between nonrestricted- and restricted-housing-supply MSAs in terms of changes to their skill and nativity composition over time, as well as in wages earned by workers and rents paid by residents. Further, I have established that these differences over time appear to be, at least in part, migration-driven changes. Next, I will establish that observed migration flows for these nativity-skill groups appear to be directed toward restricted-housing-supply MSAs with higher mean wages in 1980, and that low-skill native migration may be directed toward nonrestricted-housing-supply MSAs with higher mean wages in 1980. Lastly, I will establish that migration is both skill- and nativity-biased. That is, migrants are primarily high-skilled, foreign born, or both.

Figures 1, 2, and 3 plot the 30-year change in the ratio of high-skill, foreign-born, and low-skill-foreign-born persons, respectively, against the log of the MSA mean wage in 1980 by housing supply elasticity. Focusing on Figure 1 to start, we see that, on average, richer MSAs in 1980 experienced stronger growth in the ratio of high-skill persons on average. However, this relationship is much stronger among restricted-housing-supply MSAs - richer cities in 1980 experienced faster growth in the high-skill ratio if they also have inelastic housing supplies, regardless of the measure used. Figures 2 & 3 show us a similar story: richer cities experienced faster growth in the foreign-born and low-skill-foreign-born ratios if they also have restricted housing supplies; however, only when measured by the WRLURI. Focusing on nonrestricted-housing-supply MSAs for a moment, we see that, unlike the change in the high-skill ratio, the slope of a regression line is actually negatively sloped, suggesting the 30-year change in the native population is equal to - if not greater than - the 30-year change in the foreign-born population in richer, nonrestricted-housing-supply MSAs when housing supply elasticity is measured by the WRLURI. Together with the information from Figure 1, these figures suggest an interpretation that low-skill native migration may also be directed toward richer MSAs, but richer MSAs that also have lower housing costs. This interpretation is consistent with findings in Ganong & Shoag (2013) and Diamond (2016).

Table 4 presents the results of standardized regression estimates of the relationship between the share of *migration* across nativity-skill groups and housing supply elasticity as measured by an MSAs rank according to the WRLURI and LUI. Focusing our attention on panel A, we see that the share of high-skill and both skill groups of foreign born in total migration is increasing in housing supply elasticity, while the share of low-skill, natives, and low-skill natives, in particular, is decreasing in housing supply elasticity. Additionally, the magnitude of this relationship is much larger for foreign-born people of both skill levels, suggesting that foreign-born migration is more concentrated among MSAs with tighter housing supplies than either low- or high-skill native migrants. The results are even more stark when looking to panel B where housing supply elasticity is measured using the LUI.

Thus, I have established two additional facts regarding migration to cities:

3. Growth in the ratio of high-skill, foreign-born, and low-skill foreign-born people over the past 30 years has been increasing in restricted-housing-supply cities that were richer in 1980, suggesting migration of high-skill and foreign-born people has been directed toward richer cities in spite of high housing costs, and

4. The composition of migration in restricted-housing-supply cities appears to be foreign-born-biased, as the foreign-born share of migration becomes larger among MSAs with restricted housing supplies, while the high-skill native share of migration weakly increases in restricted-housing-supply cities and the low-skill native share of migration falls significantly with WRLURI and LUI rank.

These facts illustrate the main thesis of this paper and the direction of the theoretical and empirical analyses that follow. That is, that migration is directed toward richer cities in general, but high-skill and, in particular, foreign-born migration is directed at cities with restricted housing supplies, who, in general, were richer in 1980 and have experienced faster wage growth in the intervening 30 years than cities with less restricted housing supplies. These facts suggest the elasticity of labor mobility may be larger among foreign-born people such that they are more sensitive to increasing wages than increasing housing costs.

4 Model

In this section I modify the spatial general equilibrium model of Moretti (2013), separating workers into two groups - natives and immigrants - to explore how worker mobility interacts with the housing supply elasticity in a city to affect equilibrium wages, rents, and population.

This model treats cities as competitive economies producing a trade-able good y that is consumed everywhere and acts as numeraire. Workers choose to live and work in the city that maximizes their utility, where they inelastically supply 1 unit of labor and consume 1 unit of housing. Thus, the supply of labor to each city is determined by the interaction between worker location preferences (i.e., which city a workers prefers) and the benefit and costs of living in a city; i.e., the wage and amenities gained less the cost of living. In this model, workers are members of one of two nativities: they are either native workers (nativity N) or foreign-born workers (nativity F)[9].

[9]Throughout the paper, I will use the terms Immigrant and foreign-born interchangeably to refer to the same group of people.

The amount of utility native worker i receives from living in city c is represented by the following indirect utility function:

$$U_{ic}^{N} = w_{c}^{N} - r_{c} + A_{c}^{N} + \delta_{ic}^{N}, \tag{1}$$

where w_c^N is the nominal wage paid to native labor in city c, r_c is the nominal rent paid for a single unit of housing in city c, A_c^N is the value of amenities in city c to native workers, and δ_{ic}^N is the idiosyncratic location preference of native worker i for city c. A larger value of δ_{ic}^N represents a stronger preference for city c. This preference for city c could arise in many ways; for example, perhaps an individual prefers city c because they were born there, or they have family who lives in city c and this person prefers to live near their family, or perhaps city c holds some intrinsic value to worker i.

The indirect utility function for 'foreign-born workers is similar:

$$U_{ic}^{F} = w_{c}^{F} - r_{c} + A_{c}^{F} + \delta_{ic}^{F}. \tag{2}$$

An important feature of the model is that native and foreign-born workers compete for housing in city c so that changes in the population of one group affects the cost of living faced by the other group. I refer to the difference between wages and rents as *net wages*.

The stylized facts presents in Section 3 show that migration is differentiated across both nativity and skill, however, I will only focus on the differential across nativity in the model. The main reason for this is the data shows that, while high-skill workers are generally more mobile than low-skill workers, when looking within skill-levels, it appears that foreign-born workers are more mobile than their native counterparts. With this in mind, I focus on the differential across nativity rather than skill to reduce the complexity of the model.

I assume native and foreign-born workers work in a single firm to capture the effect of imperfect substitution between native and foreign-born workers. This is an important detail to consider when looking at the effects of productivity shocks on the wages and rents of native and foreign-born workers who may compete for similar jobs, or enhance the job opportunities of each through complementarity (Peri & Sparber 2009). Hence, a representative firm per city combines native and foreign-born workers using Cobb-Douglas technology with constant returns to scale:

$$\ln(y_c) = x_c + \alpha N_c + (1-\alpha) F_c, \tag{3}$$

where e^{x_c} is a city-specific productivity shifter, N_c is the log of the number of native workers employed in city c, and F_c is the log of the number of foreign-born workers employed in city c. The productivity shifter is city-specific and factor-augmenting, similar to a city-specific TFP.

Housing is supplied by price-taking developers who build homogeneous housing units in each city. These developers are assumed to be perfectly mobile and sell housing units to absentee landlords who rent their housing units to residents at the cost of production:

$$r_c = \zeta_c + \gamma_c L_c. \tag{4}$$

The cost of production is decomposed into two main sources: a city-specific fixed cost of construction, ζ_c, and the density of housing in city c. The contribution of the density of housing to the cost of housing in a city is determined by two factors: regulatory and geographic restrictions. These restrictions can increase the cost of constructing new homes - captured by γ_c - and the log of the total number of housing units within a city, $L_c = N_c + F_c$.

The parameter γ_c captures the city-specific way in which local regulatory and geographic restrictions on new housing will alter the degree by which increases in the population of a city will change housing prices. Cities that strictly regulate new housing, or with limited land suitable for development within city-limits, will have a larger value of γ_c, meaning that an increase in the number of workers in a city will lead to a relatively larger increase in the rental cost of housing, reflecting the difficulty of building new housing as an increase in the cost of housing. That is, γ_c captures the elasticity of the local supply of housing so that larger values imply a more inelastic local housing supply.

4.1 Deriving Supply and Demand of Workers and Housing

Supposing there are two cities, city a and city b, we can use worker i's idiosyncratic location preference to express her *relative preference* for city a:

$$\delta_{ia}^{j} - \delta_{ib}^{j} \sim \mathscr{U}(-s_j, s_j),\ j \in \{N, F\}, \tag{5}$$

where the parameter s_j represents the maximum relative preference for city a for a nativity j worker. Thus, when choosing between city a and b, workers compare net wages and amenities in each city to their idiosyncratic relative preference for city a. For example, native worker i will choose to live in city a as long as the difference between net wages and amenities in city a and city b is less than her relative preference for city a, or,

$$\delta_{ia}^{N} - \delta_{ib}^{N} > (w_b^N - r_b) - (w_a^N - r_a) + (A_b^N - A_a^N). \tag{6}$$

The marginal worker, however, must be indifferent between cities a and b. Hence, for the marginal worker,

$$\delta_{ia}^{j} - \delta_{ib}^{j} = (w_b^j - r_b) - (w_a^j - r_a) + (A_b^j - A_a^j),\ j \in \{N, F\}. \tag{7}$$

We can use this indifference condition to find the supply of native and foreign-born workers in cities a and b, as well as the total demand for housing in each city. For clarity, I will focus on native workers; the following derivation is identical for foreign-born workers. Since idiosyncratic relative preferences are distributed uniformly across the population of native workers, the area under the distribution of $\delta^N_{ia} - \delta^N_{ib}$ is a rectangle with area equal to N, the log of the total population of native workers. Hence, the marginal native worker's indifference condition implies the difference between net wages and amenities in cities a and b must lie between $-s_N$ and s_N. Therefore, we may compute the log of the native population of city a, N_a, as the area of the distribution lying between $(w^N_b - r_b) - (w^N_a - r_a) + (A^N_b - A^N_a)$ and s_N, and the log of the native population of city b, N_b, as the area of the distribution lying between $-s_N$ and $(w^N_b - r_b) - (w^N_a - r_a) + (A^N_b - A^N_a)$, where $N_a + N_b = N$ is assumed fixed. The log of the native population of city a can be computed as the area of a rectangle:

$$N_a = \frac{N}{2s_N}[s_N - (w^N_b - r_b) - (w^N_a - r_a) + (A^N_b - A^N_a)]. \tag{8}$$

Solving this equation for $(w^N_b - r_b) - (w^N_a - r_a) + (A^N_b - A^N_a)$ yields the marginal native worker's relative preference for city a:

$$s_N \frac{(N_b - N_a)}{N} = (w^N_b - r_b) - (w^N_a - r_a) + (A^N_b - A^N_a). \tag{9}$$

This expression is the core of the model, telling us exactly how wages, the cost of housing, amenities, and location preferences interact to determine the local supply of labor in both cities. It is easy to see the parameter s_N, which determines the importance of location preferences throughout the population, governs the responsiveness of labor to differences in net wages and amenities across cities. When s_N is small, labor is much more responsive to differences in net wages or amenities - workers are more willing to move to the city that offers a greater real wage or better amenities. When s_N is large, workers are less willing to move - the difference between the net wage - or amenities - in city a and city b must be larger to induce worker i to move away from their preferred city. Thus, the parameter s_N directly determines the elasticity of labor (labor mobility) of native workers.

Further, we can rearrange Equation (9) to obtain the inverse of the local supply of labor to city a, for example,

$$w^N_a = (w^N_b - r_b) + r_a + (A^N_b - A^N_a) - s_N \frac{(N_b - N_a)}{N}. \tag{10}$$

Solving a similar expression to Equation (8) for foreign-born workers leads to the equivalent of Equation (9) for foreign-born workers:

$$s_F \frac{(F_b - F_a)}{F} = (w_b^F - r_b) - (w_a^F - r_a) + (A_b^F - A_a^F). \tag{11}$$

Since native and foreign-born workers compete in the same housing market, the local demand for housing in city c is the sum of native and foreign-born local housing demand. Further, because each worker consumes one unit of housing, local demand for housing is equal to the log of the total population of city c, $L_c = N_c + F_c$. For example, the inverse of the local demand for housing in city a is

$$r_a = \frac{s_F N \lambda^N + s_N I F \lambda + s_N s_F (L_b - L_a)}{s_F N + s_N F}, \tag{12}$$

where $\lambda^j = w_a^j - (w_b^j - r_b) - (A_b^j - A_a^j),\ j \in \{N, F\}$.

The representative firm is assumed to be a cost-minimizing price-taker who pays workers a wage equal to their marginal productivity. For example, the wage earned by native workers in city c is

$$w_c^N = x_c + \ln(\alpha) + (1 - \alpha)(F_c - N_c), \quad \forall c \in \{a, b\}. \tag{13}$$

4.2 Equilibrium

The spatial equilibrium of this model is defined as a set of populations of native and foreign-born workers, wages, and rents, $\{N_c^*, F_c^*, w_c^{N*}, w_c^{F*}, r_c^*\}\ \forall c \in \{a, b\}$, that arises from clearing the housing market by setting Equation (4) equal to Equation (12) in each city and clearing the labor market by setting Equation (10) equal to Equation (13) for both natives and foreign-born in each city. This amounts to solving a system of 10 equations for 10 unknowns:

$$\begin{aligned}
&s_N \tfrac{(N_b - N_a)}{N} = (w_b^N - r_b) - (w_a^N - r_a) + (A_b^N - A_a^N) \\
&s_F \tfrac{(F_b - F_a)}{I} = (w_b^F - r_b) - (w_a^F - r_a) + (A_b^F - A_a^F) \\
&w_a^N = x_a + \ln(\alpha) + (1 - \alpha)(F_a - N_a) \\
&w_a^F = x_a + \ln(1 - \alpha) + \alpha(N_a - F_a) \\
&w_b^N = x_b + \ln(\alpha) + (1 - \alpha)(F_b - N_b) \\
&w_b^F = x_b + \ln(1 - \alpha) + \alpha(N_b - F_b) \\
&r_a = \zeta_a + \gamma_a(N_a + F_a) \\
&r_b = \zeta_b + \gamma_b(N_b + F_b) \\
&N = N_a + N_b \\
&F = F_a + F_b.
\end{aligned} \tag{14}$$

The solution to this system is a unique set of populations of native and foreign-born workers, wages, and rents in each city.

An important feature of this model that makes it useful for studying differential migration in response to labor demand shocks is that both cities remain populated by natives and foreign-born after a shock to either groups of workers or cities. In the Rosen-Roback style of spatial equilibrium, every worker must be indifferent to the city in which they live - every city must offer the same level of utility. If one city offers greater utility than the others, perhaps as the result of a productivity shock, every worker will choose to relocate to that city. In this model, however, workers have a stronger preference for one city relative to another, and thus can enjoy economic rents; only marginal workers are indifferent between cities. This is the result of a labor supply curve that is not perfectly elastic for both groups of workers. Further, because each type of worker has a different elasticity of labor, the migration response to a productivity shock can be different for each group of workers. Without this feature of the model, it would not be possible to clearly determine the differential migration response to labor demand shocks across different housing supply elasticities.

4.3 The Effect of a Productivity Shock

The objective of this model is to understand how labor mobility and the elasticity of the local housing supply interact to determine how changes in wages and rent influence the location choices of natives and foreign-born. The mechanism used to drive changing wages and rents across cities are shocks to labor demand. In the model, shocks to labor demand are characterized as productivity shocks.

After obtaining the equilibrium set of populations, wages, and rents, we can explore the effect of local productivity shocks using comparative statics. For example, suppose that firms in city b experience a productivity shock, increasing the value of the city-specific productivity shifter, x_b. To see how populations, wages, and rents change in cities a and b, we take the derivative of each variable, $\{N_c^*, F_c^*, w_c^{N*}, w_c^{F*}, r_c^*\}$, $\forall c \in \{a, b\}$, with respect to x_b.

To aide illustration of the model's predictions of the ten variables in equilibrium - wages, rent, and populations across both cities - after a labor demand shock in city b, I plot changes in wages, rents, and the immigrant-native employment ratio (y-axis) against the location preference of foreign-born (s_F) on the x-axis. These figures illustrate the evolution of each variable in equilibrium against different values of the foreign-born location preference (foreign-born mobility). I have set the location preference of natives, s_N, to 1 and allow the value of the foreign-born location preference parameter, s_F, to vary. Additionally, I have set the housing supply of city a to be elastic relative to city b. All changes are measured in proportion to the productivity shock.

Figure 4 illustrates the impact of a productivity increase in city b on the wages of natives in both cities. The productivity shock hits both foreign-born and native workers in city b, increasing their wages. As marginal natives move from city a to city b, the supply of native workers decreases in city a, driving up the wage firms must pay to keep native workers in city a. This effect is tempered by the mobility of foreign-born, however. This is due to two effects: when more workers move into city b, city b becomes less attractive because of the rising cost of living, and the natives who remain in city a are less productive due to complementarities between foreign-born and natives, reducing the wages of natives *and* foreign-born who stay in city a. Notice the negative effect due to complementarities is reduced if foreign-born are less complementary to natives in production.

Figure 5 displays the change in foreign-born wages in cities a and b due to a positive productivity shock in city b. The story for foreign-born wages in cities a and b is similar to that of natives: when foreign-born are very mobile relative to natives, the wages of foreign-born who remain in city a increases. However, the less mobile are foreign-born, the more wages fall for foreign-born who stay in city a because there are many more natives than foreign-born, so native migration hurts foreign-born wages more because of complementarities; the less complementary are natives and foreign-born, the less native migration impacts the wages of foreign-born remaining in city a. When foreign-born are very mobile, the wage they earn in city a increases because firms must raise their wages to keep foreign-born from moving. Again, because city b received the productivity shock, foreign-born wages also increase in city b, though the wage increase is smaller than the productivity shock when foreign-born are very mobile.

Figure 6 shows the changes in rent in both cities. foreign-born and natives compete in the same housing market in each city, so only two figures are needed in this case. The story here is pretty simple: because the housing supply in city b is inelastic, rent increases substantially when city b receives a productivity shock. In-migration of workers drives up the cost of living because constructing new housing units is expensive. Additionally, it is worth keeping in mind that if city b had a more elastic housing supply, the rental price of housing will increase less, leading to a larger increase in the real wage in city b. Hence, there would be more in-migration to city b if its housing supply was more elastic. Further, the rental price of housing falls substantially in city a as workers move to city b and housing units become less scarce in city a. While the model does not explicitly model vacancies in the housing market, the fall in the rental price of housing in city a could be interpreted as being due to an increase in the vacancy rate.

Lastly, Figure 7 illustrates the evolution of the immigrant-native employment ratio - defined as $\frac{F_c}{N_c}$, $c \in \{a,b\}$- in cities a and b across a range of values of foreign-born mobility, s_F. When foreign-born are very mobile, relatively more foreign-born move from city a to city b to earn higher wages. Because natives are are not as mobile, fewer natives move to city b because of the much higher cost of housing in city b, thus, the immigrant-native ratio falls in city a. The more immobile foreign-born are, however, reduces the change in immigrant-native employment ratio. Similarly, relatively more foreign-born move to city b when their location preferences are weaker (implying they respond more to differences in net wages across cities), increasing the immigrant-native ratio in the city receiving the productivity shock, even when the cost of housing rises a lot due to a highly inelastic housing supply.

Hence, like the literature has found is true for high-skill workers - migration to productive cities is low, and biased toward high-skill workers - a similar story should be the case for foreign-born if foreign-born truly have weaker location preferences than natives. That is, migration to productive cities should also be biased toward foreign-born workers of high- and low-skill relative to less productive cities. The stylized facts in Section 3 provide evidence for this may be the case: migration appears to be biased toward foreign-born workers, suggesting this group may have weaker location preferences than native workers. The following empirical analysis will attempt to use a plausibly exogenous instrument for labor demand shocks to look for equilibrium outcomes that are consistent with the model's predictions for changes in native and immigrant wages, rents, and the immigrant-native employment ratio after labor demand shocks when immigrants are more exhibit higher labor mobility they natives.

5 Empirical Strategy

The model of the previous section produces straightforward predictions for changes in wages, rents, and the employment of natives and foreign-born after a productivity shock when foreign-born have greater labor mobility than natives and some cities have inelastic housing supplies. This section outlines the empirical strategy I undertake to test for these equilibrium relationships in the data.

I construct a balanced panel of estimates of the immigrant-native employment ratio, the low-skill immigrant-native employment ratio, the high-skill employment ratio, the wages of natives and foreign-born, and rent from IPUMS data from the 1980, 1990, and 2000 Decennial Censues and the 2009-2011 3-year American Community Survey (ACS) at the MSA level, along with an instrument for local labor demand shocks and measures of local hosing supply elasticities to estimate the equilibrium relationship between key dependent variables and exogenous labor demand shocks across local labor markets in the U.S that have different housing supply elasticities. That is, the following empirical exercises are not causal in nature: I document equilibrium relationships as empirical evidence in support of the model's predictions when foreign-born are more mobile than natives, cities have different housing supply elasticities, and labor demand shocks vary by city.

5.1 Specification

This section details the specification I use to measure the reduced-form equilibrium effect of a labor demand shock on each dependent variable from section 4.3. I estimate a difference-in-difference specification using OLS. On the left-hand side is a dependent variable from the model, such as the change in the wage earned by natives, and on the right-hand side is the productivity shock its interaction with a measure of the local housing supply elasticity The coefficient on the interacted term will tell us the reduced form, differential effect of the Bartik labor demand shock on the equilibrium wage, rent, and population in cities with more inelastic housing supplies relative to cities with more elastic housing supplies.

I estimate the following equation:

$$\triangle Y_{ct} = \alpha + \alpha_t + \beta_1 D_c + \beta_2 Bartik + \beta_3 [D_c \times Bartik] + \beta_4 \triangle A_{ct} + \beta_5 X_{c1980} + \varepsilon_{ct}, \tag{15}$$

where α_t captures decade fixed effects, D_c is a dummy variable equal to 1 when the housing supply in city c is relatively inelastic based on two measures of the local housing supply elasticity, $\triangle A_{ct}$ represents a vector of changes in city-level amenities as measured by the number of Art & Recreation, Education, Food, Retail, and Transportation establishments per 1000 residents in city c at time t , and X_{c1980} is a vector of the (log) average household rent and wage in city c in the year 1980. I include these controls to account for initial differences in wages and cost of living across cities. $\triangle Bartik_{c,t}$ is the change in employment predicted by a proxy for exogenous changes in labor demand in city c at time t to be discussed in section 5.2. $\triangle Y_{ct}$ represents the change in six city-level endogenous variables of interest: the (log) average native household wage, the (log) average foreign-born household wage, average household rent, the high-skill employment ratio $(\frac{High-skill\ employment}{Low-skill\ employment})$, the immigrant-native employment ratio $(\frac{Immigrant\ employment}{Native\ employment})$, and the low-skill immigrant-native employment ratio $(\frac{Immigrant\ employment^{low\ skill}}{Native\ employment^{low\ skill}})$. The $\triangle$ operator represents the first difference over a decade; for example, the first difference of the log native household wage between 1990 and 2000. Thus, there is no need to include MSA fixed effects as they are implicitly removed by first differencing.

I estimate Equation (15) using, separately, the two measures of a city's housing supply elasticity described in section 2. I define the dummy variable, D_c, as equal to 1 when the measure of a city's housing supply elasticity exceeds the median value of its distribution; this is done separately for each measure. In the tables that follow I will refer to the dummy based on the WRLURI measure of housing supply elasticity as "$HighLURI$" and the dummy based on the LUI measure as "$HighLUI$." I choose to implement these measures as dummy variables because this provides results with the cleanest interpretation. This not without drawbacks: because the measures are continuous indices, the cut-off is somewhat arbitrary and will assign different dummy values to cities with index values on either side of the cut-off, where small differences in index values may not be meaningful differences. The best way to interpret this dummy variable is that a value of 1 indicates a group of cities with housing supplies that are *relatively* inelastic.

5.2 An Instrument for Changes in Labor Demand

When a city receives a labor demand shock that raises wages, this city becomes more attractive to workers - some of whom will choose to migrate into the city. This in-migration, however, also generates it's own migration response - in-migrating workers increase competition for housing, raising the cost of housing, leading to out-migration by some existing workers seeking a lower cost of housing. Alternatively, agglomeration forces could lead to additional in-migration as a result of the migration response to the labor shock (Moretti 2004, Glaeser and Gottlieb 2009, Glaeser and Resseger 2009, Desmet and Rossi-Hansberg 2009). In any case, it is reasonable to assume that observed changes in the population of workers across cities are endogenous, as are changes in wages and rents. Thus, identifying the response of endogenous local employment, wage, and rent for natives and foreign-born in response to a productivity shock requires exogenous variation in labor demand across cities. As a measure of exogenous labor demand shocks at the city level, I create a proxy for local productivity shocks in the spirit of Timothy Bartik (1991). This instrument calculates a change in employment in each city based on the industry composition of employment in the city when each industry grows at that industry's national growth rate.

Most similar instruments use either the change in industry wages or employment at the national level to capture national industry growth. This national growth rate is then interacted with the local level or share of industry employment (wage) to predict local employment (wage) growth based on local industry composition. I have opted for a third choice: an industry's share of gross value added. Gross value added measures the difference between the value of a final good or service and the value of the intermediate goods used as inputs; the sum of gross value added from every industry, nationally, is equal to GDP. Constructing the share of gross value added for each industry tells us the contribution each industry makes to total economic activity.

To measure the growth rate of industries nationally, I use the change in an industry's share of gross value added from the EU KLEMS database (O'Mahoney and Timmer 2009). This database contains value-added data for 34 industries using the NACE 2 classification system at the one- to two-digit industry-level from 1977 to 2010. It is constructed from detailed input-output tables by industry using a growth accounting framework. The latest release of the database includes gross value-added data for 11 OECD countries[10], including the United States. I have mapped the

[10]These 11 OECD countries are made up of nine European counties, Japan, and the United States. The nine

industries used by IPUMS (based on the Census's 1990 industry classification system) to 26 one- to two-digit NACE 2 industries[11].

This proxy for local labor demand predicts changes in city-level employment by interacting the local industry composition - measured as the metropolitan area share of employment for each industry - with the change in each industry's share of gross value added over each decade. This instrument represents plausibly exogenous, demand-induced variation in city-level employment under the exclusion restriction that changes in the national share of economic activity by industry is uncorrelated with unobserved shifts in metropolitan area labor supply.

To see why industry shares of value added can be used to construct an appropriate proxy for local productivity changes, it is useful to aggregate industries based on skill-intensity. Looking at the value added data in this way will reveal how clearly changes in industry shares of gross value added reflect two of the most important - and heavily studied - trends in the evolution of employment and wages among advanced economies since the 1980s.

Figure 8 aggregates 32 NACE 2 industries into four categories for high-skill- and low-skill-intensive services and manufacturing. Industries are defined as either a service or manufacturing industry according to their NACE 2 classification, and are further classified as either high-skill- or low-skill-intensive according to the share of labor compensation paid to high-skill workers[12] following Buera and Kaboski (2012) and Buera, Kaboski, and Rogerson (2015)[13]. The evolution of the distribution of economic activity across industries is clear: while high-skill-intensive manufacturing and low-skill-intensive services have contributed roughly the same share of economic activity over the entire 33-year period, high-skill-intensive services and low-skill-intensive manufacturing have diverged substantially. The transition of economic activity toward high-skill-intensive services reflects the rise in demand for high-skill labor documented by Katz and Murphy (1992), and an extensive literature examined by Acemoglu and Autor (2011). Further, the movement of the bulk of economic activity from low-skill-intensive manufacturing to high-skill-intensive services also reflects polarization in the labor market where rapid computerization of routine-task-intensive jobs

European countries with data in the EU KLEMS database are Austria, Belgium, Finland, France, Germany, Italy, Netherlands, Spain, and the United Kingdom.

[11]The EU KLEMS database reports data for 34 industries, but this includes as industries "Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use" and "Activities of extraterritorial organizations and bodies." These two NACE 2 industries are inconsistently measured in time across countries and IPUMS does not include similar codes for similar activity. In any case, these industries are quite small, so their exclusion should have minimal impact on my estimates. Further, I aggregate some two-digit NACE 2 industries to the one-digit level to ensure all industries are matched appropriately across the IPUMS and NACE 2 industry classification schemes. As such, I arrive at 26 industries from the 34 reported in the EU KLEMS database.

[12]Defined in the EU KLEMS database as holding at least a college degree.

[13]I use a newer release of the EU KLEMS data than Buera and Koboski (2012) and Buera et al. (2015) that uses the newer NACE 2 classification scheme rather than the NACE 1 scheme. The European Commission provides a crosswalk from NACE 1 to NACE 2 that I use to verify that I identify the same industries as high-skill- or low-skill-intensive as these earlier works.

has "hollowed out" the middle of the skill distribution and moved wage and employment growth to the tails, a fact documented by Autor and Dorn (2013). Further, we can look at how well the share of employment in, for example, high-skill-intensive services and low-skill-intensive manufacturing predicts future changes in wages, rent, and employment at the MSA-level. Figures 9 and 10 illustrates these trends.

Figure 9[14] plots the share of workers employed in high-skill-intensive services[15] in 1980 against total employment growth over the 1980-2010 period. This shows us a 1% increase in the share of employment in high-skill-intensive services in 1980 is associated with a 1.1% increase in total employment growth over the following 30 years; the relationship with wage and rent growth over the same period is even stronger.

Figure 10[16] plots the share of MSA workers employed in low-skill-intensive manufacturing in 1980 against total employment growth over the 1980-2010 period. Here, a 1% increase in the share of employment in low-skill-intensive manufacturing in 1980 is associated with a 1.4% decline in total employment growth over the next 30 years; the association with declines in wages and rent is even stronger.

These figures show cities in 1980 with a higher share of employment in industries that see relative gains in their contribution to total economic activity over the following 30 years experienced wage, rent, and employment growth; cities in 1980 with a higher share of employment in industries that experienced relative declines also experienced declining wages, rent, and employment. These figures demonstrate the trends we see in the gross value added data - trends reflecting important evolutions in employment and wage changes over the past 30 years - have a strong and meaningful relationship with the divergence of cities over the past 30 years according to their local industry composition.

To construct the shift-share instrument for local labor demand shocks, I interact changes in the share of gross value added by industry at the national-level with a city's industry composition as measured by industry j's share of total metro area employment. That is, I construct the following predicted change in MSA employment:

$$Bartik_{c,t} = \sum_{j=1}^{J} \varphi_{c,j,t-10} \times (\frac{\nu_{j,t} - \nu_{c,t-10}}{\nu_{c,t-10}}), t \in \{1990, 2000, 2010\} \tag{16}$$

where $\varphi_{c,j,t-10}$ is industry j's share of city c employment at time $t-10$ and $\nu_{j,t}$ is industry j's share of US gross value added at time t. For the remainder of the paper I refer to this instrument

[14] $\beta = 1.10$ and $s.e. = 0.721$.

[15] The x-axis of Figure 9 includes workers of *all* skill levels who are *employed* in a service industry identified as being "high-skill intensive." The x-axis of Figure 10 is similar: it includes workers of all skill levels employed in a manufacturing industry identified as being "low-skill intensive."

[16] $\beta = -1.41$ and $s.e. = 0.333$

as the *Bartik shock*.

The interaction of the Bartik shock with local housing supply elasticity gives the reduced form equilibrium relationship between each endogenous variable of interest and a labor demand shock across different elasticities of the local housing supply. That is, we can see how the responses of each endogenous variable varies across the elasticity of a city's housing supply when MSAs are hit with local labor demand shocks. Comparing this differential reaction across the endogenous variables of interest allows me to test the hypothesis that foreign-born workers are more mobile than native workers.

6 Main Results

In this section I test the empirical implications of the model discussed in section 4 using the labor demand shock developed in the previous section. The model produces the following predictions as the result of foreign-born workers having higher labor mobility than natives: When MSAs are hit with labor demand shocks:

1. The wages of natives living in nonrestricted-housing-supply MSAs grow more slowly than the wages of natives living in restricted-housing-supply MSAs after a labor demand shock;

2. Labor demand shocks cause the wages of foreign-born workers living in nonrestricted-housing-supply MSAs to grow faster than the wages of foreign-born workers living in restricted-housing-supply MSAs;

3. In restricted-housing-supply MSAs, labor demand shocks cause housing costs to grow faster than in nonrestricted-housing-supply MSAs; and

4. The Immigrant-Native employment ratio decreases in nonrestricted-housing-supply MSAs as natives move to the city with lower housing costs while the Immigrant-Native employment ratio rises in restricted-housing-supply cities as foreign-born workers are attracted to higher wages, being less deterred by high housing costs.

First, I will discuss the estimates of the change in the wages paid to native and foreign-born workers, and rents paid, across housing supply elasticity after cities are hit with labor demand shocks. Next, I will examine the differential effects of labor demand shocks on MSA employment ratios across housing supply elasticity.

6.1 Native and Foreign-born Wages and Average Rent

Table 5 reports the estimates of the effect of the Bartik labor demand shock - and its interaction with housing supply elasticity - on changes in the wages of native and foreign-born workers, as well as changes in average rent. Each set of estimates includes decade fixed effects; the specifications estimated in columns (2), (5), and (8) add controls for the change in local amenities; and columns (3), (6), and (9) add additional controls for the average MSA wage and rent in 1980 as pre-period controls. Panel A reports results when utilizing the WRLURI measure of housing supply elasticity, while Panel B reports the results when utilizing the Land Unavailability Index measure of housing supply elasticity.

Focusing on Panel A, columns (1)-(3) estimate the effect of the Bartik demand shock across housing supply elasticity on the change in the wages of natives. We can see the estimates of the noninteracted Bartik shock are both significant and smaller than 1, while the effects of the Bartik shock on native wages in restricted-housing-supply MSAs are both significant and positive. Hence, a labor demand shock of equal magnitude generates greater wage growth for natives in restricted-housing-supply MSAs than in nonrestricted-housing-supply MSAs, a result the model predicts is due to a slower migration response from natives to the labor demand shock.

Columns (4)-(6) show estimates of the effect of the Bartik demand shock on the change in foreign-born wages by housing supply elasticity. Unlike the wages of natives, labor demand shocks do not have the same effect on wage growth for foreign-born workers in restricted-housing-supply MSAs - growth in wages is no faster in restricted-housing-supply MSAs than in nonrestricted MSAs, and importantly, is also slower than that of natives. However, wage growth for foreign-born workers in nonrestricted-housing-supply MSAs is not found to be faster than natives. This is potentially a sign the native-immigrant complementarity implied by the Cobb-Douglas specification of production is too strong to fit the observed data. Another potential explanation not captured by the model is that labor demand shocks in nonrestricted-housing-supply MSAs may create an additional immigration response, as many of these areas are more rural and agriculture-centric. In any case, it is important to note that foreign-born workers see increases in their wages in MSAs receiving positive labor demand shocks.

Columns (7)-(9) show estimates of the effect of the Bartik demand shock on the change in average rent by housing supply elasticity. These results follow the model quite closely: a labor demand shock increases the rent in nonrestricted-housing-supply MSAs by an amount smaller than the shock - an *elastic* response - while the same labor demand shock increases the average rent in restricted-housing-supply MSAs by an amount larger than the shock - an *inelastic*c response. This is a due to the extra cost (either in resources, time, or both) of building new housing in response to migration creating a tighter housing market, thereby increasing the price of housing.

Turing our attention to Panel B, which changes the measure of housing supply elasticity to the Land Unavailability Index, we can see the estimates of the differential impact of labor demand shocks across different housing supply elasticities is quite similar. Growth in the wages of natives is slower in nonrestricted-housing-supply MSAs than in restricted-housing-supply MSAs, growth in the wages of foreign-born workers is slower than the growth in labor demand and in the wages of natives in restricted-housing-supply MSAs, and labor demand shocks grow the cost of housing in restricted-housing-supply MSAs by more than the size of the labor demand shock.

6.2 Population Ratios

Table 6 reports the results of estimating the effect of the Bartik labor demand shock on the change in the foreign-born ratio, the low-skill-foreign-born ratio, and the high-skill ratio[17]. This table follows the same structure as Table 5 in terms of the controls that are included under each column, and both panels feature a different measure of housing supply elasticity at the MSA level.

Columns (1)-(3) of Panel A report the estimates of the effect of the Bartik shock on the MSA-level change in the Foreign-born ratio differentially across housing supply elasticity as measured by the WRLURI. We can see that when a nonrestricted-housing-supply MSA receives a positive labor demand shock, the effect is an imprecisely measured negative effect. This imprecise negative effect could be the result of the migration of native workers to nonrestricted-housing-supply MSAs that also receive positive shocks, while the change in the foreign-born ratio is less clear on nonrestricted-housing-supply MSAs that receive negative labor demand shocks, leading to an imprecise negative effect. Restricted-housing-supply MSAs, on the other hand, experience significant growth in the foreign-born ratio as the result of a labor demand shock. This result suggests that foreign-born persons are attracted to higher wages, even in cities with higher housing costs: we know restricted-housing-supply MSAs have higher wages, so an equally-sized increase in wages in these cities translates to a larger nominal wage. Additionally, as suggested by the stylized facts of Section 3, this rather large effect is likely a combination of foreign-born in-migration and native out-migration.

Similarly, columns (4)-(6) of Panel A show an even stronger positive effect of the labor demand shock on changes in the low-skill-foreign-born ratio. Combined with the stylized facts and the results on the change in the foreign-born ratio, this large positive effect could be the result of low-skill native out-migration, specifically. Since we know high-skill native workers are migrating to high-wage cities (Costa & Kahn 2000; Shapiro 2010; Moretti 2012; Moretti 2013; Ganong and Shoag 2013; Diamond 2016), and these are more likely to have inelastic housing supplies, we

[17] Recall these ratios are defined, respectively, as $\frac{\text{foreign-born population}}{\text{native population}}$, $\frac{\text{foreign-born population}^{\text{low-skill}}}{\text{native population}^{\text{low-skill}}}$, and $\frac{\text{high-skill population}}{\text{low-skill population}}$.

should expect to find a larger effect on the low-skill-foreign-born ratio if it is indeed the case that migration to these cities has been skill- *and* nativity-biased.

Additionally, I estimate the effect of the Bartik shock on changes in the high-skill ratio as a test that my empirical strategy finds the same results as the existing literature studying the migration of high-skill workers over the past three decades. Like the existing literature[18], the estimates reported in columns (7)-(9) of Panel A are consistent with the migration of high-skill workers to rich cities that are also experiencing faster growth in the cost of housing. The high-skill ratio in nonrestricted-housing-supply MSAs is either shrinking or stagnant, while it is growing in restricted-housing -supply MSAs.

Panel B reports the same results, but use the Land Unavailability Index. These results are remarkably similar to the estimates found in Panel A, though the estimates are less precisely measured. The change in the foreign-born ratio is large and positive, while the change in the low-skill-foreign-born ratio is larger and also positive, as in Panel A. The effect of the labor demand shock on the change in the high-skill ratio, however, is an imprecisely measured positive effect. Like in Panel A, the effect on nonrestricted-housing-supply MSAs is either close to zero or negative. The more imprecisely measured results in Panel B may be the result of a weaker connection between average wages and rent found in the stylized facts of Section 3, such that some cities that are geographically restricted may not share as many of the qualities high-skill and foreign-born workers find attractive as cities with regulatory restrictions.

7 Robustness Checks

7.1 Threats to Identification

My estimation strategy faces two main threats to identification: The first threat originates with the housing supply elasticity measures, while the second comes from assuming the Bartik shock is exogenous.

The main issue with the measures of housing supply elasticity is the WRLURI and LUI are not panel measures - they are measures at a single point in time, and enter Equation (15) as fixed across decades. Hence, my specification implicitly assumes the same cities that have relatively more inelastic housing supplies in 2008 also had relatively more inelastic housing supplies in 1980. It is not clear whether this is true for all cities in my sample. If this is not the case, then there is measurement error in HR_c and estimates of the coefficients in Equation (15) will suffer from attenuation bias. In the case of a dummy variable, in which case the measurement error is

[18] See Berry & Glaeser (2005), Beaudry, Doms, and Lewis (2008), Moretti (2013), Notowidigdo (2011, and Diamond (2016)

perfectly negatively correlated [19], Aigner (1973) found the amount of attenuation bias depends on the probability a city's housing supply is indicated as being relatively inelastic when it truly is, and on the probability a city's housing supply is indicated as being relatively inelastic when it actually is not. Further, Card (1996) determined, in the case of a multivariate regression, this attenuation bias is also affected by how correlated the additional regressors are with the elasticity of housing supply; in this case, how correlated the *measures* of the housing supply elasticity are with the Bartik shock. The more correlation there is between the Bartik shock and the housing supply elasticity, the greater the attenuation bias. The sign (and size) of this attenuation bias is unclear without knowledge of the aforementioned probabilities and correlation.

Saks (2008) constructs a composite index from six surveys of housing supply regulations. These surveys covered various jurisdictions from cities to states and date from the mid-1970s to the late-1980s; all but one survey collected data before 1985[20]. However, not all metropolitan areas are surveyed in each source - Saks is able to generate the composite index for only 83 metropolitan areas. As a quick check on the persistence of housing supply regulations, I visually compared the ranking of MSAs using the composite index of Saks (2008) with the ranking of MSAs under the WRLURI. While each index doesn't observe all of the same metro areas, cities that tend to be highly ranked using Saks' index are also highly ranked under the WRLURI; many low ranked cities in Saks' index have similarly low ranks in the WRLURI. While not an ideal test, this suggests there is some degree of persistence in relative housing supply elasticity.

The second threat to identification with my estimation strategy is the assumption of exogeneity. The Bartik instrument must be uncorrelated with the error term and also must satisfy the exclusion restriction. While I estimate reduced form equations based on analytic results from the model, where exogeneity is a structural assumption, the reliability of my reduced form estimates depends on the empirical validity of exogeneity. To address this threat to identification, I employ an instrument for changes in U.S. value added shares in a robustness check.

7.2 An Instrument for the Bartik Shock

To ensure the instrument meets the exclusion restriction, some authors compute the Bartik instrument by leaving out each city's own contribution to national changes. However, this could create new problems when industries are concentrated in one or a few cities. For example, 20% of total

[19] If the dummy is equal to 1, measurement error can only be negative. If it is equal to zero, then measurement error is positive. Hence, mismeasurement is perfectly negatively correlated with the true value of the dummy variable.

[20] I have a plan to estimate the attenuation bias and recover unbiased estimates. Card (1996) implements a method for estimating the attenuation bias; I think I can implement a similar procedure using the MSA data from Saks (2008) together with the WRLURI data in a linear probability model to estimate the two probabilities discussed above. If I then estimate the correlation between the Bartik shock and the measures of housing supply elasticity using OLS, this will let me estimate the attenuation bias, and then to produce an estimate of the unbiased betas.

employment in the “Coke and refined petroleum products” industry was located within the Houston, TX MSA in 2010, up from 10% in 1980. Los Angeles, CA was home to 15% of the “Textiles, wearing apparel, leather, and related products” industry in 2010. Additionally, at least 10% of total employment in multiple industries across all years is concentrated within the New York, NY MSA. Ideally, construction of the instrument should include these MSAs in national trends to maximize the power of the instrument. Including these localities, however, could violate the exclusion restriction as many city-level characteristics are influenced by the composition of local industry. While the data on changes in value added shares in the U.S. does not allow a cities own contribution to be removed, the international scope of EU KLEMS admits an alternate strategy: I can use change sin value added shares from 10 other OECD countries. The trends in value-added shares across skill intensity in these countries closely matches the trends in the United States[21], and yet are unlikely to be correlated with any local characteristics of U.S. cities [22]

I construct an instrument for the Bartik shock using the change in value-added share by industry as measured by the *average* change in value-added shares across 10 OECD countries[23]. In other words, I recalculate the Bartik shock as,

$$Bartik_{c,t}^{OECD} = \sum_{j=1}^{J} \varphi_{c,j,t-10} \times (\frac{\overline{v}_{j,t}^{OECD} - \overline{v}_{c,t-10}^{OECD}}{\overline{v}_{c,t-10}^{OECD}}), t \in \{1990, 2000, 2010\} \tag{17}$$

where $\varphi_{c,j,t-10}$ is industry j's share of city c employment at time $t-10$ and $\overline{v}_{j,t}^{OECD}$ is industry j's average share of gross value added across 10 OECD countries at time t. I use $Bartik_{c,t}^{OECD}$ - the *OECD Bartik shock* - as an instrument for $Bartik_{c,t}$, and re-estimate equation 15.

The trend in value-added shares across industries are quite similar among all 11 OECD countries, but *changes* in the share of value added by industry in OECD countries should be uncorrelated with any local characteristics of U.S. cities.

7.2.1 First-Stage Results

The instrumental variables approach to estimating equation 15 treats $\triangle Bartik_{ct}$ and $D_c \times \triangle Bartik_{ct}$ as endogenous regressors. Hence, at least two excluded instruments are needed for a just-identified model. I use both $\triangle Bartik_{ct}^{OECD}$ and $D_c \times \triangle Bartik_{ct}^{OECD}$ as instruments for the respective right-

[21] See Buera, Kaboski, and Rogerson (2015) for detailed documentation of these similarities.

[22] This method is similar in application to Ellison, Glaeser, and Kerr (2010) who use input-output measures for UK industries as instruments for U.S. input-output relationships to obtain measures of agglomeration forces (i.e., Marshallian factors) that are orthogonal to endogenous variation in the coagglomeration patterns of U.S. industry. That is, if two industries are coagglomerated in the U.S. because of a geographic accident (e.g., bauxite deposits happen to be located near sugar canes), this is unlikely to be the case in the United Kingdom.

[23] These 10 OECD countries are: Austria, Belgium, Spain, Finland, France, Germany, Italy, Japan, Netherlands, and the United Kingdom.

hand side endogenous variables. Thus, I must estimate two first-stages - one for each excluded instrument.

Table 7 shows the results of each first-stage using the change in the OECD Bartik Shock and its interaction with local housing supply elasticity as instruments for changes in the U.S. Bartik Shock across housing supply elasticity. Columns (1) and (2) show how well the OECD Bartik shock predicts the change in the U.S. Bartik shock without the inclusion of any included exogenous regressors other than decade fixed effects. Columns (3) and (4) add controls for changes in local amenities as included exogenous regressors. Columns (5) and (6) add the local mean wage and rent in 1980 as included exogenous regressors. We see the predictive power is strong in all cases: the coefficients on the instruments are statistically significant and close to one across all columns, though the interacted instrument is not too correlated with the noninteracted Bartik shock, though this isn't surprising. The Kleibergen-Paap rk Wald F statistic[24], a heteroskedastic-robust weak identification test of the excluded instruments, ranges between 115 and 107 when using the WRLURI and between 82 and 80 when using the LUI. These values are relative to a critical value of 7.03 under the most rigorous size reported[25].

7.2.2 Instrumental Variables Results

Table 8 presents the results of estimating equation 15 when the Bartik Shock is instrumented by the OECD Bartik Shock, estimated using 2-step Generalized Method of Moments (GMM). Columns (1)-(3) report estimates of the effect of the Bartik shock on the mean wage paid to native workers, columns (4)-(6) report estimates of the effect of the Bartik shock on the mean wage paid to foreign-born workers, and columns (7)-(9) report estimates of the effect of the Bartik shock on mean rent. All columns include decade fixed effects, the second column for each dependent variable adds controls for the change in local amenities, and the third column for each dependent variable adds additional controls for the average MSA wage and rent in 1980 as pre-period controls. Panel A reports estimates using the WRLURI measure of housing supply elasticity, while Panel B reports estimates using the LUI measure of housing supply elasticity.

Focusing on Panel A, I find the results across every dependent variable are quite similar to the OLS estimates in section 6.1. Like in Table 5, I find the average wage paid to natives increases as a result of the Bartik shock in both restricted and nonrestricted-housing-supply cities, but the average wage paid to natives increases by a larger amount in restricted-housing-supply cities. That is, a 1% increase in the Bartik shock is associated with an increase in the average wage paid to natives of approximately 0.7% in nonrestricted-housing-supply cities, while the average wage

[24] See Kleibergen-Paap (2006) for a discussion of this statistic.

[25] See Stock and Yogo (2005) for a table of critical values and corresponding test sizes for the Kleibergen-Paap rk Wald F statistic for two endogenous regressors and two exogenous instruments.

paid to natives increased by approximately 1.4% in restricted-housing-supply cities. Similarly, the increase in the average wage paid to foreign-born workers is found to not be significantly different from zero, though the point estimates do suggest a larger increase in wages than the OLS results. The estimates of the change in average rent are quite similar to the OLS results, though the difference between restricted- and nonrestricted-housing-supply MSAs is not statistically different from zero.

Turning our attention to Panel B, the results look mostly quite similar to the IV results in Panel A and the OLS results in Table 5 with the exception of the results for changes in the average wage paid to foreign-born workers: the Bartik shock increases averages wages paid to foreign-born workers much more in restricted-housing-supply cities. This result runs counter to the predictions of the model.

Table 9 is similar in structure to Table 6, reporting the effect of changes in the Bartik shock on changes in the foreign-born ratio, the low-skill-foreign-born ratio, and the high-skill ratio. The IV results are also quite similar to the OLS results. In Panel A, I find a 1% change in the Bartik shock changes the foreign-born ratio in nonrestricted-housing-supply MSAs by -1.5% and by 4.4% in restricted-housing-supply MSAs, changes the low-skill-foreign-born ratio by -1.8% and 5.6%, and has no statistically significant effect on the high-skill ratio. The estimates reported in Panel B are quite similar to the OLS estimates found in Panel B of Table 6, and are similarly less precise than when using the WRLURI measure of housing supply elasticity. Overall, these results are consistent with the predictions of the model, which predicts the foreign-born ratio to decrease in nonrestricted-housing-supply MSAs and increase in restricted-housing-supply MSAs. Worth noting are the estimated coefficients in columns (1)-(6) on the noninteracted Bartik shock - the effect on nonrestricted-housing-supply MSAs.

Unlike the OLS results in Table 6, the IV estimator precisely estimates a negative effect of the shock on the ratios of foreign-born and low-skill-foreign-born in nonrestricted-housing-supply MSAs, while the marginal effect in restricted-housing-supply cities is quite similar to the OLS estimates. These findings are consistent with both the predictions of the model and with the stylized facts in section 3 that were suggestive of a scenario in which low-skilled natives migrate to low housing cost MSAs with higher wages, while foreign-born and high-skill natives migrate toward cities with the highest wages[26].

[26] Recall that the stylized facts of section 3 showed wages are higher in cities with more restricted housing supplies. That is, the highest-wage nonrestricted-housing-supply cities still have lower wages than high wage, restricted-housing-supply cities

7.3 The Employment-based Bartik Shock

The heart of what makes the Bartik instrument a plausibly exogenous predictor of local labor demand is the recognition that local shocks to industry should average out at the national level. For example, Hurricane Sandy likely had very local effects on New Jersey cities and counties along the Atlantic Coast, reducing labor demand in retail and tourism, and raising it in construction. At the same time, labor demand in these industries likely evolved quite differently in Missoula, Montana. If we take all of these local shocks by industry and average them out nationally, however, then we should be left with a trend in labor demand across industries that is relatively exogenous to local outcomes. The vast majority of research utilizing the Bartik labor demand shock - including Bartik (1991) - measures the national trend in labor demand by constructing a time series of industry employment shares at the national level. The local Bartik shock is then constructed by taking a weighted average of these national industry employment shares, using as weights the local share of employment by industry (the local industry composition). This paper, however, measures the national trend in labor demand by constructing a time series of each industry's share of gross value-added at the national level, described in section 5.2. As a robustness check, I construct an alternative Bartik shock using national industry employment shares and re-estimate Tables 5 and 6.

This alternative specification of the Bartik labor demand shock - $Bartik_{c,t}^{Emp}$ - is constructed identically to the value-added-based Bartik shock. That is,

$$Bartik_{c,t}^{Emp} = \sum_{j=1}^{J} \varphi_{c,j,t-10} \times \left(\frac{\mu_{j,t} - \mu_{c,t-10}}{\mu_{c,t-10}}\right), t \in \{1990, 2000, 2010\} \tag{18}$$

where $\varphi_{c,j,t-10}$ is industry j's share of city c employment at time $t-10$ and $\mu_{j,t}$ is industry j's share of US employment at time t. I then re-estimate equation 15 with OLS using $Bartik_{c,t}^{Emp}$ as the local labor demand shock.

Table 10 reports the effect of changes in $Bartik_{c,t}^{Emp}$ on the mean wages of natives and foreign-born workers, and on mean rent at the local level across different housing supply elasticities. As previous tables, Panel A shows estimates when the WRLURI is used to measure the elasticity of the local housing supply, while Panel B shows estimates using the LUI.

Focusing on Panel A, we see the estimates of the effect of the Bartik labor demand shock are quite similar to those using the value-added-based Bartik shock. The wages of natives increase in all cities, but more slowly in nonrestricted-housing-supply cities. The effect on changes in the average wage paid to foreign-born workers is imprecisely estimated, but the signs of the point estimates are consistent with the predictions of the model and most of the results using the value-added-based Bartik shock. The effect on the change in local mean rent for restricted-housing-supply cities is quite similar to previous estimates, but the employment-based Bartik has little effect on mean rents in nonrestricted-housing-supply cities. Overall, these results are largely consistent with what is predicted by the model. The estimates in Panel B are quite similar to those in Panel A, and thereby to previous estimates.

Table 11 reports the effect of changes in $Bartik_{c,t}^{Emp}$ on changes in the foreign-born, low-skill-foreign-born, and high-skill ratios across housing supply elasticity. The structure of this table is similar to Table 6.

I find results reported in both Panels A and B quite similar to the IV results reported in Table 9, though the effect for nonrestricted-housing-supply cities is measured imprecisely relative to the IV results. As such, the effect of the employment-based Bartik shock on changes in the foreign-born and low-skill-foreign- born ratios are very similar to both the OLS and IV estimates produced using the value-added-based Bartik shock. Overall, I find that the effects of labor demand shocks across housing supply elasticity on the endogenous variables of interest are robust to changes in estimation technique and to alternative specifications of the Bartik labor demand shock.

8 Conclusion

Over the past 30 years, the cities with large shares of high-skill-intensive service industries have experienced the fastest wage and employment growth. However, they have also experienced an increase in the cost of housing, as their expansion has run up against geographic and regulatory restrictions on the growth of their housing supplies. As labor demand growth in these cities has only continued, both wages and housing costs have increased further. As a result, these cities have become attractive for both their high wages and desirable amenities (Moretti 2012; Moretti 2013; Diamond 2016).

As I have shown, high-skill natives and foreign-born workers across both skills levels have continued to migrate to high-wage, high-rent cities in response to labor demand shocks[27], while the population of low-skill natives has stagnated or shrunk. Some evidence suggests these workers may be moving to higher-wage, lower-rent cities. Thus, migration to high-wage, high-rent cities has been skill *and* nativity-biased. This result has a few important implications for existing literatures.

First, the results presented in this paper are relevant to the continuing study of wage inequality in the United States: as rents rise in these high-wage, restricted-housing-supply cities, the benefits of the growth in these cities is concentrated to these cities' existing populations and migrants more willing, or able, to bear the costs. As long as labor demand continues to be strong in these cities, and the supply of housing is limited either by geography or local policies, wage growth will continue to accrue to existing residents. The overall effect on wage inequality, however, isn't

[27] This argument is rooted in earlier work on the migration response to demand shocks, particularly Blanchard & Katz (1992) and Bound & Holzer (2000).

clear: rising rents have both an inequality-generating and real inequality-reducing effect. Higher rents lock out potential migrants who could benefit from higher wages, limiting who can benefit from the economic opportunities in cities, while higher rents also reduce the real wage inequality in cities by eating into the growth of wages.

The concentration of high-skill foreign-born and native workers is relevant to the study of agglomeration forces in cities. Work by Arzaghi & Henderson (2008); Ellison, Glaeser, & Kerr (2007); Glaeser & Gottlieb (2009); Glaeser & Resseger (2009); Kolko (2010); and others have shown that the co-location of workers and firms, as well as the density of workers, are increasingly important in the generation of agglomeration effects within cities. This implies that the current nativity and skill-biased pattern of migration may only lead to further increases in worker productivity and, thereby the demand for labor, in these cities. The effect of agglomeration in cities under these circumstances, again, becomes unclear: if these forces of agglomeration are important drivers of overall economic growth, then restricted housing supplies could threaten the continuation of these effects by limiting migration. However, if the effect of agglomeration outpaces rent growth, then this could lead to inequality-increasing wage growth in these cities by further concentrating the benefits of agglomeration to urban workers.

Lastly, sorting along nativity and skill also has political implications: as high-skill and foreign-born workers concentrate together in cities, their political power becomes more concentrated geographically. The structure of the Electoral College in the United States is designed to reduce the political power of geographically-concentrated voters, meaning that the political views of high-skilled workers could be diluted if they continue to concentrate in a few urban areas. This could continue, and perhaps worsen, the political divisions across states and within the Legislative branch that were widely discussed in the news media throughout the presidency of Barack Obama and throughout the 2016 Election season. Additionally, the concentration of immigrants may diverge voter attitudes toward immigrants, as positive attitudes toward immigrants have been shown to be correlated with the local share of immigrants.

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Figures

Figure 1: Change in High-skill Population Ratio, 1980-2010

(a) By WRLURI

(b) By LUI

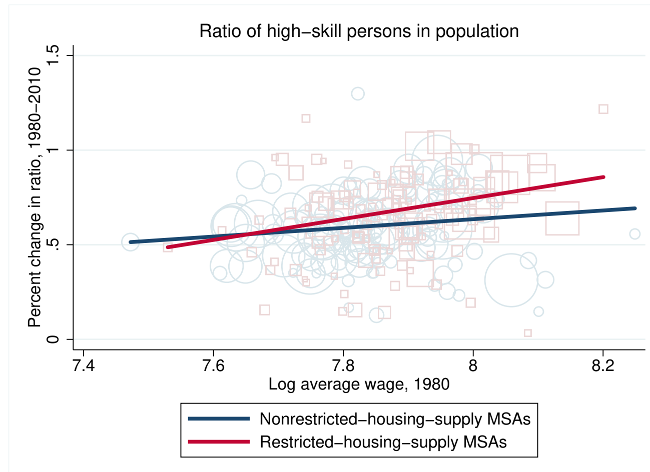
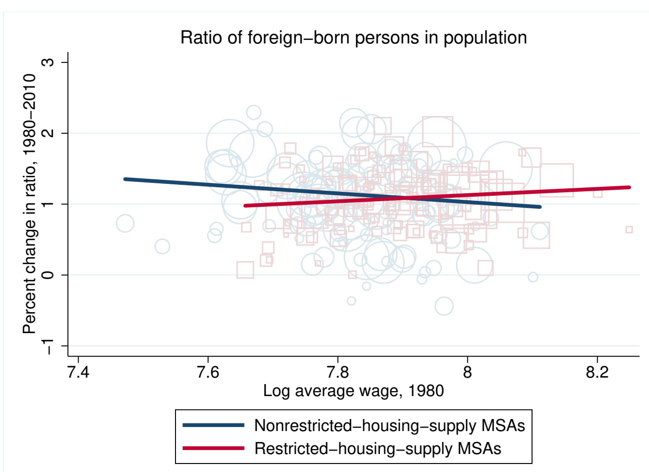


Figure 2: Change in Foreign-born Population Ratio, 1980-2010

(a) By WRLURI



(b) By LUI

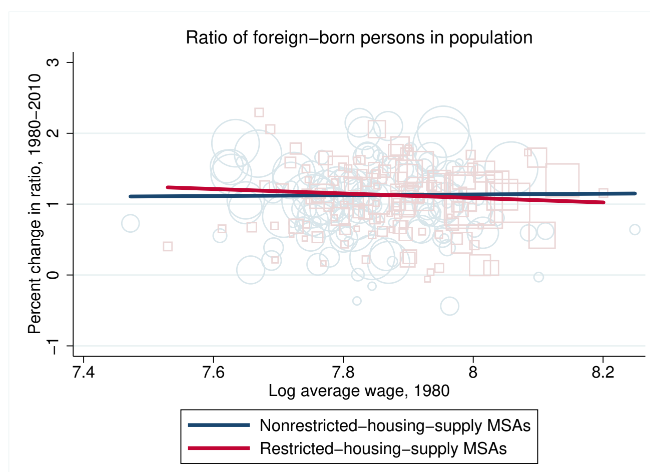
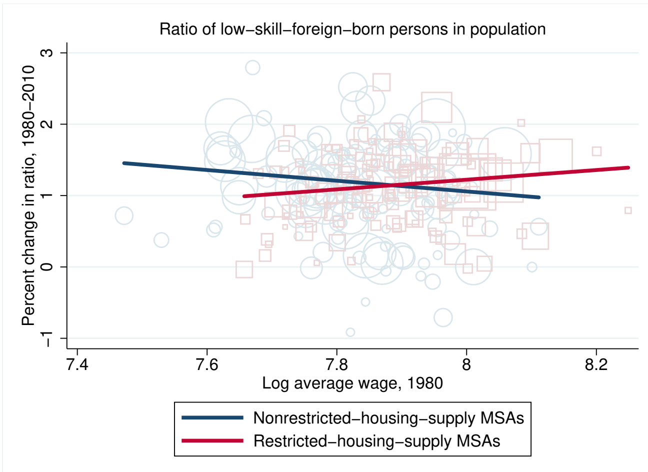


Figure 3: Change in Low-skill-foreign-born Population Ratio, 1980-2010

(a) By WRLURI



(b) By LUI

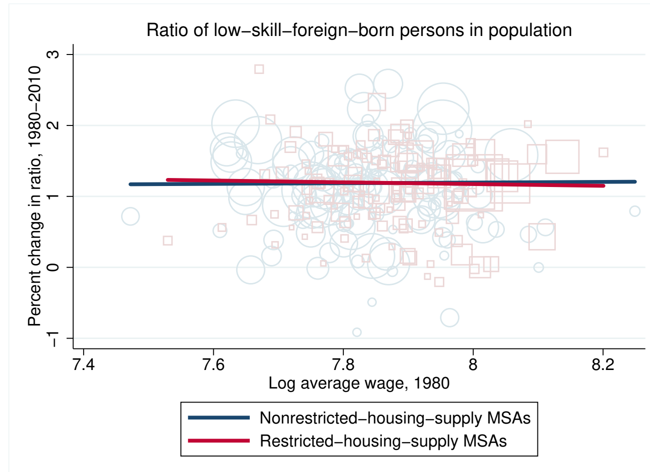
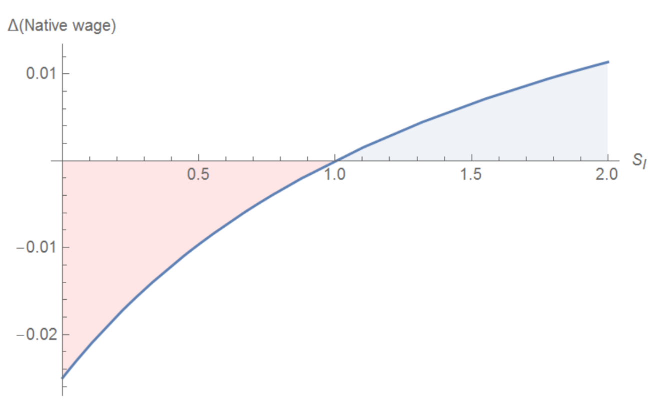


Figure 4: Change in the wages of native workers

(a) City A



(b) City B

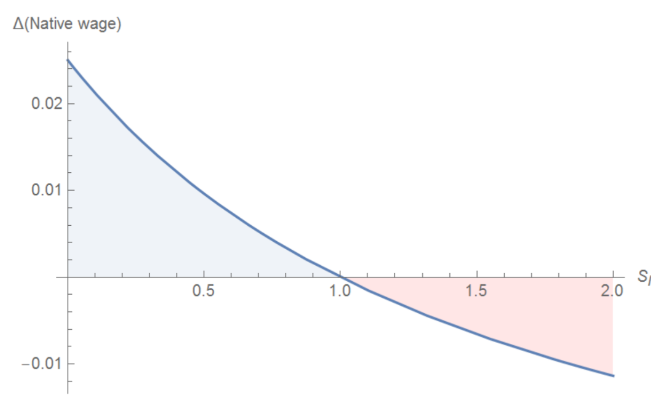


Figure 5: Change in the wages of foreign-born workers

(a) City A (b) City B

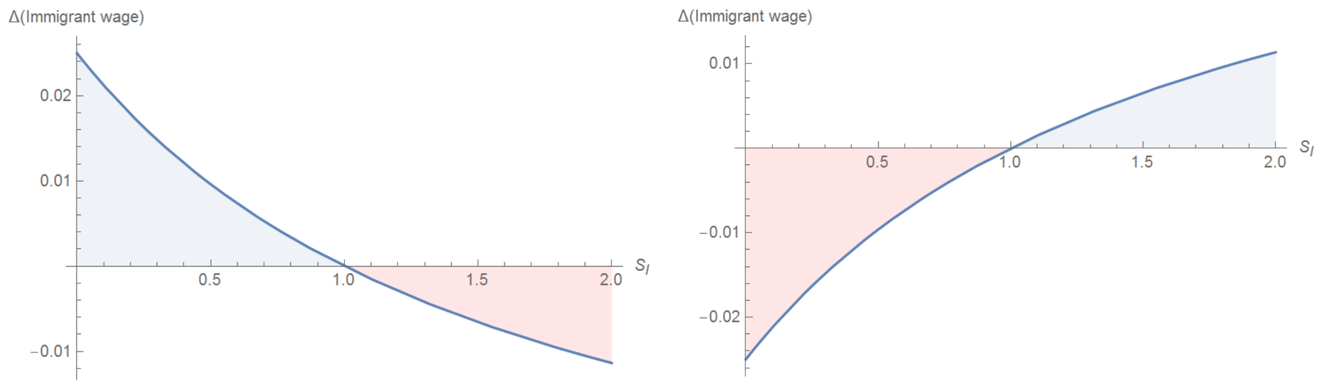


Figure 6: Change in the rental price of housing

(a) City A (b) City B

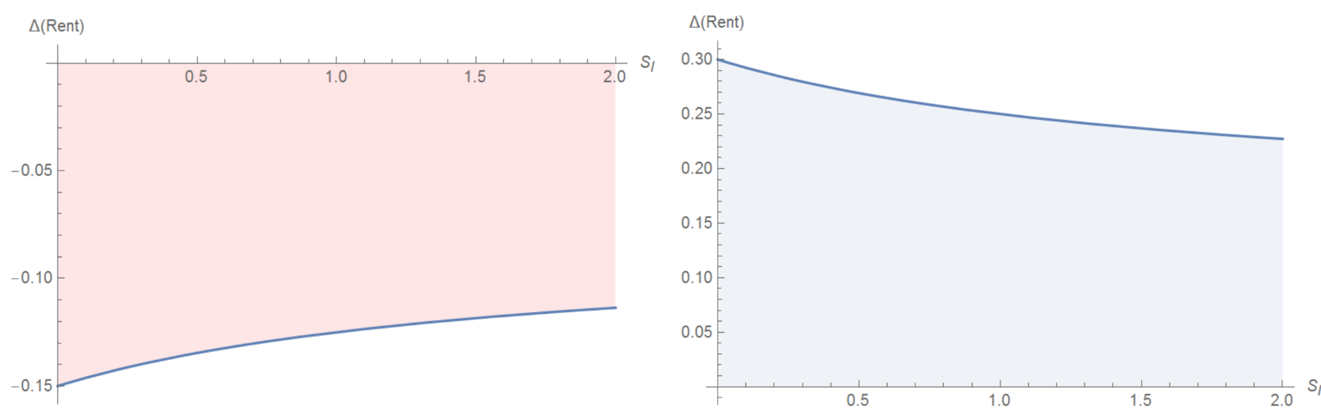


Figure 7: Change in the Immigrant-Native employment ratio

(a) City A (b) City A

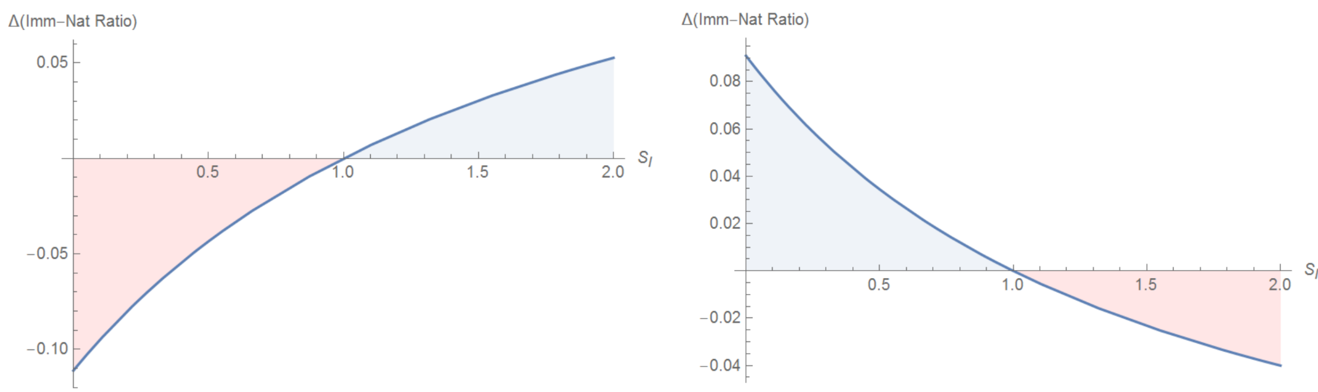


Figure 8: Share of Gross Value-Added by Skill-intensive Sector, United States, 1977-2010

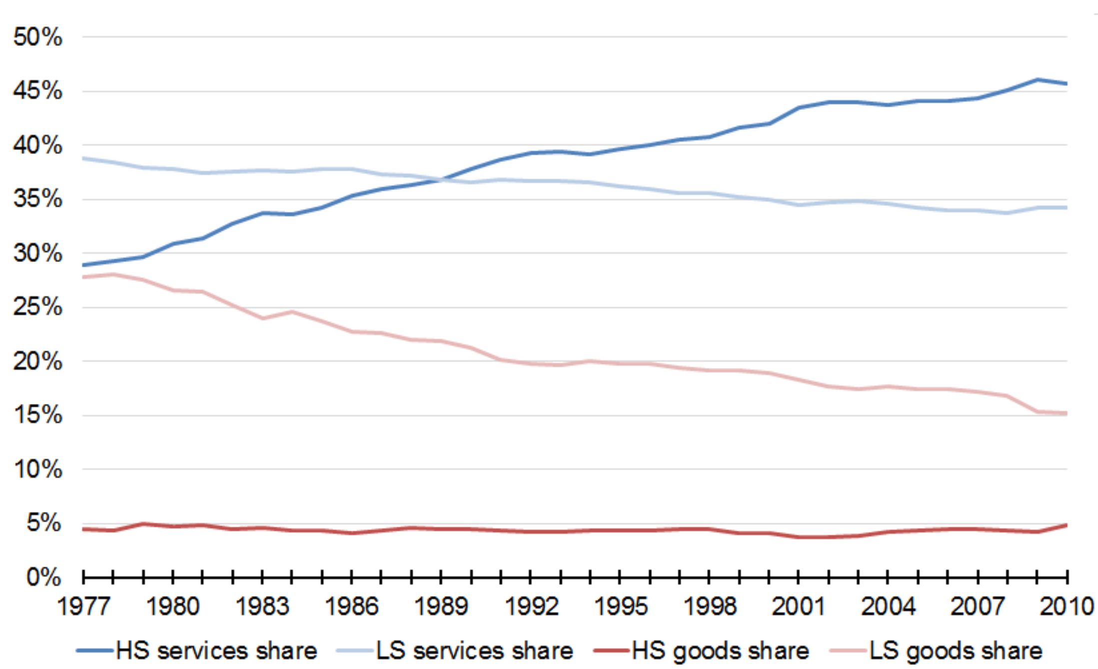


Figure 9: Employment in High-skill-intensive Services in 1980 and MSA Employment Growth, 1980-2010

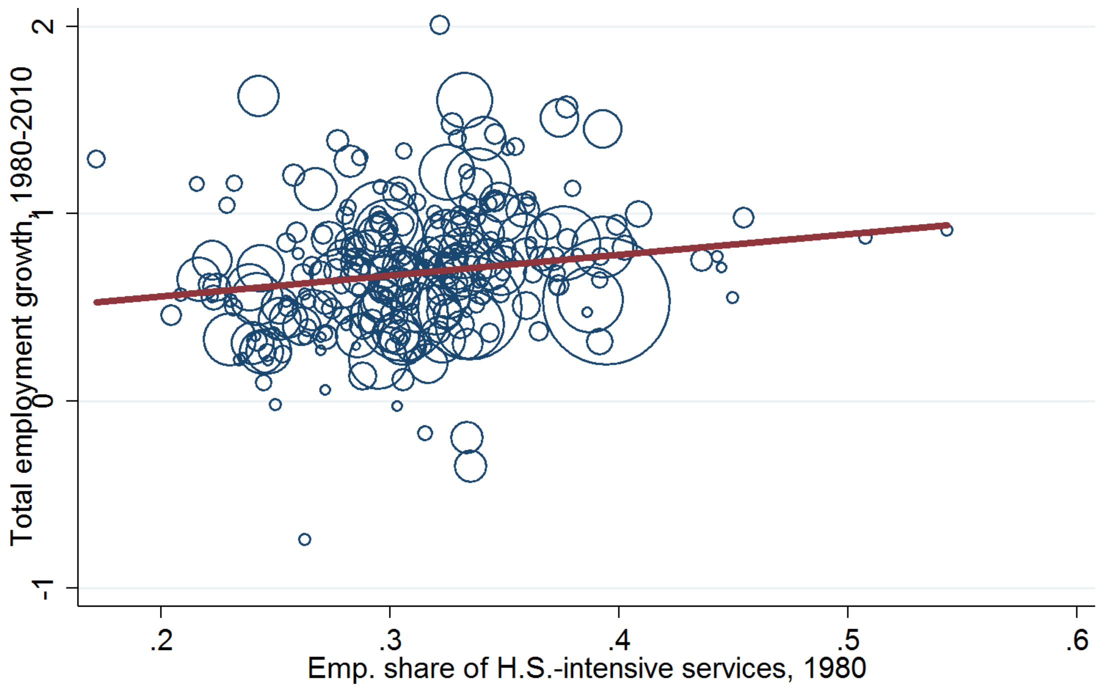
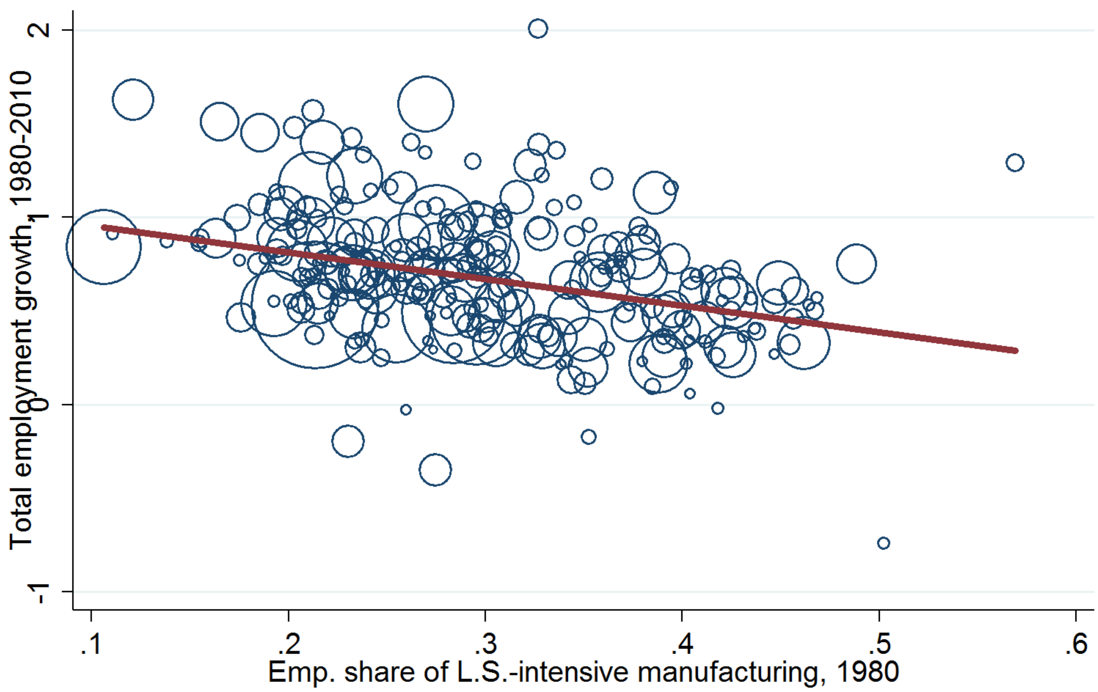


Figure 10: Employment in Low-skill-intensive manufacturing in 1980 and MSA Employment Growth, 1980-2010



Tables

Table 1: The relationship between housing supply elasticity and city characteristics

	(1)	(2)	(3)	(4)	(5)
Panel A. Wharton Residential Land-Use Regulatory Index (WRLURI)					
	MSA mean wage	MSA mean rent	High-skill Ratio	Foreign-born ratio	Foreign-born ratio, low-skill
WRLURI rank	0.738***	0.872***	0.609***	0.709***	0.702***
	[0.0893]	[0.134]	[0.0676]	[0.205]	[0.208]
Observations	992	992	992	992	992
R-squared	0.353	0.472	0.301	0.23	0.225
Panel B. Land Unavailability Index (LUI)					
	MSA mean wage	MSA mean rent	High-skill Ratio	Foreign-born ratio	Foreign-born ratio, low-skill
LUI rank	0.649***	0.711***	0.471***	0.758***	0.752***
	[0.0906]	[0.148]	[0.0612]	[0.164]	[0.169]
Observations	992	992	992	992	992
R-squared	0.349	0.4	0.23	0.335	0.329

Notes: Rank is based on each MSAs assigned index value for each measure of housing supply elasticity. MSAs are ranked from smallest to largest; that is, the MSA with the smallest index value receives rank 1. Population independent variables are calculated for each MSA using a sample of people aged 18-64 who did not live in group quarters. The wage sample is further restricted to people who worked at least 1 week in the previous year and earned a positive wage. Each regression includes decade fixed effects, and robust standard errors are clustered by state. The coefficients in each column are standardized, or "beta" coefficients.

Table 2: Changes in MSA population by nativity-skill group across housing supply elasticity, 1980-2010

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A. Wharton Residential Land-Use Regulatory Index (WRLURI)							
	Total Pop.	Native	Foreign born	High-skill native	High-skill foreign born	Low-skill native	Low-skill foreign born
WRLURI rank	3,737**	-89.30	3,826**	1,710**	1,380**	-1,799**	2,445**
	[1,634]	[351.8]	[1,656]	[720.0]	[605.1]	[786.6]	[1,063]
N	252	252	252	252	252	252	252
R^2	0.111	0.000	0.145	0.147	0.160	0.128	0.135
Panel B. Land Unavailability Index (LUI)							
	Total Pop.	Native	Foreign born	High-skill native	High-skill foreign born	Low-skill native	Low-skill foreign born
LUI rank	3,686**	-463.8	4,150**	1,571**	1,438**	-2,035***	2,712**
	[1,683]	[321.5]	[1,607]	[755.0]	[582.4]	[670.4]	[1,036]
N	252	252	252	252	252	252	252
R^2	0.138	0.016	0.218	0.158	0.221	0.209	0.211

Notes: Rank is based on each MSAs assigned index value for each measure of housing supply elasticity. MSAs are ranked from smallest to largest; that is, the MSA with the smallest index value receives rank 1. The independent variables are calculated for each MSA using a sample of persons aged 18-64 who did not live in group quarters. Coefficients are in units of people and each regression includes decade fixed effects, and robust standard errors are clustered by state.

Table 3: Relationship between lagged migration and population shares, mean wage, and mean rent

	(1)	(2)	(3)	(4)	(5)
Panel A. Wharton Residential Land-Use Regulatory Index (WRLURI)					
	High-skill Share	Foreign-born share	Low-skill foreign-born Share	MSA mean wage	MSA mean rent
In-migration$_{-1}$	-0.0521	0.165***	0.208***	0.00591	0.132**
	[0.103]	[0.0567]	[0.0517]	[0.0831]	[0.0581]
HighLURI $= 1 \times$ In-migration$_{-1}$	0.377***	0.218**	0.148	0.323***	0.258***
	[0.127]	[0.0870]	[0.0943]	[0.109]	[0.0795]
HighLURI $= 1$	0.405***	0.737***	0.714***	0.569***	1.022***
	[0.117]	[0.223]	[0.244]	[0.108]	[0.179]
Decade fixed effects	Yes	Yes	Yes	Yes	Yes
N	756	756	756	756	756
R^2	0.284	0.385	0.333	0.443	0.484
Panel B. Land Unavailability Index (LUI)					
	High-skill Share	Foreign-born share	Low-skill foreign-born Share	MSA mean wage	MSA mean rent
In-migration$_{-1}$	-0.0347	0.158***	0.198***	0.0151	0.186***
	[0.0981]	[0.0495]	[0.0523]	[0.0844]	[0.0590]
HighLUI $= 1 \times$ In-migration$_{-1}$	0.408***	0.344***	0.274***	0.391***	0.303***
	[0.101]	[0.0858]	[0.0912]	[0.0982]	[0.0849]
HighLUI $= 1$	0.143	0.492***	0.497**	0.275**	0.571***
	[0.0981]	[0.178]	[0.199]	[0.109]	[0.171]
Decade fixed effects	Yes	Yes	Yes	Yes	Yes
N	756	756	756	756	756
R^2	0.241	0.326	0.284	0.380	0.328

Notes: Dependent variables are tabulated using a sample of adults aged 18-64 not living in group quarters. The wage sample is further restricted to people who worked at least 1 week in the previous year and earned a positive wage. HighLURI is equal to 1 if a city's WRLURI index value is above the median and 0 otherwise. HighLUI is equal to 1 if a city's LUI index value is above the median and 0 otherwise. Coefficients are standardized and robust standard errors in brackets are clustered by state.

Table 4: The nativity-skill composition of migration to MSAs and housing supply elasticity

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Wharton Residential Land-Use Regulatory Index (WRLURI)						
	Native	Foreign born	High-skill native	Low-skill native	High-skill foreign born	Low-skill foreign born
WRLURI rank	-0.713***	0.714***	0.267**	-0.760***	0.599***	0.597***
	[0.158]	[0.158]	[0.101]	[0.0977]	[0.0907]	[0.161]
N	1,008	1,005	1,008	1,008	986	1,000
R^2	0.350	0.351	0.212	0.488	0.418	0.268
Panel B. Land Unavailability Index (LUI)						
	Native	Foreign born	High-skill native	Low-skill native	High-skill foreign born	Low-skill foreign born
LUI rank	-0.724***	0.725***	0.121	-0.688***	0.597***	0.614***
	[0.120]	[0.120]	[0.0891]	[0.0862]	[0.0841]	[0.112]
N	1,008	1,005	1,008	1,008	986	1,000
R^2	0.435	0.435	0.156	0.503	0.476	0.343

Notes: Rank is based on each MSAs assigned index value for each measure of housing supply elasticity. MSAs are ranked from smallest to largest; that is, the MSA with the smallest index value receives rank 1. All other independent variables are calculated for each MSA using a sample of workers aged 18-64 who worked at least 1 week in the previous year, earned a positive wage, and did not live in group quarters. Each regression includes decade fixed effects, and robust standard errors are clustered by state. The coefficients in each column are standardized, or "beta" coefficients.

Table 5: The effect of the Bartik labor demand shock on mean wages and rent across housing supply elasticity

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A. Wharton Residential Land-Use Regulatory Index (WRLURI)									
	△Mean native wage			△Mean foreign-born wage			△Mean rent		
△Bartik	0.869***	0.778***	0.818***	0.738**	0.660*	0.586*	0.423***	0.454***	0.403***
	[0.133]	[0.137]	[0.136]	[0.330]	[0.337]	[0.351]	[0.140]	[0.145]	[0.145]
HighLURI = 1 × △Bartik	0.617**	0.642**	0.636**	0.0261	0.0555	0.0755	0.637**	0.604**	0.639**
	[0.255]	[0.250]	[0.248]	[0.493]	[0.500]	[0.500]	[0.274]	[0.276]	[0.274]
HighLURI = 1	0.0200***	0.0174***	0.0197***	0.0276**	0.0243*	0.0197	0.0168**	0.0169**	0.0130*
	[0.00610]	[0.00609]	[0.00626]	[0.0128]	[0.0132]	[0.0142]	[0.00768]	[0.00801]	[0.00774]
Decade Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Local Amenities	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
1980 MSA Wage and Rent	No	No	Yes	No	No	Yes	No	No	Yes
N	744	744	744	744	744	744	744	744	744
R^2	0.633	0.653	0.654	0.265	0.271	0.272	0.528	0.533	0.569
Panel B. Land Unavailability Index (LUI)									
	△Mean native wage			△Mean foreign-born wage			△Mean rent		
△Bartik	1.010***	0.902***	0.910***	0.784**	0.689**	0.591*	0.468***	0.482***	0.424***
	[0.131]	[0.129]	[0.130]	[0.313]	[0.317]	[0.338]	[0.149]	[0.151]	[0.149]
HighLUI = 1 × △Bartik	0.540**	0.594**	0.587**	0.0452	0.0914	0.142	0.774***	0.746***	0.742***
	[0.258]	[0.252]	[0.256]	[0.512]	[0.521]	[0.526]	[0.256]	[0.254]	[0.251]
HighLUI = 1	0.00816	0.00509	0.00510	0.0219	0.0192	0.0133	0.00512	0.00603	-0.00206
	[0.00637]	[0.00674]	[0.00667]	[0.0133]	[0.0136]	[0.0147]	[0.00741]	[0.00761]	[0.00695]
Decade Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Local Amenities	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
1980 MSA Wage and Rent	No	No	Yes	No	No	Yes	No	No	Yes
N	744	744	744	744	744	744	744	744	744
R^2	0.624	0.644	0.645	0.263	0.270	0.271	0.526	0.531	0.567

Notes: Dependent variables are tabulated using a sample of adults aged 18-64, not living in group quarters, who worked at least 1 week in the previous year, and earned a positive wage. HighLURI is equal to 1 if a city's WRLURI index value is above the median and 0 otherwise. HighLUI is equal to 1 if a city's LUI index value is above the median and 0 otherwise. The Bartik shock is constructed as described in the text, where the MSA employment share is tabulated from a sample of workers aged 18-64 not living in group quarters, who worked at least 1 week in the previous year.

Table 6: The effect of the Bartik labor demand shock on changes in the foreign-born, low-skill-foreign-born, and high-skill ratios across housing supply elasticity

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A. Wharton Residential Land-Use Regulatory Index (WRLURI)									
	△Foreign-born Ratio			△Low-skill-foreign-born Ratio			△High-skill Ratio		
△Bartik	-0.208	-0.210	-0.0112	-0.129	-0.134	0.0755	-0.0519	-0.148	-0.230
	[0.660]	[0.657]	[0.615]	[0.795]	[0.791]	[0.743]	[0.215]	[0.219]	[0.218]
HighLURI = 1 × △Bartik	2.962***	2.974***	2.986***	3.545***	3.558***	3.581***	0.731*	0.751**	0.748**
	[0.903]	[0.907]	[0.905]	[1.085]	[1.091]	[1.088]	[0.374]	[0.359]	[0.346]
HighLURI = 1	-0.0764***	-0.0750***	-0.0651**	-0.0840**	-0.0826**	-0.0725**	0.0307***	0.0240**	0.0199*
	[0.0271]	[0.0281]	[0.0308]	[0.0327]	[0.0339]	[0.0368]	[0.0106]	[0.0106]	[0.0114]
Decade Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls for local Amenities	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
1980 MSA Wage and Rent	No	No	Yes	No	No	Yes	No	No	Yes
N	744	744	744	744	744	744	744	744	744
R^2	0.266	0.278	0.305	0.241	0.251	0.279	0.123	0.176	0.209
Panel B. Land Unavailability Index (LUI)									
	△Foreign-born Ratio			△Low-skill-foreign-born Ratio			△High-skill Ratio		
△Bartik	0.0245	0.0459	0.435	0.226	0.244	0.661	0.167	0.0467	-0.0762
	[0.687]	[0.689]	[0.660]	[0.830]	[0.833]	[0.795]	[0.231]	[0.226]	[0.221]
HighLUI = 1 × △Bartik	2.163**	2.112**	1.807**	2.519**	2.461**	2.120*	0.214	0.261	0.366
	[0.915]	[0.919]	[0.918]	[1.102]	[1.108]	[1.107]	[0.365]	[0.348]	[0.330]
HighLUI = 1	-0.0559**	-0.0507*	-0.0420	-0.0652**	-0.0596*	-0.0523	0.0361***	0.0321***	0.0306***
	[0.0274]	[0.0280]	[0.0281]	[0.0331]	[0.0338]	[0.0341]	[0.0105]	[0.0105]	[0.0107]
Decade Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls for local Amenities	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
1980 MSA Wage and Rent	No	No	Yes	No	No	Yes	No	No	Yes
N	744	744	744	744	744	744	744	744	744
R^2	0.252	0.263	0.290	0.228	0.238	0.265	0.120	0.175	0.212

Notes: Dependent variables are tabulated using a sample of adults aged 18-64 who were not living in group quarters. HighLURI is equal to 1 if a city's WRLURI index value is above the median and 0 otherwise. HighLUI is equal to 1 if a city's LUI index value is above the median and 0 otherwise. The Bartik shock is constructed as described in the text, where the MSA employment share is tabulated from a sample of workers aged 18-64 not living in group quarters, who worked at least 1 week in the previous year.

Table 7: First-stage relationship between the Bartik shock and the OECD Bartik Shock

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Wharton Residential Land-Use Regulatory Index (WRLURI)						
	$\triangle$Bartik	HighLURI $= 1 \times \triangle$Bartik	$\triangle$Bartik	HighLURI $= 1 \times \triangle$Bartik	$\triangle$Bartik	HighLURI $= 1 \times \triangle$Bartik
$\triangle\text{Bartik}^{OECD}$	1.015***	0.0568***	1.018***	0.0610***	1.037***	0.0673***
	[0.0342]	[0.0146]	[0.0339]	[0.0158]	[0.0381]	[0.0235]
HighLURI $= 1 \times \triangle\text{Bartik}^{OECD}$	-0.0276	0.929***	-0.0332	0.926***	-0.0419	0.923***
	[0.0857]	[0.0731]	[0.0859]	[0.0740]	[0.0860]	[0.0738]
HighLURI $= 1$	0.000731	-0.00319*	0.000987	-0.00292	0.00179	-0.00266
	[0.00195]	[0.00185]	[0.00195]	[0.00186]	[0.00197]	[0.00174]
Decade Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Amenities Controls	No	No	Yes	Yes	Yes	Yes
1980 MSA Wage and Rent	No	No	No	No	Yes	Yes
N	744	744	744	744	744	744
KP rk Wald F Statistic	114.1	114.1	113.2	113.2	107.7	107.7
Panel B. Land Unavailability Index (LUI)						
	$\triangle$Bartik	HighLUI $= 1 \times \triangle$Bartik	$\triangle$Bartik	HighLUI $= 1 \times \triangle$Bartik	$\triangle$Bartik	HighLUI $= 1 \times \triangle$Bartik
$\triangle\text{Bartik}^{OECD}$	1.055***	0.0541***	1.057***	0.0557***	1.083***	0.0600**
	[0.0323]	[0.0152]	[0.0328]	[0.0166]	[0.0391]	[0.0259]
HighLUI $= 1 \times \triangle\text{Bartik}^{OECD}$	-0.0864	0.910***	-0.0927	0.907***	-0.126	0.895***
	[0.0897]	[0.0792]	[0.0901]	[0.0799]	[0.0914]	[0.0796]
HighLUI $= 1$	-0.000550	-0.00337	-0.000311	-0.00321	0.000594	-0.00306
	[0.00214]	[0.00214]	[0.00216]	[0.00216]	[0.00213]	[0.00200]
Decade Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Amenities Controls	No	No	Yes	Yes	Yes	Yes
1980 MSA Wage and Rent	No	No	No	No	Yes	Yes
N	744	744	744	744	744	744
KP rk Wald F Statistic	81.18	81.18	80.99	80.99	80.53	80.53

Table 8: IV results of the effect of the Bartik labor demand shock on mean wages and rent across housing supply elasticity

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A. Wharton Residential Land-Use Regulatory Index (WRLURI)									
	△Mean native wage			△Mean foreign-born wage			△Mean rent		
△Bartik	0.734***	0.661***	0.736***	0.475	0.406	0.527	0.549***	0.590***	0.482***
	[0.176]	[0.181]	[0.180]	[0.317]	[0.326]	[0.328]	[0.171]	[0.177]	[0.175]
HighLURI = 1 × △Bartik	0.724**	0.709**	0.667*	0.675	0.683	0.626	0.529	0.471	0.412
	[0.360]	[0.360]	[0.355]	[0.518]	[0.526]	[0.522]	[0.382]	[0.382]	[0.354]
HighLURI = 1	0.0187**	0.0173**	0.0203**	0.000778	0.000546	0.00534	0.0155	0.0152	0.0106
	[0.00864]	[0.00851]	[0.00817]	[0.0130]	[0.0132]	[0.0134]	[0.00961]	[0.00994]	[0.00907]
Decade Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls for local Amenities	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
1980 MSA Wage and Rent	No	No	Yes	No	No	Yes	No	No	Yes
N	744	744	744	744	744	744	744	744	744
Centered R^2	0.53	0.545	0.557	0.273	0.281	0.29	0.42	0.427	0.502
Panel B. Land Unavailability Index (LUI)									
	△Mean native wage			△Mean foreign-born wage			△Mean rent		
△Bartik	0.895***	0.786***	0.847***	0.419	0.320	0.434	0.611***	0.613***	0.517***
	[0.176]	[0.172]	[0.178]	[0.301]	[0.307]	[0.313]	[0.169]	[0.172]	[0.172]
HighLUI = 1 × △Bartik	0.714**	0.776**	0.652*	1.276**	1.335**	1.165**	0.862***	0.836**	0.612*
	[0.339]	[0.345]	[0.346]	[0.533]	[0.548]	[0.548]	[0.329]	[0.328]	[0.319]
HighLUI = 1	0.00369	0.00125	0.00288	-0.0195	-0.0211	-0.0176	-0.00510	-0.00480	-0.00971
	[0.00950]	[0.00982]	[0.00928]	[0.0140]	[0.0142]	[0.0140]	[0.00923]	[0.00951]	[0.00873]
Decade Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls for local Amenities	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
1980 MSA Wage and Rent	No	No	Yes	No	No	Yes	No	No	Yes
N	744	744	744	744	744	744	744	744	744
Centered R^2	0.525	0.541	0.55	0.27	0.278	0.286	0.416	0.424	0.5

Table 9: IV results of the effect of the Bartik labor demand shock on changes in the foreign-born, low-skill-foreign-born, and high-skill ratios by housing supply elasticity

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A. Wharton Residential Land-Use Regulatory Index (WRLURI)									
	△Foreign-born Ratio			△Low-skill-foreign-born Ratio			△High-skill Ratio		
△Bartik	-1.644**	-1.657**	-1.490*	-1.905**	-1.920*	-1.784*	0.380	0.279	0.181
	[0.829]	[0.836]	[0.799]	[0.971]	[0.980]	[0.935]	[0.276]	[0.276]	[0.266]
HighLURI = 1 × △Bartik	4.518***	4.529***	4.434***	5.652***	5.670***	5.565***	0.473	0.425	0.502
	[1.097]	[1.081]	[1.076]	[1.288]	[1.276]	[1.271]	[0.429]	[0.415]	[0.410]
HighLURI = 1	-0.0603**	-0.0596**	-0.0530*	-0.0654**	-0.0643**	-0.0590*	0.0331***	0.0271***	0.0233**
	[0.0271]	[0.0276]	[0.0303]	[0.0321]	[0.0328]	[0.0355]	[0.0107]	[0.0105]	[0.0114]
Decade Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls for local Amenities	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
1980 MSA Wage and Rent	No	No	Yes	No	No	Yes	No	No	Yes
N	744	744	744	744	744	744	744	744	744
Centered R^2	0.178	0.19	0.202	0.161	0.17	0.181	0.089	0.151	0.2
Panel B. Land Unavailability Index (LUI)									
	△Foreign-born Ratio			△Low-skill-foreign-born Ratio			△High-skill Ratio		
△Bartik	-0.783	-0.771	-0.473	-0.779	-0.764	-0.504	0.545*	0.386	0.191
	[0.858]	[0.875]	[0.854]	[1.033]	[1.057]	[1.032]	[0.284]	[0.278]	[0.263]
HighLUI = 1 × △Bartik	2.342**	2.315**	1.948*	2.981**	2.961**	2.560*	0.0645	0.102	0.423
	[1.156]	[1.150]	[1.142]	[1.370]	[1.368]	[1.359]	[0.416]	[0.399]	[0.393]
HighLUI = 1	-0.0417	-0.0383	-0.0289	-0.0495	-0.0461	-0.0383	0.0354***	0.0319***	0.0262**
	[0.0292]	[0.0297]	[0.0295]	[0.0349]	[0.0353]	[0.0350]	[0.0108]	[0.0106]	[0.0106]
Decade Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls for local Amenities	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
1980 MSA Wage and Rent	No	No	Yes	No	No	Yes	No	No	Yes
N	744	744	744	744	744	744	744	744	744
Centered R^2	0.174	0.185	0.196	0.16	0.168	0.178	0.083	0.15	0.201

Table 10: The effect of the employment-based Bartik shock on changes in mean wages and rent across housing supply elasticity

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A. Wharton Residential Land-Use Regulatory Index (WRLURI)									
	△Mean native wage			△Mean foreign-born wage			△Mean rent		
△Bartik^{Emp}	0.458***	0.392***	0.318**	0.415	0.372	0.137	0.0657	0.0602	0.0222
	[0.145]	[0.140]	[0.151]	[0.317]	[0.329]	[0.329]	[0.225]	[0.223]	[0.273]
HighLURI = 1 × △Bartik^{Emp}	0.952***	0.955***	0.906***	-0.654	-0.661	-0.625	1.593**	1.541**	1.478**
	[0.334]	[0.327]	[0.339]	[0.469]	[0.474]	[0.470]	[0.704]	[0.690]	[0.723]
HighLURI = 1	0.0240***	0.0191***	0.00484	0.0499***	0.0440***	0.0216	0.0428***	0.0384**	0.0264
	[0.00720]	[0.00704]	[0.00707]	[0.0123]	[0.0126]	[0.0143]	[0.0164]	[0.0164]	[0.0167]
Decade Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls for local Amenities	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
1980 MSA Wage and Rent	No	No	Yes	No	No	Yes	No	No	Yes
N	744	744	744	744	744	744	744	744	744
R^2	0.628	0.652	0.669	0.133	0.150	0.162	0.165	0.188	0.196
Panel B. Land Unavailability Index (LUI)									
	△Mean native wage			△Mean foreign-born wage			△Mean rent		
△Bartik	0.680***	0.600***	0.450***	0.312	0.247	-0.0579	0.438	0.394	0.221
	[0.150]	[0.140]	[0.154]	[0.324]	[0.334]	[0.334]	[0.278]	[0.267]	[0.306]
HighLUI = 1 × △Bartik	0.723**	0.738**	0.683*	-0.258	-0.249	-0.187	1.259*	1.244*	1.182
	[0.339]	[0.338]	[0.362]	[0.480]	[0.490]	[0.492]	[0.720]	[0.714]	[0.765]
HighLUI = 1	0.0101	0.00514	-0.00722	0.0418***	0.0367***	0.0166	0.0165	0.0130	-0.00122
	[0.00736]	[0.00781]	[0.00663]	[0.0123]	[0.0124]	[0.0135]	[0.0176]	[0.0183]	[0.0158]
Decade Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls for local Amenities	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
1980 MSA Wage and Rent	No	No	Yes	No	No	Yes	No	No	Yes
N	744	744	744	744	744	744	744	744	744
R^2	0.611	0.638	0.663	0.124	0.142	0.158	0.141	0.167	0.183

Table 11: The effect of the employment-based Bartik shock on changes in the foreign-born, low-skill-foreign-born, and high-skill ratios across housing supply elasticity

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A. Wharton Residential Land-Use Regulatory Index (WRLURI)									
	△Foreign-born Ratio			△Low-skill-foreign-born Ratio			△High-skill Ratio		
△Bartik	-0.923	-0.926	-0.887	-1.036	-1.032	-1.078	-0.00508	-0.0609	-0.222
	[0.768]	[0.758]	[0.732]	[0.889]	[0.879]	[0.852]	[0.248]	[0.240]	[0.250]
HighLURI = 1 × △Bartik	4.320***	4.303***	4.106***	5.249***	5.230***	5.022***	0.476	0.481	0.596
	[0.967]	[0.963]	[0.914]	[1.118]	[1.116]	[1.067]	[0.423]	[0.405]	[0.407]
HighLURI = 1	-0.0660**	-0.0647**	-0.0843***	-0.0695**	-0.0675**	-0.0979***	0.0437***	0.0339***	0.0294**
	[0.0261]	[0.0269]	[0.0309]	[0.0307]	[0.0319]	[0.0372]	[0.0107]	[0.0105]	[0.0128]
Decade Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Contorls for local Amenities	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
1980 MSA Wage and Rent	No	No	Yes	No	No	Yes	No	No	Yes
N	744	744	744	744	744	744	744	744	744
R^2	0.220	0.230	0.245	0.209	0.216	0.232	0.078	0.150	0.166
Panel B. Land Unavailability Index (LUI)									
	△Foreign-born Ratio			△Low-skill-foreign-born Ratio			△High-skill Ratio		
△Bartik	-0.711	-0.699	-0.592	-0.657	-0.637	-0.635	0.124	0.0463	-0.134
	[0.823]	[0.816]	[0.824]	[0.954]	[0.947]	[0.950]	[0.277]	[0.263]	[0.266]
HighLUI = 1 × △Bartik	3.720***	3.678***	3.392***	4.335***	4.295***	4.001***	0.244	0.249	0.413
	[1.000]	[0.999]	[0.990]	[1.162]	[1.161]	[1.150]	[0.416]	[0.403]	[0.406]
HighLUI = 1	-0.0590**	-0.0548*	-0.0554**	-0.0653**	-0.0606*	-0.0690**	0.0433***	0.0366***	0.0284**
	[0.0276]	[0.0282]	[0.0271]	[0.0325]	[0.0332]	[0.0329]	[0.0105]	[0.0104]	[0.0114]
Decade Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Contorls for local Amenities	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
1980 MSA Wage and Rent	No	No	Yes	No	No	Yes	No	No	Yes
N	744	744	744	744	744	744	744	744	744
R^2	0.205	0.215	0.225	0.192	0.200	0.210	0.075	0.152	0.164