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The Impact of Immigration on Wages, Internal Migration and Welfare

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The Impact of Immigration on Wages, Internal Migration and Welfare

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Abstract

This paper studies the impact of immigration on wages, internal migration and welfare. Using U.S. Census data, I estimate a spatial equilibrium model where labor differs by skill level, gender and nativity. Workers are heterogeneous in city preferences. Cities vary in productivity levels, housing prices and amenities. I use the estimated model to assess the distributional consequences of several immigration policies. The results show that a skill selective immigration policy leads to welfare gains for low skill workers, but welfare losses for high skill workers. The negative impacts are more substantial among the incumbent high skill immigrants. Internal migration mitigates the initial negative impacts, particularity in cities where high skill workers are relatively mobile. However, the negative impacts on some workers intensify. This is because an out-migration of workers of a given type may raise the local wages for workers of that type, while reducing the local wages of workers with complementary characteristics. Overall, there are substantial variations in the welfare effects of immigration across and within cities. Further, I also use the model to assess a non-selective immigration policy and deportation of unauthorized immigrants in specific areas.

Keywords: Immigration, worker heterogeneity, local labor markets, welfare impact.

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1 Introduction

The arrival of immigrants into the U.S. in the past few decades has raised concerns partly because of its magnitude and its composition. Over the first half of the past decade, around 1.25 million immigrants arrived each year (Card, 2009). The share of immigrants in the U.S. working-age population increased from 10 percent in 1990 to about 17 percent in 2007.[1] At least a third of the new immigrants are undocumented with little education and limited English skills (Passel, 2005). A key political debate in the U.S. centers around controlling unauthorized immigrants and reforming the program of high skill immigrant visas. This raises the questions of who would lose and who would gain from these policies?

Many studies focus on the national impacts of immigration (e.g. Borjas, 2003 and Ottaviano and Peri, 2012). However, the local impacts may differ from national impacts since some cities attract relatively more immigrants. The immigrant share of the working-age population in the U.S. varies from more than 40 percent, for example in Los Angeles and Miami, to roughly two percent in cities such as Flint, MI. An inflow of immigrants may reduce wages for competing workers and raise wages for complementary labor. However, wages may not represent the full welfare effects, as any wage gains (losses) may be offset (amplified) by rising housing costs due to immigration. Heterogeneity in city characteristics, such as housing supply elasticities and amenities, could lead to greater real welfare inequality across workers.

Moreover, an inflow of new arrivals may induce internal migration which can modify the local impact and transmit immigration shocks to other cities. While previous works suggest that internal mobility attenuates adverse local shocks (e.g. Borjas, 2001, Borjas, 2006 and Cadena and Kovak, 2016), the effects are likely to be heterogeneous across workers. This is because an out-migration of workers of a given type may raise the local wages for workers of that type, while reducing the local wages of workers with complementary characteristics. For instance, if high and low skill labor are complements, then an outflow of high skill workers may reduce the local wages of low skill. Thus even within a city, workers can be affected by immigration differently due to heterogeneity in labor types and degrees of internal mobility.

Given the linkage between cities through labor relocation, I study the welfare implications of immigration using a spatial equilibrium model. I use the estimated model to assess changes in the skill mix and stock of immigrants as well as deportation of undocumented immigrants in specific areas. I quantify the wage and welfare effects of immigration on different groups of workers across cities both when workers are constrained to remain in their original locations and when all workers are free to migrate. I also quantify the increased rental income accrued to landlords, a potential

[1] Source: 1990-2000 U.S. Census and the combined 2005-7 ACS. Working-age population includes people aged 18 or older with 1 to 40 years of potential experience. See 2.1 for further details.

benefit that is often not included in welfare analysis of immigration.

To assess the impact of immigration across local labor markets, I extend the framework from Diamond (2016) in two dimensions. First, I incorporate heterogeneity across workers in skill level, gender and birthplaces.[2] Since the impacts of immigration are likely to depend on the degree of substitutability of labor, I allow for the possibility that workers of different types are imperfect substitutes. Cities differ in productivity levels, housing supply elasticities, and amenities. Workers choose the most desirable city in a static discrete choice setting. Preferences for city characteristics are heterogeneous across types of workers. Second, I modify the model to allow the value of a city among immigrants to depend on their networks in that city. A well-known settlement pattern of immigrants is that they tend to locate in country-specific enclave (Altonji and Card, 1991). Therefore, I use the number of previous immigrants born in the same country to represent the strength of the network. I also allow the value of a city among natives to depend on the distance from the city to the individual's birthplace.

I estimate the model using U.S. Census data from 1980 through 2000 and the combined 2005-7 American Community Survey. I estimate local labor demand in multiple steps using Card and Lemieux (2001) technique. The elasticities of substitution are identified using the predicted inflow rate of immigrants based on historical settlement patterns (Altonji and Card, 1991). Labor supply is estimated using the discrete choice methods developed by McFadden (1973), Berry et al. (1995) and Berry et al. (2004) which have been applied to estimate workers' preferences for locations by Bayer et al. (2007) and Diamond (2016). I adapt their approach and identify workers' preferences using local labor demand shocks driven by the city's industry mix. The housing supply elasticity is identified using the interaction of these shocks with housing supply elasticity determinants which provides variation in housing demand (Diamond, 2016).

The estimates indicate imperfect substitutability between natives and immigrants within the same skill-gender group. The substitutability between natives and immigrants is lower among high skill than low skill workers.[3] High skill workers are estimated to be less attached to their birthplaces and networks, relative to low skill workers.[4] Further, in line with Borjas (2001) Ca-

[2]Diamond (2016) extends Roback (1982) to include heterogeneity in workers' preferences for cities. In Diamond (2016)'s model, labor is only differentiated by skill levels: high and low. She decomposes welfare inequality between college and noncollege workers into changes in wages, rents and amenities. She finds that differences in local amenities lead to an increase in well-being inequality between college and noncollege workers much larger than the increase in the college wage gap alone.

[3]A similar result is obtained by Card (2009) using city-level estimation. However, Ottaviano and Peri (2012) estimate a nested-CES model using data at the national level and find that natives and immigrants exhibit particularly high substitutability among college workers, a magnitude of 10 times larger than mine, although their estimate is not precise. In Section 6.6, I provide sensitivity analyses of counterfactual policy experiments using labor demand estimates at the national level.

[4]Using a dynamic model of migration, Kennan and Walker (2013) also find that college workers are more mobile than high school graduates.

dena and Kovak (2016) and Diamond (2016), immigrants are more sensitive to changes in prices than natives. These estimates imply that cities with more previous immigrants or natives who already left their birthplaces are more likely to experience an out-migration response in response to immigration since these workers are relatively mobile. Additionally, cities with (i) lower productivity, (ii) more inelastic housing supply or (iii) lower amenities are more likely to have an outflow of incumbent workers.

The estimated model allows me to consider three relevant counterfactual policy experiments. First, I consider the effects of the U.S. adopting a skill-selective immigration policy similar to the UK, leading to a 46 percent increase in high skill immigrants. I find that the wages of low skill workers initially rise by about 5 percent in gateway cities which receive a larger portion of the new high skill immigrants, while the wages of low skill labor in other cities rise, on average, by about 1.2 percent. The wage increase is due to the complementarity between high and low skill labor. There are small positive effects on the wages of high skill natives in most locations, while the wages of the incumbent high skill immigrants fall substantially in all locations. The differential wage impacts between immigrants and natives is due to their imperfect substitutability. In line with Saiz (2007), I find that a one percent increase in a city's population due to immigration is associated with approximately a one percent increase in average housing rents.

In this counterfactual, I find the out-migration responses to be relatively strong in cities, such as San Francisco and Las Vegas, with more immigrants or natives who already left their birthplaces. The out-migration responses mitigate the adverse local wage effects for workers of that type, but they also reduce the local wages of workers with complementary characteristics. Further, cities with inelastic housing supply such as Miami have proportionately more workers moving out as housing rents become relatively more expensive. However, other city characteristics such as amenities also play a role. For example, the amenity value in Baton Rouge, LA is ranked in the bottom 25 percentile for high skill male immigrants. Despite the relatively small initial wage and rent impacts, the low amenity level causes relatively high out-migration.

The gains from internal migration realized by the movers in gateway cities are equivalent to a 500 to $1,000$ dollar increase in annual consumption. The additional rental income accrued to landlords is large, almost $6,500$ dollars per person. Overall, even after worker relocation, the welfare impact of immigration is unevenly distributed across and within cities, re-emphasizing the importance of studying the welfare consequences of immigration at the local labor market level.

In the second counterfactual policy experiment, I assume that the U.S. maintains its present skill composition of immigrants but increases the stock by the same number as in the first counterfactual. This involves a 25 percent increase in immigrants. The arrival of new immigrants has positive wage effects on high skill natives and less negative wage effects on high skill immigrants relative to the first counterfactual. This is because a larger portion of new immigrants in this counterfactual are low skill, and so the negative wage effect is counterbalanced by the complementarity between high and low skill labor. The wages and welfare of low skill natives decline.

However, when all workers are free to migrate, the negative impacts in some cities attenuate. The migration responses in this case are more dependent on housing supply elasticities. This is because the most adversely affected group in this experiment is low skill immigrants. Since low skill immigrants spend a larger fraction of their income on housing, their migration incentives are more responsive to variation in housing prices. The out-migration responses of low skill workers reduce the initial negative wage impact in inelastic housing supply cities such as Miami, while intensifying the negative wage impacts in more affordable cities. The gains from internal migration of movers are about 50 percent smaller than in the first counterfactual, and the additional rental income accrued to landlords is about 30 percent smaller.

The final policy experiment focuses on controlling unauthorized migration. Such polices are gaining traction in the US, for example the "Support Our Law Enforcement and Safe Neighborhoods Act" or SB1070 in Arizona. This includes a range of provisions intended to control unauthorized immigration. Since undocumented immigrants tend to be less educated, I assess these effects by removing fifty percent of low skill immigrants in six states that have passed anti-illegal immigration laws similar to SB1070. I show that a location-specific immigration control policy has a local and short-term positive impact on the wages and welfare of low skill workers but negative impacts on the wages of high skill labor. As workers reallocate, the impacts of removing low skill immigrants dissipate. These results highlight that a location-specific immigration policy has limited effect in the presence of internal mobility.

Early studies analyze the wage impact of immigration (e.g. Borjas, 2003, Card, 1990 and Ottaviano and Peri, 2012) separately from the rent impact (e.g. Saiz, 2007).[5] However, both of these prices affect welfare and, most importantly, the effects vary across cities. As emphasized in works on local labor markets, accounting for heterogeneity in city characteristics is crucial for measuring real welfare (Moretti, 2013, David et al., 2013, David and Dorn, 2013 and Diamond, 2016). While internal migration plays a vital role in mitigating local shocks (e.g. Blanchard et al., 1992, Borjas, 2001 and Cadena and Kovak, 2016 and Monras, 2015), this paper highlights the importance of taking into account heterogeneity in the labor types of movers and stayers. The out-migration responses mitigate the adverse local wage effects for workers of that type, but they also reduce the local wages of workers with complementary characteristics. The main contribution of this paper is to quantify the welfare impacts of immigration, integrating these key different

[5] Early studies on the wage effects of immigration provide mixed conclusions. Borjas et al. (1996) and Borjas (2003) document that immigration has a pronounced negative effect on natives' wages while Card (1990) and Ottaviano and Peri (2012) find little impact. Card (2009) argues that the discrepancy between these findings is reconciled by recognizing the high-degree of substitutability between high school graduates and dropouts as well as the imperfect substitutability between natives and immigrants.

channels, in an equilibrium model.

The rest of the paper is organized as follows: Section 2 presents an overview of the data. Section 3 specifies the model and Section 4 describes the estimation procedures. Section 5 presents the baseline results. Section 6 discusses model predictions and shows counterfactual experiments and Section 7 concludes.

2 Data Overview

2.1 Sample Description

The analysis is based on data from the five percent samples of the 1980, 1990 and 2000 U.S. Census as well as the combined 2005-7 American Community Surveys (ACS) from the Integrated Public Use Microdata Series (IPUMS) (Ruggles et al., 2010). Throughout the analysis, I refer to the combined 2005-7 ACS as the 2007 sample period.

The key characteristics of workers are skill level, gender and nativity. I define "cities" as the metropolitan statistical areas (MSA's) from the 2000 Census. I use information on definitions of MSAs at the detailed level to match the 2000 MSAs to 1980 and 1990. The ACS uses the same geographic coding as the 2000 Census. The Census includes 218 MSAs consistently across the three rounds. I focus on the 114 MSAs which have at least 200 full-time and non self-employed of each type of immigrants based on the key characteristics described above.[6] I combine other areas together and treat them as the outside option. The outside option can be regarded as the combined non-popular destinations of immigrants, relative to other cities, where its characteristics are taken to be the average characteristics of these combined areas. While the analysis could be richer by treating each MSA and the rural part of each state as a separate location choice, the numbers of immigrants in those areas are too low to identify the parameters of interest. Further, I do not have data on land use regulations and the shares of land unavailable for construction in all rural areas to estimate their housing supply functions.

Workers in the sample are restricted to individuals over the age of 18 with 1 to 40 years of potential experience who report positive earnings and worked at least one week in the previous year and not currently enrolled in schools.[7] High skill workers are defined as those with 1-3 years of college or more. Low skill workers include high school graduates and dropouts. This classification of two skill groups is supported by Ottaviano and Peri (2008) and Card (2009) who estimate the inverse elasticity of substitution between dropouts and high school graduates, and

[6] All MSAs have at least 200 full-time and non self-employed natives in each skill-gender cell.

[7] Years of potential experience are calculated using the difference between current age and the age at which the individual entered the labor force.

the inverse elasticity of substitution between workers with some college and those with a college degree or more to be near zero. Immigrants are defined as individuals born abroad.

The wage sample is a subset of the employment sample where workers who are self-employed and workers who work less than 35 hours a week and 40 weeks per year are eliminated. Additional data on land use regulations and geographic constrains are taken from Saiz (2010). The main estimation of labor demand, labor supply and housing supply use prices and employment information from the 1990, 2000 U.S. Census and the combined 2005-7 ACS. The 1980 U.S. Census is only used for constructing instrumental variables, network effects and predetermined population in the housing rent equation. See Appendix A. for further details on variable construction and Table A.1 for summary statistics of these variables.

2.2 Characteristics and Settlement Patterns of Immigrants

The motivation for the city-level analysis in this paper is illustrated in Table A.2, which presents immigrant densities in the 15 most popular destinations of immigrants. The immigrant shares of the working-age population in these cities range from about 30 to 60 percent. Further, cities that attract more immigrants in 1990 continue to attract more immigrants over time.

Table A.3 in the online Appendix reports the numbers and characteristics of immigrants from 1990-2007. The share of immigrants in the U.S. working-age population increased from about 10 percent in 1990 to 17 percent in 2007; the large inflow and the composition of immigrants has raised many concerns.[8] More than half of immigrants have only high school diplomas or less. So local workers may be affected differently due to heterogeneity in labor types. Further, a well-known immigrant settlement pattern is that they tend to locate in country-specific enclaves. Prominent examples include the concentration of Mexican immigrants in Los Angeles (see Card, 2009 for more discussion). This suggests that country of origin is also an important characteristic determining location choices and the local impacts of immigration. Additionally, Table A.4 reports the numbers of immigrants and educational attainment by country of origin.

3 Model

To analyze the effects of immigration across local labor markets, I extend a static spatial equilibrium model of Diamond (2016) in two dimensions. First, I incorporate heterogeneity across workers in skill level, gender and nativity via a nested-CES technology. I allow for the possibility that workers of different types are imperfect substitutes.

[8] The descriptive statistics presented in this paper come from the U.S. Census which may over-represent legal immigrants.

Cities differ in productivity levels, housing prices and amenities. Preferences for city characteristics may vary across worker types. Housing supply elasticities differ across cities due to differences in geographic constraints. Second, to account for immigrants' tendency to locate in the same regions as their fellow expatriates, I extend the model to allow immigrants to derive utility from cities' networks. I use the number of previous immigrants born in the same country group in the past to represent the strength of the network. Additionally, I allow the value of a city amongst natives of the same type to depend on the distance between that location and their birthplaces.

I begin this section by specifying labor demand, then discuss workers' location decisions, housing supply, and finally present the equilibrium conditions.

3.1 Labor Demand

To derive simple expressions for city-specific labor demand, I assume a one-sector economy.[9] While I do not explicitly incorporate multiple sectors into the model, I allow cities' production functions to differ in productivity to reflect differences in cities' sectoral compositions. Firms are competitive and produce identical tradeable goods using capital and labor with a constant returns technology.[10] Each city c has many homogeneous firms in year t. In what follows, I drop the firm's subscript for ease of exposition. The firm's production function takes the following form

$$Y_{ct} = A_{ct} L_{ct}^{\alpha} K_{ct}^{1-\alpha} \tag{1}$$

where A_{ct} is city-specific productivity, K_{ct} is capital, L_{ct} is a CES aggregate of different types of labor, and $\alpha \in (0,1)$ is the income share of labor.[11]

An immigrant is defined as a person born outside the U.S. Since workers are heterogeneous, the effects of immigration depends on the substitutability between labor types and the magnitude of the inflow. Intuitively, immigrants may put downward pressure on the wages of substitute labor and upward pressure on the wages of complements. The model incorporates imperfect substitution amongst labor inputs via a nested CES production function similar to Ottaviano and Peri (2012).[12]

[9] A single tradeable good sector allows simple local labor demand functions which are convenient for estimation purposes (Card, 2009, Diamond, 2016 and Ottaviano and Peri, 2012). Kennan (2012, 2013) analyzes the wage impacts of immigration in a multi-sector economy where wages in efficiency units are equalized. My paper assumes a single tradeable good sector with a constant returns production function. When different types of workers are imperfect substitutes, immigration impacts wages, even in the long run, by changing the composition of the labor force. However, migration responses partially re-balance these changes which reduces the overall impacts even without arbitrage in product markets.

[10] As estimated by Basu and Fernald (1997), production functions in most industries exhibit roughly constant returns to scale. Using plant-level data, Baily et al. (1992) find that firms produce with approximately constant returns technology.

[11] The alternative is to allow complementarity between capital and labor as in Krusell et al. (2000); however, data on capital at the city level is restricted.

[12] Manacorda et al. (2012) use a similar nested-CES production function as Ottaviano and Peri (2012) to study the

There are two main differences between my setup and Ottaviano and Peri (2012). First, I allow male and female labor to be imperfect substitutes. Given that males and females tend to work in different occupations, their imperfect substitutability captures occupational differences across genders in this single national product setup.[13] As reported in Johnson and Keane (2013), unconditional on occupations, the substitutability between men and women is low. Second, I do not differentiate workers by age since I focus on long run equilibrium where workers make location choices in a static setting.[14] The CES nests are ordered by skill, gender and nativity. I place skill levels in the upper nests since education seems to be the primary determinant of labor substitutability. I put gender in the second level and place workers' immigration status in the last level.[15]

The first-level nest of labor aggregate is a combination of high and low skill labor according to

$$L_{ct} = \left(\sum_{e} \theta_{ect} L_{ect}^{\rho_E} \right)^{\frac{1}{\rho_E}}, \tag{2}$$

where the skill levels are high and low $e \in \{H, L\}$, and $\sigma_E = \frac{1}{1-\rho_E}$ is the elasticity of substitution between skill levels. The parameters $\theta_{Hct}, \theta_{Lct}$ represent the relative productivity levels of high and low skill labor, respectively.[16] These may vary over time due to skill-biased technical change. Further, the relative productivity levels at each CES level may vary across cities. This is to reflect variation in cities' productivities based on differences in industrial compositions. I normalize $\theta_{Hct} + \theta_{Lct} = 1$ and similarly for the relative productivity levels in the lower CES levels; any common multiplying factor is absorbed in A_{ct}.

This classification of two skill groups is commonly used (see for example Katz and Murphy, 1992 and Card and Lemieux, 2001). The alternative is to have four skill groups: college, some college, high school and dropouts (Borjas, 2003). However, as noted in Card (2009) and Ottaviano and Peri (2012), the inverse elasticities of substitution between college and some college, as well as between high school graduates and dropouts are approximately zero.

national impact of immigration in the UK.

[13] An alternative is to distinguish types of workers by occupation or major of study. However, the counterfactual exercises involve solving for an equilibrium allocation of workers across cities. Therefore, I abstract from the substitutability between labor of different occupations to keep the number of worker types computationally manageable.

[14] I provide a sensitivity analysis of labor demand estimation when wages are residualized against age in Section 5.5.

[15] In Section 5.5, I provide a sensitivity analysis of labor demand estimation when the order of skill and gender levels are reversed.

[16] A concern with assigning skill levels of workers based on their educational levels is that immigrants may be downgraded, e.g. an immigrant with a Bachelor degree may be working in a low skill occupation. See Dustmann et al. (2013) for more discussion.

At the next level, the skill-specific labor L_{ect} is a CES aggregate of male and female labor

$$L_{ect} = \left(\sum_g \phi_{egct} L_{egct}^{\rho_G} \right)^{\frac{1}{\rho_G}}, \tag{3}$$

where $g \in \{F, M\}$ denotes female and male respectively, $\phi_{eFct} + \phi_{eMct} = 1$, and $\sigma_G = \frac{1}{1-\rho_G}$ is the elasticity of substitution between genders. The parameters ϕ_{eFct}, ϕ_{eMct} vary by skill level, city and over time. Johnson and Keane (2013) estimate that conditional on education and occupation, men and women are close substitutes. However, the unconditional substitutability between genders is low.

Finally, L_{egct} is a combination of labor supplied by natives, N_{egct} and immigrants, M_{egct}. I allow the elasticity of substitution between natives and immigrants to vary across skill levels as follows

$$L_{egct} = \left(\sum_s \beta_{egct}^s S_{egct}^{\rho_{M,E}} \right)^{\frac{1}{\rho_{M,E}}}, \tag{4}$$

where $s \in \{M, N\}$ denotes immigrant and native, respectively, $\beta_{egct}^N + \beta_{egct}^M = 1$, and $\sigma_{M,E} = \frac{1}{1-\rho_{M,E}}$ denotes the elasticity of substitution between natives and immigrants in each skill level. I allow for the possibility that immigrants might be closer substitutes to natives amongst low skill labor since factors such as differences in the quality of education and English skills may be less crucial. Further, the relative productivity levels between natives and immigrants, $\beta_{egct}^N, \beta_{egct}^M$ are allowed to vary by skill, gender, city and time. This allows wages of natives relative to immigrants in a specific group and city to vary over time due to changes in the cohort quality of immigrant labor.

I focus on long run equilibrium where capital is perfectly elastically supplied at a common priceκ_t. Let P_t denote the output price. Firms operate in a perfectly competitive output market so real wages equal the marginal product of labor. The city's demands for workers of characteristics: (e, g, s) in city c in year t is given by

$$\begin{aligned} \ln W_{egct}^s / P_t \quad = \quad & \frac{1}{\alpha} \ln A_{ct} + \ln \eta_t + \ln \theta_{ect} + \frac{1}{\sigma_E} \left(\ln L_{ct} - \ln L_{ect} \right) + \ln \phi_{egct} \\ & + \frac{1}{\sigma_G} \left(\ln L_{ect} - \ln L_{egct} \right) + \ln \beta_{egct}^s + \frac{1}{\sigma_{M,E}} \left(\ln L_{egct} - \ln S_{egct} \right) \end{aligned} \tag{5}$$

and

$$\eta_t = \ln \left(\alpha \left(\frac{(1-\alpha)}{\kappa_t / P_t} \right)^{\frac{1-\alpha}{\alpha}} \right).$$

3.2 City Amenity and Network

In reality, cities differ in many dimensions. To better understand how individuals make their location decisions, I allow cities to differ in amenities. This includes climate, proximity to natural features as well as the quality of goods and services. All residents within a city have access to these amenities, but different groups of workers do not need to value these amenities equally. The amenities in city c in year t is denoted by x_{ct}^{A}.

A well-known settlement pattern of new immigrants is that they tend to locate in country-specific enclaves (Card, 2009).[17] This could be because it is easier to move or adjust to a city where an individual has a larger network. For instance, there are more ethnic grocery stores in areas where immigrants are concentrated (Largent et al., 2013).[18] Therefore, I consider the utility value an immigrant gains from a city-specific network size. I use the city's number of previous immigrants born in the same country group as a proxy for network size. The network values are independent of the current number of immigrants; I make this assumption to reduce the multiplicity of equilibria. Intuitively, we can think of the number of previous immigrants as a proxy for the availability of place-specific information as well as ethnic goods and services (e.g. restaurants and grocery stores). Furthermore, given the enclave patterns of immigrants in the data, holding the network strength fixed enables us to pin down an equilibrium that is likely to realize. Define $x_{c,t-\tau}^{rb}$ as a 22 element vector where each component contains city c's number of immigrants in year $t-\tau$ born in each of the 22 country groups (see Table A.4 for the list of 22 country groups).

For natives, I allow workers to derive the network values from living in their birthplaces. Since I only observe birthplaces at the state level, I allow natives to gain utility from living in or near their states of birth (I also include U.S. outlying areas as natives' birth places: American Samoa, Guam, Puerto Rico and U.S. Virgin Islands). Define x_{c}^{st} as a 54 element vector where each component k is equal to one if part of city c is contained in state k. For natives who live outside their birth states, the network value depends on the distance from one's birth state to the destination city. Define x_{c}^{d} as a 54 element vector where each component k contains the distance from the population centroid in state k to the population centroid in city c. The vector of network value and amenities to worker i in city c in period t is

$$N_{ct} = \left(\mathbb{1}_{\{S=N\}} \left(x_{c}^{st}, x_{c}^{d} \right), \mathbb{1}_{\{S=M\}} x_{c,t-\tau}^{rb}, x_{ct}^{A} \right) \tag{6}$$

where $\mathbb{1}_{\{S=N\}}$ and $\mathbb{1}_{\{S=M\}}$ are indicator functions equal one if a worker is native or immigrant,

[17] Prominent examples include the concentration of Arab immigrants in Detroit (see Abraham, 2000) and Mexican immigrants in Los Angeles and Chicago.

[18] Curran and Rivero-Fuentes (2003) and Massey and Espinosa (1997) find that networks affect immigration decisions. Additionally, Munshi (2003) documents that a Mexican immigrant is more likely to find a job in the U.S. if his network is larger.

respectively.

3.3 Labor Supply

Each worker i chooses the most desirable location taking all cities' characteristics as given.[19] For simplicity, the original immigration decision is taken to be exogenous; upon arrival in the U.S., an immigrant must choose a city of residence. Natives are born and initially live in their birth locations. Upon entering the labor market, they choose a city of residence. In reality, immigration may affect the employment incentives of natives, at least in the short run in high immigrant density areas as documented in Card (2001) and Dustmann et al. (2016).[20] However, the long run effect is likely to be modest (Beerli and Peri, 2016) and so, for tractability, I abstract from labor supply decisions.[21]

The worker maximizes utility by choosing a city c, the quantity of a housing good Q_t which has a local price of R_{ct}, and a national good G_t which has a common price of P_t. Let z denote a vector of the worker's characteristics which includes skill level $e \in \{H, L\}$, gender $g \in \{F, M\}$, and nativity $s \in \{M, N\}$. A worker of type z inelastically supplies one unit of labor and earns a wage of W_{ct}^{z}. The utility of worker i living in city c, U_{ict} is defined as

$$U_{ict} = \max_{Q,G} \ln\left(Q_{it}^{\lambda_z^r}\right) + \ln\left(G_{it}^{1-\lambda_z^r}\right) + u_i\left(N_{ct}\right) \tag{7}$$

subject to

$$P_t G_{it} + R_{ct} Q_{it} \leq W_{ct}^{z}$$

where $u_i\left(N_{ct}\right)$ is the utility from city amenities and networks, $0 \leq \lambda_z^r \leq 1$ is a parameter which can be trivially identified as the share of income on housing. Most empirical studies find that housing is a normal good, with an income elasticity of $0.8 - 0.87$ (Polinsky and Ellwood, 1979). This suggests that housing expenditure shares may be lower for higher income workers. Since income inequality is most pronounced between college and noncollege workers (Katz and Autor, 1999), I restrict λ_z^r to only vary across skill-nativity groups.

[19]The present framework has eight types of workers and 115 locations. While the role of joint location decisions for couples is important, this requires estimating parameters for many possible types of households. Therefore, I leave this to future work.

[20]Card (2001) finds that the inflows of new immigrants into the U.S. between 1985-1990 reduced the employment rates of natives and earlier immigrants by up to 1 percentage point in most cities, and up to 3 percentage points in gateway cities. Dustmann et al. (2016) study the employment effect of the inflow of Czech workers into Germany between 1990-1993, and find that this leads to a 0.9 percent decline in the employment of natives. However, the employment response is largely driven by the decreased inflows of natives into work rather than the outflows.

[21]Focusing on the long run over a ten year period, Beerli and Peri (2016) find no effect of immigration on the employment rate of other workers.

Maximizing (7), the worker's indirect utility from living in city c in year t is given by

$$V_{ict} \quad = \quad w_{ct}^{z} - \lambda_{z}^{r} r_{ct} + u_{i}\left(N_{ct}\right) \tag{8}$$

where $w_{ct}^{z} = \ln\left(W_{ct}^{z}/P_{t}\right)$ and $r_{ct} = \ln\left(R_{ct}/P_{t}\right)$. The value of amenities and networks to worker i in city j in period t is defined as

$$u_{i}\left(N_{ct}\right) = \beta_{z}^{A} x_{ct}^{A} + \beta_{zt}^{st} st_{i} x_{c}^{st} + \beta_{zt}^{d} st_{i} x_{c}^{d} + \beta_{zt}^{rb} rb_{i} x_{c,t-\tau}^{rb} + \lambda_{z}^{\sigma} \varepsilon_{ict} \tag{9}$$

where rb_{i} is a 22 element binary vector with each component equal to one if the worker was born in the country group; and st_{i} is 54 element binary vector where each component equals one if the worker was born in the state. Each worker has an individual idiosyncratic taste for cities, ε_{ict} drawn from a Type I Extreme Value distribution. I assume that the variance of workers' idiosyncratic tastes for each city only differ across immigration status and skill levels (this allows me to estimate the parameters of interest more precisely). However, worker i's marginal utility of the amenities β_{z}^{A}, and the value of networks $\beta_{zt}^{st}, \beta_{zt}^{d}, \beta_{zt}^{rb}$ can vary across all types of workers. Furthermore, I allow the value of networks to vary across time for two reasons. First, this greatly simplifies the computation (see Section 4). Second, this allows the model to capture the cohort effects and account for the growth of immigrants into nontraditional cities.[22]

For identification purposes, I normalize the standard deviation of workers' idiosyncratic taste for cities to one by dividing (8) by λ_{z}^{σ}, and redefine the parameters of the normalized optimized utility function as

$$\begin{aligned} V_{ict} \quad = \quad & \lambda_{z}^{w}\left(w_{ct}^{z} - \lambda_{z}^{r} r_{ct}\right) \\ & + \lambda_{z}^{A} x_{ct}^{A} + \lambda_{zt}^{st} st_{i} x_{c}^{st} + \lambda_{zt}^{d} st_{i} x_{c}^{d} + \lambda_{zt}^{rb} rb_{i} x_{c,t-\tau}^{rb} + \varepsilon_{ict}. \end{aligned} \tag{10}$$

where $\left(w_{ct}^{z_i} - \lambda_{z}^{r} r_{ct}\right)$ is the worker's income net of housing expenditure or local real wage.

The preferences amongst workers of type z for a given city differ due to their birthplaces and idiosyncratic taste for cities. Let Γ_{ct}^{z} denote the common utility value of city c for all workers of type z,

$$\Gamma_{ct}^{z} = \lambda_{z}^{w}\left(w_{ct}^{z_i} - \lambda_{z}^{r} r_{ct}\right) + \lambda_{z}^{A} x_{ct}^{A}.$$

The term Γ_{ct}^{z} represents the mean utility of workers of type z from living in city c net of the home or network values. Eq (10) can be rewritten as

$$V_{ict} \quad = \quad \Gamma_{ct}^{z} + \lambda_{zt}^{st} st_{i} x_{c}^{st} + \lambda_{zt}^{d} st_{i} x_{c}^{d} + \lambda_{zt}^{rb} rb_{i} x_{c,t-\tau}^{rb} + \varepsilon_{ict}.$$

[22] Kritz and Gurak (2006) document a rapid growth of immigrants into cities with historically small immigrant populations from 1980-2000; examples includes Atlanta, Dallas, Orlando, and Sacramento.

Since the preference shocks are drawn from an extreme value distribution, the probability of a person choosing to live in city c is

$$\mathrm{Pr}_{ict} = \frac{\exp\left(\Gamma^{z}_{ct} + \left(\lambda^{st}_{zt} st_i x^{st}_c + \lambda^{d}_{zt} st_i x^{d}_c + \lambda^{rb}_{zt} rb_i x^{rb}_{c,t-\tau}\right)\right)}{\Sigma_{k\in C}\exp\left(\Gamma^{z}_{kt} + \left(\lambda^{st}_{zt} st_i x^{st}_c + \lambda^{d}_{zt} st_i x^{d}_c + \lambda^{rb}_{zt} rb_i x^{rb}_{c,t-\tau}\right)\right)}. \tag{11}$$

Therefore the labor supplies for each worker type in city c in year t are

$$Z_{ct} = \Sigma_{i\in \mathscr{Z}_t} \mathrm{Pr}_{ict}$$

where Z_{ct} is the number of workers of type z in city c in year t, and $\mathscr{Z}_t$ is the set of workers of type z in the economy (McFadden, 1973).

3.4 Housing Market

Housing supply serves as a congestion force. Each city is endowed with a fixed amount of land suitable for construction. Developers are price-takers and sell identical houses. Let $P_{h,ct}$ denote local hosing prices which are set through equilibrium in the competitive market. Following Davis and Palumbo (2008) and Diamond (2016), the inputs to housing production include construction materials and land. Thorsnes (1997) estimates the elasticity of substitution between land and non-land inputs in the housing production to be around one. Therefore, I assume the housing production technology to take the following form

$$Q_{ct} = a_{ct} \ell^{\varphi}_{ct} m^{1-\varphi}_{ct},$$

where Q_{ct} is the quantity of houses in city c in year t, a_{ct} is city-specific productivity in the housing production, ℓ_{ct} is the amount of developable land and m_{ct} is the quantity of construction materials.The parameter φ represents the share of land in the housing production.

The developer's profit function is

$$\pi = P_{h,ct} Q_{ct} - P_{\ell,ct}\ell_{ct} - P_{m,t} m_{ct},$$

where the price of construction materials $P_{m,t}$ is exogenous and the price of land $P_{\ell,ct}$ is a function of houses. The idea is that as a city expands, the land available for development decreases and hence land prices rise. The land price takes the following form

$$P_{\ell,ct} = Q^{\nu_c}_{ct} \tag{12}$$

where ν_c measures the elasticity of land price. Since developers are price takers, the housing price is set at the average cost of production,

$$P_{h,ct} = AC = \frac{1}{a_{ct}} \left[\left(\frac{\varphi}{1-\varphi} \right)^{1-\varphi} + \left(\frac{\varphi}{1-\varphi} \right)^{-\varphi} \right] P_{m,t}^{1-\varphi} P_{\ell,ct}^{\varphi}. \tag{13}$$

In the steady state equilibrium, housing prices equal the discounted values of rents,

$$R_{ct} = i_t \times P_{h,ct}, \tag{14}$$

where i_t is the interest rate. Substituting (12) and (13) into (14) yields the following housing supply equation

$$\ln(R_{ct}) \quad = \quad \ln(CC_{ct}) + \nu_c \varphi \ln Q_{ct} \tag{15}$$

where the construction cost $\ln CC_{ct} = \ln i_t + \ln \frac{1}{a_{ct}} \left[\left(\frac{\varphi}{1-\varphi} \right)^{1-\varphi} + \left(\frac{\varphi}{1-\varphi} \right)^{-\varphi} \right] P_{m,t}^{1-\varphi}$.

For simplicity, I assume that absentee landlords initially own and sell land to developers. Given workers' preferences in (7), the demand for local houses is given by

$$Q_{ct} = \sum_z Z_{ct} \frac{\lambda_z^r W_{ct}^z}{R_{ct}} \tag{16}$$

where Z_{ct} is the population of each worker type z living in city c year t. Substituting (16) into (15), the equilibrium housing rent is determined by

$$\ln(R_{ct}) = \ln(CC_{ct}) + \gamma_c \ln \left(\sum_z Z_{ct} \lambda_z^r W_{ct}^z \right) \tag{17}$$

where $\ln CC_{ct} = (1/(1+\varphi \nu_c)) \left(\ln i_t + \ln \frac{1}{a_{ct}} \left[\left(\frac{\varphi}{1-\varphi} \right)^{1-\varphi} + \left(\frac{\varphi}{1-\varphi} \right)^{-\varphi} \right] P_{m,t}^{1-\varphi} \right)$, and γ_c measures the elasticity of rent with respect to housing demand.

The rent elasticity varies by geographic and regulatory constraints. Scarcity of land suitable for development limits new construction and leads to a more inelastic housing supply. However, as noted in Saiz (2010), geographic constraints are less likely to be binding when the level of construction is low, while regulatory constraints can be crucial regardless of the existing number of population. Therefore, I use the interaction of predetermined initial log city population with geographic constraint as a measure of land scarcity. I approximate γ_c as follows

$$\gamma_c = \gamma^{geo} x_c^{geo} \times \ln(pop_c) + \gamma^{regu} \ln(x_c^{regu}). \tag{18}$$

In Eq (18), γ^{geo} measures the contribution of effective geographic constraints on the inverse elasticity of housing rent where x_c^{geo} measures the share of land within 50 km of each city's center that is unavailable for development due to wetlands, water bodies or steep slopes, and pop_c is the predetermined initial population levels. The third term, γ^{regu} measures how variation in regulatory constraint x_c^{regu} impacts the inverse elasticity of housing supply. The 2005 Wharton Regulation Survey collected data on land use regulation; I use the Wharton Regulation Index (WRI) as a measure of regulatory constraints. Saiz (2010) provides these measures at the MSA level.

3.5 Equilibrium

Equilibrium is defined by a set of prices $(w_{ct}^{z*}, r_{ct}^{*})$ and populations of each type (Z_{ct}^{*}) such that

1. Every worker i maximizes his or her utility by choosing the optimal city c^*:

$$c^* = \underset{j \in C}{\text{argmax}} V_{ijt} \tag{19}$$

2. Every firm j chooses an optimal production plan y_{jt}^{*} to maximize its profit:

$$P_t^* Y_{jt}^* \geq P_t^* Y, \forall Y_{jt} \in \mathbf{Y}_{jt} \tag{20}$$

3. The labor demand and labor supply of each worker type are equal:

$$Z_{ct}^* = \Sigma_{i \in \mathscr{Z}_t} \text{Pr}_{ict} \tag{21}$$

$$\begin{aligned} w_{ct}^{z*} = & \frac{1}{\alpha} \ln A_{ct} + \ln \eta_t + \ln \theta_{ect} + \frac{1}{\sigma_E} (\ln L_{ct} - \ln L_{ect}) + \ln \phi_{egct} \\ & + \frac{1}{\sigma_G} (\ln L_{ect} - \ln L_{egct}) + \ln \beta_{egct}^{s} + \frac{1}{\sigma_{M,E}} (\ln L_{egct} - \ln Z_{ct}^*) \end{aligned} \tag{22}$$

4. Total local housing demand satisfies the housing rent equation

$$\ln(R_{ct}^*) = \ln(CC_{ct}) + \gamma_c \ln\left(\sum_z Z_{ct}^* \lambda_z^r W_{ct}^{z*}\right) \tag{23}$$

Under the assumptions that ε_{ict} is drawn from a Type I Extreme Value distribution which is continuous, and u_i as well as the firm's objective function are continuous, an equilibrium exists (see Appendix C. for the proof of existence). Bayer and Timmins (2005) show that the uniqueness of an equilibrium depends on the following features of the model: (i) the magnitude of the agglomeration and congestion forces; (ii) the total number of cities; (iii) the importance of individual tastes in the utility function; and (iv) the variation and importance of fixed attributes across cities such as home premiums and network values. A sufficiently strong agglomeration effect can change the preference rank-ordering of locations leading to multiple equilibria, while a congestion effect gives rise to a unique equilibrium by inducing workers to disperse which preserves the rank-order of locations. The present model incorporates a congestion force through housing supply. Further, network values are measured by the numbers of previous immigrants and independent of the current number of immigrants in a given city; hence there is no agglomeration incentive due to current networks for immigrants.[23] However, heterogeneity in labor types may induce complementary workers to concentrate in the same locations. Nonetheless, provided that the housing supply congestion effect is sufficiently strong, a unique equilibrium can be obtained (see Appendix C. for further discussion).

4 Estimation

The estimation consists of estimating the parameters of labor demand, worker preferences and housing rent equation. I estimate each part of the model separately and discuss identification below.

4.1 Labor Demand

In general, the labor demand functions can be estimated in one step using nonlinear techniques. However, since the firm's production function takes a three-level nested CES form, estimating the parameters using a nonlinear system of equations generates numerical difficulties. Thus, I follow Card and Lemieux (2001) by proceeding iteratively from the lowest nest to the top.[24]

Step 1: Estimate immigrant-native parameters: β^s_{egct} and $\sigma_{M,E}$

Using (5), the relative wage of native to immigrant of given characteristics can be expressed as

$$\ln\left(\frac{W^N_{egct}}{W^M_{egct}}\right) = \ln\left(\frac{\beta^N_{egct}}{1-\beta^N_{egct}}\right) - \frac{1}{\sigma_{M,E}}\ln\left(\frac{N_{egct}}{M_{egct}}\right) + \xi_{egct} \qquad (24)$$

[23] I impose that the network effects are independent of the current number of immigrants to reduce the multiplicity of equilibria. However, since new immigrants tend to locate in the same regions as their fellow expatriates, holding the network strength fixed also enables us to pin down an equilibrium that is likely to realize.

[24] Other papers, e.g. Manacorda et al. (2012), also use this iterative estimation method.

where W^N_{egct} and W^M_{egct} are the average wages of natives and immigrants in group (g,e) in city c and year t. N_{egct} and M_{egct} are the numbers of employed natives and immigrants, respectively. ξ_{egct} represents other sources of variation in native-immigrant wage gaps. A concern with equation (24) is that ξ_{egct} may be correlated with the relative labor supply.[25] Therefore, I estimate (24) using an instrumental variable for the relative labor supply $\ln\left(\frac{N_{egct}}{M_{egct}}\right)$ (described in detail below).

As in Manacorda et al. (2012), (24) assumes that $\ln\left(\frac{\beta^N_{egct}}{1-\beta^N_{egct}}\right)$ varies additively as follows

$$\ln\left(\frac{\beta^N_{egct}}{1-\beta^N_{egct}}\right) = d_g + d_e + d_t + d_c + \mathrm{KM}_{egct} \tag{25}$$

where d_g, d_e and d_t are the gender, education and time fixed effects, respectively. Additionally, I include city-level variables d_c to capture any permanent city-specific factors, and estimates of the transitory shocks to the relative demand, KM_{egct}. For permanent city-specific factor control variables d_c, I include the log city size in 1980 and the mean wage residuals in 1980.[26] To measure transitory shocks KM_{egct}, I adapt an index of labor demand shifts proposed by Katz and Murphy (1992) which is also used in Moretti (2004a) and Notowidigdo (2011). The index represents shifts in the relative demand for different worker groups, predicted by a city's industrial composition. Formally, I define the Katz and Murphy (KM) index as[27]

$$\mathrm{KM}_{egct} = \sum_{i=1}^{ind} \omega_{i,c} \triangle L_{i,eg,-c,t} \tag{26}$$

where *ind* indexes three-digit industry, $\omega_{i,c}$ is the share of total hours worked in industry *ind* in city c in year $t-\tau$, and $\triangle L_{i,eg,-c,t}$ is the change in the log of total hours worked in the same industry nationally excluding workers in city c and workers in other cities in the given state, between $t-\tau$ and t by workers of type (g,e) in year t. I use the share of total hours in 1980, 1990 and 2000 for computing the KM indices in 1990, 2000 and 2007, respectively.

To address the endogeneity problem in (24), I instrument for the relative labor supply $\ln\left(\frac{N_{egct}}{M_{egct}}\right)$ using the predicted inflow rate of immigrants. Given the tendency of new immigrants to settle in country-specific enclaves, the number and city distribution amongst new arrivals are predictable (Altonji and Card, 1991). If M_{egjt} immigrants with characteristics (e,g) arrive from country j to

[25] ξ_{egct} may contain unobserved factors in a city such as labor-augmenting productivity differences of immigrants relative to natives.

[26] Wage residuals are obtained from a linear regression model fit by gender, immigration status, age, age squared, skill level, ethnicity variables, and interactions of skill level with a measure of years in the U.S. of immigrants.

[27] The term "Katz and Murphy" index is adopted from Moretti (2004a). This is similar to the Bartik instrument which measures local labor demand shifts using changes in the average national wages weighted by a city's industrial composition (Bartik, 2002).

the U.S. between year $t-5$ to t, then the predicted inflow rate as a fraction of the city's current population is given by

$$\hat{M}_{egct} = \sum_j \left(M_{jc,t-\tau}/M_{j,t-\tau}\right) M_{egjt}/P_c \tag{27}$$

where $M_{j,t-\tau}$ denotes the earlier population of immigrants from country j in the U.S. in 1980; $M_{jc,t-\tau}$ denotes the number living in city c in 1980; and P_c is the city's current population. Eq (27) shows that the predicted inflow rate $\hat{M}_{egct}$ is an average of the national inflow rates from each source country, weighted by the shares of the country's previous immigrants in city c.

I estimate (24) using two-stage least squares weighted by population in each cell. The exclusion restriction is that the national inflow rates from each source country are exogenous to local conditions.[28] The inverse of the coefficients on the group-specific relative labor supply give estimates of the elasticities of substitution between immigrants and natives amongst high skill labor $\sigma_{M,H}$ and amongst low skill labor $\sigma_{M,L}$. The coefficients on the characteristics and city control variables provide estimates of each β^S_{egct}. Using these estimates, L_{egct} can be computed by (4).

Step 2: Estimate male-female parameters: ϕ_{egct} and σ_G

Similar to previous steps, I use (5) to compute the relative wages between gender separately for natives and immigrants. The relative returns are given by

$$\begin{aligned} \ln\left(\frac{W^s_{eMct}}{W^s_{eFct}}\right) &= \frac{1}{\sigma_{M,E}}\left(\ln\left(\frac{L_{eMct}}{L_{eFct}}\right) - \ln\left(\frac{S_{eMct}}{S_{eFct}}\right)\right) + \ln\left(\frac{\beta^s_{eMct}}{\beta^s_{eFct}}\right) \\ &\quad + \ln\left(\frac{\phi_{eMct}}{\phi_{eFct}}\right) - \frac{1}{\sigma_G}\ln\left(\frac{L_{eMct}}{L_{eFct}}\right). \end{aligned}$$

Given the estimates from step 1 and 2, the RHS terms on the first two lines can be computed. Thus the relative return to gender can be expressed as

$$\ln\left(\frac{\hat{W}^s_{eMct}}{\hat{W}^s_{eFact}}\right) = \ln\left(\frac{\phi_{eMct}}{\phi_{eFct}}\right) - \frac{1}{\sigma_G}\ln\left(\frac{L_{eMct}}{L_{eFct}}\right) \tag{28}$$

where

$$\ln\left(\frac{\hat{W}^s_{eMct}}{\hat{W}^s_{eFct}}\right) = \ln\left(\frac{W^s_{eMct}}{W^s_{eFct}}\right) - \frac{1}{\sigma_{M,E}}\left(\ln\left(\frac{L_{eMct}}{L_{eFct}}\right) - \ln\left(\frac{S_{eMct}}{S_{eFct}}\right)\right) - \ln\left(\frac{\beta^s_{eMct}}{\beta^s_{eFct}}\right).$$

[28] I discuss a concern that the initial immigrant shares may be correlated with unobserved factors in a city in Section 5.5.

I assume that $\ln\left(\frac{\phi_{eMct}}{\phi_{eFct}}\right)$ varies additively as follows

$$\ln\left(\frac{\phi_{eMct}}{\phi_{eFct}}\right) = d_e + d_t + d_c + \text{KM}_{ect}$$

where d_e, d_t are the education and time dummies, d_c captures permanent city-specific factor control variables as in step 1, and KM_{ect} measures the transitory shocks to the relative demand of the combined gender labor.[29] I estimate equation (28), weighted by population in each cell, using the predicted inflow rate of male immigrants $\hat{M}_{eMct}$, defined in (27) as an IV. The estimates of σ_G, ϕ_{eMct} and ϕ_{eFct} allow us to compute L_{ect} using (3).

Step 3: Estimate high and low skill parameters: θ_{ect} and σ_E

Using (5), the relative returns to skill level is given by

$$\begin{aligned}\ln\left(\frac{W^s_{Hgct}}{W^s_{Lgct}}\right) &= \frac{1}{\sigma_{M,H}}\left(\ln\left(\frac{L_{Hgct}}{S_{Hgct}}\right)\right) - \frac{1}{\sigma_{M,L}}\left(\ln\left(\frac{L_{Lgct}}{S_{Lgct}}\right)\right) \\ &\quad + \ln\left(\frac{\beta^s_{Hgct}}{\beta^s_{Lgct}}\right) + \frac{1}{\sigma_G}\left(\ln\left(\frac{L_{Hct}}{L_{Lct}}\right) - \ln\left(\frac{L_{Hgct}}{L_{Lgct}}\right)\right) \\ &\quad + \ln\left(\frac{\phi_{gHct}}{\phi_{gLct}}\right) + \ln\left(\frac{\theta_{Hct}}{\theta_{Lct}}\right) - \frac{1}{\sigma_E}\ln\left(\frac{L_{Hct}}{L_{Lct}}\right).\end{aligned}$$

The relative returns to education can be expressed as

$$\ln\left(\frac{\hat{W}^s_{Hgct}}{\hat{W}^s_{Lgct}}\right) = \ln\left(\frac{\theta_{Hct}}{\theta_{Lct}}\right) - \frac{1}{\sigma_E}\ln\left(\frac{L_{Hct}}{L_{Lct}}\right), \tag{29}$$

where the LHS term,

$$\begin{aligned}\ln\left(\frac{\hat{W}^s_{Hgct}}{\hat{W}^s_{Lgct}}\right) &= \ln\left(\frac{W^s_{Hgct}}{W^s_{Lgct}}\right) - \frac{1}{\sigma_{M,H}}\left(\ln\left(\frac{L_{Hgct}}{S_{Hgct}}\right)\right) + \frac{1}{\sigma_{M,L}}\left(\ln\left(\frac{L_{Lgct}}{S_{Lgct}}\right)\right) - \ln\left(\frac{\beta^s_{Hgct}}{\beta^s_{Lgct}}\right) \\ &\quad - \frac{1}{\sigma_G}\left(\ln\left(\frac{L_{Hct}}{L_{Lct}}\right) - \ln\left(\frac{L_{Hgct}}{L_{Lgct}}\right)\right) - \ln\left(\frac{\phi_{gHt}}{\phi_{gLt}}\right)\end{aligned}$$

can be computed using the estimates from previous steps. I approximate $\ln\left(\frac{\theta_{Hct}}{\theta_{Lct}}\right)$ as

$$\ln\left(\frac{\theta_{Hct}}{\theta_{Lct}}\right) = d_c + d_t + \text{KM}_{ct}$$

[29] The KM index is computed similarly as in step 1 except that I combine hours of all workers within each skill group.

where d_t is the time dummies, d_c captures permanent city-specific factors and KM_{ct} measures the transitory shocks to the relative demand.[30] I estimate equation (29) using the predicted inflow rate of high skill relative to low skill immigrants as an IV, defined similar to (27). The difference in this step is that the IV is the predicted ratio of high skill to low skill immigrants combining male and female workers.

Finally, Eq (5) implies that η_t and A_{ct} can be estimated as the time and city fixed effects as follows

$$\ln\left(\hat{W}^s_{egct}\right) = d_t + d_{ct}$$

where

$$\begin{aligned}
\ln\left(\hat{W}^s_{egct}\right) &= \ln\left(W^s_{egact}\right) - \frac{1}{\sigma_E}\left(\ln\left(L_{ct}\right)\right) - \ln\left(\theta_{ect}\right) \\
&\quad - \left(\frac{1}{\sigma_G} - \frac{1}{\sigma_E}\right)\ln L_{ect} - \ln\phi_{egct} - \left(\frac{1}{\sigma_{M,E}} - \frac{1}{\sigma_G}\right)\ln L_{egct} \\
&\quad - \ln\beta^s_{egct} + \frac{1}{\sigma_{M,E}}\ln S_{egct}.
\end{aligned}$$

4.2 Labor Supply

Labor supply is estimated in two steps using the technique from Berry et al. (1995, 2004). These methods have been applied to estimate workers' preferences for locations by Bayer et al. (2007) and Diamond (2016). I adapt their approach.

The indirect utility of worker i in city c in year t is given by

$$\begin{aligned}
V_{ict} &= \Gamma^z_{ct} + \lambda^{st}_{zt} st_i x^{st}_c + \lambda^{d}_{zt} st_i x^{d}_c + \lambda^{rb}_{zt} rb_i x^{rb}_{c,t-\tau} + \varepsilon_{ict}, \\
\Gamma^z_{ct} &= \lambda^w_z\left(w^z_{ct} - \lambda^r_z r_{ct}\right) + \lambda^A_z x^A_{ct}.
\end{aligned}$$

The utility of a type z worker consists of the common utility value of the city for all workers with the same type, Γ^z_{ct} plus the network or birthplace value $\lambda^{st}_{zt} st_i x^{st}_c + \lambda^{d}_{zt} st_i x^{d}_c + \lambda^{rb}_{zt} rb_i x^{rb}_{c,t-\tau}$, and a worker-specific idiosyncratic taste for the city, ε_{ict}.

In the first step, I treat Γ^z_{ct} as parameters and estimate them together with the birthplace and network parameters by maximizing the log-likelihood,

$$LL\left(\Gamma^z_{ct}, \lambda^{st}_t, \lambda^{d}_t, \lambda^{rb}_t\right) = \sum_{i=1}^{n} \log\left(\frac{\exp\left(\Gamma^z_{ct} + \left(\lambda^{st}_{zt} st_i x^{st}_c + \lambda^{d}_{zt} st_i x^{d}_c + \lambda^{rb}_{zt} rb_i x^{rb}_{c,t-\tau}\right)\right) 1\left\{c_i = c\right\}}{1 + \sum^j_k \exp\left(\Gamma^z_{kt} + \left(\lambda^{st}_{zt} st_i x^{st}_k + \lambda^{d}_{zt} st_i x^{d}_k + \lambda^{rb}_{zt} rb_i x^{rb}_{k,t-\tau}\right)\right)}\right),$$

where $1\left\{c_i = c\right\}$ is an indicator function for whether worker i chooses to live in city c, and n is

[30] The KM index is computed similarly as in step 1 except that I combine hours of all types of workers.

the total number of workers. I include 114 MSAs as city choices, and combine the other MSAs as the outside option where the utility is normalized to zero. Differences in the proportions of people across cities identify the mean utilities. In the absence of values for networks and birthplaces, the mean utility of a given worker's type simply equals the log proportion of people of that type living in that city.

In the second step, I estimate the values of each city characteristic using the mean utility from step one. Given the workers' utility function, λ_z^r represents the share of income on housing. I take the values of housing expenditure shares per household member from the combined 2005-7 ACS. I tried estimating λ_z^r jointly with λ_z^w. However, this results in a noisy estimate and unreasonable value of λ_z^r that exceeds one. Therefore, I take the values of housing expenditure shares from the data and check how sensitive the estimates are to different values of λ_z^r in Section (5.5). I set λ_z^r to 0.3 for high skill natives, 0.3 for low skill natives, 0.34 for high skill immigrants and 0.36 for low skill immigrants.

The amenities x_{ct}^A for city c in year t consist of permanent city-specific components, such as proximity to lakes or oceans, and time-variant components such as the quality of goods and services. Let θ_c^A and ξ_{ct}^z denote the fixed and time-variant amenity components, respectively, then a city's amenities is given by

$$x_{ct}^A = \theta_c^A + \xi_{ct}^A.$$

Taking first differences of the mean utilities over periods gives

$$\triangle\Gamma_{ct}^z = \lambda_z^w \left(\triangle w_{ct}^z - \lambda_z^r \triangle r_{ct}\right) + \lambda_z^A \triangle \xi_{ct}^A. \tag{30}$$

The change in a city's mean utility for workers of type z consists of changes in wages, rents and time-variant amenities. Note that since the mean utilities in the first step are identified relative to the outside option, changes in local prices on the RHS of (30) are defined as relative prices to the outside option. Changes in cities' local real wages: $\left(\triangle w_{ct}^z - \lambda_z^r \triangle r_{ct}\right)$ are observed in the data. However, amenity changes are unobserved by the researcher. Define $\triangle\xi_{ct}^z$ as the change in unobserved utility value of city c's amenities across decades for workers of type z,

$$\triangle\xi_{ct}^z = \lambda_z^A \triangle \xi_{ct}^A. \tag{31}$$

Substituting (31) into (30) gives

$$\triangle\Gamma_{ct}^z = \lambda_z^w \left(\triangle w_{ct}^z - \lambda_z^r \triangle r_{ct}\right) + \triangle \xi_{ct}^z. \tag{32}$$

A concern with equation (32) is that $\left(\triangle w_{ct}^z - \lambda_z^r \triangle r_{ct}\right)$ may be influenced by unobserved changes in local amenities. Thus, I estimate λ_z^w using labor demand shocks as instrumental variables. Since the KM indices, as defined in (26), measure national changes in industrial productivity, they provide variation in local labor demand that is not related to unobserved changes in local amenities.[31] The moment restrictions are

$$\mathrm{E}\left(\triangle\xi_{ct}^{z}\mathrm{KM}_{egct}\right) \quad = \quad 0. \tag{33}$$

4.3 Housing Supply

Taking first differences of cities' rents over decades, we have

$$\triangle\ln\left(R_{ct}\right)=\triangle\ln\left(CC_{ct}\right)+\gamma_{c}\triangle\ln\left(\sum_{z}Z_{ct}\lambda_{z}^{r}W_{ct}^{z}\right)$$

where

$$\gamma_{c}=\gamma^{geo}x_{c}^{geo}\times\ln\left(pop_{c}\right)+\gamma^{regu}\ln\left(x_{c}^{regu}\right).$$

I take the values of housing expenditure shares, λ_{z}^{r} from the combined 2005-7 ACS as in Section 4.2. Changes in each city's wages W_{ct}^{z} and population Z_{ct} as well as the measure of effective geographic constraints $x_{c}^{geo}\times\ln\left(pop_{c}\right)$ and regulatory constraints x_{c}^{regu} are observed in the data. However, changes in construction costs are not observed by the researcher. To identify the elasticity of housing supply, γ^{geo} and γ^{regu}, requires variation in housing demand that is not related to changes in unobserved construction costs. Define changes in unobserved construction costs as $\triangle\varepsilon_{ct}^{CC}$, the housing supply curve can be rewritten as

$$\triangle\varepsilon_{ct}^{CC}=\triangle\ln\left(R_{ct}\right)-\left(\gamma^{geo}x_{c}^{geo}\times\ln\left(pop_{c}\right)+\gamma^{regu}\ln\left(x_{c}^{regu}\right)\right)\triangle\ln\left(\sum_{z}Z_{ct}\lambda_{z}^{r}W_{ct}^{z}\right).$$

To instrument for changes in housing demand, I use the interactions of KM indices with housing supply elasticity determinants as in Diamond (2016). As workers migrate to arbitrage increased wages caused by the labor demand shocks, they will drive up rents. The geographic and regulatory constraints x_{c}^{geo} and x_{c}^{regu} impact the elasticity of housing supply. Cities with inelastic housing supplies exhibit larger rent increases leading to relatively less in-migration. Since the KM productivity shocks are driven by national changes in industrial productivity, the KM indices interacted with housing supply elasticity determinants provide variation in housing demand unrelated to un-

[31] While λ_{z}^{w} is restricted to be common amongst workers of the same skill level and nativity, I also include worker-type fixed effects in the estimation to capture any differences across workers of different genders.

observed local construction costs.[32] This leads to the following moment restrictions:

$$\mathrm{E}\left(\triangle\varepsilon_{ct}^{CC}\Theta_{ct}^{z}\right) = 0 \tag{34}$$

where

$$\Theta_{ct}^{z} \in \left\{ \mathrm{KM}_{egct}, \quad \mathrm{KM}_{egct}x_{c}^{geo}, \mathrm{KM}_{egct}x_{c}^{regu} \right\}.$$

5 Baseline Results

5.1 Labor Demand

The estimates of labor demand functions are reported in Panel I of Table 1. I estimate the elasticity of substitution between high skill natives and high skill immigrants to be 6.93, and between low skill natives and low skill immigrants to be 17.87. The estimates imply that low skill immigrants are closer substitutes to natives relative to higher skill immigrants. This could be because differences in the quality of education and English skills are less important for low skill labor. A similar conclusion is found in the city-level estimation in Card (2009). However, using data at the national level, Ottaviano and Peri (2012) find that natives and immigrants have a lower substitutability amongst low educated workers.

The elasticity of substitution between male and female workers, σ_G is estimated to be 1.97. Johnson and Keane (2013) estimate the elasticity of substitution between genders conditional on occupation and education to be 5.26; however, the unconditional elasticity of substitution between genders lies in the range of $1.85-2.20$. Since I do not differentiate labor types by occupation, my estimate of σ_G lies in the range of their unconditional elasticity. Finally, the elasticity of substitution between high and low skill workers is estimated to be 2.19. This parameter lies between the range of estimates at the MSA level provided by Diamond (2016) and Card (2009). For estimates at the national level, this parameter tends to be smaller (Katz and Autor, 1999). Goldin and Katz (2009) argue that the values of $1/\sigma_E$ from more recent data tend to smaller because the estimates are confounded by a slowdown in the pace of skill-biased technical change.

[32] I also include year fixed effects for the housing supply estimation to capture any proportional changes in CC_{ct} common to all cities.

5.2 Worker Preferences

Panel II of Table 1 displays the elasticity of workers' demand for a city with respect to local real wage.[33] The ratio of workers' marginal utility with respect to local real wage λ_z^w to the housing expenditure share λ_z^r measures the elasticity of workers' demand with respect to local rents. The results show that all workers prefer cities with higher local real wages. Low skill natives are slightly more sensitive to changes in local wages and rents than high skill natives. Immigrants are much more sensitive. For example, a one percent wage rise increases the high and low skill native population by about 1.3 and 1.4 percent, respectively, while it leads to about 3.2 and 2.6 percent increase in population of the immigrant counterparts. The elasticity of workers' demand with respect to local rents implies that a one percent rent increase reduces the native population by about 0.4 percent, while reducing the population of immigrants by almost 1 percent.

Similarly, using 1980-2000 U.S. Census data, Diamond (2016) finds immigrants to be more price responsive than natives. However, her estimates for λ_z^w are higher than my estimates for all worker types. In her model, immigrants do not value city-specific networks and they earn the same wages as natives of the same skill level. Workers also have preferences for local amenities, measured by the city's college employment ratio. A higher value of λ_z^w means migration decisions are more responsive to wages, which would lead to smaller impacts of immigration in my counterfactuals.

Table 2 reports the estimates of birthplace and network attachments for natives and immigrants. Overall, low skill natives have stronger preferences to live in their birth states than high skill natives.[34] For example, in 2007 high skill male natives are about 2.8 times more likely to live in a given MSA if it is located in their birth states, while low skill male natives are almost 3.6 times more likely. Both low and high skill natives are less likely to live in a given MSA the farther it is from their birth states. Among high skill natives, females have slightly stronger attachments to their birthplaces than males. The reverse is true among low skill natives; however the differences are small.

The estimates in Panel II. of Table 2 show that all immigrants are more likely to live in a given MSA if it had more immigrants from the same country group in the past. This is consistent with the well-known fact that immigrants tend to settle in country-specific enclaves (Card, 2009). Overall, low skill immigrants value the size of city networks more than high skill immigrants. Amongst immigrants of the same skill level, female workers have slightly stronger preferences for networks than male workers. From 1990-2007, the values of networks are decreasing for all types

[33]Given the distributional assumption of workers' idiosyncratic tastes for cities, the magnitudes of these coefficients represent the elasticity of workers' demand for a small city with respect to its local prices.

[34]This is in line with Kennan and Walker (2011) who estimate the moving cost of high school graduates to be higher than the moving cost of college workers.

of immigrants; this concurs with findings of the growing number of immigrants in nontraditional cities in the past few decades (Kritz and Gurak, 2006). One possible reason could be rising housing costs in traditional immigrant gateway cities such as New York and other large MSAs.[35]

5.3 Housing Supply

Panel III. of Table 1 shows the estimates of inverse housing supply elasticities. The estimates show that housing supply is less elastic in areas with more geographic and regulatory constraints which is consistent with Saiz (2010) and Diamond (2016). The predicted inverse housing supply elasticities, reported in Panel IV., range from 0.03 to 1.18. The average inverse housing supply elasticity is 0.69 and the standard deviation is 0.27 which are close to Saiz (2010)'s average and standard deviation.

5.4 Goodness of Fit

This section assesses the goodness of fit by comparing the predicted and observed numbers of natives living outside their birthplaces. For immigrants, I assess the fit by comparing the predicted and observed numbers of workers from major sending countries in each city. This includes Mexico, Central America, South America and the Caribbean.

Overall, the model predicts the proportions of each worker type across cities well. Figure A.1 plots the predicted and observed proportions of natives who do not live in their states of birth in 2007. Figure A.2 shows the fit of the predicted number of immigrants from the major sending countries in 2007. The fits for 1990 and 2000 are similar to the 2007 plots, and available upon request.

5.5 Sensitivity Analysis

Panel I of Table A.5 reports the estimated substitution elasticities using various measures of wages and labor supply as well as different specifications. The first column reports the estimates of labor demand parameters in the baseline case. The second column reports the substitution elasticities when immigrants with more than thirty years in the U.S. are classified as natives. In this case, the elasticities of substitution are close to the baseline estimates. The third column reports the substitution elasticities using a different measure of labor supply. I adopt Card (2009)'s relative numbers of efficiency units by defining the labor supply of low skill workers as the sum of high school graduates, plus 0.7 times the number of dropouts and plus 1.2 times one-half the people

[35] Kritz and Gurak (2006) find that the propensity to migrate to nontraditional cities of immigrants also vary by country of origins.

with 1–3 years of college education. For high skill labor, I define this as the sum of college graduates plus 0.8 times one-half the people with 1–3 years of college education. This yields the elasticities of substitution between immigrants and natives that are slightly higher than my estimates. The elasticity of substitution between high and low skill increases to 3.51 which is closer to Card (2009)'s estimate. In the baseline case, I do not adjust the labor supply of each skill group by their relative efficiency units in order to keep the number of worker types in the counterfactuals manageable. However, in Section 6.6, I examine the sensitivity of counterfactual policy experiments when the substitution elasticity between high and low skill labor increases.

The forth column reports the substitution elasticities using wage residuals. I residualize wages against worker's age, age squared and detailed level of education separately for each group of workers. This yields elasticities that are similar to the benchmark model. Finally, I examine whether the substitution elasticities are sensitive to the ordering of the CES production function. I reverse the order by placing gender on the top and skill on the second level. As shown in the last column, the elasticity of substitution between high and low skill labor becomes larger. However, in all of these specifications, my estimates indicate imperfect substitutability between natives and immigrants.

Finally, one may be concerned that the initial immigrant shares used in (27) are correlated with unobserved factors in a city, even if the national inflow rates are exogenous. As discussed in Card (2009), given the large inflows of Mexican immigrants in the past, the instruments are highly correlated with a city's fraction of Mexican immigrants in 1980. I have re-estimated the elasticities of substitution between immigrants and natives by removing Mexican immigrants from the IV construction. I find that the elasticity of substitution between immigrants and natives of high skill labor remains roughly the same ($\sigma_{M,H} = 6.96$), while the substitutability among low skill labor becomes slightly larger ($\sigma_{M,L} = 20.62$).

Panel II displays the elasticity of workers' demand for a city with respect to local real wage, λ_z^w. The second column reports the estimates of λ_z^r using different housing expenditure shares. I take local good expenditure shares from Moretti (2013) and set λ_z^r to be 0.62 for all types of workers. The estimates of worker preferences λ_z^w are not very sensitive to the values of housing expenditure shares λ_z^r. Further, recall that in the second step of worker preference estimation, I define changes in local real wage on the RHS of (32) as prices relative to the outside option. As shown in the third column of Panel II, when prices are not expressed in relative terms, the estimates of λ_z^w become considerably smaller for all groups of workers, and imprecisely estimated for high skill natives. Since the mean utilities in the first step of the estimation are identified relative to the outside option, it is consistent to use relative prices in the second step.

Panel III. presents the estimates of housing supply elasticities under different specifications. The first column shows the baseline estimates. The second column reports the estimates when the measure of geographic constraints are included without the interaction term, and the third column shows the estimates when both terms are included. The implied housing supply elasticities in the second specification is similar to the baseline case. However, in the full specification, the coefficient on the interaction of geographic constraint with predetermined population has a negative sign. This leads to the counter-intuitive interpretation that geographic constraints matter less when population increases. Therefore, I do not utilize this full specification in the baseline model.

6 The Impacts of Immigration

6.1 Overview

I now analyze the effects of changes in the skill mix and stock of immigrants as well as a location-specific immigration policy. The outcomes of interest are the wages and welfare of different groups of workers. I measure welfare effects using changes in the indirect utility in (10).

One potential benefit that is often not included in immigration analyses is the additional rental income accrued to landlords. The U.S. Census provides information on individuals' residential house values and dividend/rental income, but the actual number of landlords who own rental property is not available. To incorporate these gains in the welfare calculation, I approximate the number of landlords by classifying workers in the combined 2005-7 ACS who meet my sample criteria and report positive rental income and positive values of houses as landlords.[36] The share of landlords consists of 7.1 percent high skill natives, 1.8 percent low skill natives, 0.9 percent high skill immigrants and 0.2 percent low skill immigrants.

In all analyses, I consider fixed and free migration cases. In the fixed migration case, the allocation of natives and immigrants across cities is held fixed. In the free migration case, all workers make their location decisions simultaneously. In each counterfactual, I solve for the allocation of workers and prices using the equilibrium conditions: (21)-(23). This requires finding 920 fixed points (115 city populations for 8 types of workers). I solve for the equilibrium by substituting (22) and (23) into (21) and searching for an allocation (Z_{ct}^{*}) such that

$$Z_{ct}^{*} = \underset{(Z_{ct})}{\text{argmin}} \left[Z_{ct} - \Sigma_{i \in \mathscr{Z}_t} \text{Pr}_{ict} \left(Z_{ct}, \Omega \right) \right]$$

where Ω is the vector of model parameters and Pr_{ict} is the choice probability in (11). The welfare analysis is based on simulated location choices of a random draw of 240,000 individuals given prices in the initial and new equilibrium.

[36] See Section 2.1 for sample description.

6.2 Model Predictions

Before proceeding to the counterfactuals, let us first consider how a change in the number of immigrants affects the wages of each group. Let $d\ln M_{egct}$ denote a hypothetical change in the number of immigrants of each type. The change in a native's wage is

$$d\ln W^{N}_{egct} = \frac{1}{\sigma_E}\left(d\ln L_{ct} - d\ln L_{ect}\right) + \frac{1}{\sigma_G}\left(d\ln L_{ect} - d\ln L_{egct}\right) + \frac{1}{\sigma_{M,E}} d\ln L_{egct} \tag{35}$$

Similarly, the change in an immigrant's wage is

$$\begin{aligned} d\ln W^{M}_{egct} = & \frac{1}{\sigma_E}\left(d\ln L_{ct} - d\ln L_{ect}\right) + \frac{1}{\sigma_G}\left(d\ln L_{ect} - d\ln L_{egct}\right) \\ & + \frac{1}{\sigma_{M,E}}\left(d\ln L_{egct} - d\ln M_{egct}\right). \end{aligned} \tag{36}$$

There are three effects. First, Eq (36) shows that increased immigration by a specific group and city will reduce the wages of immigrants by the term $-\frac{1}{\sigma_{M,E}} d\ln M_{egct}$; the negative effect is due to decreasing marginal product of labor. However, this effect is counterbalanced by the imperfect substitutability between natives and immigrants within gender-skill groups, $\frac{1}{\sigma_{M,E}} d\ln L_{egct}$. Further, in the extreme case where immigrants and natives are perfect substitutes (i.e. $\sigma_{M,E} \to \infty$) then (35) and (36) become identical.

The second effect comes from the deviation in the labor supply of each gender-skill group relative to the overall supply of each skill group (which is the same for natives and immigrants): $\frac{1}{\sigma_G}\left(d\ln L_{ect} - d\ln L_{egct}\right)$. The third effect comes from changes in the aggregate supply of each skill group: $\frac{1}{\sigma_E}\left(d\ln L_{ct} - d\ln L_{ect}\right)$. Increased immigration by a specific group decreases the wages of all workers in that group. However, this effect will be mitigated by the complementarity between workers of different types.

With respect to workers' preferences, the estimates in Section 5.2 reveal that natives are 3-4 times more likely to live in a given MSA if it is located in their birth state. This implies that a city with a large share of natives who already left their birthplaces is more likely to experience an out-migration response, since this group of natives is relatively mobile. Thus the wage impacts of immigration are likely to be attenuated in these cities. Further, while immigrants value their city-specific networks (measured by the number of previous immigrants from the same country group), the availability of large networks across other cities can increase their migration propensity. For example, there are 60 cities which have more than 10,000 Mexicans (see Table A.4 for the number of cities with at least 10,000 immigrants from each country group). The fact that Mexican workers have 60 cities with large networks means that they can move across these 60 cities without losing significant network value. Therefore cities with more previous immigrants who have dispersion of large networks are more likely to have smaller wage impacts due to workers' relocation.[37]

Moreover, the estimates show that workers prefer cities with higher local real wages and amenities. Hence, cities with (i) lower productivity, (ii) more inelastic housing supply and (iii) lower amenities are more likely to experience an outflow of workers in the incidence of negative immigration shocks. Since cities have mixed characteristics, with possibly opposing effects on migration incentives, the migration response depends on the relative strength of these characteristics. Tables A.6-A.8 report the top and bottom ten cities on each of these characteristics in 2007.

6.3 Skill Selective Immigration

Some countries select immigrants based on skill levels. For example, Australia and Canada employ point systems that grant entry to a significantly lower proportion of unskilled workers relative to the U.S. (Antecol et al., 2003). In this section, I examine the price and welfare effects of an increase in immigrants if the U.S. were to adopt a skill selective immigration policy. The experiment consists of an increase in the ratio of immigrants to natives amongst high skill workers from 0.17 to 0.25. This figure is in line with the UK ratio of high skill immigrants between 2003-2005 (Manacorda et al., 2012). This corresponds to increasing high skill immigrants by roughly 46 percent, or around 3.6 million workers in 2007, holding the gender mix constant. I consider two cases. In the first case, I increase the number of high skill immigrants in each city proportionately, holding the locations of all workers fixed. In the second case, natives and previous immigrants can migrate in response to the immigration; hence all workers, including the new immigrants, simultaneously make their location decisions.

6.3.1 National Impact

The arrival of high skill immigrants puts downward pressure on the wages of previous high skill immigrants. There is a small positive effect on the average wages of high skill natives. Table 3 reports the average annual wages of each group, expressed in 2015 dollars, weighted by employment at the city level. I present average wages for two types of city: gateway cities, defined as being in the top 5 percentile in terms of the fraction of new high skill immigrants, and all other cities. The gateway cities include Fort Lauderdale, Miami, New York, San Francisco and San Jose. As shown in column one, the average annual wages of high skill natives increases by 276 dollars for males and 324 dollars for females in the fixed migration case, while the average annual wages of high skill immigrants fall by $4,432$ dollars for males and $3,122$ dollars for females in gateway cities. The differential wage impact is due to the imperfect substitutability between high skill natives and

[37] Cadena and Kovak (2016) find that natives who live in MSAs with a large number of Mexican immigrants experience a weaker relationship between local shocks and local employment probabilities.

high skill immigrants. In contrast, given the complementarity between high and low skill labor, the influx of high skill immigrants increases the wages of low skill workers. In gateway cities, the average wages of low skill labor in the fixed migration case increase by $2,232$ and $1,823$ dollars for male and female natives, respectively, and $1,538$ and $1,351$ dollars for the immigrant counterparts. As shown in column 3 of Table 3, the average wage impacts on high skill natives and other low skill workers are much smaller in other cities since they receive a less substantial flow of new immigrants.

When workers are free to move, the average gains for low skill wages become smaller. The average adverse wage impacts are slightly attenuated for high skill immigrants in gateway cities, and slightly intensified in other cities; this is displayed in columns two and four in Table 3.

Moreover, the average annual rent weighted by city population initially increases by around $1,228$ dollars in gateway cities, and by around 231 dollars in other cities (see Table 3). In the free migration case, as people move away from the popular destinations for new immigrants, the increase in rent becomes smaller relative to the fixed migration case, while rents in some smaller cities slightly rise. Overall, a one percent increase in a city's population due to immigration is associated with around a 1.14 percent increase in the average housing rent in the fixed migration case, and 1.1 percent increase in the free migration case.[38] This is in line with Saiz (2007) who finds a one percent increase of a city's population due to immigration is associated with a one percent increase in average housing rents and prices.

6.3.2 Local Impact

Figure 1 plots the percentage change in natives' wages when the workers' locations are held fixed against the percentage change when all workers are free to migrate. Each bubble is a metropolitan area. The size of a bubble reflects the number of new immigrants as a proportion of local population in the associated city. Further, red bubbles represent the ten cities with most inelastic housing supply, while green bubbles represent the ten with the least inelastic supply. Figure 2 displays the same comparison for immigrants' wages across cities. These scatter plots show that there is substantial variation in the impact across cities, and the initial wage impacts are more substantial in cities with larger fractions of new high skill immigrants (represented by larger bubbles).

Moreover, the initial positive wage impacts on low skill workers are more substantial in the cities with most inelastic housing supply (represented by red bubbles) than the least (represented by green bubbles). This is because cities with inelastic housing supply tend to have more high skill workers. Therefore, given the complementarity between high and low skill labor, the gains in the wages of low skill workers are larger in these cities.

[38] This result is obtained by regressing the changes in rents on changes in local population in the counterfactual.

When workers are free to move, the wage impacts change substantially in some locations. First, the model predicts that a city with undesirable characteristics (more inelastic housing supply, lower productivity and lower amenities), would have a larger outflow of incumbent workers in response to immigration, all else equal. Second, a city with a higher share of natives who have already left their birthplaces and immigrants with dispersion of large networks should experience a stronger out-migration response. This is because these workers are relatively mobile and so more likely to migrate in response to the immigration (See Tables A.6-A.8 for the list of top and bottom cities ranked by each characteristic).

Figure 1 shows that in the free migration case, the wages of high skill natives increase in some cities with inelastic housing supply as workers out-migrate to more affordable cities, while the gains in the wages of low skill workers in those places become smaller. This is because an out-migration of workers of a given type raises the local wages for all workers of that type, while reducing the local wages of workers with complementary characteristics. However, the difference between migration responses between elastic and inelastic housing supply cities is not substantial.[39] This is because other city characteristics are also important for migration decisions.

As discussed above, a city with a higher share of immigrants with large dispersed networks and natives who already left their birthplaces are likely to have more workers out-migrate in response to negative shocks. Therefore, a city with relatively elastic housing supply may have more out-migration if it also has more mobile workers. A notable example in this case is Las Vegas which has an inverse housing supply elasticity of 0.43 but experiences a larger fraction of high skill male natives (9 percent) moving out in response to immigration than Miami (4 percent) which has an inverse housing supply elasticity of 1.13. The main difference between these two cities is that 61 percent of workers in Las Vegas are natives who have left their birthplaces, of which 32 percent are high skill and 28 percent are low skill. In Miami, this similar group of high and low skill natives only accounts for 6 and 12 percent of its labor force, respectively. Therefore, despite having similar initial wage impacts, heterogeneity in workers' birthplace attachments leads Miami and Las Vegas to have very different wage impacts on high skill male natives in the free migration case. As can be seen in Figure 1 (a), in the free migration case, the wage of high skill male natives in Miami increases by 0.26 percent, while in Las Vegas the wage of this group increases by 2.19 percent.

In contrast, the negative wage impact for high skill female natives in Las Vegas is intensified. This is mostly due to the complementarity between male and female labor, meaning that the outflow of high skill male natives reduces the wage of high skill female natives in Las Vegas. At the same time, only 1 percent of high skill female natives in Las Vegas move out. This is be-

[39] In the second counterfactual, where the adversely affected group is low skill immigrants then migration responses depend on housing supply elasticities more strongly. This is because low skill immigrants spend a larger fraction of their income on housing, are therefore are more sensitive to changes in housing rents.

cause female workers are estimated to have slightly stronger birthplace attachments than their male counterparts. Further, there are also 4 percent fewer female than male high skill natives who have already left their birthplaces in Las Vegas.

Figure 2 shows that the most substantial differences in wage impacts between the fixed and free migration cases are for high skill immigrants. In this counterfactual policy experiment, low skill workers have less incentive to move since the gains in their wages partially offset the increased housing cost. There is more relocation among high skill immigrants since they are most affected by the arrival of the new immigrants. Further, they are more sensitive to changes in prices than other groups, as reflected in the higher estimate of their migration elasticity with respect to local real wage λ_z^w. While housing supply elasticities and location attachments are important, other factors such as amenities and city-specific productivity also affect location choices. For example, the amenity value in Baton Rouge, LA is ranked in the bottom 25 percentile for high skill male immigrants. Although the initial wage and rent impacts are not especially severe compared to some other places, the relatively low amenity level causes a relatively high level of out-migration.

The top panel of Figure 5 displays the changes in rents across cities. Housing rents in cities such as San Jose and Miami, where the wage gains for low skill workers are large, also have a relatively large increase in housing rents. This implies that the gains in "local real wages" of low skill workers (losses in local real wages of high skill workers) in some places could be a lot lower (higher) than is the nominal gains (losses). Figures 3 and 4 show maps of quartiles of the percentage change in average local real wages of each skill-nativity group from the initial levels to the free migration levels. Internal migration responses reduce the initial rent impact in more adversely affected cities. However, even after worker relocation, the welfare impact of immigration is unevenly distributed across and within cities. The biggest winners among native workers in this case are low skill labor in Houston, TX (1.58 percent increase in local real wage), while the biggest losers are high skill labor in San Jose, CA (4.58 percent decline in local real wage). Similarly high skill immigrants in San Jose, CA lose the most, (9.77 percent decline in local real wage), while low skill immigrants in Pittsburgh, PA gain more than all other workers (2.12 percent increase in local real wage).

6.3.3 Welfare Changes

Given the impacts on wages, housing rents and workers' utility derived from city specific amenities and networks, I summarize the welfare effects as changes in the indirect utility. The welfare analysis is based on simulated outcomes among a random draw of 240,000 individuals. Table 4 reports changes in average welfare in annual wage units by worker type in gateway and other cities. In the fixed migration case, the average welfare impact on high skill natives in gateway cities is equivalent to a reduction of $3,153$ and $2,016$ dollars in annual consumption for males and females, respectively. The reduction is considerably more severe for high skill immigrants, equivalent to a $5,233$ and $7,337$ dollars loss in annual consumption for males and females. The impacts are less substantial in other cities. Among low skill workers in gateway cities, the average welfare improves by 617 and 500 dollars for male and female natives, respectively, and by 195 and 166 dollars for the immigrant counterparts; the gains for low skill workers in other cities are smaller.

In the free migration case the negative impacts on the average welfare of high skill natives in all cities and high skill immigrants in gateway cities attenuate. The welfare losses of those who move from gateway cities are substantially mitigated. This is shown in columns 5 and 6 of Table 4, where the change in utility of "forced stayers" measures the difference between the initial utility and the counterfactual utility that those workers who choose to move in equilibrium would have derived had they not been allowed to move. The difference between the change in welfare of movers and forced stayers represent the gains from internal migration, equivalent to an almost $1,000$ dollar increase in annual consumption for high skill male natives in gateway cities. The welfare gains for low skill immigrants become slightly smaller. Further, none of the simulated low skill natives move from gateway cities. This is because low skill natives are more attached to places than other groups. Additionally, their wage gains compensate the increased housing rents and so they have little incentive to migrate.

Finally, one potential benefit that is usually not included in immigration studies is the increased housing rents accrued to landlords. This additional income can be significant, but not necessarily evenly distributed. As can be seen in the last row of Table 4, the average welfare gains are sizable for landlords. The increased rental income per landlord is $6,473$ dollars in the fixed migration and $6,410$ dollars in the free migration.[40] If the additional rental income were to be redistributed equally, the average net welfare gain would be 61 dollars per person.

Overall, a policy favoring the entry of high skill immigrants improves the welfare of low skill workers, but reduces the welfare of high skill labor. The welfare loss is much more substantial among high skill immigrants. There is a significant increase in welfare of landlords. Further, this policy leads to reduced real wage inequality. As shown in the lower panel of Table 3, the 90-50 and 90-10 local real wage ratios decline as a result of having more high skill immigrants. Finally, the present framework does not take into account positive externalities from high skill workers. Moretti (2004b) finds that a percentage point increase in the supply of college graduates raises college graduates' wages by 0.4 percent and noncollege workers' wages by up to 1.9 percent. Therefore, the results in this paper may understate the wage gains from high skill immigrants.

[40] See 6.1 for details on the estimated number of landlords.

6.4 Change in the Stock of Immigrants

To better understand how the skill composition of immigrants leads to different distributional consequences, I increase the stock of immigrants in this experiment by the same magnitude as in the previous counterfactual, but hold the skill and gender mix constant as in 2007. This corresponds to roughly a 25 percent increase in the stock of immigrants in 2007 or 1.5 million new high skill immigrants and 2.1 million new low skill immigrants.

6.4.1 National Impact

The lower panel of Figure 5 displays the distribution of the percentage change in rents across cities. Rents rise in all cities due to the increased population. A one percent increase in the immigrant population is associated with a 0.83 and 0.81 percent increase in the average housing rent in the fixed and free migration cases respectively. Overall, the effect of immigration on housing rents is smaller than in the first counterfactual. This is because an inflow of high skill workers puts more upward pressure on housing demand than low skill workers, and a larger portion of the new immigrants in this counterfactual are low skill.

The changes in the average wages are reported in Table 5. The annual wage, expressed in year 2015 dollars, of each group is weighted by employment at the city level. The gateway cities (defined as those in the top 5 percentile in terms of attracting new immigrants in the counterfactual) include Los Angeles, Miami, New York, Salinas-Sea and San Jose. There is little negative impact on the average wages of low skill natives. In gateway cities, the average wages of high skill natives rise by $1,285$ dollars for males and 944 dollars for females ($3-4$ times of the wage increase in the first counterfactual). The effects are smaller in other cities. The average wages of high skill immigrants fall by $1,142$ dollars for males and 792 dollars for females ($3-4$ times smaller than the reduction in the previous counterfactual). Further, the average wages of low skill immigrants fall by 476 dollars for males and 299 dollars for females. The differential wage impacts between immigrants and natives are due to their imperfect substitutability. The negative wage impacts are more concentrated on immigrants.

6.4.2 Local Impact

Figures 6 plots the percentage change in natives' wages when the workers' locations are held fixed against the percentage change when all workers are free to migrate. Each bubble is a metropolitan area. Red bubbles represent the ten cities with most inelastic housing supply, while green bubbles represent the ten with the least inelastic supply. Figures 7. displays the same comparison for immigrants' wages across cities. Cities with larger fractions of new immigrants (represented by larger bubbles) tend to experience a more substantial decline in the wages of low skill workers. Conversely, the wages of high skill natives increase more in cities with larger shares of new immigrants, while the wages of high skill immigrants fall less in those cities. This is because a larger portion of new immigrants are low skill and so the negative wage effect is counterbalanced by the complementarity between high and low skill labor. This is also shown in Table 5 where the reductions in the average wages of high skill immigrants in non-gateway cities are larger than the reductions in gateway cities.

As discussed earlier, cities are more likely to experience out-migration of workers in response to adverse local shocks if they have either (i) higher shares of workers who are less attached to their current locations or (ii) undesirable characteristics such as inelastic housing supply, low amenities and low city-specific productivity (see Section 6.2 for more discussion). In the free migration case, the negative impacts on low skill wages generally attenuate. The out-migration response is particularly strong in Miami as can be seen in the lower panels of Figures 6 and 7. This is consistent with the model predictions given that Miami has a lot of previous immigrants who are more mobile (even after excluding Cubans who have relatively little dispersion of large networks) and more sensitive to price changes. Additionally, Miami is one of top 10 cities with most inelastic housing supply. This results in a number of low skill workers moving out thereby attenuating the initial negative wage impacts. However, given the complementarity between high and low skill labor, an outflow of low skill workers reduces the wages of high skill workers.

Overall, the difference in migration responses between relatively elastic and inelastic housing supply cities is more pronounced than in the first counterfactual experiment. This is because low skill immigrants, who are more sensitive to changes in housing rents as they spend a larger fraction of their income on housing, are most adversely affected group in this case. However, there are cities with relatively elastic housing supply where workers choose to move out because of relatively low amenities or local-specific productivity e.g. Little-Rock, AR.

In summary, relative to the first counterfactual, the increase in the stock of immigrants has a less adverse impact on the local real wages of high skill natives. Among cities with relatively elastic housing supply, the local real wages of high skill natives rise by around 0.3 – 1 percent. However, the local real wages of both low skill natives and low skill immigrants fall in most cities. Figures 8 and 9 show maps of quartiles of the percentage change in average local real wages of each skill-nativity group from the initial levels to the free migration levels. The biggest winners among natives are high skill labor in Augusta-Aiken, GA-SC (about 1 percent increase in local real wage), while the biggest losers are low skill labor in Santa Barbara-Santa Maria-Lompoc, CA (2.68 percent decline in local real wage). Among high skill immigrants, the biggest losers remain high skill workers in San Jose, CA (4.46 percent decline in local real wage), but the loss is half of the reduction under skill selective immigration policy. In terms of spatial inequality, the increase in the stock of immigrants lead to slightly bigger differences between the local real wages of the very top and bottom income earners (see Table 5).

6.4.3 Welfare Changes

Table 6 reports the changes in the average welfare of each group, where welfare is measured by the average utility expressed in annual wage units. In comparison with the first counterfactual, all groups experience welfare losses in this case; however the welfare losses of high skill workers are about $3-4$ times smaller than before. In gateway cities, the losses of high skill natives are equivalent to a reduction of 946 dollars in annual consumption for males and 592 dollars for females in the fixed migration case. The losses are larger for high skill immigrants, a reduction of $3,071$ dollars and $2,209$ dollars for males and females, respectively. The welfare losses among low skill workers are about $1,000$ dollars and the losses are much smaller in other cities. When workers are free to move, the losses are mitigated for all groups in gateway cities, but become slightly larger for immigrants in other cities. Overall, the gains from migration as measured the difference between the change in welfare of movers (column 4) and forced stayers (column 5) are larger for low skill workers relative to the first policy experiment as they are much more adversely affected in this counterfactual.[41]

The increased rental income per landlord is $4,568$ dollars in the fixed migration and $4,525$ dollars in the free migration. While the total additional rental income gains in this case are smaller relative to the first counterfactual, the overall net welfare gains when rental income was equally redistributed equally are larger than the first counterfactual, an equivalent of an increase in annual consumption of 85 dollars per person. This is primarily because the welfare losses for high skill workers are much smaller.

6.5 Location-Specific Immigration Control

In April 2010, Arizona passed the "Support Our Law Enforcement and Safe Neighborhoods Act," commonly known as SB1070. The legislation enacted a wide range of provisions intended to control illegal immigration. Examples include requiring law enforcement agencies to verify the immigration status of any individual during a lawful stop. Since SB1070 passed, five other states have passed similar legislation (Utah, Indiana, South Carolina, Georgia, and Alabama).

The expected effect of such laws is a reduction in the number of illegal immigrants, most of whom are low skill. One consequence of this reduction is that housing rents in those states should decrease, at least in the short run. However, the long run impacts on the wages and welfare of different groups of workers are less clear. I do not observe legal status of immigrants in the

[41] The change in utility of forced stayers is the difference between the initial utility and the counterfactual utility that those workers who choose to move in equilibrium would have derived had they not been allowed to move.

data. However, since undocumented immigrants tend to be less educated, I assess the effects of these policies by removing 50 percent of low skill immigrants from Arizona, Utah, Indiana, South Carolina, Georgia, and Alabama in 2007. Table A.9 displays the number of low skill immigrants removed from the 9 MSAs in these six states.

The last two columns of Table A.9 show the percentage change in rents in the 9 cities. Rents initially decrease as expected. In the long run, as the reduced rents induce people to migrate into these cities, rents revert towards the initial levels leading to a negligible long run effect. Meanwhile, the reduction in the low skill immigrant population causes the wages of high skill workers in those cities to fall initially. However, the wages of all low skill workers rise because low skill labor becomes scarce. The increase in wages is more substantial for low skill immigrants than low skill natives, as reported in Table 7.

In the long run, the wage impacts on high skill workers in the 9 cities remain negative but become extremely small. Likewise, the initial positive impacts on the wages of low skill workers dissipate. Further, there are little wage and welfare effects on workers in other cities (see Table A.10 for changes in welfare).

Overall, location-specific immigration control policy has a local and short-term positive impact on the wages and welfare of low skill workers, and a negative impact on high skill workers. But as people migrate in response to the policy, the impacts of removing low skill immigrants become negligible. These results highlight that a location-specific immigration policy has limited effect in the presence of internal mobility.

6.6 Sensitivity of Counterfactual Analyses

In this section, I examine the sensitivity of counterfactual analyses using the estimates of labor demand at the national level from Ottaviano and Peri (2012). In their specification with fixed effect controls, Ottaviano and Peri (2012) estimate the elasticities of substitution between immigrants and natives to be 11.9 among high school dropouts, 10.1 among high school graduates, and 14.7 among workers with some college education. Further, they estimate the substitution elasticity between immigrants and natives who have college degrees to be 111.1; however, this estimate is not precise.

Since my model divides workers into high and low skill labor, I set the elasticity of substitution between immigrants and natives of high skill σ_{M-H} to be the average of the immigrant-native substitution elasticities of workers with some college education and with college degrees, weighted by their working-age population shares. This gives an elasticity of 57.6. Similarly, I set the elasticity of substitution between immigrants and natives of low skill σ_{M-L} to be the weighted average of immigrant-native substitution elasticities among high school dropouts and high school graduates:

11. I set the elasticity of substitution between high and low skill labor is to 2 which is close to the baseline estimate in my paper. As Ottaviano and Peri (2012) only include males in their sample for this specification, I assume male and female workers to be perfect substitutes, but allow for differences in productivity levels (β^S_{egct}).

Tables A.11 and A.12 display the changes in wages, rents, and welfare in the skill selective immigration policy using Ottaviano and Peri (2012)'s national labor demand estimates. The second last two rows of Table A.12 report the national average welfare loss/gains with and without rental income. While the overall net loss/gains without rental income are similar to my baseline case, the welfare and wage changes of high skill workers are strikingly different. Ottaviano and Peri (2012) estimate the substitutability between natives and immigrants amongst high skill labor to be substantially higher than my estimate. Further, they find immigrants and natives to be closer substitutes among high skill labor than low skill, while Card (2009) and I find the reverse at the city level.[42] The wage and welfare effects on low skill workers are similar to the baseline case given that our estimates of the substitutability between high and low skill labor are similar. However, the higher degree of substitutability between high skill immigrants and high skill natives leads to adverse wage and welfare impacts on high skill natives. The negative wage and welfare impacts among high skill immigrants are less severe as the impacts are diffused across a bigger group of workers.

Using Ottaviano and Peri (2012)'s national labor demand estimates in the second counterfactual, the wage and welfare effects of immigration on low skill natives are slightly attenuated, but stronger for low skill immigrants (see Tables A.13 and A.14). This is because Ottaviano and Peri (2012)'s estimates for the elasticities of substitution between low skill immigrants and low skill natives are lower than mine. Similarly, the gains are more equalized across all high skill workers. The positive wage impacts on high skill natives become much smaller, hence the average welfare losses on high skill natives are intensified. Therefore, while the "national average welfare change" is not very sensitive, the positive wage effects of immigration on high skill natives become much lower when using the labor demand estimates at the national level.

Additionally, I examine whether the results of counterfactual analyses are sensitive to the ordering of the nested-CES production function. Table A.15-A.18. show the wage and welfare effects of each counterfactual when I reverse the order of gender and skill in the production function. As shown previously in Table A.5, the elasticity of substitution between high and low skill labor becomes larger while the substitutability between genders remain roughly the same. In the skill selective immigration policy, this leads to a larger increase in the wages of high skill natives (and

[42] Card (2009) estimates the elasticity of substitution between immigrants and natives to be higher than my estimates for both skill groups. This would imply larger wage effects of immigration on natives, but qualitatively our results would be similar.

a smaller decrease in the wages of high skill immigrants). The wage gains for low skill workers become smaller. The average welfare losses of high skill workers decreases by about $100-500$ dollars annually. The welfare effects on low skill workers in gateway cities become negative, but small. The results in the increased stock of immigration experiment are reasonably close to the baseline. Finally, I also ran all counterfactuals using the estimates of workers' marginal utility with respect to local real wage from Diamond (2016). This involves setting λ_z^w to be 2.12 for high skill native, 4.03 for low skill natives, 3.06 for high skill immigrants and 4.33 for low skill immigrants. The results are similar qualitatively, but the migration responses among natives are stronger as they are more sensitive to changes in prices, relative to my results.

7 Conclusion

The effects of immigration are the subject of considerable debate in the U.S. This paper quantifies the impact of immigration, taking into account migration responses as well as heterogeneity in labor types and city characteristics. Despite the public concern, the results indicate that a large increase in the stock of immigrants has little impact on the wages of natives. The impacts are more highly concentrated on previous immigrants. Most welfare losses come from rising housing costs.

Further, a policy favoring the entry of high-skill immigrants leads to welfare gains for low skill workers, while reducing the wages and welfare of high skill workers. As a result, this policy reduces real local wage inequality across workers. The gains from internal migration are sizable, particularly for high skill natives in the popular destinations of immigrants.

This paper shows that there are substantial variations in the welfare effects across and within local labor markets. Out-migration in response to new migrants is stronger in cities with larger shares of previous immigrants and natives who already left their birthplaces. Cities with (i) lower productivity, (ii) more inelastic housing supply or (iii) lower amenities are also more likely to have an outflow of incumbent workers. Consequently, the initial adverse welfare impacts tend to be attenuated in these locations. Further, it is important to take into account heterogeneity in labor types: an out-migration of workers of a given type raises the local wages for workers of that type, while reducing the local wages of workers with complementary characteristics. In all cases, there is a significant increase in rental income accrued to landlords. This suggests that an appropriate tax scheme on rental income and housing regulations would be an important consideration if policymakers want to redistribute gains/losses more evenly.

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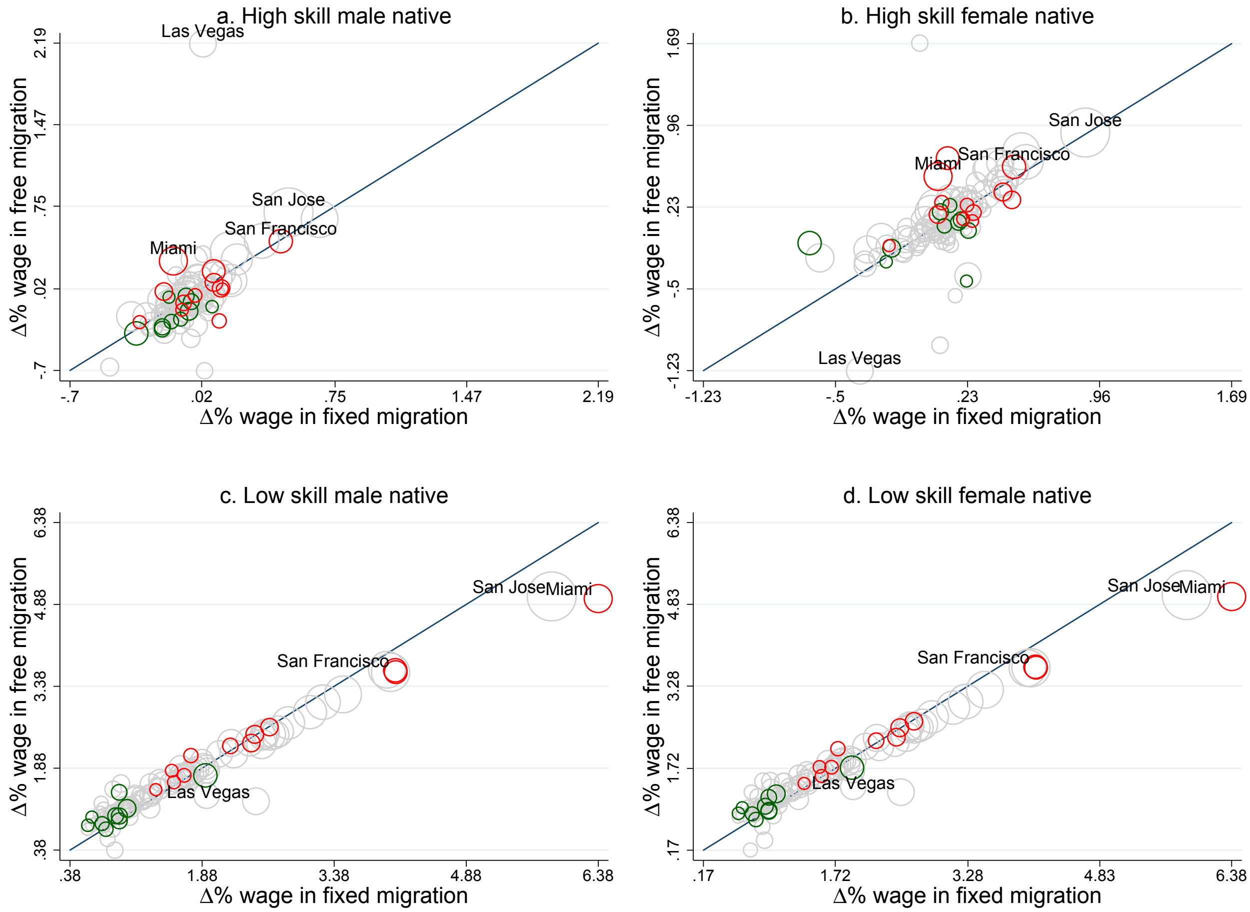
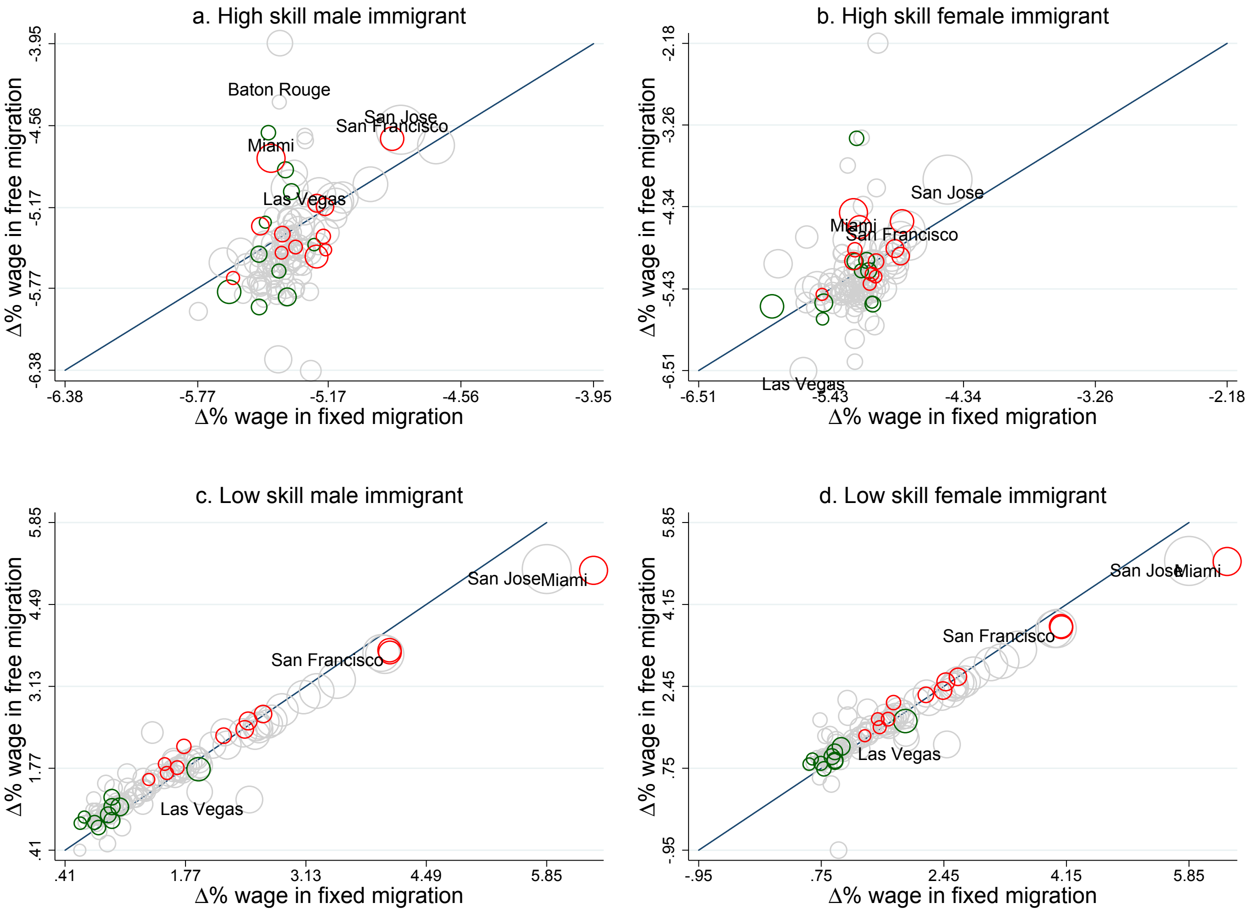
Figure 1: Native Wages: Increase in High Skill Immigrants



Each bubble is a metropolitan area. The size of a bubble reflects the number of new immigrants as a proportion of local population in a given city. The x-axis represents the percentage change from the initial wages to the fixed-migration wages where workers are constrained to remain in their original locations. The y-axis represents the percentage change from the initial wages to the free-migration case where all workers simultaneously relocate. Red bubbles represent the ten cities with most inelastic housing supply, while green bubbles represent the ten with the least inelastic supply.

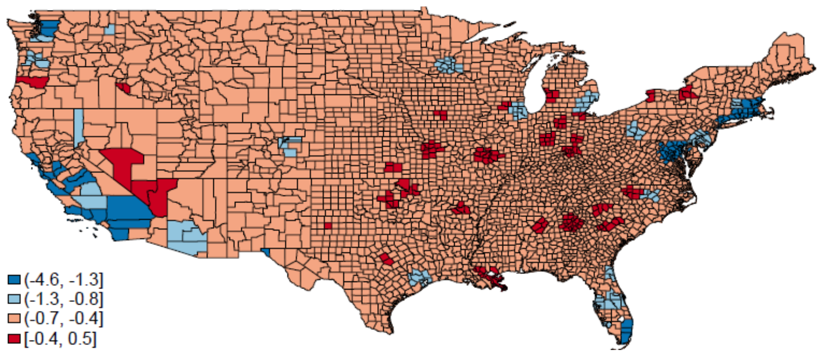
Figure 2: Immigrant Wages: Increase in High Skill Immigrants



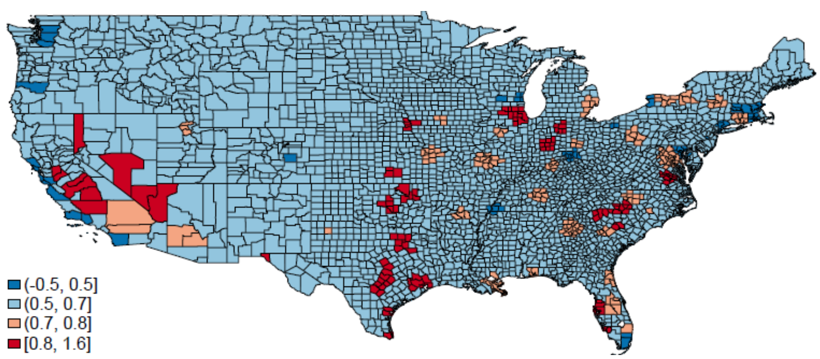
Each bubble is a metropolitan area. The size of a bubble reflects the number of new immigrants as a proportion of local population in a given city. The x-axis represents the percentage change from the initial wages to the fixed-migration wages where workers are constrained to remain in their original locations. The y-axis represents the percentage change from the initial wages to the free-migration case where all workers simultaneously relocate. Red bubbles represent the ten cities with most inelastic housing supply, while green bubbles represent the ten with the least inelastic supply.

Figure 3: Local Real Wage Impact on Natives: Increase in High Skill Immigrants

(a) Percentage Change in Local Real Wage: High Skill Natives



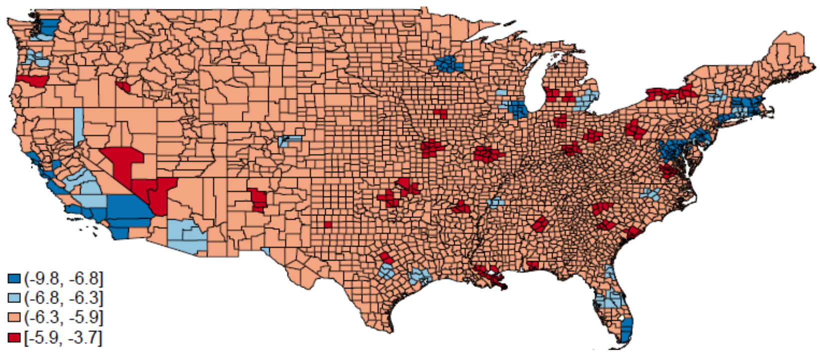
(b) Percentage Change in Local Real Wage: Low Skill Natives



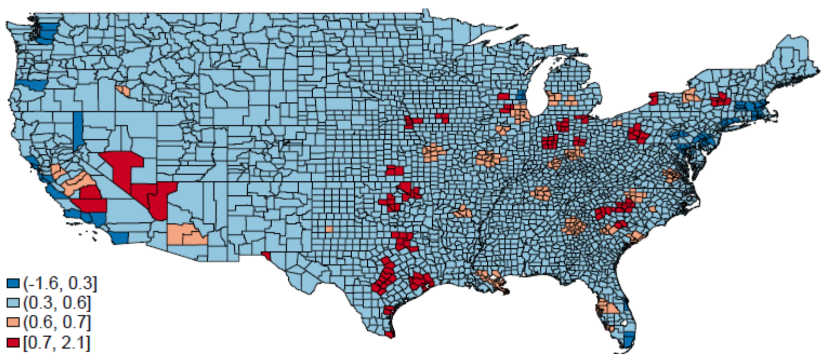
These maps show quartiles of the percentage change from the initial wages to the free-migration wages, adjusted for changes in housing rents, across the 114 MSAs which have the highest immigrant population from 1990-2007. The remaining cities are combined as the outside option, or "non-popular destination for immigrants". This group also includes Alaska and Hawaii which are not shown on the maps for readability. Base local CPI is calculated as the average housing rent before the influx of immigrants. The housing expenditure shares are set to 0.3 for both high and low skill natives, 0.34 for high skill immigrants and 0.36 for low skill immigrants.

Figure 4: Local Real Wage Impact on Immigrants: Increase in High Skill Immigrants

(a) Percentage Change in Local Real Wage: High Skill Immigrants

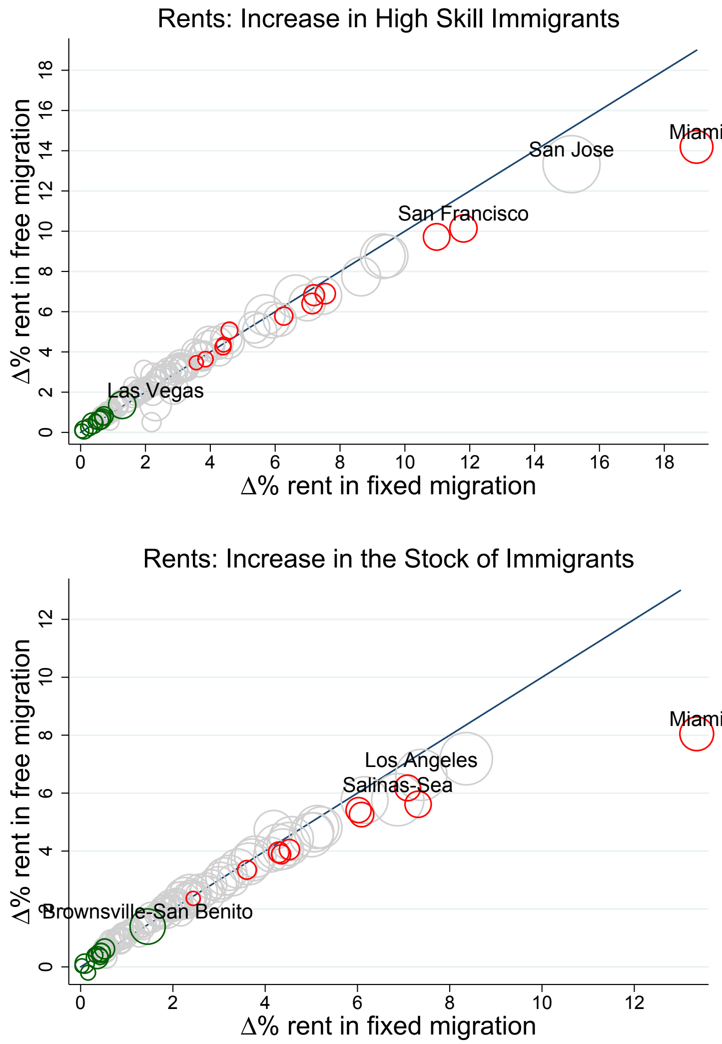


(b) Percentage Change in Local Real Wage: Low Skill Immigrants



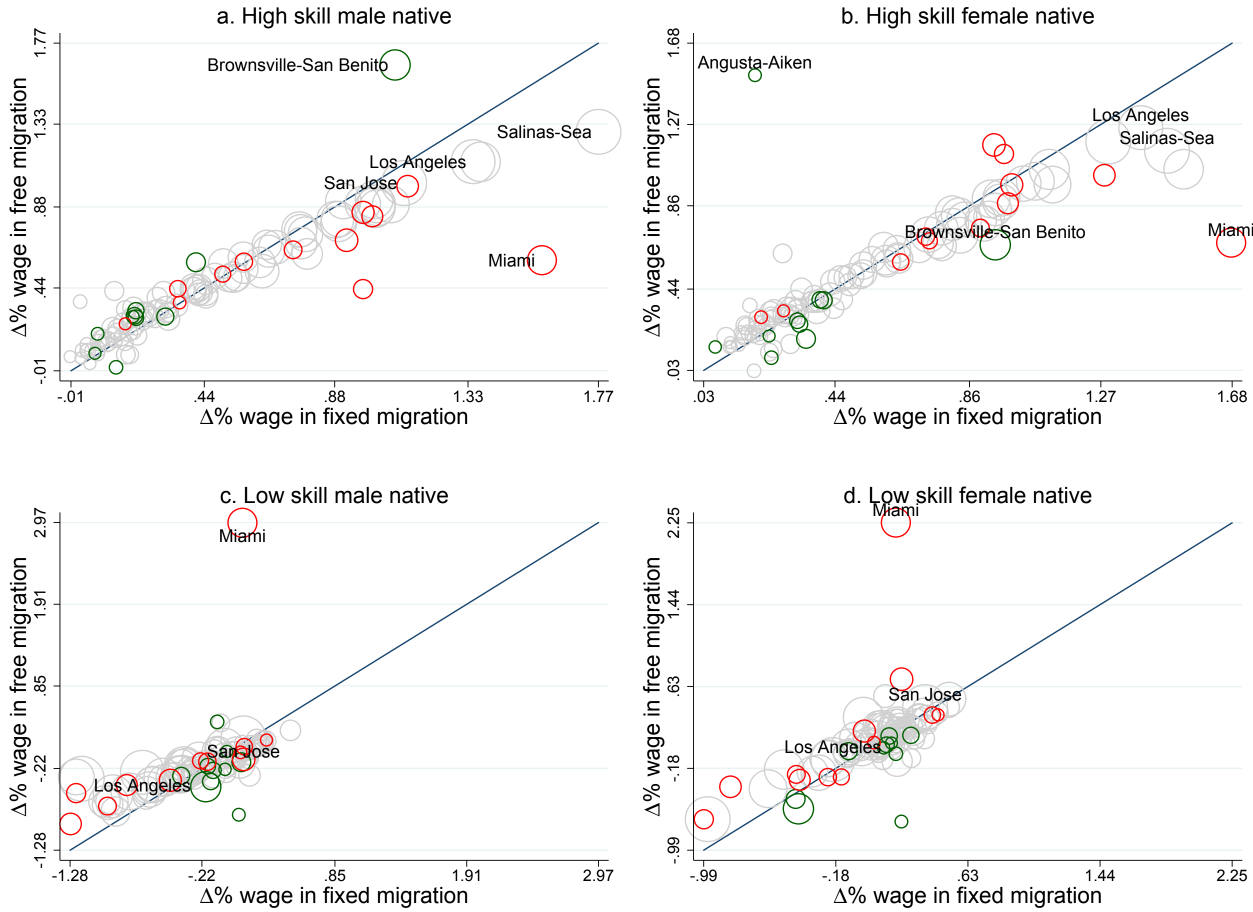
These maps show quartiles of the percentage change from the initial wages to the free-migration wages, adjusted for changes in housing rents, across the 114 MSAs which have the highest immigrant population from 1990-2007. The remaining cities are combined as the outside option, or "non-popular destination for immigrants". This group also includes Alaska and Hawaii which are not shown on the maps for readability. Base local CPI is calculated as the average housing rent before the influx of immigrants. The housing expenditure shares are set to 0.3 for both high and low skill natives, 0.34 for high skill immigrants and 0.36 for low skill immigrants.

Figure 5: Cities' Rent Distribution



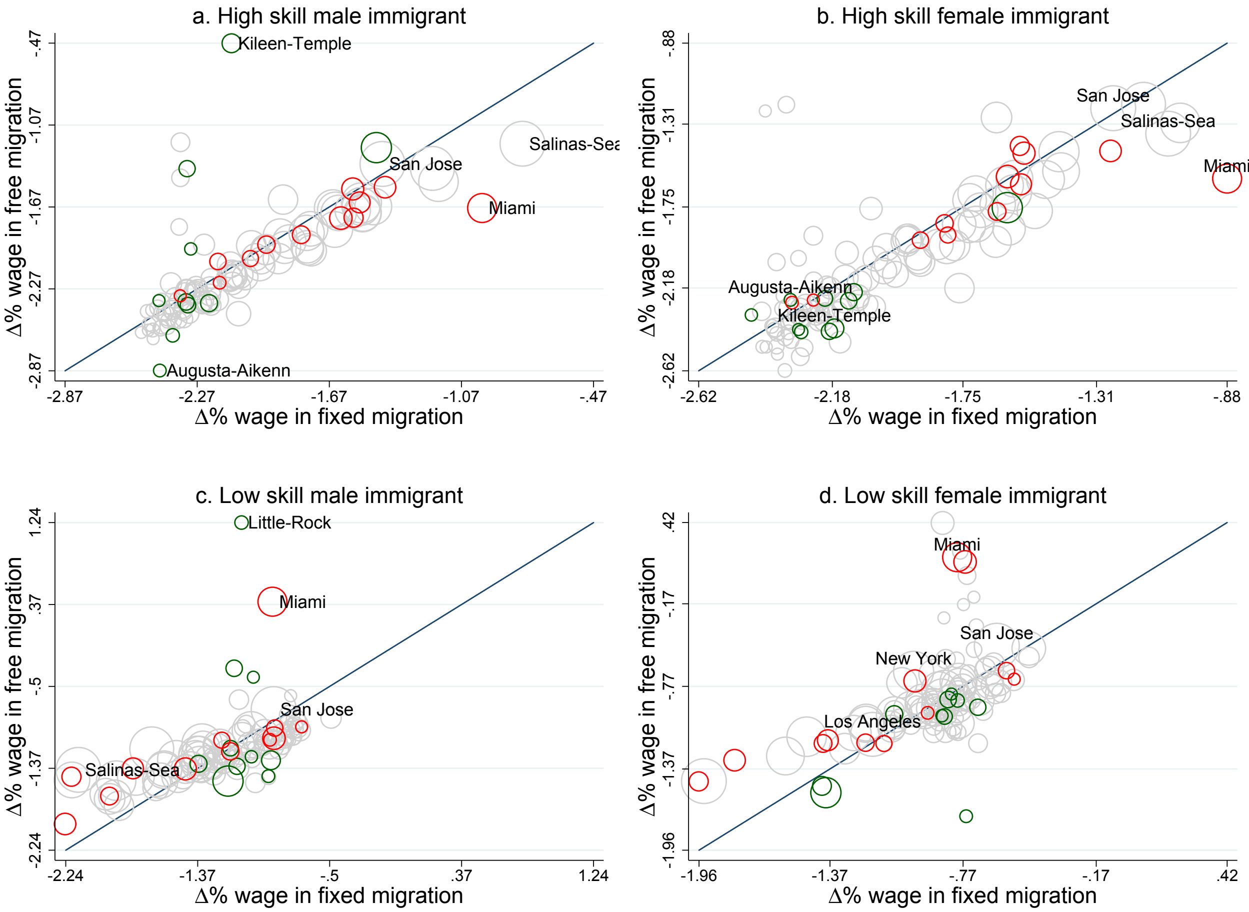
Local rent in 2015 dollars. Fixed-migration change measures the difference between the initial rents and the rents when natives and immigrants' locations are held fixed. Free-migration change measures the difference between the initial rents and the rents after all workers simultaneously choose locations. Each bubble is a metropolitan area. The size of a bubble reflects the number of new immigrants as a proportion of local population in a given city. Red bubbles represent the ten cities with most inelastic housing supply, while green bubbles represent the ten with the least inelastic supply.

Figure 6: Native Wages: Increase in the Stock of Immigrants



Each bubble is a metropolitan area. The size of a bubble reflects the number of new immigrants as a proportion of local population in a given city. The x-axis represents the percentage change from the initial wages to the fixed-migration wages where workers are constrained to remain in their original locations. The y-axis represents the percentage change from the initial wages to the free-migration case where all workers simultaneously relocate. Red bubbles represent the ten cities with most inelastic housing supply, while green bubbles represent the ten with the least inelastic supply.

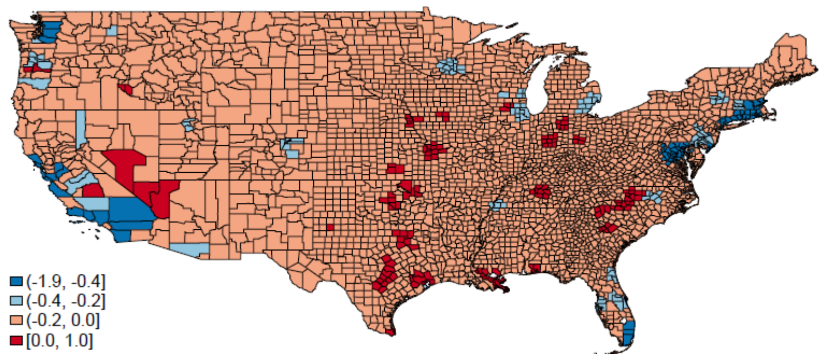
Figure 7: Immigrant Wages: Increase in the Stock of Immigrants



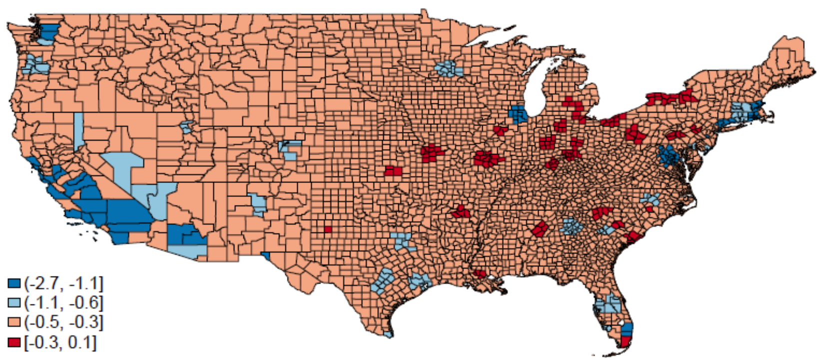
Each bubble is a metropolitan area. The size of a bubble reflects the number of new immigrants as a proportion of local population in a given city. The x-axis represents the percentage change from the initial wages to the fixed-migration wages where workers are constrained to remain in their original locations. The y-axis represents the percentage change from the initial wages to the free-migration case where all workers simultaneously relocate. Red bubbles represent the ten cities with most inelastic housing supply, while green bubbles represent the ten with the least inelastic supply.

Figure 8: Local Real Wage Impact on Natives: Increase in the Stock of Immigrants

(a) Percentage Change in Local Real Wage: High Skill Natives



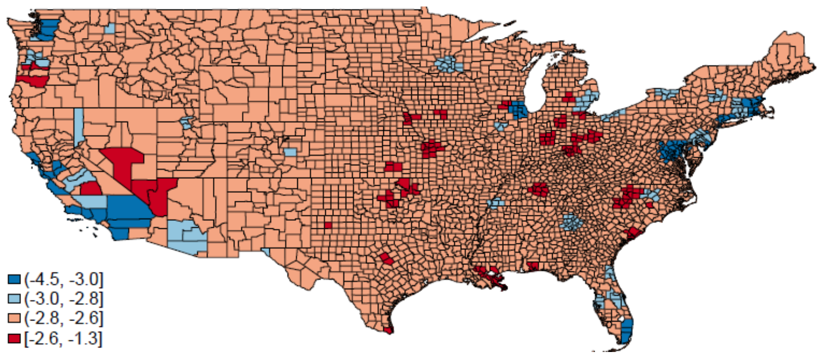
(b) Percentage Change in Local Real Wage: Low Skill Natives



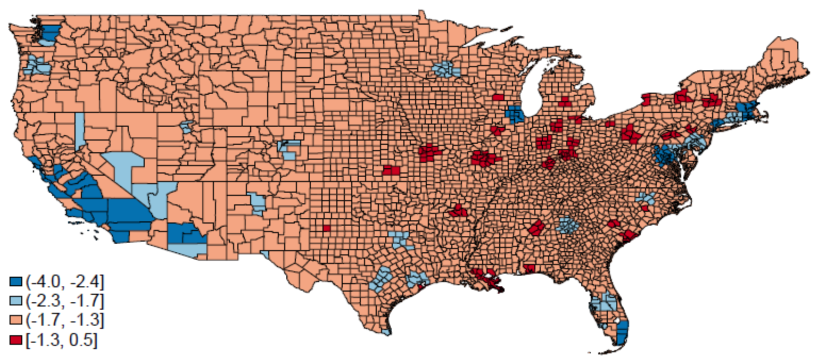
These maps show quartiles of the percentage change from the initial wages to the free-migration wages, adjusted for changes in housing rents, across the 114 MSAs which have the highest immigrant population from 1990-2007. The remaining cities are combined as the outside option, or "non-popular destination for immigrants". This group also includes Alaska and Hawaii which are not shown on the maps for readability. Base local CPI is calculated as the average housing rent before the influx of immigrants. The housing expenditure shares are set to 0.3 for both high and low skill natives, 0.34 for high skill immigrants and 0.36 for low skill immigrants.

Figure 9: Local Real Wage Impact on Immigrants: Increase in the Stock of Immigrants

(a) Percentage Change in Local Real Wage: Immigrants



(b) Percentage Change in Local Real Wage: Low Skill Immigrants



These maps show quartiles of the percentage change from the initial wages to the free-migration wages, adjusted for changes in housing rents, across the 114 MSAs which have the highest immigrant population from 1990-2007. The remaining cities are combined as the outside option, or "non-popular destination for immigrants". This group also includes Alaska and Hawaii which are not shown on the maps for readability. Base local CPI is calculated as the average housing rent before the influx of immigrants. The housing expenditure shares are set to 0.3 for both high and low skill natives, 0.34 for high skill immigrants and 0.36 for low skill immigrants.

Table 1: Parameter Estimates

I. Elasticity of Substitution				
σ_E: skill level	2.193**	σ_{M-H}: high-skill	6.925**	
	(0.109)	nativity	(0.154)	
σ_G: gender	1.973**	σ_{M-L}: low-skill	17.870**	
	(0.167)	nativity	(0.819)	
II. Worker preferences				
	High skill natives	Low skill natives	High skill immigrants	Low skill immigrants
Wage	1.247**	1.386*	3.219**	2.617**
	(0.253)	(0.801)	(0.071)	(0.064)
Implied Rent	-0.374	-0.416	-1.094	-0.942
III. Housing Supply Elasticities				
Geo*pop	0.029**	Regulation	0.712**	
	(0.004)		(0.022)	
IV. Predicted Inverse Housing Supply Elasticities				
Mean	0.686	Minimum	0.031	
SD	0.266	Maximum	1.183	

Standard errors in parentheses, computed using 100 bootstrapped samples. **p<0.05, *p<0.1. Wage parameter estimates represent worker's demand elasticity with respect to local real wage in a small city. Implied rent preferences computed using the housing expenditure shares multiplied by worker's demand elasticity with respect to local real wage.

Table 2: Network Effects for Natives and Immigrants

I. Natives						
	1990	2000	2007	1990	2000	2007
	High skill male natives			High skill female natives		
Birth state	2.73**	2.737**	2.78**	2.793**	2.846**	2.907**
	(0.005)	(0.005)	(0.006)	(0.006)	(0.005)	(0.007)
Distance (1000 miles)	-0.684**	-0.638**	-0.638**	-0.716**	-0.667**	-0.662**
	(0.004)	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)
	Low skill male natives			Low skill female natives		
Birth state	3.525**	3.59**	3.63**	3.405**	3.498**	3.572**
	(0.007)	(0.006)	(0.009)	(0.007)	(0.008)	(0.01)
Distance (1000 miles)	-0.649**	-0.583**	-0.578**	-0.745**	-0.662**	-0.631**
	(0.006)	(0.006)	(0.008)	(0.007)	(0.007)	(0.01)

II. Immigrants						
	1990	2000	2007	1990	2000	2007
	High skill male immigrants			High skill female immigrants		
Number of previous	2.245**	1.443**	1.034**	2.442**	1.721**	1.2**
immigrants (in million)	(0.027)	(0.014)	(0.013)	(0.038)	(0.018)	(0.017)
	Low skill male immigrants			Low skill female immigrants		
	1990	2000	2007	1990	2000	2007
Number of previous	2.767**	1.718**	1.286**	2.844**	1.818**	1.377**
immigrants (in million)	(0.02)	(0.019)	(0.022)	(0.023)	(0.017)	(0.018)

Standard errors in parentheses, computed using 100 bootstrapped samples.
**p<0.05, *p<0.1.

Table 3: Changes in Annual Wages: Increase in High Skill Immigrants

	Gateway cities		Other cities	
	△ annual wage Fixed migration	△ annual wage Free migration	△ annual wage Fixed migration	△ annual wage Free migration
High-skill male native	276	448	-55	-66
High-skill female native	324	481	68	61
Low-skill male native	2,232	1,990	543	571
Low-skill female native	1,823	1,620	443	465
High-skill male immigrant	-4,432	-4,332	-4,046	-4,082
High-skill female immigrant	-3,122	-2,970	-2,897	-2,945
Low-skill male immigrant	1,538	1,367	652	634
Low-skill female immigrant	1,351	1,194	557	537
Housing rents	1,228	1,096	231	233

	90-50 local real wage ratio	90-10 local real wage ratio
Initial	1.65	2.56
Fixed migration	1.63	2.50
Free migration	1.63	2.50

Gateway cities: Fort Lauderdale, Miami, New York, San Francisco and San Jose. Average wage of each group weighted by the number of workers in each city. Annual wages in 2015 dollars. Fixed-migration change measures the difference between the initial wages and the wages when natives and immigrants' locations are held fixed. Free-migration change measures the difference between the initial wages and the wages after all workers simultaneously choose locations.

Table 4: Welfare: Increase in High Skill Immigrants

	△ ave. utility Fixed migration	△ ave. utility Free migration all	mover	forced stayer	stayer
Natives in gateway cities:					
High-skill male	-3,153	-2,666	-1,872	-2,764	-2,676
High-skill female	-2,016	-1,631	-1,038	-1,752	-1,641
Low-skill male	617	525	.	.	525
Low-skill female	500	422	.	.	422
Immigrants in gateway cities:					
High-skill male	-7,337	-6,939	-6,273	-6,989	-6,968
High-skill female	-5,233	-4,873	-4,352	-4,846	-4,894
Low-skill male	195	168	189	110	168
Low-skill female	166	140	132	78	141
Natives in other cities:					
High-skill male	-872	-829	-790	-1,293	-829
High-skill female	-465	-462	-484	-820	-462
Low-skill male	330	320	-218	-1,082	320
Low-skill female	273	263	260	193	263
Immigrants in other cities:					
High-skill male	-4,877	-4,938	-5,048	-5,511	-4,937
High-skill female	-3,533	-3,604	-3,913	-4,278	-3,600
Low-skill male	164	172	189	112	172
Low-skill female	135	140	143	97	140
Rental income and overall loss/gains:					
Net loss/gains without rental income	-734	-708	-2,415	-2,915	-700
Net loss/gains with rental income equally distributed	43	61	-1,646	-2,146	70
Rental income per landlord	6,473	6,410			

The welfare analysis is based on simulated outcomes amongst a random draw of 240,000 individuals. Changes in average utility reported in 2015 annual wage dollars. Forced stayer's change in utility measures the difference between the initial utility and the counterfactual utility that those workers who choose to move in equilibrium would have derived had they not been allowed to move. Net loss/gains weighted by population share of each group. See text for more details.

Table 5: Wages: Increase in the Stock of Immigrants

	Gateway cities		Other cities	
	△ annual wage Fixed migration	△ annual wage Free migration	△ annual wage Fixed migration	△ annual wage Free migration
High-skill male native	1,285	1,075	291	308
High-skill female native	944	852	246	254
Low-skill male native	-224	-58	-44	-58
Low-skill female native	-26	100	47	44
High-skill male immigrant	-1,142	-1,272	-1,554	-1,590
High-skill female immigrant	-792	-841	-1,092	-1,133
Low-skill male immigrant	-476	-331	-409	-406
Low-skill female immigrant	-299	-220	-242	-240
Housing rents	750	662	160	160

	90-50 local real wage ratio	90-10 local real wage ratio
Initial	1.65	2.56
Fixed migration	1.66	2.59
Free migration	1.66	2.60

Gateway cities: Los Angeles, Miami, New York, Salinas-Sea and San Jose. Average wage of each group weighted by the number of workers in each city. Annual wages in 2015 dollars. Fixed-migration change measures the difference between the initial wages and the wages when natives and immigrants' locations are held fixed. Free-migration change measures the difference between the initial wages and the wages after all workers simultaneously choose locations.

Table 6: Welfare: Increase in the Stock of Immigrants

	△ ave. utility Fixed migration	△ ave. utility Free migration all	mover	forced stayer	stayer
Natives in gateway cities:					
High-skill male	-946	-938	-478	-949	-941
High-skill female	-592	-533	-320	-589	-534
Low-skill male	-1,211	-940	-635	-1,009	-945
Low-skill female	-854	-637	-425	-760	-639
Immigrants in gateway cities:					
High-skill male	-3,071	-2,970	-2,626	-2,978	-2,976
High-skill female	-2,209	-2,088	-1,893	-2,080	-2,092
Low-skill male	-1,263	-1,042	-849	-1,068	-1,048
Low-skill female	-1,016	-814	-629	-826	-818
Natives in other cities:					
High-skill male	-206	-190	-221	-384	-190
High-skill female	-83	-83	-90	-240	-83
Low-skill male	-350	-347	-336	-524	-347
Low-skill female	-171	-173	-208	-325	-173
Immigrants in other cities:					
High-skill male	-2,203	-2,234	-2,474	-2,681	-2,233
High-skill female	-1,588	-1,615	-1,905	-2,078	-1,614
Low-skill male	-592	-614	-722	-910	-613
Low-skill female	-429	-440	-513	-653	-439
Rental income and overall loss/gains:					
Overall net loss/gains without rental income	-474	-458	-772	-989	-457
Overall net loss/gains with rental income equally distributed	74	85	-229	-446	86
Rental income per landlord	4,568	4,525			

The welfare analysis is based on simulated outcomes amongst a random draw of 240,000 individuals. Changes in average utility reported in 2015 annual wage dollars. Forced stayer's change in utility measures the difference between the initial utility and the counterfactual utility that those workers who choose to move in equilibrium would have derived had they not been allowed to move. Net loss/gains weighted by population share of each group. See text for more details.

Table 7: Wages: Removal of Low Skill Immigrants

	Removed-immigrant cities		Other cities	
	△ annual wage Fixed migration	△ annual wage Free migration	△ annual wage Fixed migration	△ annual wage Free migration
High-skill male native	-1,124	-57	0	-56
High-skill female native	-780	-40	0	-39
Low-skill male native	1,380	70	0	53
Low-skill female native	451	14	0	17
High-skill male immigrant	-1,085	-53	0	-73
High-skill female immigrant	-795	-39	0	-55
Low-skill male immigrant	2,449	110	0	122
Low-skill female immigrant	1,409	47	0	62
Housing rents	-191	-10	0	96

	90-50 wage ratio	90-10 wage ratio
Initial	1.65	2.56
Fixed migration	1.65	2.56
Free migration	1.65	2.56

Removed-immigrant cities: Atlanta, Augusta, Birmingham, Charleston, Columbia, Greenville, Phoenix, Salt Lake City and Tuscon. Average wage of each group weighted by the number of workers in each city. Annual wages in 2015 dollars. Fixed-migration change measures the difference between the initial wages and the wages when natives and immigrants' locations are held fixed. Free-migration change measures the difference between the initial wages and the wages after all workers simultaneously choose locations.

Online Appendix

A. Data

Labor Supply

Workers in the sample are restricted to individuals over the age of 18 with 1 to 40 years of potential experience who report positive earnings, not currently enrolled in schools and worked at least one week in the previous year. Labor supply is a count of employed people multiplied by the individual's person weight. Years of potential experience are calculated using the difference between current age and the age at which the individual entered the labor force. I assume that high school dropouts enter the labor force at age 17, high school graduates enter at 19, people with some college education enter at 21, and people with at least a college degree enter at 23. Immigrants are defined as individuals born abroad. High skill workers are defined as as those with 1–3 years of college or more. Low skill workers include high school graduates and dropouts.

Wages

The wage sample is a subset of the employment sample where workers who are self-employed and workers who work less than 35 hours a week and 40 weeks per year are eliminated. Cities' wages are deflated using the CPI-U index to 2015 dollars. Topcoded wages are multiplied by 1.5. Wages are constructed by calculating the real hourly wages of individuals and taking their weighted average where the weights are the hours worked by the individual times person weight.

Networks

Immigrant networks are measured by the number of previous immigrants in the past decade from each country group. For the network size in 1990, 2000 and 2005-7, I include all individuals born outside the U.S. living in each MSA in 1980, 1990 and 2000, respectively.

The distance from natives' states of birth to each MSA is calculated as a distance from the population centroid in each state to the the population centroid in each MSA. The Census website provides latitudes and longitudes of population centroids at the state and county levels, but not at the MSA level. I use the average latitudes and longitudes of population centroids from all counties located in a given MSA as the population centroid.

Rents and other Variables

City rents are measured as the average gross annual rent (which includes both the housing rent and the cost of utilities) per household member. For households owning houses, I impute rents from housing values using a discount rate of 7.85 percent (Peiser and Smith, 1985) where annual expenditures for utilities are added to obtain gross imputed rent.

Additional data on land-use regulations and land unavailability are taken from Saiz (2010). The price of national goods is set at the CPI-U index of all goods measured in 2015 dollars.

B. Characteristics of Immigrants

Table A.3 reports the numbers of immigrants and educational attainment by country of origin, respectively. Nearly 40 percent of immigrants are from Mexico and Central America, with 70 to 80 percent having at most a high school education. Large fractions of Immigrants from Europe, India, Japan and China, on the other hand, have at least college degrees.

C. Existence and Uniqueness

The proof of existence is based on Bayer and Timmins (2005). Eq (19)-(23) implicitly define the vector of population $\overline{Z}_t = \Sigma_{i\in\mathscr{Z}_t}\text{Pr}_{it}$ that maps $[0,Z_t]^C$ into itself where Z_t is the total population of type-z workers and C is the number of cities in the choice set. An equilibrium is a fixed point,

$$\overline{Z}_t^* = g\left(\overline{Z}_t^*,\Omega\right) \equiv \Sigma_{i\in\mathscr{Z}_t}\text{Pr}_{it}$$

where Ω is the vector of parameters. The following proposition provides sufficient conditions under which a fixed point of to the above equation exists.

Proposition 1. *If (i) ε_{ict} is drawn from a continuous well-defined distribution function, (ii) each consumer's utility u_i is continuous in $\overline{Z}_t$ and (iii) each firm's production possibility set y_j is closed, bounded, convex and $0 \in y_j \subseteq \mathbb{R}^n$, then an equilibrium exists.*

Proof. Assumption (iii) and the continuity of the firm's objective function ensure that the solution to (21) exists. Assumptions (i) and (ii) imply that the mapping g is a continuous mapping of a closed and bounded interval into itself. By the Brouwer fixed-point theorem, there exists a fixed point of this mapping g. □

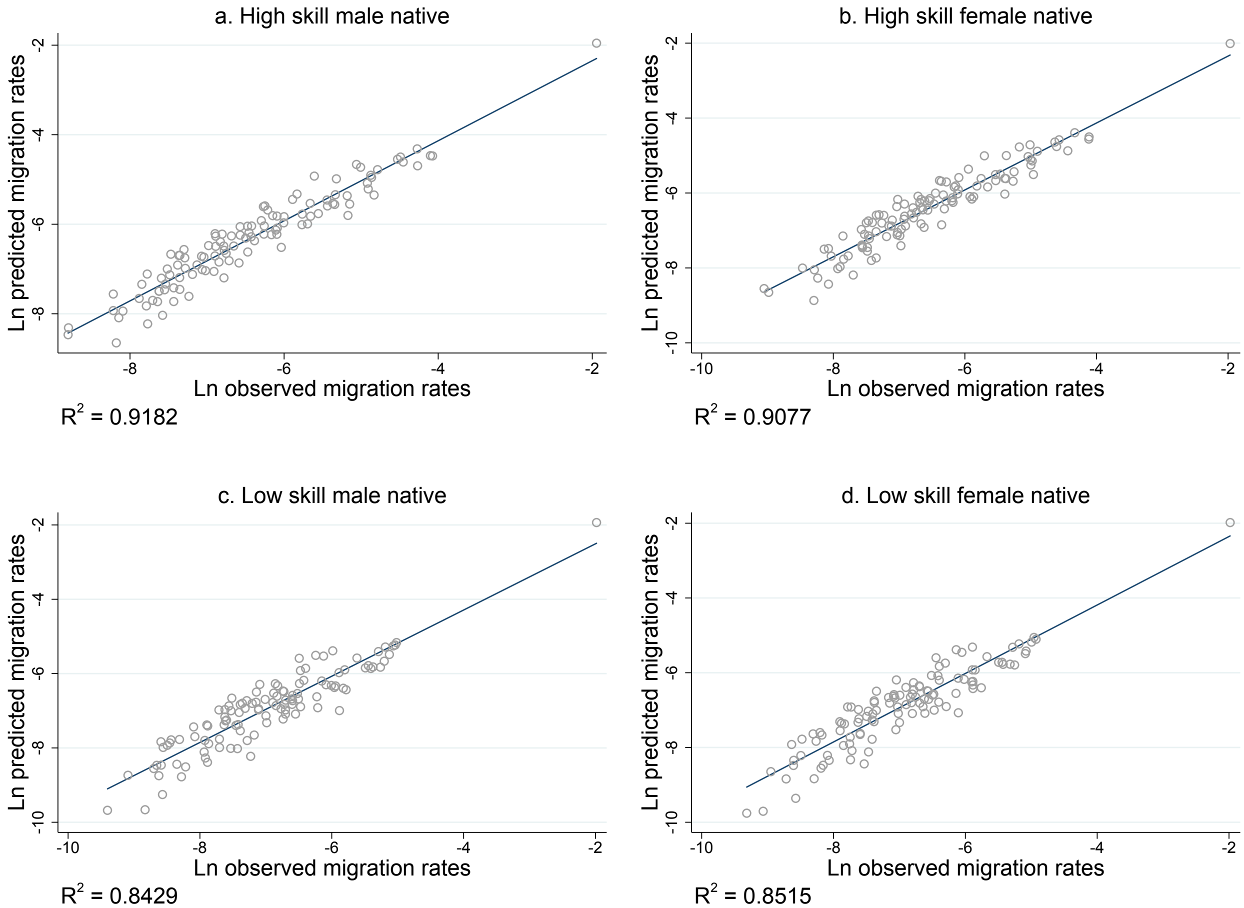
Given that ε_{ict} is drawn from a Type I Extreme Value distribution, it is continuous; u_i is continuous; and the firms' production possibility set satisfies (iii), thus Proposition 1 implies that an equilibrium exists.

As discussed in Bayer and Timmins (2005), the uniqueness of an equilibrium depends on the following features of the problem: (i) the magnitude of the agglomeration and congestion forces; (ii) the total number of cities; (iii) the importance of individual tastes in the utility function; and (iv) the variation and importance of fixed attributes across cities such as home premiums and network values. Bayer et al. (2004) and Bayer and Timmins (2005) show that a congestion effect gives rise to a unique equilibrium. The present model incorporates a congestion force through housing supply.

A congestion effect causes workers to disperse which preserves the preference rank-ordering of locations. However, a sufficiently strong agglomeration effect can alter the rank-order of locations leading to multiple equilibria. In the present framework, network values are measured by the numbers of previous immigrants and independent of the current number of immigrants in a given city. So there is no agglomeration incentive due to current networks for immigrants. However, complementarity between labor types may induce some workers to cluster in the same locations. Nonetheless, if the housing supply congestion effect is sufficiently strong, a unique equilibrium can be obtained.

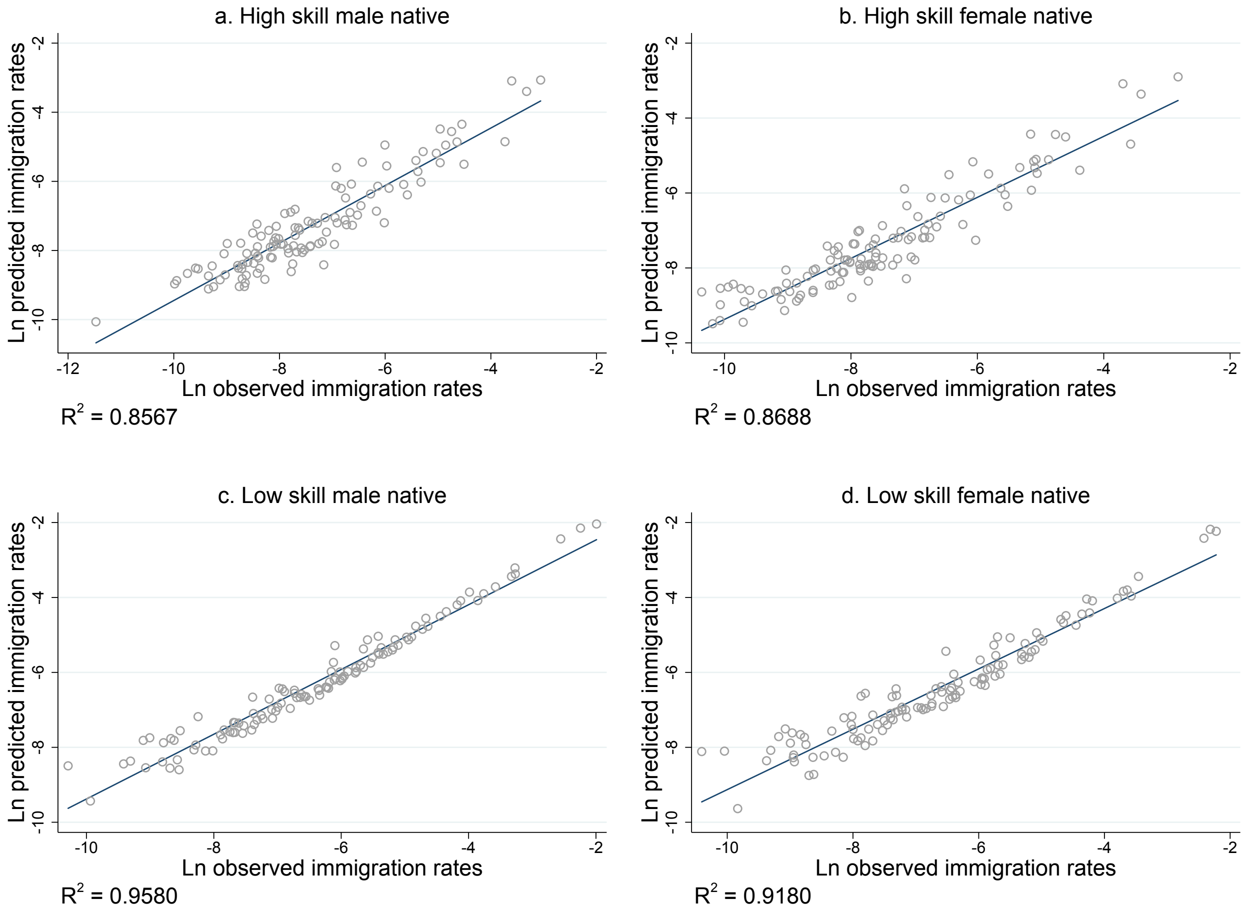
Given the number of parameters, the restrictions on the model primitives for which a unique equilibrium arises cannot be easily characterized. However, as noted in Bayer and Timmins (2005), it is possible to verify whether an equilibrium is unique. Consider the two sequences defined by $\left\{\overline{Z}_t, g\left(\overline{Z}_t\right), g\left(g\left(\overline{Z}_t\right)\right), \ldots\right\}$ starting at the endpoints of $\overline{Z}_t$. If an agglomeration effect induces multiple equilibria, then these sequences converge to at least two points. So one may verify uniqueness by applying $g(.)$ iteratively starting near the endpoints of $\overline{Z}_t$ and determining whether the sequences converge to distinct fixed points.

Figure A.1: Goodness of Fit: High Skill Natives in 2007



Each bubble is a metropolitan area. The x-axis represents the predicted proportion of natives who reside outside their birth states while the y-axis represents the observed proportion.

Figure A.2: Goodness of Fit: High Skill Immigrants in 2007



Each bubble is a metropolitan area. The x-axis represents the predicted proportion of immigrants from major sending countries: Mexico, Central America, South America and the Caribbean, while the y-axis represents the observed proportion.

Table A.1: Summary Statistics: Levels

	1990				2000				2007			
	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max
Ln natives' wages												
High-skill male	3.46	0.14	3.02	3.97	3.58	0.16	3.17	4.36	3.67	0.20	3.24	4.80
High-skill female	3.08	0.12	2.87	3.50	3.23	0.14	2.94	3.87	3.32	0.16	3.03	4.13
Low-skill male	3.06	0.13	2.63	3.40	3.09	0.12	2.70	3.39	3.07	0.12	2.73	3.50
Low-skill female	2.76	0.12	2.43	3.08	2.86	0.12	2.54	3.24	2.86	0.13	2.49	3.17
Ln immigrants' wages												
High-skill male	3.46	0.18	2.98	3.85	3.55	0.18	3.01	4.18	3.60	0.22	3.01	4.51
High-skill female	3.07	0.16	2.64	3.50	3.23	0.14	2.96	3.74	3.29	0.19	2.80	3.82
Low-skill male	2.88	0.20	2.43	3.36	2.83	0.13	2.50	3.26	2.77	0.15	2.43	3.45
Low-skill female	2.62	0.17	2.20	3.02	2.67	0.13	2.25	2.93	2.61	0.14	2.14	2.97
Ln rent	8.97	0.20	8.54	9.54	8.94	0.17	8.59	9.67	9.13	0.22	8.73	10.02

The sample include a balanced panel of 345 MSA's which have at least 200 full-time and non self-employed of all types of workers. Hourly wages and annual rents are measured in logs and expressed in 2015 dollars.

Table A.2: Immigration at City Level

1990		2000		2007	
Top 15 MSAs	Percent Immigrants	Top 15 MSAs	Percent Immigrants	Top 15 MSAs	Percent Immigrants
Miami-Hialeah, FL	54.9	Miami-Hialeah, FL	62.5	Miami-Hialeah, FL	62.7
Los Angeles, CA	39.2	Los Angeles, CA	47.2	San Jose, CA	49.5
McAllen-Edinburg, TX	35.9	San Jose, CA	44.4	Salinas-Sea, CA	47.1
Salinas-Sea, CA	34.9	Salinas-Sea, CA	42.3	Los Angeles, CA	44.8
El Paso, TX	34.4	McAllen-Edinburg, TX	41.2	New York-NE, NJ	41.4
Brownsville, TX	29.8	New York-NE, NJ	39.0	Fort Lauderdale, FL	40.5
San Jose, CA	29.2	Visalia-Tulare, TX	37.7	Visalia-Tulare, TX	39.6
New Bedford, MA	28.2	El Paso, TX	36.3	McAllen-Edinburg, TX	39.2
Visalia-Tulare, TX	27.6	San Francisco, CA	35.8	San Francisco, CA	38.6
New York-NE, NJ	26.5	Brownsville, TX	35.6	Stockton, CA	37.3
Stamford, CT	25.4	Fort Lauderdale, FL	35.3	Santa Barbara, CA	37.3
San Francisco, CA	25.2	Santa Barbara, CA	33.3	El Paso, TX	36.8
Ventura-Oxnard, CA	24.6	Ventura-Oxnard, CA	32.8	Yakima, WA	36.4
Fresno, CA	23.9	Fresno, CA	32.8	Stamford, CT	35.2
Santa Barbara, CA	23.5	Riverside, CA	29.8	Riverside, CA	34.0

Percent immigrants expressed in terms of city's working-age population which includes people aged 18 or older with 1 to 40 years of potential experience. Immigrants are individuals born abroad.

Table A.3: Characteristics of Immigrants and Natives

	Working-age population (thousands)			Share of US population		
	1990	2000	2007	1990	2000	2007
All U.S.	133,698	155,429	165,553	100.0	100.0	100.0
Natives	119,380	131,765	136,732	89.3	84.8	82.6
Immigrants	14,318	23,664	28,821	10.7	15.2	17.4

	Share of working-age immigrants (percent)			Share of working-age natives (percent)			Immigrant to native working-age ratio		
	1990	2000	2007	1990	2000	2007	1990	2000	2007
Dropouts	28.3	27.4	24.8	10.9	7.9	6.6	0.30	0.60	0.81
High School	25.5	29.7	31.1	35.5	40.4	39.0	0.08	0.13	0.17
Some College	22.5	16.5	15.6	31.0	25.1	25.6	0.08	0.11	0.13
College	23.7	26.4	28.5	22.6	26.6	28.8	0.12	0.17	0.21
Female	42.4	41.4	40.3	46.2	47.4	47.1	0.11	0.15	0.18
Male	57.6	58.6	59.7	53.8	52.6	52.9	0.12	0.19	0.24

Working-age population includes people aged 18 or older with 1 to 40 years of potential experience. Immigrants are individuals born abroad.

Table A.4: Educational Attainment and Networks of Immigrants in 2007

Country group	Share of all immigrants	No. of cities with large networks	Educational Attainment			
			Dropout	High school	Some college	College
Mexico	31.8	60	53.6	33.7	7.8	4.9
Central America	7.8	23	44.0	33.6	12.5	9.9
Central Europe	7.6	44	5.0	32.1	22.4	40.6
South America	6.8	22	11.7	38.0	20.6	29.7
Caribbean	6.2	17	17.3	41.6	21.8	19.4
India	5.4	18	5.6	14.5	9.5	70.4
China	4.7	17	11.0	21.3	12.5	55.3
Philippines	4.4	18	3.5	21.2	25.4	49.9
Africa	3.7	17	8.3	28.6	22.5	40.6
Vietnam	3.0	19	19.0	35.0	20.4	25.5
Japan and East Asia	2.7	14	3.6	24.6	18.8	53.0
Canada and Other North America	2.1	22	4.6	24.4	24.3	46.7
UK and Ireland	2.1	19	2.5	26.5	24.9	46.1
Southern Europe	2.0	17	15.9	38.2	17.1	28.8
Cuba	1.9	8	11.5	43.0	19.5	26.0
Middle East	1.9	11	10.9	30.7	17.8	40.6
Other Southeast Asia	1.9	19	18.2	32.7	19.8	29.3
Korea	1.3	9	2.4	21.9	27.2	48.6
Other Southwest Asia	1.1	6	4.9	22.4	18.4	54.3
Western Europe	0.9	7	1.8	19.9	22.6	55.6
Australia and New Zealand	0.5	4	7.4	34.2	20.6	37.7
Northern Europe	0.3	2	1.9	18.3	25.9	53.9

Working-age population includes people aged 18 or older with 1–40 years of potential experience. Immigrants are individuals born abroad. The shares and education attainment of immigrants and drawn from the combined 2005-7 ACS. The number of cities with large networks represent MSAs in the estimation sample which have at least 10,000 immigrants from each country group in year 2000. The estimation sample consist of 115 cities which have at least 200 full-time and non-self employed of each type of workers.

Table A.5: Sensitivity Analysis of Parameters

I. Labor Demand					
Substitution elasticity	Baseline	Only immigrants with less than 30 yrs in US	Efficiency unit of labor	Residualized wage	Re-ordered gender-skill
σ_{M-L}: low-skill nativity	17.870**	22.441**	20.588**	18.369**	17.870**
	(0.819)	(1.384)	(0.949)	(0.783)	(0.725)
σ_{M-H}: high-skill nativity	6.925**	7.007**	7.272**	10.482**	6.925**
	(0.154)	(1.772)	(0.202)	(0.319)	(0.147)
σ_G: gender	1.973**	2.00**	1.756**	2.609**	2.115**
	(0.167)	(0.167)	(0.128)	(0.176)	(0.222)
σ_E: skill	2.193**	1.966**	3.509**	2.240**	3.183**
	(0.109)	(0.085)	(0.246)	(0.098)	(0.161)
II. Worker Preferences					
	Baseline	Different housing exp. shares	Non-relative local real wage		
High skill natives	1.247**	1.513**	0.022		
	(0.253)	(0.232)	(0.142)		
Low skill natives	1.386*	1.20*	0.575**		
	(0.801)	(0.63)	(0.266)		
High skill immigrants	3.219**	2.703**	1.282**		
	(0.071)	(0.074)	(0.012)		
Low skill immigrants	2.617**	2.255**	1.118**		
	(0.064)	(0.073)	(0.017)		
III. Housing Supply Elasticities					
	Baseline	Without interaction term	Full model		
Geo	-	0.389**	7.801**		
		(0.053)	(0.907)		
Geo*Pop	0.029**	-	-0.540**		
	(0.004)		(0.069)		
Regulation	0.712**	0.684**	0.756**		
	(0.022)	(0.0174)	(0.020)		

Standard errors in parentheses, computed using 100 bootstrapped samples. **p<0.05, *p<0.1.

Table A.6: City Characteristics: Productivity, Housing Supply, Share of Mobile Workers

Highest city-specific productivity	Lowest city-specific productivity
Stamford, CT	Brownsville-Harlingen-San Benito, TX
San Jose, CA	Kileen-Temple, TX
Bridgeport, CT	El Paso, TX
San Francisco-Oakland-Vallejo, CA	Lubbock, TX
New York-Northeastern NJ	Pensacola, FL
Washington, DC/MD/VA	Fayetteville, NC
Trenton, NJ	Fort Wayne, IN
Boston, MA-NH	Boise City, ID
Santa Cruz, CA	Greensboro-Winston Salem-High Point, NC
Hartford-Bristol-Middleton- New Britain, CT	Augusta-Aiken, GA-SC
Most inelastic housing supply	Least inelastic housing supply
Ventura-Oxnard-Simi Valley, CA	Fort Wayne, IN
Miami-Hialeah, FL	Wichita, KS
Santa Rosa-Petaluma, CA	Augusta-Aiken, GA-SC
Boston, MA-NH	Kileen-Temple, TX
Santa Barbara-Santa Maria-Lompoc, CA	Greenville-Spartanburg-Anderson SC
Worcester, MA	Des Moines, IA
San Francisco-Oakland-Vallejo, CA	Brownsville-Harlingen-San Benito, TX
Fort Lauderdale-Hollywood-Pompano Beach, FL	Little Rock--North Little Rock, AR
Providence-Fall River-Pawtucket, MA/RI	Kansas City, MO-KS
Baltimore, MD	Lubbock, TX
Highest share of mobile workers	Lowest share of mobile workers
Las Vegas, NV	Buffalo-Niagara Falls, NY
Reno, NV	Pittsburgh, PA
Fort Myers-Cape Coral, FL	Syracuse, NY
West Palm Beach-Boca Raton-Delray Beach, FL	Peoria, IL
Phoenix, AZ	Toledo, OH/MI
Fort Lauderdale-Hollywood-Pompano Beach, FL	Akron, OH
Orlando, FL	Rochester, NY
Colorado Springs, CO	Lansing-E. Lansing, MI
Melbourne-Titusville-Cocoa-Palm Bay, FL	Albany-Schenectady-Troy, NY
Tampa-St. Petersburg-Clearwater, FL	Harrisburg-Lebanon--Carlisle, PA

City-specific productivity levels and based on the 2007 estimates. Mobile workers include natives who have left their birthplaces and immigrants who have at least 10,000 previous immigrants from the same country group in at least 10 other cities. This includes immigrants from all country groups listed in Table A.4. except for Cuba, Korea, Southwest Asia, Western Europe, Northern Europe, and Australia & NZ.

Table A.7: City Amenities for Natives in 2007

Best amenities for high skill male natives	Worst amenities for high skill male native
Phoenix, AZ	Stamford, CT
Los Angeles-Long Beach, CA	Salinas-Sea Side-Monterey, CA
Seattle-Everett, WA	Santa Cruz, CA
Atlanta, GA	Bridgeport, CT
Dallas-Fort Worth, TX	Visalia-Tulare-Porterville, CA
Denver-Boulder, CO	Trenton, NJ
Minneapolis-St. Paul, MN	Brownsville-Harlingen-San Benito, TX
Chicago, IL	Rockford, IL
New York-Northeastern NJ	Galveston-Texas City, TX
Washington, DC/MD/VA	Atlantic City, NJ
Best amenities for high skill female native	**Worst amenities for high skill female native**
Phoenix, AZ	Salinas-Sea Side-Monterey, CA
Los Angeles-Long Beach, CA	Brownsville-Harlingen-San Benito, TX
Atlanta, GA	Visalia-Tulare-Porterville, CA
Seattle-Everett, WA	Santa Cruz, CA
New York-Northeastern NJ	Stamford, CT
Chicago, IL	Rockford, IL
Dallas-Fort Worth, TX	Galveston-Texas City, TX
Boston, MA-NH	Lubbock, TX
Denver-Boulder, CO	Modesto, CA
Minneapolis-St. Paul, MN	Trenton, NJ
Best amenities for low skill male native	**Worst amenities for low skill male native**
Phoenix, AZ	Santa Cruz, CA
Las Vegas, NV	Salinas-Sea Side-Monterey, CA
Los Angeles-Long Beach, CA	Stamford, CT
Tampa-St. Petersburg-Clearwater, FL	Santa Barbara-Santa Maria-Lompoc, CA
Atlanta, GA	Galveston-Texas City, TX
New York-Northeastern NJ	Brownsville-Harlingen-San Benito, TX
Seattle-Everett, WA	Corpus Christi, TX
Denver-Boulder, CO	Ann Arbor, MI
Dallas-Fort Worth, TX	Visalia-Tulare-Porterville, CA
Salt Lake City-Ogden, UT	Santa Rosa-Petaluma, CA
Best amenities for low skill female native	**Worst amenities for low skill female natives**
Phoenix, AZ	Santa Cruz, CA
Las Vegas, NV	Salinas-Sea Side-Monterey, CA
Atlanta, GA	Santa Barbara-Santa Maria-Lompoc, CA
New York-Northeastern NJ	Visalia-Tulare-Porterville, CA
Tampa-St. Petersburg-Clearwater, FL	Galveston-Texas City, TX
Los Angeles-Long Beach, CA	Stamford, CT
Detroit, MI	Santa Rosa-Petaluma, CA
Chicago, IL	Kileen-Temple, TX
Dallas-Fort Worth, TX	Brownsville-Harlingen-San Benito, TX
Seattle-Everett, WA	Worcester, MA

Table A.8: City Amenities for Immigrants in 2007

Best amenities for high skill male immigrant	Worst amenities for high skill male immigrant
New York-Northeastern NJ	Toledo, OH/MI
Los Angeles-Long Beach, CA	Peoria, IL
Chicago, IL	Lubbock, TX
Washington, DC/MD/VA	Des Moines, IA
Miami-Hialeah, FL	Fayetteville, NC
Riverside-San Bernardino,CA	Syracuse, NY
San Francisco-Oakland-Vallejo, CA	Stamford, CT
Fort Lauderdale-Hollywood-Pompano Beach, FL	Little Rock--North Little Rock, AR
Atlanta, GA	Akron, OH
Dallas-Fort Worth, TX	Eugene-Springfield, OR
Best amenities for high skill female immigrant	**Worst amenities for high skill female immigrant**
New York-Northeastern NJ	Little Rock--North Little Rock, AR
Los Angeles-Long Beach, CA	Salem, OR
Miami-Hialeah, FL	Lubbock, TX
Chicago, IL	Peoria, IL
Washington, DC/MD/VA	Akron, OH
San Francisco-Oakland-Vallejo, CA	Toledo, OH/MI
Fort Lauderdale-Hollywood-Pompano Beach, FL	Eugene-Springfield, OR
Boston, MA-NH	Des Moines, IA
San Diego, CA	Augusta-Aiken, GA-SC
Orlando, FL	Corpus Christi, TX
Best amenities for low skill male immigrant	**Worst amenities for low skill male immigrant**
New York-Northeastern NJ	Peoria, IL
Dallas-Fort Worth, TX	Pittsburgh, PA
Houston-Brazoria, TX	Olympia, WA
Chicago, IL	Akron, OH
Phoenix, AZ	Spokane, WA
Los Angeles-Long Beach, CA	Buffalo-Niagara Falls, NY
Miami-Hialeah, FL	Toledo, OH/MI
San Francisco-Oakland-Vallejo, CA	Lansing-E. Lansing, MI
Atlanta, GA	Ann Arbor, MI
Riverside-San Bernardino,CA	Fayetteville, NC
Best amenities for low skill female immigrant	**Worst amenities for low skill female immigrant**
New York-Northeastern NJ	Peoria, IL
Houston-Brazoria, TX	Lansing-E. Lansing, MI
Chicago, IL	Ann Arbor, MI
Miami-Hialeah, FL	Olympia, WA
Dallas-Fort Worth, TX	Lubbock, TX
Los Angeles-Long Beach, CA	Corpus Christi, TX
Riverside-San Bernardino,CA	Eugene-Springfield, OR
Washington, DC/MD/VA	Akron, OH
San Francisco-Oakland-Vallejo, CA	Buffalo-Niagara Falls, NY
San Diego, CA	Fort Wayne, IN

Table A.9: Number of Removed Immigrants and Changes in Rents

MSA	Removed low skill immigrant	△% rent fixed migration	△% rent free migration
Atlanta, GA	-48,424	-1.98	-0.11
Augusta-Aiken, GA-SC	-292	-0.14	-0.01
Birmingham, AL	-2,676	-0.64	-0.04
Charleston-N.Charleston,SC	-1,576	-0.60	-0.04
Columbia, SC	-1,904	-0.46	-0.03
Greenville, SC	-4,482	-0.52	-0.03
Phoenix, AZ	-102,047	-4.61	-0.23
Salt Lake City-Ogden, UT	-17,618	-2.75	-0.14
Tucson, AZ	-13,496	-3.96	-0.18

The fixed-migration column reports the difference between initial rents and the rents when natives and immigrants' locations are held fixed. The free-migration column reports the difference between the initial rents and the rents after all workers simultaneously choose locations.

Table A.10: Welfare: Removal of Low Skill Immigrants

	△ ave. utility Fixed migration	△ ave. utility Free migration all	mover	forced stayer	stayer
Natives in removed-immigrant cities:					
High-skill male	-533	-26	.	.	-26
High-skill female	-376	-18	.	.	-18
Low-skill male	1,826	90	135	73	90
Low-skill female	771	30	.	.	30
Immigrants in removed-immigrant cities:					
High-skill male	-456	-20	.	.	-20
High-skill female	-335	-15	-15	-15	-15
Low-skill male	2,916	130	.	.	130
Low-skill female	1,740	63	.	.	63
Natives in other cities:					
High-skill male	0	-26	-27	-53	-26
High-skill female	0	-18	-16	-25	-18
Low-skill male	0	83	81	51	83
Low-skill female	0	37	40	19	37
Immigrants in other cities:					
High-skill male	0	-19	-14	-32	-19
High-skill female	0	-14	-8	-17	-14
Low-skill male	0	126	131	73	126
Low-skill female	0	72	75	52	72
Rental income and overall loss/gains:					
Overall net loss/gains without rental income	46	24	72	39	24
Overall net loss/gains with rental income equally distributed	17	-6	42	9	-6
Rental income per landlord	-243	-250			

The welfare analysis is based on simulated outcomes amongst a random draw of 240,000 individuals. Changes in average utility reported in 2015 annual wage dollars. Forced stayer's change in utility measures the difference between the initial utility and the counterfactual utility that those workers who choose to move in equilibrium would have derived had they not been allowed to move. Net loss/gains weighted by population share of each group. See text for more details.

Table A.11: Wages: Increase in High Skill Immigrants using National Labor Demand Estimates

	Gateway cities		Other cities	
	△ annual wage Fixed migration	△ annual wage Free migration	△ annual wage Fixed migration	△ annual wage Free migration
High-skill male native	-1,738	-1,305	-469	-513
High-skill female native	-1,187	-896	-328	-363
Low-skill male native	2,426	1,848	508	573
Low-skill female native	1,981	1,515	417	465
High-skill male immigrant	-1,962	-1,555	-1,109	-1,104
High-skill female immigrant	-1,428	-1,145	-842	-831
Low-skill male immigrant	1,686	1,275	656	624
Low-skill female immigrant	1,482	1,112	561	535
Housing rents	1,228	1,096	238	239

	90-50 local real wage ratio	90-10 local real wage ratio
Initial	1.65	2.56
Fixed migration	1.64	2.51
Free migration	1.64	2.50

Gateway cities: Fort Lauderdale, Miami, New York, San Francisco and San Jose. Average wage of each group weighted by the number of workers in each city. Annual wages in 2015 dollars. Fixed-migration change measures the difference between the initial wages and the wages when natives and immigrants' locations are held fixed. Free-migration change measures the difference between the initial wages and the wages after all workers simultaneously choose locations.

Table A.12: Welfare: Increase in High Skill Immigrants using National Labor Demand Estimates

	△ ave. utility Fixed migration	△ ave. utility Free migration			
		all	mover	forced stayer	stayer
Natives in gateway cities:					
High-skill male	-5,149	-4,078	-2,891	-4,156	-4,099
High-skill female	-3,507	-2,772	-1,936	-2,873	-2,793
Low-skill male	771	520	.	.	520
Low-skill female	623	426	.	.	426
Immigrants in gateway cities:					
High-skill male	-4,963	-3,922	-3,016	-4,020	-3,978
High-skill female	-3,606	-2,861	-2,169	-2,947	-2,902
Low-skill male	302	193	223	155	193
Low-skill female	264	164	159	121	164
Natives in other cities:					
High-skill male	-1,435	-1,429	-1,662	-2,238	-1,428
High-skill female	-987	-986	-1,126	-1,585	-986
Low-skill male	286	297	257	129	297
Low-skill female	237	245	224	110	245
Immigrants in other cities:					
High-skill male	-1,999	-1,996	-2,318	-2,968	-1,991
High-skill female	-1,509	-1,497	-1,803	-2,275	-1,491
Low-skill male	137	159	97	-1	159
Low-skill female	113	133	124	48	133
Rental income and overall loss/gains:					
Overall net loss/gains without rental income	-767	-707	-1,706	-2,332	-700
Overall net loss/gains with rental income equally distributed	31	76	-923	-1,548	83
Rental income per landlord	6,653	6,526			

The welfare analysis is based on simulated outcomes amongst a random draw of 240,000 individuals. Changes in average utility reported in 2015 annual wage dollars. Forced stayer's change in utility measures the difference between the initial utility and the counterfactual utility that those workers who choose to move in equilibrium would have derived had they not been allowed to move. Net loss/gains weighted by population share of each group. See text for more details.

Table A.13: Wages: Increase in the Stock of Immigrants using National Labor Demand Estimates

	Gateway cities		Other cities	
	△ annual wage Fixed migration	△ annual wage Free migration	△ annual wage Fixed migration	△ annual wage Free migration
High-skill male native	574	554	172	164
High-skill female native	392	370	115	110
Low-skill male native	-78	-46	-32	-24
Low-skill female native	-100	-74	-43	-36
High-skill male immigrant	151	147	-21	-49
High-skill female immigrant	116	124	-17	-44
Low-skill male immigrant	-575	-572	-561	-549
Low-skill female immigrant	-514	-512	-492	-489
Housing rents	757	619	161	160

	90-50 local real wage ratio	90-10 local real wage ratio
Initial	1.65	2.56
Fixed migration	1.67	2.60
Free migration	1.66	2.61

Gateway cities: Los Angeles, Miami, New York, Salinas-Sea and San Jose. Average wage of each group weighted by the number of workers in each city. Annual wages in 2015 dollars. Fixed-migration change measures the difference between the initial wages and the wages when natives and immigrants' locations are held fixed. Free-migration change measures the difference between the initial wages and the wages after all workers simultaneously choose locations.

Table A.14: Welfare: Increase in the Stock of Immigrants using National Labor Demand Estimates

	△ ave. utility	△ ave. utility			
	Fixed	Free migration			
	migration	all	mover	forced stayer	stayer
Natives in gateway cities:					
High-skill male	-1,651	-1,319	-849	-1,381	-1,322
High-skill female	-1,141	-913	-563	-890	-917
Low-skill male	-1,080	-875	-585	-903	-880
Low-skill female	-936	-777	-521	-802	-780
Immigrants in gateway cities:					
High-skill male	-1,800	-1,440	-1,015	-1,480	-1,450
High-skill female	-1,322	-1,047	-783	-1,095	-1,054
Low-skill male	-1,380	-1,239	-1,027	-1,252	-1,246
Low-skill female	-1,232	-1,081	-884	-1,079	-1,086
Natives in other cities:					
High-skill male	-373	-382	-512	-741	-382
High-skill female	-258	-264	-321	-527	-264
Low-skill male	-325	-306	-321	-483	-306
Low-skill female	-293	-278	-306	-432	-278
Immigrants in other cities:					
High-skill male	-698	-694	-994	-1,278	-692
High-skill female	-527	-525	-745	-1,020	-523
Low-skill male	-755	-767	-850	-996	-766
Low-skill female	-660	-677	-738	-863	-676
Rental income and overall loss/gains:					
Overall net loss/gains without rental income	-492	-462	-672	-918	-461
Overall net loss/gains with rental income equally distributed	61	81	-128	-375	82
Rental income per landlord	4,610	4,526			

The welfare analysis is based on simulated outcomes amongst a random draw of 240,000 individuals. Changes in average utility reported in 2015 annual wage dollars. Forced stayer's change in utility measures the difference between the initial utility and the counterfactual utility that those workers who choose to move in equilibrium would have derived had they not been allowed to move. Net loss/gains weighted by population share of each group. See text for more details.

Table A.15: Wages: Increase in High Skill Immigrants using Different CES Order

	Gateway cities		Other cities	
	△ annual wage Fixed migration	△ annual wage Free migration	△ annual wage Fixed migration	△ annual wage Free migration
High-skill male native	869	961	130	123
High-skill female native	688	697	167	171
Low-skill male native	1,565	1,445	372	393
Low-skill female native	1,298	1,182	321	338
High-skill male immigrant	-3,985	-3,851	-3,831	-3,902
High-skill female immigrant	-2,829	-2,771	-2,763	-2,825
Low-skill male immigrant	1,078	993	450	441
Low-skill female immigrant	961	865	397	390
Housing rents	1,240	1,065	231	232

	90-50 local real wage ratio	90-10 local real wage ratio
Initial	1.65	2.56
Fixed migration	1.63	2.52
Free migration	1.63	2.51

Gateway cities: Fort Lauderdale, Miami, New York, San Francisco and San Jose. Average wage of each group weighted by the number of workers in each city. Annual wages in 2015 dollars. Fixed-migration change measures the difference between the initial wages and the wages when natives and immigrants' locations are held fixed. Free-migration change measures the difference between the initial wages and the wages after all workers simultaneously choose locations.

Table A.16: Welfare: Increase in High Skill Immigrants using Different CES Order

	△ ave. utility Fixed migration	△ ave. utility Free migration all	mover	forced stayer	stayer
Natives in gateway cities:					
High-skill male	-2,613	-2,085	-1,531	-2,234	-2,091
High-skill female	-1,684	-1,387	-893	-1,537	-1,395
Low-skill male	-34	36	-22	-61	36
Low-skill female	-6	35	-50	-136	35
Immigrants in gateway cities:					
High-skill male	-6,941	-6,427	-5,962	-6,502	-6,441
High-skill female	-4,974	-4,624	-4,171	-4,577	-4,639
Low-skill male	-248	-150	-85	-191	-151
Low-skill female	-210	-135	-68	-176	-136
Natives in other cities:					
High-skill male	-662	-660	-681	-1,025	-659
High-skill female	-351	-345	-368	-677	-345
Low-skill male	109	112	94	15	112
Low-skill female	113	115	107	60	115
Immigrants in other cities:					
High-skill male	-4,679	-4,756	-5,005	-5,328	-4,754
High-skill female	-3,411	-3,478	-3,799	-4,073	-3,476
Low-skill male	25	19	21	-66	19
Low-skill female	26	24	4	-68	24
Rental income and overall loss/gains:					
Overall net loss/gains without rental income	-733	-704	-2,099	-2,436	-699
Overall net loss/gains with rental income equally distributed	47	65	-1,330	-1,667	71
Rental income per landlord	6,492	6,411			

The welfare analysis is based on simulated outcomes amongst a random draw of 240,000 individuals. Changes in average utility reported in 2015 annual wage dollars. Forced stayer's change in utility measures the difference between the initial utility and the counterfactual utility that those workers who choose to move in equilibrium would have derived had they not been allowed to move. Net loss/gains weighted by population share of each group. See text for more details.

Table A.17: Wages: Increase in the Stock of Immigrants using Different CES Order

	Gateway cities		Other cities	
	△ annual wage Fixed migration	△ annual wage Free migration	△ annual wage Fixed migration	△ annual wage Free migration
High-skill male native	1,159	1,039	264	277
High-skill female native	880	800	235	244
Low-skill male native	-93	-4	-18	-25
Low-skill female native	45	122	51	50
High-skill male immigrant	-1,227	-1,280	-1,592	-1,641
High-skill female immigrant	-841	-890	-1,109	-1,150
Low-skill male immigrant	-387	-292	-361	-364
Low-skill female immigrant	-251	-196	-228	-227
Housing rents	750	648	160	160

	90-50 local real wage ratio	90-10 local real wage ratio
Initial	1.65	2.856
Fixed migration	1.67	2.59
Free migration	1.67	2.60

Gateway cities: Los Angeles, Miami, New York, Salinas-Sea and San Jose. Average wage of each group weighted by the number of workers in each city. Annual wages in 2015 dollars. Fixed-migration change measures the difference between the initial wages and the wages when natives and immigrants' locations are held fixed. Free-migration change measures the difference between the initial wages and the wages after all workers simultaneously choose locations.

Table A.18: Welfare: Increase in the Stock of Immigrants using Different CES Order

	△ ave. utility Fixed migration	△ ave. utility Free migration all	mover	forced stayer	stayer
Natives in gateway cities:					
High-skill male	-1,071	-932	-570	-979	-935
High-skill female	-654	-552	-285	-624	-554
Low-skill male	-1,084	-861	-575	-937	-865
Low-skill female	-786	-601	-419	-692	-603
Immigrants in gateway cities:					
High-skill male	-3,150	-2,942	-2,647	-2,954	-2,947
High-skill female	-2,256	-2,107	-1,892	-2,078	-2,110
Low-skill male	-1,188	-987	-812	-1,011	-992
Low-skill female	-973	-805	-622	-808	-810
Natives in other cities:					
High-skill male	-246	-231	-258	-411	-231
High-skill female	-99	-94	-99	-267	-94
Low-skill male	-306	-307	-285	-466	-307
Low-skill female	-162	-171	-204	-314	-171
Immigrants in other cities:					
High-skill male	-2,235	-2,276	-2,591	-2,764	-2,275
High-skill female	-1,601	-1,632	-1,922	-2,094	-1,631
Low-skill male	-560	-580	-680	-843	-579
Low-skill female	-421	-430	-507	-628	-429
Rental income and overall loss/gains:					
Overall net loss/gains without rental income	-476	-457	-756	-959	-456
Overall net loss/gains with rental income equally distributed	72	85	-213	-417	86
Rental income per landlord	4,567	4,520			

The welfare analysis is based on simulated outcomes amongst a random draw of 240,000 individuals. Changes in average utility reported in 2015 annual wage dollars. Forced stayer's change in utility measures the difference between the initial utility and the counterfactual utility that those workers who choose to move in equilibrium would have derived had they not been allowed to move. Net loss/gains weighted by population share of each group. See text for more details.