Immigration and Spatial Equilibrium: the Role of Expenditures in the Country of Origin

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Abstract

This paper investigates the spatial distribution of immigrants across US cities. We document that (a) immigrants concentrate in large, expensive cities, (b) the earnings gap between natives and immigrants is larger in these cities, (c) these patterns are stronger when price levels in the country of origin are lower, and (d) immigrants consume less locally than natives. We develop a spatial equilibrium model in which immigrants spend a fraction of their income in their countries of origin. Thus, immigrants care not only about local prices but also about price levels in their home countries, which gives them a comparative advantage for living in more productive cities, where nominal earnings are higher and where they accept lower wages than natives. We rely on arguably exogenous variation in real exchange rates to estimate the model. Counterfactual simulations suggest that immigrants' location choices reduce economic activity in smaller, less productive cities, while they expand it in larger, more productive ones. Due to these distributional effects, the model predicts that current levels of immigration lead to 1.3% higher worker productivity and 0.6% higher welfare.

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1 Introduction

There are fundamentally two theories explaining immigrants' location choices. First, it is well known that immigrants tend to move to cities or regions that are thriving. One reading of this evidence is that immigrants may be particularly important for "greasing the wheels" of the labor market since they arbitrage away opportunities across locations – explored theoretically in Borjas (2001) and empirically in Cadena and Kovak (2016). This observation has had a profound influence on the literature that estimates the effects of immigration on labor market outcomes. Many papers have compared high- to low-immigration regions to try to infer the causal effect of immigration on outcomes of interest. However, if immigrants' primary motive for choosing particular cities or regions is that those areas are thriving, then there is a spurious correlation between labor market outcomes and immigrant settlement patterns.

Second, and in part as a solution to the aforementioned endogeneity concerns, many authors emphasize that immigrants tend to move where previous immigrants settled (Munshi 2003). Former immigrants help newer ones both in migrating and in finding jobs and suitable neighborhoods for their new life in the host country. This idea has been the basis for the networks instrument, the most widely used instrument in the migration literature (Altonji and Card 1991). Simply stated, past stocks of immigrants are usually a good predictor of future flows, which, in the absence of serially correlated outcomes, provides exogenous regional variation in immigrant inflows. The widespread use of this instrument – despite numerous criticisms (Borjas et al. 1996; Jaeger et al. 2018; Goldsmith-Pinkham et al. 2018; Adao et al. 2018; Borusyak et al. 2018) – highlights the importance of understanding immigrant location choices within host economies.

In this paper, we provide a completely new look at immigrants' location choices, which we argue has important implications for host economies and for our understanding of the incentives driving immigrants' settlement patterns. Migrants tend to spend large fractions of their income in their home country. Many send remittances to their families, plan on returning, or simply spend their leisure time at home.[1] This means that they care not only about the prices in the location where they live but also about the prices in their home countries. We argue that immigrants' expenditure in the country of origin profoundly shapes their residential choices and wages, which, in turn, affects the distribution of economic activity across locations and the general equilibrium in the host economy.

In the first part of the paper, we use a number of different data sets to document four cross-sectional empirical regularities using data on metropolitan statistical areas in the United States.[2] First, we report that immigrants concentrate disproportionately in large and expensive cities, where, as it is well known in the urban economics literature, nominal wages and productivity tend to be higher (Combes and Gobillon 2014; Glaeser 2008). Second, the gap in earnings between natives and immigrants is *larger* in these cities, even when we consider wage gaps within narrowly defined skill cells and when we control for native-immigrant imperfect substitutability following Ottaviano and Peri (2012). Third, we show that

[1] Dustmann and Mestres (2010) document that immigrants in Germany remit around 10% of their income. The literature on temporary migrations, summarized in Dustmann and Gorlach (2016), takes into account that expenditures in the home country influences immigrants experience, but previous papers do not analyze how this shapes the spatial equilibrium in the host country.

[2] In particular we use data from the US Census, the American Community Survey (ACS), the Consumer Expenditure Survey, the Matricula Consular, the New Immigrant Survey, and the World Bank's International Comparison Program database.

there is significant heterogeneity across immigrant groups both in location choices and relative wages. We use cross-origin and arguably exogenous within-origin variation in real exchange rates to document that when real exchange rates are lower, immigrants' concentration in expensive cities is stronger and the gap in wages between natives and immigrants is higher. We then use data of state-to-state migration flows from Mexico to the United States to show that Mexican immigrants from poorer states, where presumably price levels are lower, tend to disproportionately migrate to the richest and most expensive states in the United States. Using variation in years since arrival and plausibly exogenous variation in legal status due to the Immigration Reform and Control Act of 1986, we also show that the patterns are weaker for immigrants that are likely to be more attached to the US and, hence, more similar to natives. Finally, we provide evidence that immigrants consume less locally than natives by comparing housing and total expenditures of otherwise comparable native and immigrant households within locations.

In the second part of the paper, we explain these four strong empirical regularities with a spatial equilibrium model, in which immigrants' location choices are influenced by price differences between host and origin country. When a part of immigrants' consumption is related to their country of origin, they have strong incentives to settle in locations with high nominal prices and wages. All else being equal, a native may be indifferent between one location and an alternative one that is twice as expensive as long as wages are also twice as high. However, immigrants' smaller share of local consumption implies that they have incentives to live in the high-wage, high-price city. As a consequence, immigrants concentrate in expensive cities and, if wages partly reflect the value of living in a city – which is the case in non-competitive labor markets – the native-immigrant wage gap is higher in these locations.[3] Some degree of substitutability between home and local goods allows this mechanism to be stronger for immigrants coming from cheaper countries, which is in line with the data both when we compare location and wage patterns across countries of origin and when we relate them to real exchange rates.

To assess the economic importance of the role of expenditures in the home country, in the third part of the paper we estimate the key parameters of our model using variation in immigrants' origin countries across metropolitan areas. Intuitively, the model estimates the share of total expenditures immigrants spend on home country goods and the degree of substitution between consuming locally and at home that rationalizes the higher concentration of immigrants and the larger wage gap to natives in expensive cities as well as the heterogeneity in these relationships across immigrants from different origins. We complement these estimates with parameters from prior literature to perform quantitative exercises. Specifically, we rely on Albouy (2016), Combes and Gobillon (2014), and Saiz (2010). Our baseline estimates, which are obtained using only labor market data, imply that immigrants' average share of total expenditure in the home country is around 21% and the elasticity of substitution between consuming locally and in the country of origin is around 1.61.[4] We validate our estimation by showing that the model performs well at predicting a range of non-targeted moments. In particular, we compare

[3]In order to obtain this result, wage differences between workers cannot be competed away. This means that we depart from standard perfectly competitive models of the labor market and instead consider wage bargaining. See Becker (1957) and Black (1995).

[4]We also analyze the sensitivity of this estimate to the parameters we borrow from the literature. Using a large number of alternatives, we obtain a range of estimates for the average share of consumption in the origin country between 15% and 25%. The range of estimates that we find in our sensitivity analysis for the elasticity of substitution between consuming locally and in the country of origin goes from 1.5 to 2.5.

the model predictions on labor market outcomes and on consumption by origin country with the patterns in the data.

We then use the estimated model to compute two counterfactuals that highlight the importance of taking into account that immigrants spend part of their income in their countries of origin. Specifically, we explore how a native-induced and an immigrant-induced population increase of 20% would change the distribution of economic activity and aggregate outcomes in our model. We then compare these two simulations to assess the role of immigration in shaping the spatial equilibrium. Our main finding is that there is a significant redistribution of economic activity from small, unproductive cities to large, productive ones as a consequence of immigration.[5] We show that low-productivity cities are around 20% smaller, while those with high productivity are around 30% larger when the increase in population is induced by immigrants as opposed to natives. This movement of economic activity towards more productive locations has aggregate implications as it leads to a rise in the average productivity of workers by around 1.3%.

We conclude our analysis by exploring how immigrants' consumption and location choices affect native workers' welfare. First, the expansion of the population in more productive locations induces an increase in average productivity. Second, immigration affects local consumption of non-tradables through two channels. On the one hand, given that part of what immigrants earn is spent in their countries of origin, each immigrant household (relative to a similar-looking native household) tends to have a lower demand for local non-tradable goods and, hence, increases their prices by *less* than natives, which is positive for native workers' welfare. On the other hand, immigrants disproportionally concentrate in highly productive locations, where prices of non-tradables rise due to the higher aggregate demand. Thus, natives are priced out into less productive locations. Combining all these forces, we estimate that native workers' welfare is around 0.6% higher as a consequence of immigrants' consumption behavior and location choices than in a counterfactual in which population growth is driven by natives.

This paper extends the seminal work of Borjas (2001), who argues that immigrants "grease the wheels" of the labor market by moving into the most favorable local labor markets.[6] Within a spatial equilibrium framework, this means that they pick cities where wages are highest relative to living costs and amenity levels. Thus, in this context, immigrants do not necessarily choose the most productive cities or those with the highest nominal wages. Instead, in our model, migrants prefer high-nominal-income cities because they care less than natives about local prices. This is a crucial difference that has important consequences for both the distribution of economic activity across space and the general equilibrium. Moreover, this insight also has important implications for empirical studies that estimate the effect of immigration on the labor market by comparing metropolitan statistical areas (Card 1990; Altonji and Card 1991; Borjas et al. 1997; Card 2005; Lewis 2012; Llull 2018a; Glitz 2012; Borjas and Monras 2017; Monras Forthcoming; Dustmann et al. 2017; Jaeger et al. 2018).[7] In particular, it provides an explanation for the positive

[5] Large, expensive cities are so, in the context of our model, because they are more productive. See Albouy (2016). In related work, Hsieh and Moretti (2017) show how housing constraints are responsible in part for the smaller than optimal size of the most productive cities. This paper shows that immigrant location choices reduce these constraints. On optimal city size see also Eeckhout and Guner (2014).

[6] There are other papers with models that help to make arguments similar to the one made in Borjas (2001), such as Bartel (1989) and Jaeger (2007).

[7] Dustmann et al. (2016) provide a recent review of this literature. We discuss in more detail the literature on immigration

correlation between wage levels and immigrant shares across cities, and, given the persistence in city size rankings (Duranton 2007), it offers an alternative reason for why immigrants keep settling in the same locations decade after decade.

This paper is also strongly related to a large body of recent work on quantitative spatial equilibrium models, including Redding and Sturm (2008), Ahlfeldt et al. (2015), Redding (2014), Albouy (2009), Fajgelbaum et al. (2016), Diamond (2015), Monras (2015), Caliendo et al. (2015), Caliendo et al. (Forthcoming), Monte et al. (2015) and Bilal and Rossi-Hansberg (2019), among others, which explore neighborhoods within cities, the spatial consequences of taxation, local shocks, endogenous amenities, the dynamics of internal migration, international trade shocks, commuting patterns, and location choices over the life cycle.[8] In this literature, only Burstein et al. (2018), Caliendo et al. (2018), Piyapromdee (2017), and Monras (Forthcoming) use spatial equilibrium models to study immigration. In these papers, immigrants are not characterized by how they consume but rather by differences in observable characteristics that may be important for the labor market but that are silent on the many empirical facts uncovered in our paper. Our view on what fundamentally defines immigrants uncovers novel local and aggregate effects of immigration in the host economy that were unexplored until now. We explain the novelty of our paper relative to the various papers that study the effect of immigration on host economies in detail in section 4.1.

Finally, this paper also ties in with the literature that investigates the effects of migrants on housing markets and local prices more generally. There is evidence suggesting that Hispanic migrants tend to settle in expensive cities and that they exert pressure on housing price (Saiz 2003, 2007; Saiz and Wachter 2011). Relative to these papers, we show that the effect of immigration on housing prices may be very heterogeneous across cities, depending on the type of city. This heterogeneity, which explains how immigration affects natives differently across locations, was not explored before. There is also some work showing that immigration may decrease the price of some non-tradables (Lach 2007; Cortes 2008). This is usually explained by its impact on the cost of producing local goods. We abstract from this mechanism in this paper but we could integrate it in our model.

In what follows, we first describe our data in Section 2. Section 3 introduces a number of facts on immigrants' location choices, wages, and consumption patterns. We present a quantitative spatial equilibrium model consistent with these facts in Section 4, which we estimate and use to study the effects of immigration on the spatial equilibrium in Section 5. Finally, Section 6 concludes the paper.

2 Data

In the empirical part of this paper, we rely on various publicly available data sets for the United States. For individual information on locations and labor market outcomes, we use the US Census and the American Community Survey (ACS), both available on Ruggles et al. (2016) and widely used in previous work. To document consumption patterns, we use the Consumer Expenditure Survey, Census and ACS data. We use data from the World Bank to compute real exchange rates between the various countries

in Section 4.1.

[8] Redding and Rossi-Hansberg (Forthcoming) provide a recent review of this literature.

of origin and the US dollar. Finally, we use Matricula Consular data to compute Mexican flows at the state-to-state level. We describe these data sources below.

2.1 Census and American Community Survey data

Our main data set is the Census of population data for the years 1980, 1990, and 2000, and the American Community Survey 2009-2011. In particular, we use information on the metropolitan statistical area (MSA) of residence of surveyed individuals, the wage they received in the preceding year, the number of weeks that they worked in the preceding year, and their country of birth. We only consider salary workers aged between 25 and 59 who are not in school and report positive weeks and hours worked in our sample, and we define immigrants as individuals born outside the United States. To control for potential demographic differences between natives and immigrants, we construct composition-adjusted wages. That is, we use the residuals of a regression of weekly wages on sex, racial categories and marital status categories for each year.

We use these composition-adjusted wages to compute the difference in wages between natives and immigrants, which we refer to as the wage gap, at the city level. When workers are heterogeneous and can be divided into different factor types, there are two potential problems when computing city-specific wage gaps. First, it may be that immigrants and natives within narrowly defined skill groups are imperfect substitutes, and hence immigrants might earn relatively less in locations where they are more highly concentrated because of competition effects. Second, the skill sorting of natives and immigrants across cities might be different and could partly drive local wage gaps. Third, it could be that the gap in earnings between natives and immigrants is larger among high-skilled workers than among low-skilled workers. Then, the higher concentration of high-skilled workers in larger cities, i.e the sorting of skills across cities, could generate higher average wage gaps in these locations.

To control for these factors, we combine the estimation equations of Card (2009) and Ottaviano and Peri (2012). In particular, we estimate a model in which we relate the ratio between natives' and immigrants' wages to the ratio of labor supplies in an MSA following Card (2009). Moreover, we group workers in skills cells based on education and experience and calculate wage and employment ratios within those cells as in Ottaviano and Peri (2012). The inclusion of skill cell fixed effects absorbs any variation in wage gaps across cities due to different sorting along the education and experience dimensions. More concretely, we estimate the following regression:

$$\ln(\frac{w_{I,k,c,t}}{w_{N,k,c,t}}) = \phi_k + \phi_{c,t} + \gamma \ln(\frac{L_{I,k,c,t}}{L_{N,k,c,t}}) + \varepsilon_{i,t}, \tag{2.1}$$

where k denotes the skill cell, which is defined by four education groups (high school dropout, high school graduate, some college and college graduate) and eight experience intervals starting with one to five years and ending with 36 to 40 years, and $L_{I,k,c,t}$ and $L_{N,k,c,t}$ are the total hours worked in skill cell k, city c and year t by immigrants and natives, respectively.[9]

This specification allows us to extract the city-time-specific component of the wage gaps as the city-

[9]For the calculation of the experience, we follow Ottaviano and Peri (2012) in assuming that high school dropouts enter the labor market at age 17, high school graduates at age 19, workers with some college at age 21, and college graduates at age 23.

time fixed effects $\phi_{c,t}$, which are adjusted for any effects due to spatial sorting or imperfect substitution between natives and immigrants within education-experience cells.

We also use data from the Census and ACS to compute local price indices. We thereby follow Moretti (2013) and apply his code to our sample ranging to the year 2011. From this, we obtain a local price index for each of the MSAs in our sample that takes the variation in local housing cost into account.[10]

To give a sense of the metropolitan statistical areas in our analysis, Table 1 reports the MSAs with the highest immigrant shares in the United States in 2000, together with some of the main economic variables used in the analysis. As we can see in Table 1, most of the MSAs with high levels of immigration are also large and expensive and pay high wages. The gap in earnings between natives and immigrants is also large in these cities. In this general description, there are a few notable outliers, which are mostly MSAs in California and Texas close to the border between the US and Mexico.

Table 1 goes around here

2.2 Current Population Survey data

To explore whether our results hold for higher frequency data, we rely on the Current Population Survey (CPS). In particular, we use the CPS March supplement to generate yearly cross-sectional data of individuals including information on their demographic characteristics, labor market variables and location of residence. Although the CPS data are gathered monthly, only the March files contain detailed information on yearly incomes, country of birth, and other variables that we need. In particular, we use information on the current location – mainly MSAs – in which the surveyed individuals reside, the wage they received in the preceding year, the number of weeks that they worked in the preceding year, and their country of birth. We only consider salary workers who are not in school and report positive weeks and hours worked in our sample, and we define immigrants as individuals born outside the United States. This information is only available after 1994, which is why we only use CPS data for the period 1994-2011.

2.3 Consumer Expenditure Survey data

To document consumption patterns, we employ two different data sets. First, we use the Consumer Expenditure Survey, which is maintained by the Bureau of Labor Statistics and has been widely employed to document consumption behavior in the United States. It is a representative sample of US households and contains detailed information on consumption expenditure and household characteristics. Unfortunately, it contains no information on birthplace or citizen status, which is why it is impossible to directly identify immigrants. Instead, we rely on one of the Hispanic categories that identifies households of

[10] We use the version of Moretti's price index that is calculated as the weighted sum of local housing cost and the cost of non-housing consumption, which is assumed to be the same across areas. Local housing costs are measured as the average of the monthly cost of renting a two- or three-bedroom apartment in an MSA.

Mexican origin in the years 2003 to 2015.[11] The data set contains around 30,000 households per year, of which around 7% are of Mexican origin.

We also document consumption patterns using the Census and the ACS. Both the Census and the ACS record the rent paid by households who are renting. This is the most important local expenditure for many households and typically accounts for roughly 25% of household income.

2.4 Real exchange rate data

An important aspect of our empirical analysis is to document the variation by price levels of immigrants' countries of origin. To measure price levels at origin, we use real exchange rate data. The World Bank provides real exchange rates with respect to the United States for a large number of countries in its International Comparison Program database.[12] These data expand the 89 countries of origin that we use in our estimation exercise.[13] In Table 2, we provide a list of the top and bottom 10 countries in terms of the average real exchange rate with respect to the United States over the years 1990, 2000, 2010. While price levels in countries like Norway or Japan are around 35% higher, the number of countries with real exchange rates larger than one is relatively low. Australia, ranked 10th in the table, is only 7% more expensive than the United States. On the other end, prices in countries like Vietnam (with large immigrant communities in the United States) have prices that are only 20% of those in the United States.

Table 2 goes around here

2.5 Matricula Consular data

Mexican immigrants in the United States are encouraged to register in the local consulates, which issue a card called the Consular ID. In order to obtain this card, Mexican immigrants need to show, essentially, their birth certificate or passport. In principle both immigrants legally admitted to the US and undocumented ones can obtain this card. The card is useful, among other things, to open bank accounts in a number of financial institutions. These gives sufficient incentives to many Mexicans to register and obtain this ID card.

Among the information recorded with this registration process is the address of destination in the US and the municipality of origin within Mexico. This enables to compute the flows of Mexicans in any given year. In theory, these can be computed at the municipality level, although only state-to-state flows are publicly available. Caballero et al. (2018) and Allen et al. (2019) show that these data matches well

[11] Monras (Forthcoming) shows that the overlap between individuals identified as Hispanics of Mexican origin and Mexican-born individuals is around 85% in Census data. This gives us confidence that, by using the Hispanic variable in Consumption Expenditure data, we are capturing a large number of Mexican-born individuals.

[12] The exact title of the series is "Price level ratio of PPP conversion factor (GDP) to market exchange rate."

[13] An alternative source of similar information is provided by the OECD and the Penn World Tables. The OECD also estimates price levels of various countries. The number of countries that the OECD covers is smaller, which is why we report estimates in the paper using the World Bank data, although estimates for OECD countries may be more reliable because they cover richer, more developed, countries. We obtain similar estimates using OECD data. We also obtain similar estimates using the GDP per capita in the country of origin, obtained from the Penn World Tables, to proxy for the price index.

representative data sets on stocks. In this paper, we use the state-to-state migration flows for the year 2016.

3 Empirical evidence

3.1 Immigration and cities

In this section, we document two very strong facts about the cross-sectional relationship between immigration and cities. First, we show that immigrants concentrate much more than natives in large and expensive cities. Second, we document that the gap in wages between immigrants and natives is larger (i.e. more negative) in large and expensive cities.

To document the first fact, we define the "relative immigrant share" as the share of immigrants living in city c divided by the share of natives living in city c (as fractions of the whole respective populations in the US) and regress this measure (in logs) on the size or price level of city c. More specifically, we run the following regression:

$$\ln\left(\frac{\text{Imm}_{c,t}}{\text{Imm}_t}/\frac{\text{Nat}_{c,t}}{\text{Nat}_t}\right) = \beta_Q \ln P_{c,t} + \psi_c + \psi_t + \varepsilon_{c,t}, \tag{3.1}$$

where $\text{Imm}_{c,t}$ is the number of immigrants and $\text{Nat}_{c,t}$ is the number of natives in city c at time t, and Imm_t and Nat_t is the overall number of immigrants and natives in the entire country.[14] $P_{c,t}$ is either the total number of people in the city or its price level. An estimate $\beta_Q > 0$ means that immigrants concentrate more in large/expensive metropolitan areas than natives.

The second fact that we investigate is how the gap in wages between natives and immigrants is related to city size and city prices. If wages reflect, at least in part, the value of living in a location – which is a natural result in non-competitive labor market models, see Section 4 – we should expect the relationship between wage gaps and city size and city prices to be the mirror image of relative location choices. To estimate the relationship between wage gaps and the city characteristics, we use the following regression:

$$\hat{\phi}_{c,t} = \beta_P \ln P_{c,t} + \psi_c + \psi_t + \varepsilon_{c,t}. \tag{3.2}$$

where $\hat{\phi}_{c,t}$ is the gap in wages between natives and immigrants adjusted for both observable characteristics and heterogeneous labor, as explained in section 2.1, equation (2.1). In particular, $\hat{\phi}_{c,t}$ accounts for the possibility that natives and immigrants are imperfect substitutes and that workers of different educational background sort into different locations. An estimate of $\beta_P < 0$ indicates that the adjusted gap in wages between natives and immigrants is larger, i.e. more negative, in more populous or more expensive cities.

We report the results of estimating equations (3.1) and (3.2) in Figure 1 and Table 3, and provide a large number of robustness checks in Table 4. Figure 1 shows these relationships using only cross-sectional data from the 2000 Census. In the left-hand panel of panel A, we observe that, even if there

[14] We only use urban population for the entire analysis. Non-urban local labor markets are usually defined by commuting zones (Autor et al. 2013). To define non-urban commuting zones we need information on county of residence, which is not provided for ever year in CPS data. Urban commuting zones and MSAs are essentially the same.

is some variance in the relative immigrant share across metropolitan statistical areas, there is a positive and statistically significant relationship between the distribution of immigrants and city population. The marker sizes are proportional to the respective city price indices and indicate that the more populous cities also tend to be more expensive. The relationship between the relative immigrant share and price indices, shown in the right-hand side of panel A, is even stronger, and the linear fit is better.[15] Here, marker sizes reflect city population levels. While there are some outliers, mainly along the US-Mexico border, a city with a local price index that is 1% higher is associated with an 8% higher relative immigrant share. In Appendix A.3, we show that this relationship also holds when using commuting zones instead of MSAs.[16] This evidence is in line with the contemporaneous paper by Albouy et al. (2018), who argues that immigrants live in relatively high-nominal wage, high-amenity locations.

Figure 1 goes around here

Panel B of Figure 1 shows that the relationship between wage gaps and city size and price levels is the mirror image of what we have seen for relative immigrants shares. As can be seen in the graph on the left, there is a strong negative relationship between wage gaps and city size. This means that the difference in the wages of immigrants and natives is larger in big than in small cities, i.e. immigrants have relatively higher wages in small than in large cities. The graph on the right hand-side of panel B shows that, again, the relationship is stronger between wage gaps and city price indices than it is with city sizes.

We quantify these results in Table 3. In the first column, we show that, when pooling all the years together, larger cities have a higher relative share of immigrants (panel A) and a larger wage gap (panel B). This could be driven by variation across the years in the overall size or price level of cities. In column 2, we include year fixed effects, hence the estimates are the average cross-sectional relationships across the four decades of our data. Both the coefficients in panel A and panel B remain similar. Column 3 includes MSA fixed effects. Hence, β_Q and β_P are identified from within-city variation over time. While not the focus of the paper, since we are most interested in the cross-sectional variation, we also obtain similar results in this column.

Table 3 goes around here

In columns 4 to 7 we investigate the relationships of relative immigrants shares and wage gaps with city price indices, computed following Moretti (2013). Columns 4 and 5 are akin to columns 1 and 2 but using city level price indices instead of city size. We obtain the same results. In the cross-section, immigrants concentrate in expensive cities where their wages relative to those of natives are lower. These relationships may be driven by endogenous factors. Perhaps, immigrants make cities larger and more expensive, and hence it is not that they prefer to live in expensive cities but rather they are the cause

[15] This is also the case when we include both city price and city size in a bivariate regression.

[16] Commuting zones are a partition of the US territory. Commuting zones can be divided between urban and rural commuting zones. Urban commuting zones are equivalent to MSAs, whereas rural commuting zones are not captured by MSA information.

of these high prices. While this is unlikely to be the case given the persistence in city sizes rankings (Duranton 2007) and the current levels of immigration, we use an IV strategy in column 6 .

It is well documented that part of the variation in house prices across cities is driven by geographic constraints, see for example Gyourko and Saiz (2006). Based on this idea, Saiz (2010) builds estimates of housing supply elasticities that are based on the share of developable land around each city center. This is a good predictor of high housing prices, which, in turn, is the most important aspect of local price indices. Hence, we use the housing supply elasticities to predict the local price indices in the first stage regression of our IV specification.

The second stage regression is shown in column 6. Again, it is clear from this column that immigrants choose to live in expensive cities, and that the gap of their wages with respect to those of natives is larger in these cities. While not the focus of the paper, in column 7, we shows that we also obtain a similar relationship when using only within city variation, although the magnitudes are smaller.

There are potentially different explanations for the results reported in Table 3. In particular, they could be driven by particular subsamples of immigrants. We explore this in Table 4, in which we report the regressions shown in columns 5 and 6 of Table 3 for various subsamples of immigrants.

Table 4 goes around here

Columns 1 and 2 of Table 4 show that when we restrict the sample of immigrants to those who are likely documented or likely undocumented, we obtain very similar results. If anything, the results are stronger for undocumented immigrants, maybe reflecting (as we argue in subsection 3.2.3) that undocumented immigrants are less attached to the host country. We code likely documented or likely undocumented immigrants following Borjas (Forthcoming), who uses, among others, variables indicating the participation in welfare programs that require being legally in the country to identify documented immigrants. In panel A and C we show the OLS results on relative immigrant shares and wage gaps, respectively, while in panels B and D we show the same regressions using the IV strategy based on Saiz (2010).

Columns 3 to 6, panels A to D, show the results restricting the sample of immigrants and natives to one of the four education groups. It is well documented that immigrants are concentrated in the bottom and the top of the education distribution (Borjas 2003; Ottaviano and Peri 2012). If for whatever reason very high- and very low-skilled workers had higher incentives to live in large cities (Eeckhout et al. 2014), then it could be that the results in Table 3 are driven by this. However, columns 3 to 6 show that there are higher concentrations of immigrants in expensive cities at each education level. We also obtain similar wage results across education groups.

In the last column of the table we show that these results are not driven by Latin American immigrants only. If we drop all immigrants from Latin American countries, we obtain results that are similar to our baseline specifications.

In this paper we argue that the patterns we uncover are driven by the comparative advantage that immigrants have in living in expensive cities, which originates from the fact that part of their consumption is not subject to local prices but rather prices in their countries of origin. In the following section 3.3 we

corroborate this reading of the evidence by exploring in detail the heterogeneity by country of origin's price levels and exchange rate fluctuations.

As we argue in more detail in Section 3.4, our findings are not driven by sorting of immigrants across US cities or imperfect substitution. All our regressions control for potential imperfect substitutability between immigrants and natives following Ottaviano and Peri (2012), and hold even when we restrict our regressions to particular education groups. Furthermore, we also investigate in Appendix A.2 whether these relationships hold when we control for immigrant networks.

3.2 Immigrant Heterogeneity

In this section, we show that the results documented so far are stronger for immigrants whose consumption share in the home country is likely to be higher, either because of lower prices in the home country or a lower attachment to the US.

3.2.1 Heterogeneity across and within origin countries

To the extent that there is some degree of substitution between consuming locally or consuming in the country of origin, the patterns documented so far should be stronger for immigrants coming from countries of origin with lower price levels relative to the United States or, in other words, lower real exchange rates with respect to the US. Moreover, it should also be the case that for each country of origin the incentives to concentrate in more expensive cities are larger when it is cheaper to consume in the home country.

To highlight that our results are not driven by particular countries of origin, we first show in a simple graph the elasticities of relative locations and wage gaps of immigrants with respect to city size and price levels from different countries of origin as a function of the real exchange rate using data from the year 2000. For this, we estimate equation (3.1) at the city-origin level (i.e. we replace Imm by the immigrant population from the respective origin, and we estimate origin-specific coefficients β_{Qo}, including origin and MSA fixed effects in the regression).

We then estimate equation (2.1) at the skill-city-origin-time level and replace the city-time with city-origin-time fixed effects.[17] In the second step, we estimate origin-specific elasticities by the following regression:

$$\hat{\phi}_{c,o,t} = \beta_o \ln P_c + \phi_t + \phi_c + \phi_o + \varepsilon_{c,o}. \tag{3.3}$$

One challenge of this exercise is that there are some countries of origin for which we observe immigrants only in a subset of the MSAs in our sample, and hence there are some zeros when computing relative immigrant shares at the MSA-origin level. Moreover, some skill-city-origin-time cells cannot be included due to zero immigrant observations. To address this problem, we concentrate on the top 100 MSAs by size and the top 89 sending countries, with which we can obtain non-missing wage gaps in around 60%

[17] We still aggregate immigrant labor supply at the skill-city-time level as in (2.1). Results are virtually unchanged, if we also disaggregate it at the origin level.

of all possible skill-city-origin-time combinations.[18] Furthermore, in Table 5 we take into account the zeros by using a Poisson pseudo maximum likelihood (PPML) estimator.

Figure 2 shows the plots of the city price elasticities and city size elasticities of the relative immigrant share against real exchange rates in panel A and the elasticities of the wage gap in panel B. All plots show statistically significant relationships that go in the expected direction. Panel A shows that the elasticity of the relative share of immigrants with respect to city size or city price from countries with *lower* real exchange rates is *higher*. This means that immigrants from cheaper countries concentrate more in larger and more expensive cities than immigrants from more expensive countries. The relationship of the elasticity of the wage gap with respect to city size or city price and real exchange rates is, again, the mirror image of the relative location choices.[19] As can be seen in panel B, the elasticity of the wage gap is higher for immigrants from more expensive countries, meaning that the difference in wages between natives and immigrants does not increase as much for them. Overall, these graphs show that there is substantial variation across countries of origin, which is well aligned with the role that differences in prices should play in shaping the importance of home country expenditures for immigrants from different countries of origin.[20]

Figure 2 goes around here

To document these relationships more systematically and to use arguably exogenous exchange rate variation within countries of origin, we expand equations (3.1) and (3.2) by interacting the city variable directly with the real exchange rate (RER) and pool the Census years 1990 and 2000 and the combined ACS 2009-2011 (real exchange rates are not available for 1980 in the World Bank data). In particular, we estimate regressions of the following type:

$$\ln\left(\frac{\text{Imm}_{c,o,t}}{\text{Imm}_{o,t}} / \frac{\text{Nat}_{c,t}}{\text{Nat}_t}\right) = \alpha_1 \ln P_{c,o,t} + \alpha_2 \ln RER_{o,t} + \alpha_3 \ln P_{c,t} * \ln RER_{o,t} + \delta_t + \delta_o + \delta_c + \varepsilon_{c,o,t} \quad (3.4)$$

$$\hat{\phi}_{c,o,t} = \beta_1 \ln P_{c,t} + \beta_2 \ln RER_{o,t} + \beta_3 \ln P_{c,t} * \ln RER_{o,t} + \delta_t + \delta_o + \delta_c + \varepsilon_{c,o,t}, \quad (3.5)$$

where as before $\ln P_{c,t}$ denotes the population or the price level of MSA c, and $RER_{o,t}$ is the real exchange rate of origin country o with respect to the United States at time t. We estimate the relative share equation using a PPML regression model in order to deal with the incidence of zeros (Santos Silva and Tenreyro 2006).

The estimates of interest are α_3 and β_3. A negative estimate of α_3 means that immigrants from cheaper countries tend to concentrate more in larger or more expensive cities. Similarly, a positive

[18] Different selections of MSAs lead to slightly different selections on the number of sending countries, which results in small changes in the estimates. Expanding the number of MSAs tends to introduce more measurement error, which attenuates the estimates of regressions with many fixed effects. Reducing the number of MSAs obviously reduces the number of observations, which has small consequences on the point estimates and confidence intervals.

[19] Recall that the wage gap is defined as immigrant wage minus native wage. Therefore, a negative elasticity indicates an increasing wage gap.

[20] An alternative to this exercise is to see if the interaction of the immigrant dummy and city size or city price of equation (3.2) is higher at lower quantiles of the wage distribution. We show that this is indeed the case in Figure D.1 of the appendix.

estimate of β_3 implies that the wage gap of immigrants from these countries of origin is larger in these cities. When including origin and location fixed effects (δ_o and δ_c), the identifying variation only comes from RER fluctuations across decades for each country of origin.

Table 5 goes around here

We present the results in Table 5. Panel A, reports the results on the relative immigrant share. In the first column, we only include the real exchange rate. A positive estimate means that the distribution of immigrants from countries of origin with higher exchange rates tends to be more similar to the distribution of natives. The relationship is not very strong, however. In the second column, we include population, which replicates the result we have shown before: The relative share of immigrants is increasing in city size and city price. In column 3, we introduce the interaction between real exchange rates and city sizes. A negative estimate suggests that the relative concentration of immigrants from high exchange rate origins (e.g., Japan, Germany, or the United Kingdom) in larger cities is less strong than for immigrants from low exchange rate origins (e.g. India or China). Including MSA fixed effects in column 4 leaves the coefficient of the interaction term virtually unchanged. Columns 6 and 7 repeat the specification of columns 3 and 4 but using city prices instead of city sizes. The estimate is, again, negative, suggesting that immigrants from cheaper countries disproportionately locate in expensive cities.

In panel B of Table 5, we repeat the exercise of panel A using the wage gap as dependent variable. In column 1, we include the real exchange rate, which shows that immigrants from expensive countries tend to have higher relative wages than those from cheaper countries. This likely reflects that the possibility of consumption at lower prices decreases the reservation wage of immigrants. Column 2 confirms the previous result that the gap in immigrant's earnings increases in city size. In column 3, we include the interaction between city size and the real exchange rate. The positive coefficient indicates that the effect of city size on the wage gap is attenuated for origin countries with higher prices levels relative to the US. The coefficient remains similar, when we include MSA fixed effects in column 4. In columns 5 to 7, we replace city size with price level and find again significant effects with the expected signs. The city price elasticity of the wage gap is stronger for immigrants from origins with lower real exchange rates.

3.2.2 Heterogeneity across Mexican immigrants

The country that sends the most migrants to the US is Mexico. Given the number of Mexicans in the US, we can explore in more detail the heterogeneity among Mexican immigrants to see if we obtain results consistent with the heterogeneity documented pooling all countries of origin.

One caveat of the results shown in Table 5 is that we can only use exchange rate variation over 10-year gaps, when Census data is available. To complement this evidence, we also exploit fluctuations in real exchange rates between the United States and Mexico at a higher, yearly frequency. Exchange rate fluctuations are common and difficult to anticipate over short time horizons, offering arguably exogenous variation.[21] More concretely, we focus our analysis on Mexican immigrants who move to the United

[21] In this paper, we complement the evidence shown in Nekoei (2013). Exchange rate fluctuations affect not only the intensive margin of immigrant labor supply decisions (i.e. hours worked) but also, and very importantly, the extensive margin (i.e. location choices).

States from abroad or who move within the United States across states in a given year to see where they locate and the wages that they receive relative to natives as a function of the real exchange rate. For this exercise, we can only compute city size elasticities and not city-price elasticities because CPS data does not include the necessary information to compute city price levels as in Moretti (2013).

To obtain yearly elasticities of the relative immigrant shares with respect to city size we estimate again (3.1) separately for each year.[22] As the CPS contains a much lower number of observations than the Census and the immigrant sample is additionally reduced by only considering Mexican movers, we cannot calculate wages of immigrants at the skill-MSA-time level to estimate (2.1), i.e. we cannot adjust for potential imperfect substitutability between natives and immigrants. Instead, we account for the potential underlying individual level heterogeneity by estimating for each year standard Mincerian wage regressions at the individual level (pooling natives and Mexican movers), including an immigrant indicator, a dummy variable for each skill cell (again defined by experience and education groups) and additional controls for race, marital status and 82 occupation categories for this exercise. The dependent variable is the weekly wage and the city size elasticity of the wage gap is identified by an interaction between the immigrant dummy and MSA population.

Figure 3 goes around here

Figure 3 plots the estimated elasticities against the yearly average real exchange rate between the Mexico and the US. The two plots show a linear fit that goes in the expected direction. The lower are the prices in Mexico relative to US prices, the more positive is the elasticity of the relative share of Mexican immigrants and the more negative is the elasticity of the wage gap with respect to city size. In other words, Mexicans concentrate more in large cities and are paid lower wages in them relative to natives when the Mexican Peso is relatively cheap.

To explore immigrant heterogeneity even further, we turn next, to analyze data on Mexican flows from particular states of origin in Mexico to particular states of destination in the United States.[23] As before, if there is some degree of substitution between consuming in Mexico and in the US, then immigrants from cheaper origins in Mexico should disproportionately move towards expensive destinations in the United States. Unfortunately, we do not have local price index data for Mexican locations. Instead we use GDP per capita at the state level to proxy for local price indices. There is a strong correlation between price levels, wages levels, and GDP per capita, which suggests that using GDP per capita is a good proxy.

More specifically, to investigate the heterogeneity in migration flows by Mexican state of origin we use the following estimation equation:

$$F_{ij} = \beta_1 \ln P_i + \beta_2 \ln P_j + \beta_3 \ln P_i * \ln P_j + (\delta_i + \delta_j) + \varepsilon_{ij}, \tag{3.6}$$

where F_{ij} is either the fraction of all immigrants from Mexican state of origin i that move to US state of destination j or the log of this fraction, $\ln P_i$ is the GDP per capita in i, and $\ln P_j$ is the GDP per

[22] We do not take the log of the left-hand side of equation (3.1) to avoid losing MSAs without Mexican immigrant movers.
[23] The publicly available Matricula Consular data is only available at the state level.

capita in j. In some specifications we also control for the level of population at origin and destination, or include origin and destination fixed effects. Our main hypothesis is that β_3 is negative. If $\beta_3 < 0$, there are relatively less flows to high GDP pc destinations from high GDP pc origin states.

Table 6 goes around here

Table 6 presents the results. In the first two columns we simply explain the flows of Mexican immigrants from origin i to destination j by the GDP per capita at origin and at destination. Mexicans of all origins tend to disproportionately move to high GDP per capita states in the United States. This can be read as further corroborating that immigrants prefer to move to high nominal income locations. The positive coefficient GDP per capita in the origin shows that there are more migrants from high GDP per capita origin states. Selection or credit constraints when migrating can explain this result (Angelucci 2015). The next two columns control for the size of the origin and destination states. This is an important control since larger origin states and larger destination states likely send and receive more migrants, respectively. In the next two columns, we include state of origin and state of destination fixed effects. These should control for unobservable characteristics of the states that go beyond size and GDP per capita. The last two columns exclude California as a destination state. All the specifications show the same result. There is a disproportionate flow of immigrants from low GDP per capita origin states towards high GDP per capita destinations.

3.2.3 Heterogeneity by attachment to the United States

On top of the price differences or fluctuations, there are other reasons that may generate heterogeneity in the importance of the host country for an immigrant. We explore in this section two such reasons. First, we document that our results weaken for immigrants who have spent a long time in the US. Second, we use variation due to the legalization of immigrants in the Immigration Reform and Control Act (IRCA) of 1986 that gave legal status to immigrants who arrived to the US prior to 1982. We exploit the idea that when gaining legal status immigrants may become more attached to the host economy and, hence, reduce the importance that they give to consuming in the home country.

According to Dustmann and Mestres (2010), immigrants who do not intend to return to their countries of origin remit a smaller share of their income. They are also less likely to spend time back home and thus are, in some way, more similar to natives. There is also a large body of literature starting with Chiswick (1978) that estimates the speed of assimilation into the receiving country. This literature has documented an early gap in wages between natives and immigrants that tends to disappear or attenuate over time. This literature has interpreted this early gap as reflecting the lack of certain skills specific to the receiving country that immigrants may not have upon arrival.

The literature on immigrant assimilation has not explored, however, how immigrant native wage gaps and their relationship with either city size or city price levels, evolves with the length of immigrant stays. If immigrants who have been longer in the US care less about consuming in the home country than immigrants who have just arrived, then we should see that the gap in wages between immigrants and natives in large relative to small cities is larger for the late arrivals than the early ones.

Figure 4 goes around here

To investigate this idea, we use the year of immigration available in the Census data and divide immigrants into groups of 5-year intervals depending on their time spent in the United States. We then estimate equation (3.3) but instead of the origin o, we disaggregate the wage gaps by the groups defined by time in the US and estimate β for each of these groups. We plot the different city size-wage gap elasticities and city price-wage gap elasticities in Figure 4. The positive and strongly linear fits in both plots indicate that the relationships between wage gaps and both city size and prices diminish with the length of immigrants' stay in the United States.

In the second exercise of this section, we exploit a sudden policy change that the Reagan Administration introduced in 1986. Among other things, the Immigration Reform and Control Act (IRCA) legalized the working status of immigrants in the US that had arrived to the country before January 1st 1982. Hence, immigrants who arrived in the US prior to this date are much more likely to be documented than those who arrived just after.

Hence, if gaining work permits makes immigrants have greater chances of staying in the US and hence, makes them care less about their countries of origin, we should see that the gap in wages between natives and immigrants in large and expensive relative to smaller and cheaper cities is larger for immigrants who arrived just after 1982, relative to those who arrived just before 1982. In other words, the year 1982 should generate a discontinuity in the relationship between the wages of immigrants and city size and city price levels. We explore this idea with the following regressions.

First, we compute whether the gap in wages of different groups (labeled by G in the equation) of immigrants with respect to natives increases more with city size and city price levels than for other groups of immigrants.

$$\ln w_{i,c,t} = \alpha_{1t} + \alpha_2 Imm^G_{i,c,t} + \beta^G Imm^G_{i,c,t} * \ln P_{c,t} + \gamma \ln P_{c,t} + \phi X_{i,c,t} + \varepsilon_{i,c,t}, \tag{3.7}$$

where $\ln w_{i,c,t}$ is the weekly wage in location c at time t of individual i, $Imm^G_{i,c,t}$ is a dummy variable indicating that individual i is an immigrant of group G, and where $\ln P_{c,t}$ is either the size or price index of location c. The baseline regression is ran using low-skilled workers only, including immigrants of group G and natives. We concentrate on low-skilled workers because we use the procedure suggested by Borjas (Forthcoming) to identify undocumented immigrants which Albert (2017) shows does a particularly good job for low-skilled immigrants.

In particular, we separately estimate β^G for the immigrant group that arrived before 1982 and for the group that arrived after 1982. For this exercise, we concentrate on immigrants who moved to the US between 1976 and 1987. Immigrants who arrived before 1982 are (discontinuously) more likely to have gained legal status, hence we expect $|\beta^{\text{Before 82}}| < |\beta^{\text{After 82}}|$, and both $\beta^{\text{Before 82}}$ and $\beta^{\text{After 82}}$ to be negative since we expect that gap in wages between natives and immigrants to be larger in large and more expensive cities for both groups of immigrants. In this regression, we control for the convergence in wages between natives and immigrants using a linear convergence rate following the assimilation rate. We code the convergence rate variable as 35 minus the number of years that the immigrant has been in

the US. This assumes that there is no gap in wages between immigrants who have been in the US for 35 years, and that the gap is larger for immigrants who arrived more recently.

We report the results in Table 7. The first column estimates $|\beta^{\text{Before 82}}|$ and the second column estimates $|\beta^{\text{After 82}}|$ with respect to population levels, and columns 4 and 5 with respect to city prices. It is clear from the table that in both cases $|\beta^{\text{Before 82}}| < |\beta^{\text{After 82}}|$. In Figure D.6 we show that the fact that $|\beta^{\text{Before 82}}| < |\beta^{\text{After 82}}|$ comes from a discontinuity in 1982. In particular we plot the immigrant - native wage gap elasticity with city prices for immigrants who arrived in each year between 1976 and 1987 relative to the immigrant - native wage gap of the immigrants arriving to the US in 1981. The graph shows that the gap in wages between natives an immigrants is larger (i.e. β^G above more negative) for immigrants arriving after 1982 which are likely to be more attached to their country of origin because they are less likely to be legally residing in the US.

An alternative way to explore whether immigrants who are exogenously granted legal status seem to be more attached to the host country is to directly compare the wages of immigrants who arrived before 1982 and those who arrived after 1982 and how they relate to city size and price levels. For this, we use the following regression estimated using only data on immigrants who arrived between 1976 and 1987, and where Before $82_{i,c,t}$ is a dummy variable indicating whether immigrant i arrived to the US before 1982. An estimate of $\beta > 0$ means that wages of immigrants who arrived before 1982 increase more with city size and city price levels than immigrants who arrived after 1982.

$$\ln w_{i,c,t} = \delta_{1t} + \delta_2 \text{Before } 82_{i,c,t} + \beta \text{Before } 82_{i,c,t} * \ln P_{c,t} + \gamma \ln P_{c,t} + \phi X_{i,c,t} + \varepsilon_{i,c,t} \tag{3.8}$$

Columns 3 and 6 in Table 7 show that $\beta > 0$. This is in line with columns 1, 2, and 4, 5, and with the idea that immigrants who are less likely to have obtained legal status are less attached to the US and thus their wage elasticities with respect to city population or prices are larger.

3.3 Immigrant consumption patterns

We have suggested that the previous results on relative wages and location of immigrants can be explained by the fact that immigrants spend part of their income in their countries of origin. To the best of our knowledge a data set that contains information on wages in the host economy and consumption in the origin country does not exist. Instead, we rely on data on remittances and, especially, local consumption to investigate the differential consumption patterns of immigrants relative to natives.

Dustmann and Mestres (2010) report that immigrants in Germany remit around 10% of their income. While data of similar quality as in their study do not exist for the US, we can use the New Immigrant Survey to get some notion of the remittance behavior of newly admitted immigrants in the US. For instance, in Table F.3 of the Appendix, we report the likelihood, the average share of income sent as remittances, and the average share of income for those immigrants who remit, for a number of different broad origins. There is quite some variation in the likelihood of remitting across origins. For example, 20% of immigrants from Mexico and as much as 32% of immigrants from other Latin American countries seem to remit part of their income to their home countries. This number is significantly lower for immigrants from European countries. For the entire population of immigrants, immigrant remittances

represent approximately between 2% and 3% of income. For those who remit, this number logically increases to between 10% and 15%, which is closer to the estimate provided in Dustmann and Mestres (2010). All in all, the numbers for the US seem broadly consistent with this prior literature. The main drawback of New Immigrant Survey data is that it does not include undocumented immigrants. Including them would likely change the numbers significantly.

An alternative strategy is to look at data on local consumption of immigrants in the host economy (and compare it to natives), instead of trying to measure consumption in the country of origin. Measuring consumption is not an easy task as described in Attanasio and Pistaferri (2016), with difficulties arising from measurement issues and from the treatment of durable goods. Our assumption is that total consumption can be decomposed between local consumption (part of which can be measured), savings, and remittances (or income spent in another country), and that the true overall consumption behaves like the observable component. Hence, if we observe that immigrants spend less than natives locally it must mean that they either save more (maybe thinking about a possible return to their country of origin), or spend a significant fraction of their income on remittances. In any case, however, only a small fraction of income is devoted to savings for the vast majority of households.[24] Hence, by looking at local consumption we can infer something about whether immigrants are likely to spend an important share of their income in their countries of origin, as hypothesized.

More concretely, we investigate whether immigrants consume less locally than natives using two alternative data sets: the Consumption Expenditure Survey data and Census data. The former allows us to investigate overall consumption but only identifies Mexican immigrants, as explained in more detail in Section 2. The latter allows us to identify immigrants from multiple countries of origin but contains only expenditures on housing, which represent around 25% of total expenditures (Davis and Ortalo-Magne 2011).

We start by investigating local consumption with Consumer Expenditure Survey data using the following regression:

$$\ln \text{Total Expenditure}_i = \alpha + \beta \text{Mexican}_i + \sum_j \gamma_j \text{HH Income category } j_i + \eta X_i + \delta_s + \delta_t + \varepsilon_i \tag{3.9}$$

where "Total Expenditure" is the quarterly total expenditure at the household level.[25] Consumer Survey data identifies income only by category, hence we use income bracket dummies indexed by j. "Mexican" identifies households of Mexican origin and δ_s and δ_t are state and time dummies, respectively. The coefficient of interest (β) measures the difference in total expenditures between Mexicans and non-Mexicans conditional on observable characteristics, most importantly income categories. The location fixed effects (δ_s) ensure that the identification of β comes from within location comparisons. In Consumption Expenditure Survey data the finest level of geographic disaggregation is state of residence.

[24] As can be see in data from the St Louis Fed (`https://fred.stlouisfed.org/series/PSAVERT`), the aggregate personal savings rate has fluctuated between 2 and 12% since 1980. See also Dynan et al. (2004) for a discussion on how savings vary with income.

[25] More specifically, we use the variable "totexpcq" from the Consumer Expenditure Survey. This variable combines expenditures on all items.

The results are reported in panel A of Table 8, which suggests that, unconditionally, Mexicans consume on average 33% less than non-Mexican households, and as much as 38% when we force within state comparisons (column 2). In column 3 we include income controls, which reduce the estimate to around 15%. When we include all the controls in column 4, which include family size, race, and marital status, our preferred estimate suggests that Mexican households consume around 22% less locally than non-Mexicans. With close to zero savings rates (in the early 2000s the saving rate was around 2%), this number also represents the share of income that is potentially devoted to consuming in the home country.

Table 8 goes around here

An important part of local expenditures is housing – something that we can measure both with the Consumption Expenditure Survey and with Census data. In Panel B of Table 8 we repeat the regressions of Panel A but using the rents paid as dependent variable. The patterns are similar than what we observed in the Panel A, showing that an important part of the difference between how immigrants and natives consume is likely related to the housing market. In particular, columns 3 and 4 suggest that Mexicans consume around 10 to 18 percent less than similar looking non-Mexicans.

To explore in more detail how immigrants and natives consume housing we turn in Panel C to Census data. In Census data we know both ownership status and the rents that renters pay. In Table F.4 in the Appendix we show that immigrants are less likely to own the place where they live. Here we concentrate on renters. With Census data we can run the following type of regressions:

$$\ln \text{Housing Rents}_i = \alpha + \beta \text{Immigrant}_i + \gamma \ln \text{HH Income}_i + \eta X_i + \delta_c + \delta_t + \varepsilon_i, \tag{3.10}$$

where δ_c are metropolitan area fixed effects, δ_t indicate year fixed effects, and X_i is a vector of individual characteristics including dummies for the number of persons present in the household, sex, marital status, and age. Income is, in this case, a continuous variable. An alternative regression that yields the same results is to use the share of income devoted to paying housing rents as dependent variable (either ins logs or levels), which we show in Table F.5 in the Appendix.

Like in Panel B of Table 8, we see in the first two columns of Panel C that immigrant households spend around 7.5 to 15% less on rents than observationally similar natives within metropolitan areas, in line with the results reported in Panel B. In column 3 we investigate whether immigrants pay relatively higher rents in more expensive cities than in cheaper ones. While positive, the coefficient on the interaction between the immigrant household dummy and (the log of) the city price level is not different than zero, suggesting little heterogeneity along this dimension. In column 4, we investigate instead, restricting the sample to immigrant households, whether immigrants from more expensive countries of origin spend more on housing than immigrants from cheaper origins, conditional on income, household characteristics, and metropolitan area fixed effects. Consistent with the model that we later present, immigrants from more expensive origins spend relatively more on housing in the host economy. One way to think about the magnitude of the estimates is to realize that if immigrants spend between 15 to 22% less on housing rents (as estimated in Panel A), and housing rents represent around 25% of income, then the share of

income devoted to housing should be around 3 to 5 percent lower for immigrant households (.15 x .25), broadly consistent with the direct estimates of this number provided in Panel B of Table F.5 in the Appendix.[26]

Overall, these results suggest that immigrants spend less than natives on local goods, with only small differences across metropolitan areas, and that immigrants that come from more expensive locations are likely to consume less in their countries of origin and more in the host country. We return to this in Section 5.2 when we compare the moments on consumption predicted by the model, which we estimate solely on labor market data.

3.4 Discussion of additional mechanisms

For some of the evidence presented so far, one could think of alternative mechanisms as explanations. In this section, we discuss several such alternative mechanisms that we have not discussed so far and check the robustness of the patterns we have uncovered by presenting additional empirical evidence which we present more formally in Appendix A.2. As a remainder, in the main regressions we showed that our results are not driven by imperfect substitutability between natives and immigrants, by differential levels of human capital between natives and immigrants, nor by the fact that some immigrants are undocumented, see Table 4.

One unaddressed potential concern is that there is a large literature documenting the role of immigrant networks in shaping immigrant location choices (Altonji and Card 1991; Munshi 2003). Immigrant networks might be a potential explanation for some of the empirical patterns we described in previous sections, if immigrants initially settled in random locations and then these locations grew due to subsequent immigration inflows as predicted by immigrant networks. This could have generated bigger gaps in wages between natives and immigrants in these cities because newer immigrant inflows put disproportionate pressure on wages of immigrants.

To address this concern, we extend our wage gap regressions with a control for the relative size of the immigrant community within the MSA for each of our countries of origin. As shown in more detail in Appendix A.2 and Table F.2, including immigrant networks as a control does not change our main results. Furthermore, it is difficult to explain the country of origin immigrant heterogeneity. It is unclear why immigrants from low-income countries would concentrate in large and expensive cities in the earlier periods, or why cities in which immigrants from low-income countries concentrate grow disproportionately more than cities with more immigrants from high-income countries. In general, the evolution of city sizes is slow and the level of immigration in the United States not sufficiently large to dramatically change city size rankings (Duranton 2007). In Appendix A.2, see Table F.1, we also show that our results do not change if we measure city size using only native population or lagged city size. Taken altogether, we believe that this additional evidence suggests that immigrants keep going to the same large and expensive cities not just because former immigrants moved into them but also because the same incentives that drove the earlier immigrants also shape location choices of more recent ones.

[26] A direct comparison is not possible given that Consumer Survey data identifies Mexicans, while US Census data identifies all immigrants.

A second concern is that immigrants might settle in larger cities because it is easier to find a job there. However, this does not provide an explanation for why immigrants earn less relative to natives in these cities. To further discard this explanation, we show in the Appendix A.2, Figure D.3, that there is no systematic relationship between city size and job finding rates or unemployment rates of immigrants. Thus, labor market opportunities of immigrants in large cities do not seem to be systematically better than in smaller ones.

A third unaddressed concern is that there might be differences in the distribution of jobs available in large cities. For instance, there could be more jobs in the lower part of the wage distribution, which may be disproportionately held by immigrants. This would be in line with the extreme skill complementarity hypothesis discussed in Eeckhout et al. (2014) and could generate a gap in wages between natives and immigrants, especially in large cities. To address this concern, we show in Appendix A.2.4 that skewness and kurtosis of the *native* wage distribution do not seem to be systematically related to city size or city price levels.[27] Also, we show in Table 4 that all our results hold within education groups. Finally, it is not clear how differences in the distribution of wages in large and small locations would explain the observed heterogeneity by country of origin.

A final concern is that the patterns might reflect that in larger cities there are more products that immigrants value (Handbury 2011; Handbury and Weinstein 2015). For instance, tradable goods from origin countries may only make it to the largest locations in the United States if there is a fixed cost of entering local product markets. It is difficult, however, to explain the observed immigrant heterogeneity with tradable goods. For instance, it is unclear why there should be more products from the poorest Mexican states of origin in the most expensive US states of destination, making these states disproportionately attractive to Mexicans from low-income countries of origin. Similarly, it is unclear why there should be relatively more Mexican products in places like New York City, than, for example, German or Canadian products, being that New York City is a relatively high-income area and Germany and Canada are countries specializing in relatively higher quality products.

4 A spatial equilibrium model with immigration

In this section, we introduce a quantitative spatial equilibrium model with immigrants that consume part of their income in their countries of origin. The model rationalizes the facts described so far. In Appendix B, we present a more general version of this model with minimal assumptions that delivers the same qualitative results than this quantitative model. We estimate the model and use it for counterfactual analysis in Section 5.

4.1 Definition of immigration

Perhaps the first challenge in any model of the labor market with immigration is to precisely define in what ways an immigrant is different than a native. Prior work has emphasized several aspects and in

[27] In fact, part of the wages observed and documented in prior literature in the tails of the overall wage distribution, particularly in the lower tail, within cities is driven by immigrants.

fact one can argue that the way in which different researchers have thought about the distinctive features of immigrants relative to natives has shaped the type of questions that different strands of the literature investigating the effects of immigration on labor markets have taken.[28]

A first way to think about immigration is to recognize that immigrants often arrive with an imperfect knowledge of country-specific skills; this deficit impedes workers' ability to thrive in particular labor markets (Chiswick 1978). Many authors have measured substantial gaps in wages between immigrants and natives that tend to disappear over time.[29] In this view, immigrants and natives are essentially the same, except that it takes some time for immigrants to fully adapt to the host country. Papers in this strand of the literature include Borjas (2015, 1987); Hanson and Chiquiar (2005); Fernandez-Huertas (2012); Lessem and Sanders (2018); Abramitzky et al. (Forthcoming, 2014).

A second part of the literature – perhaps the largest in number of publications – views immigrants simply as workers, and studies how immigrants affect natives or how immigrants themselves are influenced by the migration experience. In the literature that studies the effect of immigration on native outcomes, there is nothing particular from being an immigrant, but rather the distribution of immigrants over a certain characteristic defining a labor market, like education or location, is different than the distribution of natives. In this sense, immigration is a negative shock to the workers who share characteristics with immigrants and a positive shock to all other factors of production. Hence, from this view, immigration has mainly re-distributive consequences, which some papers estimate to be large and others to be small. Papers that view immigrants as workers and hence can be included in this strand of the literature include Borjas (2003); Llull (2018b); Dustmann et al. (2013, 2017, 2016); Card (1990, 2001, 2005); Borjas (Forthcoming); Monras (Forthcoming); Cadena and Kovak (2016); Caliendo et al. (2018); Cortes (2008); Davis and Weinstein (2002); Glitz (2012); Friedberg (2001); Lach (2007); Lewis (2012); Burchardi et al. (2019b); Allen et al. (2019); Morten and Bryan (Forthcoming); Bryan et al. (2014).

Finally, a third strand in the literature emphasizes that immigrants and natives are essentially different factors of production (Ottaviano and Peri 2012). This means that natives and immigrants are imperfect substitutes even conditional on observable skills. Papers that estimate or rely on imperfect substitutability between natives and immigrants include Peri and Sparber (2009); Borjas et al. (2012); Manacorda et al. (2012); Burstein et al. (2018); Card (2009); Piyapromdee (2017).[30] According to this view, the most important aspect is usually to understand how the arrival of immigrants re-shapes the patterns of specialization of native workers across tasks, occupations, or sectors.

In this paper we take the view that immigrants and natives are identical except for the fact that immigrants have an extra good in their utility function, which can only be consumed in their country of origin. This extra good may represent the consumption by family members, thanks to the remittances; it may also represent future consumption in the country of origin; or it may reflect that immigrants spend a part of their time in their home country. Only a relatively small number of papers have effectively seen

[28] We are omitting here work that has emphasized that immigrants bring a link to the home economy that may benefit the host economy. A recent example of this type of research is Burchardi et al. (2019a).

[29] There is some debate in this literature on the speed of convergence given the changing "quality" of cohort arrivals. See Borjas (1985).

[30] In this literature, Borjas et al. (2012) argue that the evidence in favor of imperfect native - immigrant substitutability is at most weak.

immigration in this way, usually concentrating on studies of temporary and return migration, see a review of the literature in Dustmann and Gorlach (2016) and the recent paper Gorlach (2019). This previous literature has not investigated, however, how temporary migration might affect the spatial equilibrium in host economies.

In the model, we abstract from various aspects that previous work has emphasized, for instance the fact that natives and immigrants may be imperfect substitutes or may be distributed differently over certain important characteristics for the labor market. We do so because our aim is to show how our new mechanism affects host economies.

4.2 Location choices

The utility function in location c for an individual i from country of origin j is given by:

$$\ln U_{ijc} = \rho + \ln A_c + \alpha_t \ln C^T_{jc} + (1-\alpha_t)\frac{\sigma}{\sigma-1}\ln\left(\frac{\alpha_l}{\alpha_l+\alpha_f}(C^{NT}_{jc})^{\frac{\sigma-1}{\sigma}} + \frac{\alpha_f}{\alpha_l+\alpha_f}(C^{NT}_{j})^{\frac{\sigma-1}{\sigma}}\right) + \varepsilon_{ijc}$$

where α_t denotes the share of consumption devoted to tradable goods, and where α_l and α_f denote the weight of consumption in local non-tradable and foreign non-tradable goods, respectively. Tradable goods are denoted by C^T and the basket of non-tradable goods is denoted by C^{NT}. Within non-tradable goods, σ is the elasticity of substitution between local and foreign non-tradables. Note that there are alternative interpretations for what C^{NT}_j represents. It could include consumption in non-tradables in the home country, remittances sent to relatives, or future consumption in the home country. We do not explicitly model these different potential channels. We prefer to use a simpler formulation that encapsulates all of them, rather than attempting to model the specificities that each of these channels may exhibit.[31] C^{NT}_{jc} should be thought, in the context of the model, as consumption of housing and other non-tradable goods available in location c. For simplicity, we will henceforth use the term "housing" interchangeably with the term "non-tradable goods".

Importantly, the α's govern the shares of expenditure on the various types of goods. The difference between natives and immigrants is that for natives α_f is assumed to be zero, as stated more formally below. Besides this, ρ is a constant that ensures that there is no constant in the indirect utility function to be derived in what follows, ε is an extreme-value distributed idiosyncratic taste parameter for living in location c, and A_c denotes local amenities.

Individuals maximize their utility subject to a standard budget constraint given by:

$$p^T C^T_{jc} + p_c C^{NT}_{jc} + p_j C^{NT}_j \leq w_{jc}$$

We assume $\alpha_t + \alpha_l + \alpha_f = 1$ and define the auxiliary parameters $\bar{\alpha}_l = \frac{\alpha_l}{\alpha_l+\alpha_f}$ and $\bar{\alpha}_f = \frac{\alpha_f}{\alpha_l+\alpha_f}$. We assume that tradable goods are the numeraire, hence $p^T \equiv 1$. By utility maximization, we then obtain the following indirect utility of living in each location (derivation in Appendix C.1):

[31] Moreover, it is very plausible that the importance of each of these channels differs from one type of immigrant to another. For instance, remittances may be more relevant for low-skilled immigrants, while future consumption may be more relevant for high-skilled immigrants. We do not attempt to address this heterogeneity in this paper.

$$\ln V_{ijc} = \ln V_{jc} + \varepsilon_{ijc} = \ln A_c + \ln(w_{jc}) - (1-\alpha_t)\ln \bar{p}_{jc}(\bar{\alpha}_l, \bar{\alpha}_f) + \varepsilon_{ijc}, \tag{4.1}$$

where

$$\bar{p}_{jc}(\bar{\alpha}_l, \bar{\alpha}_f) = (\bar{\alpha}_l^{\sigma} p_c^{1-\sigma} + \bar{\alpha}_f^{\sigma} p_j^{1-\sigma})^{\frac{1}{1-\sigma}}.$$

Given this indirect utility, workers decide where to live by selecting the location that delivers the highest level of indirect utility given the realization of the taste parameter. Given the distribution of ε, the outcome of this maximization yields:

$$\pi_{jc} = \frac{V_{jc}^{1/\lambda}}{\sum_k V_{jk}^{1/\lambda}} = \left(\frac{V_{jc}}{V_j}\right)^{1/\lambda}, \tag{4.2}$$

where λ is the parameter governing the variance of ε_{ijc}, $V_j = (\sum_k V_{jk}^{1/\lambda})^{\lambda}$ is the value of the economy to workers from country of origin j, and π_{jc} is the share of workers from j that decide to live in city c as a function of indirect utilities. Note that indirect utility increases in wages and local amenities and decreases in local prices. Thus, locations with higher wages, higher amenity levels, and lower price indices will attract more people.

4.3 Production of tradable goods

Tradable goods are produced by one-worker firms using one unit of labor as the only input. Thus, the output value of tradables in city c is:

$$Q_c^T = B_c L_c \tag{4.3}$$

where $L_c = \sum_j L_{jc}$ is the sum of workers from all origins who live in c. B_c is the technological level of city c for the production of tradables. If it depends on L_c, we have agglomeration externalities. In particular, we can assume that $B_c(L_c) = B_c L_c^a$ with $a \geq 0$.[32] We will come back to this point in Section 5, but we ignore it in the presentation of the model to keep it simple. Note also that we are assuming that natives and immigrants are perfect substitutes.[33]

The marginal revenue of hiring an extra worker is given by B_c. The cost of hiring an additional worker, possibly from origin j, is the wage that the worker receives, which we denote by w_{jc}. Thus, the extra profit generated by hiring an additional worker is given by $B_c - w_{jc}$. The average cost of hiring workers across all the cities is given by $\bar{w}$. Note that we can choose to re-express the average amenity level in the economy so that this average is relatively close to 1. Thus, using a Taylor expansion and taking logs, we have that $(B_c - w_{jc}) \approx B_c - 1 - \ln w_{jc} = \ln \tilde{B}_c - \ln w_{jc} = S_{jc}^F$. This expression is the value of a new hire.

[32] Note that agglomeration forces cannot be too strong to guarantee the existence of equilibrium.

[33] It is not complicated to introduce imperfect substitutability between natives and immigrants by assuming that $L_c = ((\sum_{j \neq N} L_{jc})^{\rho_I} + L_{Nc}^{\rho_I})^{1/\rho_I}$, where L_{Nc} indicates natives in location c.

4.4 Labor market

We assume that labor markets are not competitive. Most of the literature on immigration has assumed that labor markets are perfectly competitive. However, there is ample evidence that a number of phenomena are better understood with non-competitive labor markets. This includes, for example, the long-lasting consequences of job loss or year of entry into the labor market (Davis and von Wachter 2011; Oreopoulos et al. 2012; Jarosch 2016), the literature on discrimination in the labor market (Becker 1957; Black 1995), and most of the literature investigating unemployment. In this paper, we argue that the facts shown in our empirical section are explained quite naturally by assuming non-competitive labor markets, although this assumption is not key for our results. What is crucial for our argument is that wages reflect, at least in part, the value of living in a location for each worker.

Firms and workers meet, negotiate over the wage, and split the total surplus of the match. A worker's surplus in matching with a firm is given by:

$$S_{jc}^{W} = \ln V_{jc}$$

Hence, we make the simplifying assumption that once located in a city, the worker's surplus no longer depends on the initial taste shock drawn (which we assume is unobservable to the firm) and that his outside option to working is receiving an indirect utility of zero.[34] That is, a worker who chooses city c benefits from the local indirect utility derived in that city.

The outcome of the negotiation between workers and firms is determined by Nash bargaining. Workers' weight in the negotiation is given by β. Thus, a share β of the total surplus generated by a match accrues to workers. Using this assumption, we can determine the wage levels of a worker from country of origin j living in location c:

$$\ln w_{jc} = -(1-\beta)\ln A_c + \beta \ln \tilde{B}_c + (1-\beta)(1-\alpha_t)\ln \bar{p}_{jc} \tag{4.4}$$

This equation shows standard results from the spatial economics literature. Higher wages in a city reflect lower amenity levels, higher local productivity, or higher local price indices.

The firm profits are given by $\sum_c \tilde{B}_c L_c - \sum_c \sum_j w_{jc} L_{cj}$ and are positive as long as B_c are sufficiently large because of the non-competitive nature of the labor markets. We assume that they are distributed to absentee firm owners, who only consume tradable goods (see other papers in the literature that make similar assumptions, like Eeckhout et al. (2014)).[35]

4.5 Housing market

For the sake of simplicity, we assume that housing is supplied by absentee landlords and that supply is increasing in the local price of housing.[36] A special case of this assumption is that there is a fixed supply

[34] The basic results of this paper are not sensitive to the exact specification of the worker surplus as long as it depends positively on local wages and amenities and negatively on local price levels.

[35] Alternatively, we could assume that firm profits are distributed to workers who each hold a representative portfolio of the firms in the economy. While this would have implications for welfare, it would not affect the main predictions of the model in terms of location choices, wages, and local prices.

[36] A number of papers in this literature assume absentee landlords. See, as an example, Eeckhout et al. (2014).

of housing in each location.

Demand for housing is, in this model, the demand for the non-tradable local goods introduced before. The demand for housing is different between natives and immigrants because wages are different and because the weight of housing in total expenditures is also different.

More explicitly, we assume the supply of housing is given by $H_c(p_c)$, an increasing function in housing prices p_c that reflects that at higher prices builders want to build more housing units. Local housing prices are then defined by market clearing in each city:

$$H_c(p_c) = \sum_j C_{jc}^{NT} = (1-\alpha_t)(\sum_{j\neq N}((\frac{\bar{\alpha}_l}{p_c})^\sigma \bar{p}_{jc}^{\sigma-1} L_{jc} w_{jc}) + \frac{1}{p_c} L_{Nc} w_{Nc}), \tag{4.5}$$

which can be transformed into

$$p_c = \frac{(1-\alpha_t)}{H_c(p_c)}[\bar{\alpha}_l^\sigma \sum_{j\neq N}(\frac{\bar{p}_{jc}}{p_c})^{\sigma-1} L_{jc} w_{jc} + L_{Nc} w_{Nc}]. \tag{4.6}$$

This expression defines housing prices as a weighted average of the demand for housing of natives and immigrants.[37]

4.6 Properties

Given these primitives of the model, in this subsection we derive a number of properties. These properties are the basis for the structural estimation described in Section 5.1. The difference between natives and immigrants is the weight they give to local and foreign price indices:

Assumption. *Natives only care about local price indices so that $\alpha_f = 0$ and $\alpha_l = \alpha$. Immigrants care about local and foreign price indices so that $\alpha_f \neq 0$ and $\alpha_l + \alpha_f = \alpha$.*

Proposition 1. *Under the assumptions made, there is a gap in wages between natives and immigrants that increases in the local price index and that is larger when p_j is lower. The wage gap is given by the following expression:*

$$\ln w_{Nc} - \ln w_{jc} = (1-\beta)(1-\alpha_t)\ln(p_c/\bar{p}_{jc}) \tag{4.7}$$

Proof. Appendix C.2

□

This expression highlights that there are no differences in the wage gap between natives and immigrants only in two extreme cases. First, if $\alpha_t = 1$, then all income is spent on tradable goods and therefore the price difference in price indices of non-tradables is irrelevant. Second, when $\beta = 1$, workers have all the bargaining power and always demand a wage equal to their output as can be seen from (4.4). Thus, both local amenities and prices of non-tradables are not reflected in wages.

[37] An alternative to this assumption is to assume that natives and immigrants consume one unit of housing as is done in many other papers in urban economics, and that consumption of non-tradables reflects both this housing unit and other non-tradables. This alternative results in a simpler relationship between city housing prices and native and immigrant population.

It is also worth noting that differences in the price index of the country of origin do not play a direct role *only* in the special case of $\sigma = 1$. In this case, the share of expenditure in home country goods is always the same, irrespective of the prices. If instead $\sigma > 1$, then there is some degree of substitutability between local and home consumption, which increases with σ.

In Section 3, we have also shown empirically that immigrants concentrate in higher proportions in larger, more expensive cities. This can be summarized in the following proposition:

Proposition 2. *Under the assumptions made, immigrants concentrate in expensive cities. The spatial distribution of immigrants relative to natives is given by:*

$$\ln \frac{\pi_{jc}}{\pi_{Nc}} = \frac{1}{\lambda}\beta(1-\alpha_t)\ln(p_c/\bar{p}_{jc}) + \ln \frac{\sum_k \left(A_k \tilde{B}_k / p_k^{1-\alpha_t}\right)^{\frac{\beta}{\lambda}}}{\sum_k \left(A_k \tilde{B}_k / \bar{p}_{jk}^{1-\alpha_t}\right)^{\frac{\beta}{\lambda}}} \tag{4.8}$$

Proof. Appendix C.2 □

As for the wages, there is no difference in the location choices between natives and immigrants if $\alpha_t = 1$. However, the role of the bargaining power parameter for the distribution of immigrants relative to natives is different. If $\beta = 1$, immigrants benefit most from locating in more expensive cities as they enjoy the same wages as natives despite being less affected by the local price levels. If on the contrary firms have all the bargaining power and thus $\beta = 0$, the wages offered to immigrants fully take into account the prices they face, which implies that they do not benefit more than natives from living in expensive cities. Hence, the spatial distribution of natives and immigrants would be the same.

Propositions 1 and 2 are directly linked to the facts that we report in Section 3. They show the concentration of immigrants and that immigrants receive lower wages than natives in expensive cities. We can use the allocation of workers across locations to obtain the equilibrium size of the city. In particular, the following proposition characterizes the distribution of workers across cities given the total native and immigrant populations (L_N and L_j for each country of origin j).

Proposition 3. *The equilibrium size of the city increases in local productivity and amenities according to:*

$$L_c = (A_c \tilde{B}_c)^{\frac{\beta}{\lambda}} \sum_j \frac{L_j / \bar{p}_{jc}^{(1-\alpha_t)\frac{\beta}{\lambda}}}{\sum_k (A_k \tilde{B}_k / \bar{p}_{jk}^{(1-\alpha_t)})^{\frac{\beta}{\lambda}}} + \frac{(A_c \tilde{B}_c / p_c^{1-\alpha_t})^{\frac{\beta}{\lambda}}}{\sum_k (A_k \tilde{B}_k / p_k^{1-\alpha_t})^{\frac{\beta}{\lambda}}} L_N \tag{4.9}$$

Proof. Appendix C.2 □

Note that this proposition also means that immigrants make large cities even larger. That is, because they care less than natives about the cost of large cities (i.e., congestion), they enable big cities to become larger. Moreover, it shows that cities are large because they are either productive (B_c) or pleasant to live in (A_c). Thus, conditional on amenity levels, immigration concentrates the population in more productive cities.

To see the aggregate effect of immigration on total output via immigrants' location choices, we can obtain an expression of total output per capita depending on immigrant shares.

Proposition 4. *Aggregate output per capita increases with the share of immigrants in the economy and is given by the expression:*

$$q = \sum_c \left[(A_c \tilde{B}_c^{\frac{\beta+\lambda}{\beta}})^{\frac{\beta}{\lambda}} \sum_j \frac{\frac{L_j}{L} / \bar{p}_{jc}^{(1-\alpha_t)\frac{\beta}{\lambda}}}{\sum_k (A_k \tilde{B}_k / \bar{p}_{jk}^{(1-\alpha_t)})^{\frac{\beta}{\lambda}}} \right] + \frac{\sum_c (A_c \tilde{B}_c^{\frac{\beta+\lambda}{\beta}} / p_c^{1-\alpha_t})^{\frac{\beta}{\lambda}}}{\sum_k (A_k \tilde{B}_k / p_k^{1-\alpha_t})^{\frac{\beta}{\lambda}}} \frac{L_N}{L} \tag{4.10}$$

Proof. Appendix C.2 □

In Section 4.4, we mentioned the possibility of allowing for agglomeration forces (external to firms), which we model with an agglomeration parameter $a > 0$. When there are agglomeration forces, the movement of economic activity towards more productive locations makes these locations even more productive. This, in turn, creates even more incentives for immigrants and natives to be in these locations. Hence, our results are stronger when $a > 0$ but qualitatively unchanged.

A final property of the model is that immigrants have a heterogeneous effect across locations on the demand for housing. On the one hand, immigrants consume housing but spend a smaller fraction of their income on housing than natives. This increases the demand for housing but less than it would if immigrants consumed like natives. Hence, immigrants tend to reduce the per capita demand for housing at the local level. Across cities, immigrants are drawn towards expensive cities. Hence, the increase in the local aggregate demand for housing is larger in expensive than in cheaper cities. We show this more explicitly in the estimated model.

5 Model estimation and counterfactuals

5.1 Estimation

There are three key parameters in the model. First, we need to estimate α_f, which governs the (average) importance of home country in total expenditures. Second, we need to estimate σ, which measures the heterogeneity across immigrants from different countries of origin. And third, we need an estimate of λ, which governs how much of the immigrant-native differences are observed in wages versus locations.

To obtain the first two key parameters, we use the relationship between wage gaps and city prices across countries of origin. We estimate the model combining 1990, 2000, and 2010 Census and ACS data and World Bank real exchange rate data. We use the exact same data that we used for documenting immigrant heterogeneity in Section 3.2.1, except that we limit the local price to include only the cost of housing. In our empirical analysis, we have used local price levels that are a weighted average of the national consumer price index (including tradable goods) and the city-specific rental price indices following Moretti (2013). However, in the model, p_c refers to the price of non-tradable goods only. For the estimation and solution of the model, we therefore proxy p_c with the rental price component of the local price index. While non-tradable goods might include other goods apart from housing, this is the most directly measurable component of the cost of living in a location. Moreover, to the extent that other non-tradable goods require land, for example barbers or other local services, their prices should be strongly correlated with local housing costs.

We first use the relationship between wage gaps and local price indices that the model generates at the country of origin-MSA level given by equation (4.7) to estimate $\{\bar{\alpha}_f, \sigma\}$. More specifically, as can be seen from the proof of proposition 4 in the appendix, we obtain:

$$\frac{\partial \ln \frac{w_{N,c}}{w_{j,c}}}{\partial \ln p_c} = (1-\beta)(1-\alpha_t)(1-\Omega_l)$$
$$\frac{\partial \ln \frac{w_{N,c}}{w_{j,c}}}{\partial \ln p_c \partial \ln p_j} = (1-\beta)(1-\alpha_t)(1-\sigma)\Omega_l(1-\Omega_l)$$

where $\Omega_l = (\bar{\alpha}_l^\sigma p_c^{1-\sigma})/(\bar{\alpha}_l^\sigma p_c^{1-\sigma} + \bar{\alpha}_f^\sigma p_j^{1-\sigma})$ is the share of consumption on local goods and a function that depends on the two parameters of interest, $\bar{\alpha}_f$ and σ, and on the relative price index of foreign to local goods. We evaluate this term at the average city price level and real exchange rate in the year 2000 (to obtain a common Ω_l). In particular, we use the fact that on average origin country price levels are 52% of the price level in the United States.

To obtain the values of the above derivatives, we estimate the specification in column 6 of Table 5 but use the rental price component to measure the prices of non-tradable goods instead of the overall city price index. The coefficient of the rental price is -0.168 and the coefficient of its interaction with the real exchange rate is 0.067.[38] Thus, we set the first derivative equal to former and the second derivative equal to the latter value:[39]

$$(1-\beta)(1-\alpha_t)(1-\Omega_l) = 0.168$$
$$(1-\beta)(1-\alpha_t)(1-\sigma)\Omega_l(1-\Omega_l) = -0.067$$

This is a (non-linear) system of two equations and four unknowns: $\{\bar{\alpha}_f, \sigma, \beta, \alpha_t\}$. We reduce the dimensionality of the parameter space by assuming that $\beta = 0.2$ and $\alpha_t = 0.4$. This means that we assume that the weight of workers when bargaining for wages is 20%, and that the share of consumption that goes to non-tradables is 60%.

There exist various estimates of the workers' bargaining weight in the literature. Recent work suggests that an estimate of 20% is reasonable. For example, Lise et al. (2016) obtain an estimate of around 20% for workers with, at most, a high school diploma, and 30% for college graduates. Since immigrants with lower education levels are relatively more prevalent in the United States, we opt for the lower estimate.[40] Note that an estimate of 20% means that firms can extract quite some value from workers' location decisions.[41] This implies that, in the context of our model, wages reflect to a large extent, the value of living in each location. The tradable goods weight of 40% is based on the sum of the weights of those goods in the BLS consumer price index (CPI-U) that are either tradable or difficult to substitute with goods from the origin because they are mainly consumed locally. Specifically, these are *Food and*

[38] Note that because we demean variables, the coefficient of the rental price indicates the effect on the wage gap at the mean real exchange rate.

[39] Because in the model we define the gap as native wage minus immigrant wage, we have to switch the signs of the coefficients.

[40] All results are virtually unchanged when using a bargaining power of 0.3 (see Appendix D).

[41] See also the survey article Manning (2011). In recent papers, the range of estimates moves from 5 to 34%.

beverages, *Apparel*, *Transportation* and *Education and communication*.[42] In Appendix D, we test the robustness of the model predictions to setting the tradable share to 60%. This means that non-tradable goods roughly have the same weight as the *Housing* component in the CPI-U. As non-tradable goods usually include more than just housing, we view a tradable share of 60% as an upper bound of the actual share of tradable consumption.

Once we have assumed specific values for α_t and β, we are left with a system of two equations and two unknowns. We solve this system (numerically) and obtain the values $\bar{\alpha}_f = 0.35$ and $\sigma = 1.61$. These parameter estimates have clear economic meaning. The fact that $\bar{\alpha}_f$ is around 35% means that the distribution of immigrants across locations and their wages is consistent with the fact that, on average, immigrants consume around 35% of non-tradables in their country of origin. This represents around 21% of their total consumption (α_f in the utility function defined above), since 60% of income is spent, on average, on non-tradables. This number is close to the number estimated in column 4 of panel A of Table 8 using consumption data directly. The elasticity of substitution σ is identified from the heterogeneity across countries of origin. An elasticity larger than one means that immigrants substitute consuming locally for home country consumption. Thus, immigrants from cheaper countries consume relatively more in their country of origin than immigrants from more expensive origins. Our estimate of $\sigma = 1.61$ captures quantitatively the extent to which immigrants substitute local and foreign consumption. In Appendix D.1, we show how alternative assumptions on β and α_t change our estimates of α_f and σ. Using a 30,000 point grid, we obtain a range of estimates for α_f that goes from 0.15 to 0.25, and a range for σ that goes from 1.5 to around 2.5.

To estimate λ, we use equation (4.8) and the estimates of β, α_t, σ, and α_f. From these we can obtain the relevant price index for each country of origin and estimate equation (4.8) with PPML as we did in Table 5. We obtain that $\frac{1}{\lambda}\beta(1-\alpha_t) = 10.06$ with a standard error of 1.30.[43] From this we get $\lambda \approx 0.012$. The implied (internal) migration elasticity (which is $1/\lambda$) is slightly higher than other estimates in the literature, see Monras (2015) or Caliendo et al. (2015). However, the comparison is not straightforward since the variation used in previous literature is quite different from what we use.

For the productivity levels, amenities, and housing-supply elasticities across cities, as well as local agglomeration forces, we rely on prior literature. We use the productivity and amenity levels estimated by Albouy (2016) for 168 (consolidated) MSAs, which are the ones we use to solve and simulate the model. The Albouy model is similar to ours except for the fact that we take into account the role of immigrants. For the housing-supply elasticities, we rely on Saiz (2010).[44] Finally, we use an estimate of local agglomeration forces of 0.05, which is consistent with the consensus in the literature (Combes and Gobillon 2014; Duranton and Puga 2004).

[42] The remaining components of the CPI-U are *Housing*, *Medical care*, *Recreation*, and *Other goods and services*. While housing is also consumed locally, unlike transportation or education, it can be partially substituted with home consumption, for example by renting a low-quality apartment in the host country while sending remittances or saving to rent or buy an apartment of higher quality in the home country. This notion is consistent with our findings on differences in housing expenditure between natives and immigrants in Section 3.3.

[43] Note that we remove the term $\ln(\sum_k \left(A_k \tilde{B}_k / p_k^{1-\alpha_t}\right)^{\frac{\beta}{\lambda}})/(\sum_k \left(A_k \tilde{B}_k / \bar{p}_{jk}^{1-\alpha_t}\right)^{\frac{\beta}{\lambda}})$ from equation (4.8) using country of origin fixed effects.

[44] Saiz (2010) reports housing-supply elasticities at the primary metropolitan statistical area (PMSA), so we use Albouy (2016)'s crosswalk between PMSAs and consolidated metropolitan statistical areas (CMSAs).

In our baseline solution of the model with an immigrant worker share of around 18%, we use the rental prices from the data as equilibrium housing prices p_c^*. We then make use of the housing market equation (4.5) to back out the equilibrium housing supply H_c^*. When we use the model to perform counterfactuals by varying the share of immigrant workers in the economy, we apply the housing supply elasticities from Saiz (2010) to obtain the counterfactual equilibrium housing supplies and prices for each city. Thus, we approximate the housing supply equation by $H_c(p_c) = (p_c/p_c^*)^{\eta_c} H_c^*$, where η_c is the city-specific housing supply elasticity estimated by Saiz (2010).[45] Table 9 summarizes the value and source of our calibration and estimated parameters.

Table 9 goes around here

5.2 Comparison of the model versus the data

5.2.1 Non-targeted moments I: Labor market data

Once we have all the parameters – those that we estimate ourselves and those that we borrow from the literature – we can compare the quantitative predictions of our model with the data. Using various moments of the data should serve to show that our model can quantitatively match some of the key features of MSA-level cross-sectional US data.

In Figure 5, we plot a number of variables against the estimate of city level productivity. Note that our estimation of the model is at the city-origin level, while the moments in Figure 5 are at the MSA level. The underlying productivities and amenities estimates taken from Albouy (2016) are the primitive parameters that drive the results on both location and wages. Appendix Table F.6 gives an overview over these parameters for the bottom 20 and the top 20 cities in terms of productivity.

The top-left graph in Figure 5, labeled as panel A, shows that the population distribution across US cities generated by the model is very similar to the distribution in the data both in terms of steepness and dispersion. The model only performs somewhat worse at the extremes of the distribution. It underpredicts the size of the two largest cities, which are New York and Los Angeles, while it somewhat overpredicts the size of the smallest cities. The model matches remarkably well the relationship between wages (centered around the mean) and productivity as shown in panel B of Figure 5. In Appendix D.2 we show that this fit does not change substantially with alternative calibrations of β and α_t.

Figure 5 goes around here

The model also does a fairly good job in explaining the immigrant population shares and native-immigrant wage gaps (aggregated at the city level). That is, the model predicts productivity to be positively related to immigrant shares and negatively related to immigrants' relative earnings, mimicking the relationships in the data. Naturally, there is less dispersion in the model than in the data, as all

[45] Results do not change substantially if we assume inelastic supply of housing instead.

differences between locations of similar productivity are only based on variation in amenities and non-tradable prices, while in the real world there are many more sources of heterogeneity that drive immigrant shares and wage gaps.

It is interesting to see that there are some outliers in terms of immigrant shares. The smaller MSAs with high shares of immigrants in the data are always close to the Mexican border. This is something that the model cannot match. Another outlier with respect to the prediction is the most productive city, San Francisco, for which the model predicts an immigrant share of around 70% – almost twice as high as in the data. San Francisco is a special case because it is at the extreme end of the distribution with respect to all of its characteristics (see Table F.6). It is the most productive city and has the highest rental price index by a large margin. Moreover, it has the second highest amenity value (after Santa Barbara) and the second lowest housing supply elasticity (after San Diego). Naturally, for such a location, the model predicts an extreme outcome in terms of the number of immigrants, who are attracted by the high nominal wage, which is driven by both the exceptionally high productivity and high non-tradable price level. Because of the large discrepancy between data and model for this special case, we drop San Francisco from the counterfactual analysis that we perform in the next section.

5.2.2 Non-targeted moments II: Consumption data

A second way to confront the model to non-targeted moments is to turn to consumption data. Note that we estimate the model using exclusively labor market data. From this we obtain two key parameters for consumption: the share of consumption that immigrants devote to home-country goods and the elasticity of substitution between consuming in the home and host economies. We can thus compare our model to these two moments.

As mentioned before, on average, the model predicts that immigrants (from all countries of origin) spend around 21 percent of their income in their countries of origin. We can compare this number to the estimate provided in Table 8, Panel A, column 4. This estimate suggests that Mexicans – the only immigrants that we can identify in the Consumption Expenditure Survey data – spend around 22 percent less locally than similar looking natives, which is quite close to the 21 percent estimate implied by the model. It is worth keeping in mind for this comparison that Mexicans are the largest immigrant group in the US (and hence driving to a large extend the estimate implied by the model), and that if anything, we would expect that the importance of the home country is larger for Mexicans than it is for immigrants from other countries of origin given both the price level in Mexico and the proximity of Mexico to the US.

The model also speaks to the heterogeneity in spending that exists across immigrants from different countries of origin. Consumption Expenditure data does not allow us to identify immigrants from different countries of origin. However, we used data on housing expenditures from the Census to document the existing heterogeneity in local consumption by country of origin and how it relates to exchange rate changes. Using these estimates, which were presented in Table 8, Panel C, column 4, we can predict how much immigrants from the different countries of origin spend on local housing, which we can confront to the model's quantitative predictions.

We do this exercise in Figure 6. In panel A, we confront the share of rent expenses that we observe in the data for immigrants of different countries of origin (each dot is the average for a different country), against the predicted share of local non-tradable consumption in the model. To be able to make this comparison we adjust the consumption data for observable immigrant characteristics that we evaluate at the mean. It is apparent from Panel A of Figure 6 that there is a strong correlation between the model's predictions and the data.

Underlying the comparison shown in Panel A is the fact that there might be heterogeneity in housing consumption across cities that is driven by mechanisms other than the one we highlight in this paper. For instance, we have assumed for simplicity that there are no non-homotheticities in non-tradable local consumption, something that may not be true in reality. Hence, to make the comparison tighter between the model and the data, in Panel B of Figure 6 we control for city fixed effects, before aggregating our consumption data at the country of origin. Hence, in this figure the variables are measured as deviations from the mean. Again, it is apparent from the graph that there is a tight relationship between the model and the data, which lies reasonably close to a 45 degree line (displayed in the graph).

In sum, the predictions of the model – estimated exclusively using Census (hence labor market) data – on consumption patterns of immigrants by country of origin do a remarkable job at predicting consumption data. This gives further credibility to the quantitative merits of our model.

5.3 The impact of immigration on the spatial equilibrium

In this section we use our model to understand the quantitative importance of the fact that immigrants consume a fraction of their income in their countries of origin. In particular, we perform two counterfactual exercises to investigate the changes in the equilibrium arising from immigration. First, starting from the actual number of immigrants and natives, we simulate an increase in the population equal to the size of the actual immigrant share under the assumption that immigrants behave exactly like natives. That is, the weight on home consumption α_f is equal to zero both for natives and new incoming workers. Second, we repeat this simulation assuming that the new arrivals' α_f is equal to its estimated value. By comparing the predictions of these two simulations, we can quantify the importance of the mechanism that we highlight throughout the paper.[46]

More concretely, we calculate the city-level percentage changes in four outcome variables predicted by the model when the number of immigrants increases to 20% of the overall population (holding the actual distribution over countries of origin as the one observed in the Census data). These four variables are the overall population, the native population, the prices of non-tradable goods and native wages. We perform this exercise both with and without agglomeration forces (i.e., with $a = 0$ and $a = 0.05$ in equation (4.3)).

Figure 7 goes around here

[46] Note that an alternative way to isolate the effects of immigrants' consumption choices would be to simulate an increase in the share of immigrants while keeping total population constant and calculate the predicted changes in equilibrium outcomes. The results using this alternative are almost identical to those we report here, which is why we do not even include them in an appendix. Previous versions of this paper performed this alternative exercise.

The blue dots (each dot represents a city) in Figure 7 show the predicted equilibrium changes of the first simulation, which captures the effects of a *pure* increase in population. In this exercise, the variation in the predicted population growth rates across cities illustrated in panel A is driven by the city-specific housing supply elasticity. If the housing supply elasticity was the same across cities, the population in every city would just grow at the same rate as the overall population. In the data, the housing supply elasticity tends to be higher in smaller cities, which implies that prices rise less strongly with the population induced increase in the demand for housing. Hence, low-productivity cities can attract relatively more workers than large cities, where housing prices rise more strongly, as seen in panel C. Thus, the distribution of population shifts towards smaller, less productive cities and this decreases the aggregate worker productivity in the economy, which is the first main take-away from this simulation. The higher living costs are only partially compensated by an increase in native wages, which is just around half of the increase in price levels, as seen in panel D. Therefore, the second result is that the welfare of native workers decreases, especially in cities with low housing supply elasticities.[47]

If we assume that there are positive agglomeration forces (red crosses in the graphs of each panel), population gains in a city also result in city-level productivity increases. Part of these productivity increases translate into higher wages (Panel D), which in turn, increase the demand for housing. Low-productivity cities see, with agglomeration forces, how their housing prices increase by more than when we did not assume agglomeration forces. This is a result of two forces. First, low-productivity cities tend to have higher elasticities of housing and, hence, can accommodate more workers without large increases in housing prices. Second, agglomeration forces increase the income of workers in cities that grow the most, increasing the demand for housing. As a consequence, assuming positive agglomeration forces reduces the variance in the effect of population growth on both wage changes and housing price changes across cities.

Figure 8 goes around here

Figure 8 shows the simulated changes in the equilibrium outcomes when the arriving immigrants behave according to our estimates and, hence, consume a part of their income in their origin (i.e. this exercise effectively estimates the effects of doubling of the immigrant population). Now, the effects are drastically different. This is because the new immigrants, in addition to having incentives to settle in a city where they would exert low pressure on housing prices, have strong incentives to settle in cities where nominal earnings are high. This implies that high-productivity cities can attract more of the additional workers compared to the previous simulation. Therefore, as panel A shows, both high-productivity cities and low-productivity cities with very high housing supply elasticities are the ones that grow the most, whereas most cities with intermediate productivity levels grow only by little. The growth rates of high-productivity cities are now up to 45%, whereas they were only between 10% and 20% previously. As a result of immigrants' strong incentives for cities with high nominal wages, the changes in price levels

[47] Note that we do not explicitly model the production of non-tradable goods, i.e. housing. If native workers were owners of housing, their welfare would increase due to the rise in prices.

are not anymore a mere mirror image of the changes in population but instead strongly increase in productivity, which drives natives to move from more into less productive cities as shown in panel B.

Agglomeration forces do not have a smoothing effect on prices and wages in this simulation anymore because the additional increase in demand for housing in high-productivity cities implies that the growth in price levels increases even more steeply with productivity than in the previous simulation. While prices and wages almost uniformly increase by 9% and 4.5%, respectively, in Figure 7, these increases range from 5% to 12% for prices and from 2.5% to 6% for wages in Figure 8.

Overall, these two simulations suggest that immigrants' location choices in combination with agglomeration forces can potentially account for a significant part of the increase in the dispersion of living costs and nominal wages across metropolitan areas in the US, in line with evidence reported in Moretti (2013). In the context of the model, however, real-wage dispersion does not increase since price changes are more pronounced than changes in nominal wages.

5.4 The impact of immigration on aggregate productivity and welfare

In Table 10, we present the effects of immigration on aggregate labor productivity (i.e., average tradable output produced per worker), native workers' welfare (measured as the common component of the indirect utility of natives expressed in equation (4.1), V_c), and house owners' welfare.[48] The latter is calculated as the hypothetical change in welfare that arises due to a change in income caused by changes in housing prices across cities.[49]

As mentioned before, when we assume that immigrants consume like natives (Counterfactual 1), an increase in overall population implies relatively higher population growth in low-productivity cities, where housing supply is on average more elastic. Given our estimated model, this results in a decrease in aggregate labor productivity of around 0.47% when we assume no agglomeration forces. Moreover, the higher housing prices lead to a decrease in natives' welfare of around 0.84%. House price increases are, on average, around 3.58%. We show these estimates in the first row of Table 10.

In contrast, when immigrants spend a part of their income in their origin country (Counterfactual 2), aggregate labor productivity *increases* by 0.64%. This is because high-productivity cities grow relatively more in this counterfactual. Native workers' welfare decreases by only 0.21% as immigrants put less pressure on housing prices when consuming a part of their income abroad. Home-owners' welfare, which is driven by housing price changes, increases by only 2.65% in this case. We show these estimates in the second row of Table 10.

By taking the difference between counterfactual 1 and counterfactual 2, we obtain an idea of the importance of accounting for the fact that part of immigrants' income is spent in the country of origin, which, in turn, can be considered the differential contribution of immigration to aggregate outcomes. In the third row of Table 10, we show that immigrants enhance the effect of a population increase on average labor productivity by around 1.1 and the effect on aggregate native workers' welfare by around

[48] Recall that we abstract from the welfare changes of firm owners, which are not modeled.

[49] For simplicity, we assume that house owners are distributed across cities like natives, only own houses in the city the live in and earn income from supplying H_c units of housing at price p_c before the population increase and the same quantity at new prices p'_c after the population increase.

0.63 percentage points. Instead, house owners lose on average 0.93 percentage points of their welfare increase due to a smaller rise in housing demand.

Table 10 goes around here

If we assume that there are agglomeration forces, the effect of a population increase on labor productivity is positive (0.55%). This is because new workers increase endogeneously the productivity in the cities they settle in. Hence, even if population increases concentrate in the least productive cities (where housing is supplied more elastically), on aggregate agglomeration forces dominate. Productivity increases by 1.85% if the arriving workers choose where to live according to immigrant preferences. In this case, on top of affecting local productivity, immigrant workers have incentives to live in the most productive cities, which are those that can sustain high house prices and wages. Despite the pressure that immigration puts on house prices, aggregate native workers' welfare does not decrease with the arrival of immigrants when we assume agglomeration forces. This is a result of the combined effect of higher productivity and house prices. When comparing counterfactual 1 and counterfactual 2 with agglomeration forces we obtain that immigration increases the welfare effect of a population increase by around 0.6 percentage points. The differential aggregate effect on house owner's welfare is also similar in magnitude with and without agglomeration forces.

In Appendix D.2, we perform a range of robustness checks to show that the disaggregate and aggregate predictions of the model do not change substantially with alternative calibrations of β and α_t (i.e. with the parameters on preferences that we do not estimate directly but instead take from the literature). Overall we obtain similar results under these alternative calibrations, as can be seen in Figures D.8, D.9, D.10, and D.11, and Table F.7. We estimate that aggregate productivity gains are in the order of 1 to 2.6 percentage points higher and native worker's welfare in the order of 0.4 to 0.8 percentage points.

Overall, our model and estimates highlight the importance of taking into account that immigrants spend an important fraction of their income in their countries of origin. The model-based counterfactuals presented in this section show that acknowledging this defining feature of immigrants changes substantially our understanding of how immigration affects the host economy, both on aggregate and across locations.

6 Conclusion

In the first part of this paper, we document that immigrants concentrate in larger, more expensive cities and that their earnings relative to natives are lower there. We show that these patterns are stronger for immigrants coming from countries with low price levels and that immigrant household consume less locally than similar-looking native households.

Taking all this evidence together, we posit that these patterns emerge because a share of immigrants' consumption is not affected by local price indices but rather by prices in their country of origin. That is, given that immigrants send remittances home and are more likely to spend time and consume in their countries of origin, they have a greater incentive than natives to live in high-nominal-income locations.

We build a quantitative spatial equilibrium model labor market with frictions to quantify the importance of this mechanism. We estimate the model and show that the differential location choices of immigrants relative to natives have important consequences: economic activity moves from low-productivity to high-productivity cities. Model simulations suggest that, compared to a counterfactual in which incoming workers behave like natives, immigration has boosted overall worker productivity by around 1.3% and increased native welfare by around 0.6% on average in US cities.

This paper extends some of the insights in the seminal contribution of Borjas (2001). Borjas' main argument is that immigrants choose the locations where demand for labor is higher, thus helping to dissipate arbitrage opportunities across local labor markets. We show in this paper that immigrants not only choose locations with higher demand for labor but specifically more productive locations, and we quantify how much these choices contribute to overall production in the United States.

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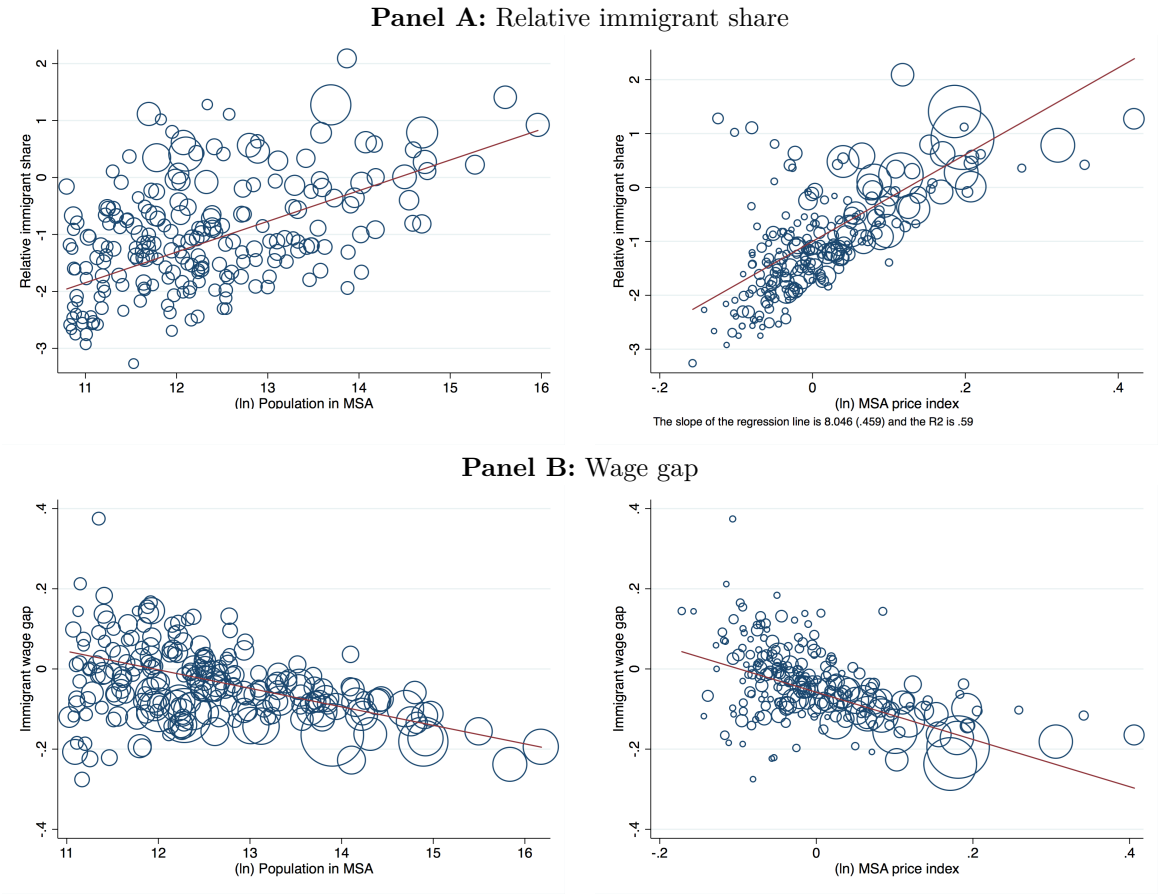
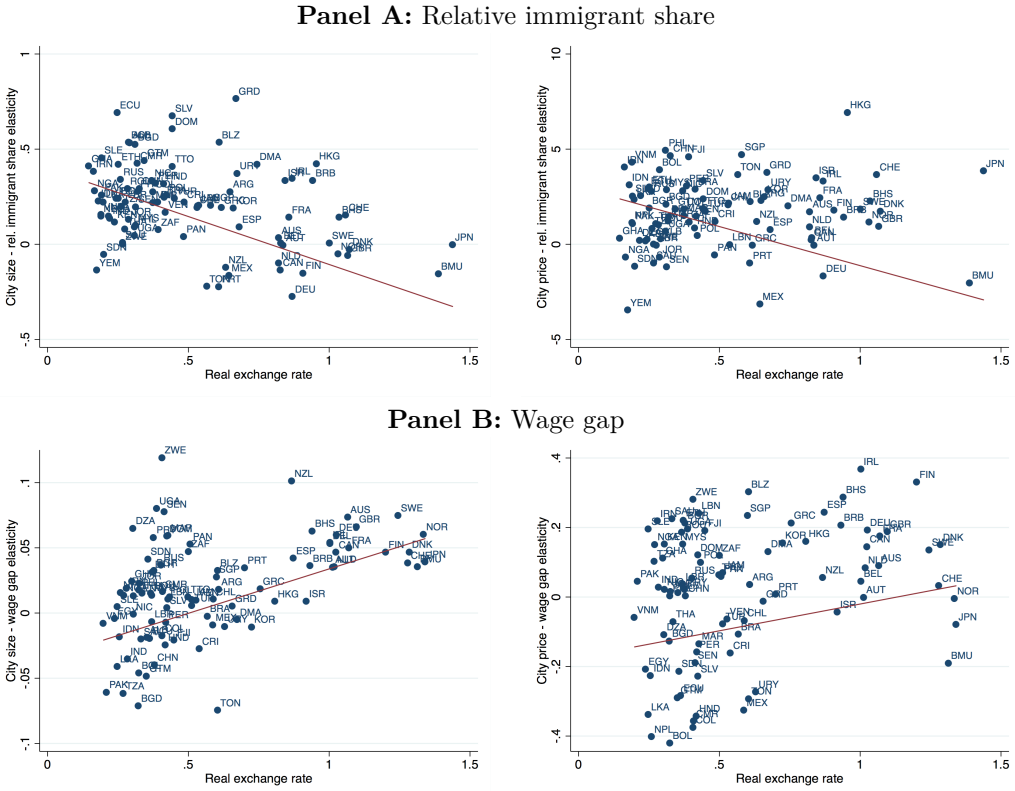
7 Figures

Figure 1: Immigration and cities



Notes: Panel A of this figure shows the relationship between the relative share of immigrants in an MSA and the MSA population (left) and price index (right). The relative share of immigrants is measured as the number of immigrants in the MSA relative to all immigrants in the United States divided by the number of natives in the MSA relative to all natives in the United States. Panel B of this figure plots the MSA-specific component of the wage gap against MSA population (left) and price index (right). A negative number for the immigrant wage gap means that immigrants are paid less than natives in that metropolitan area. The figure is based on the sample of prime-age workers (25-59) from the 2000 Census. The MSA price indices are computed following Moretti (2013). Each dot represents one of 219 MSAs in the sample. Marker sizes reflect MSA price indices in the left-hand plot and population level in the right-hand plot.

Figure 2: City size/price elasticity of relative immigrant share and wage gap by origin price level

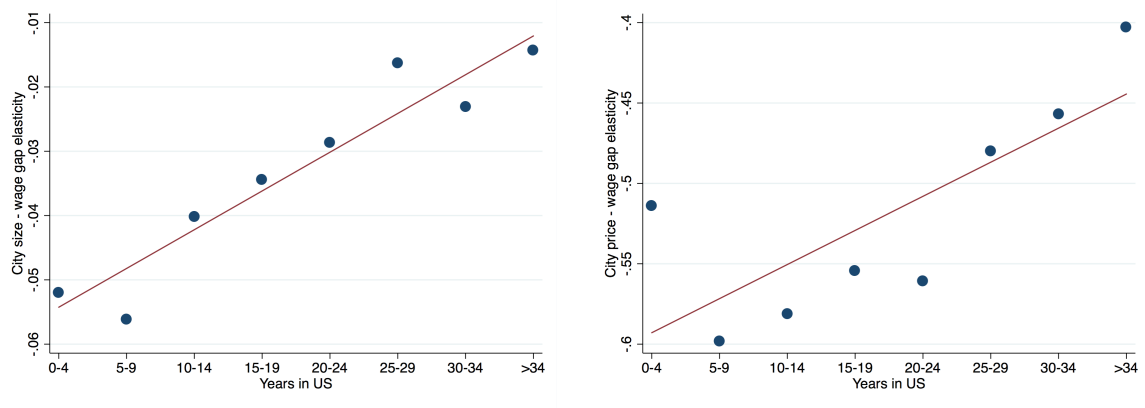


Notes: This figure uses data from the 2000 Census to show the elasticity between the relative immigrant shares (panel A) and the native-immigrant wage gaps (panel B) with respect to the city size and city price, for each of the different countries of origin as a function of the country of origin price level. The dots represents the origin-specific coefficients β obtained by estimating equation (3.1) at the origin-level in case of panel A and equation (3.3) in case of panel B.

Figure 3: City size elasticity of relative immigrant share and wage gap of Mexicans

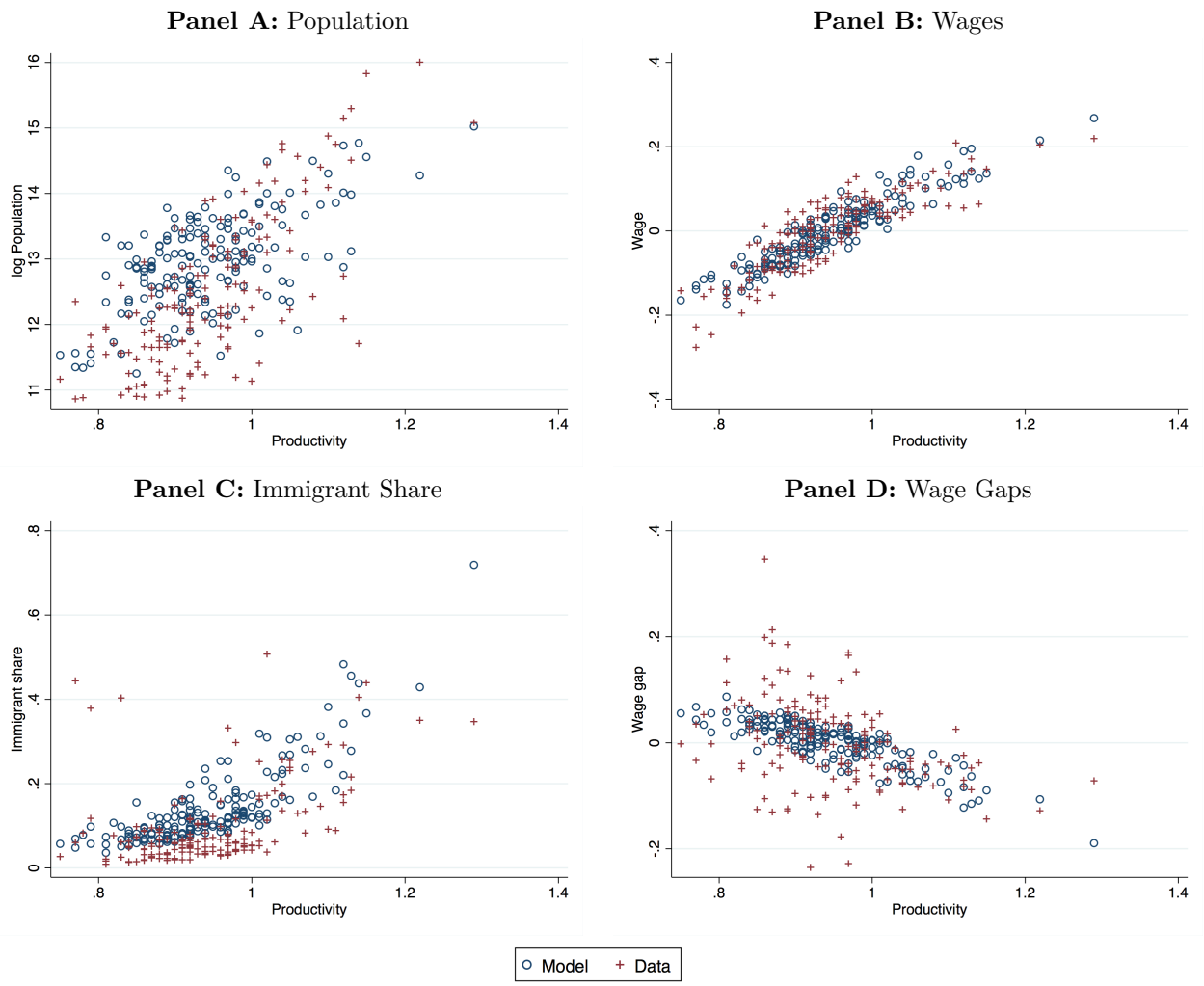
Notes: This figure uses data from the CPS 1994-2011 to show the relationships between the relative immigrant share and the (composition-adjusted) wage gap of Mexican immigrants who changed location during the indicated year and the city size elasticity. More specifically, we estimate the elasticity for each year and plot it against the average real exchange rate of the Mexican peso to the US dollar during that year. Hence, each dot represents an estimate of the coefficient β for the particular year based on equations (3.1) and (3.2). We can only compute city size elasticities because price indices can only be computed using ACS and Census data, which is available only in selected years.

Figure 4: City size/price elasticity of wage gap by immigrants' years in the country



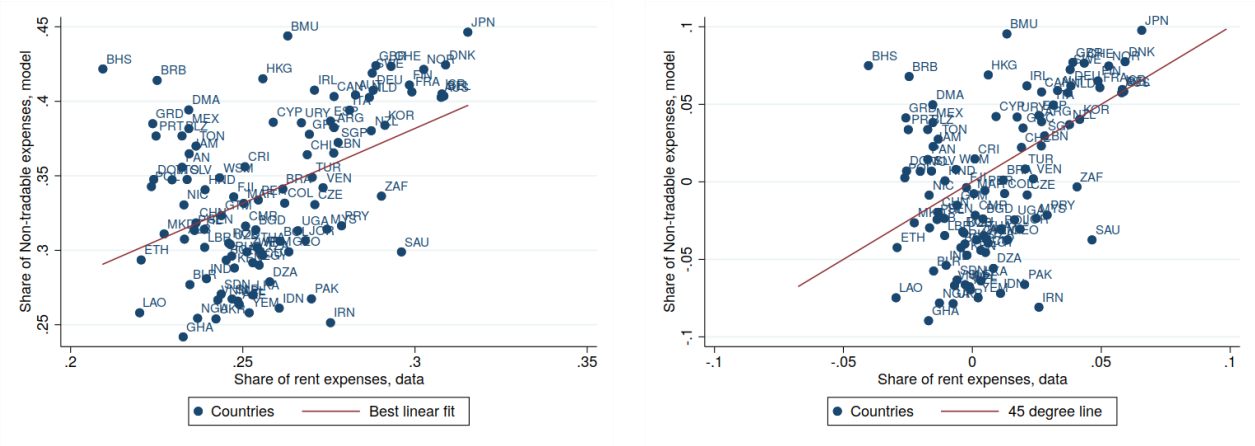
Notes: This figure uses Census data to show the relationships between the city size and city price elasticity of the native-immigrant wage gap as a function of the time spent in the United States. Each dot represents an estimate of the coefficient β for the indicated immigrant group based on a model similar to (3.3) but in which o denotes the groups defined by years spent in the US.

Figure 5: Non-targeted moments I: population and wages at the MSA-level



Notes: This figure compares four untargeted moments in the data and the model. The model is estimated using country of origin variation. From these estimates, we aggregate to the city level the data generated by the model to compute the four moments shown in the figure. Each dot represents one of the 168 consolidated metropolitan statistical areas from Albouy (2016).

Figure 6: Non-targeted moments II: share of expenditures in non-tradable goods

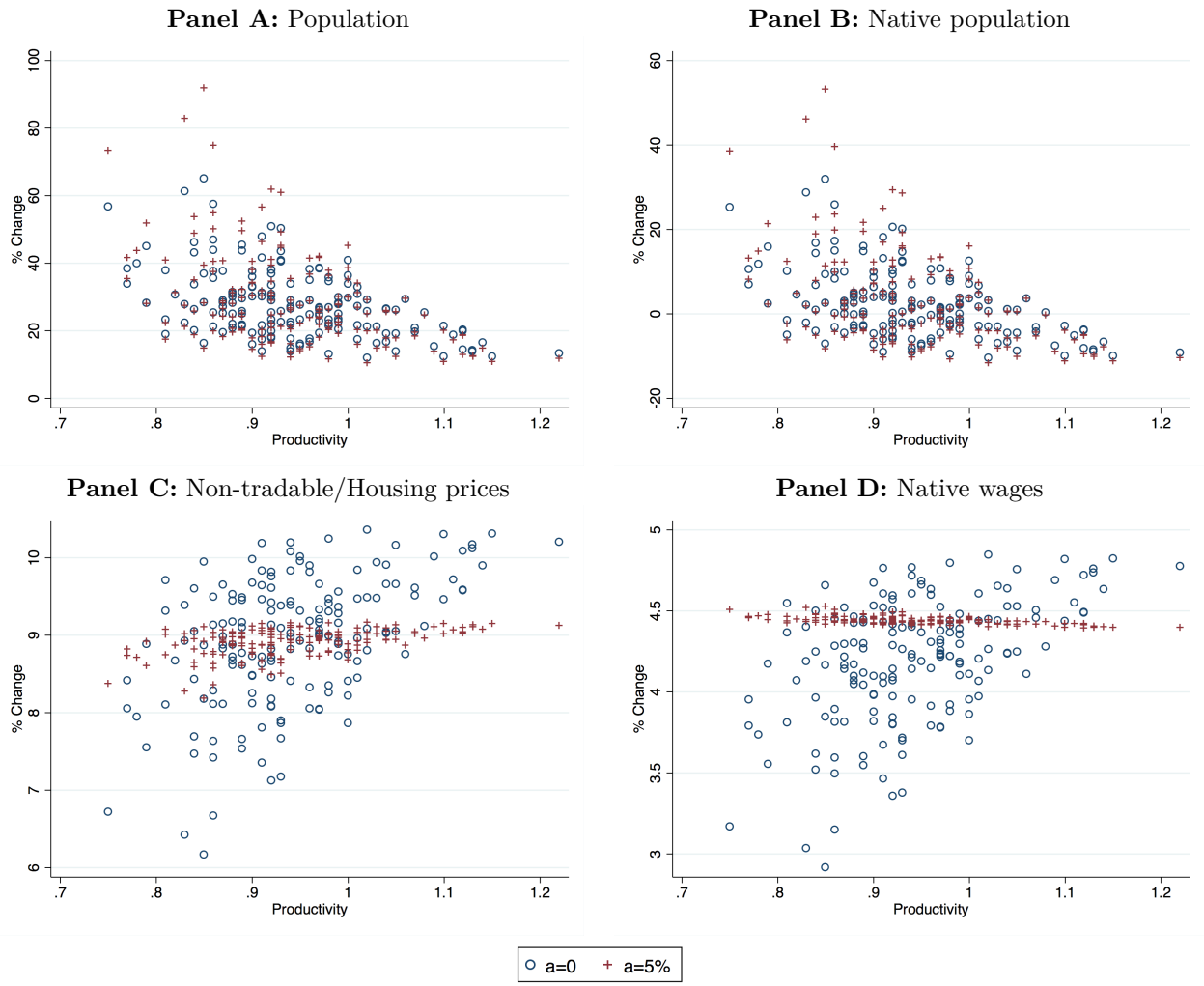


Panel A: char. adj. comparison

Panel B: char. adj. conditional on city FE

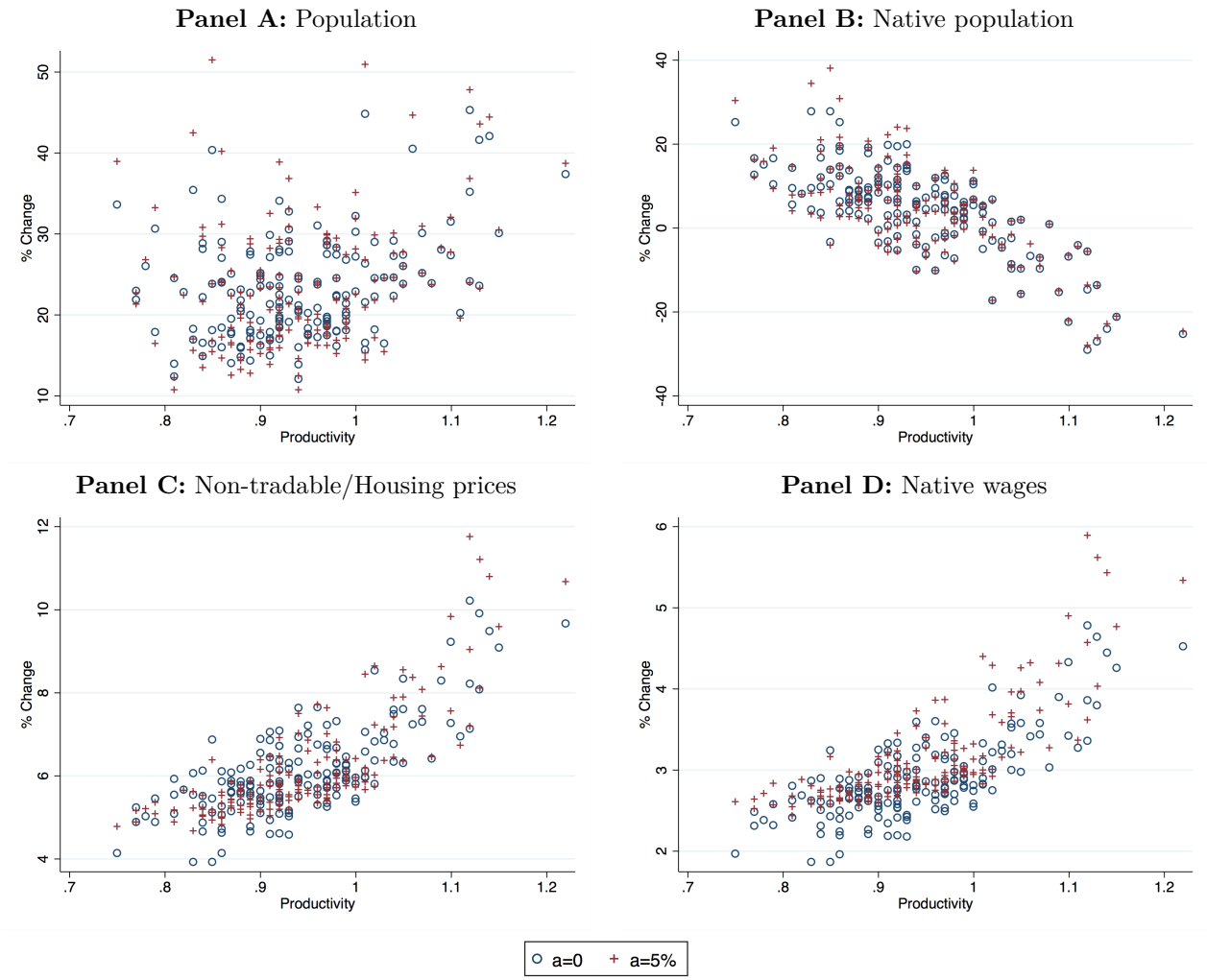
Notes: The y-axis shows the share of expenditures in non-tradable goods predicted by the model for each country of origin keeping wages constant and subtracting MSA means. The x-axis shows the share of expenditures in the data for each country of origin adjusted for income and observable characteristics: familiy size, age, marital status and travel time to work.

Figure 7: Effects of immigration if new immigrants were like natives (i.e. with $\alpha_f = 0$)



Notes: This figure compares the distribution of selected variables predicted by the model given a native-induced increase in population equal to the size of the actual share of immigrants of 20%, both with and without agglomeration forces. Each dot represents one of the 168 consolidated metropolitan statistical areas from Albouy (2016) and indicates the percentage difference to the counterfactual.

Figure 8: Effects of immigration with new immigrants consuming in the country of origin (i.e. with $\alpha_f = 0.21$)



Notes: This figure compares the distribution of selected variables predicted by the model given an immigrant-induced increase in the population equal to the size of the actual share of immigrants of 20%, both with and without agglomeration forces. Each dot represents one of the 168 consolidated metropolitan statistical areas from Albouy (2016) and indicates the percentage difference to the counterfactual.

8 Tables

Table 1: List of top US cities by immigrant share in 2000

MSA	Immig. (%)	Size rank	Population	Weekly wage	Price index	Wage gap (%)
Miami-Hialeah, FL	64	23	1,056,504	332	1.13	-20
Los Angeles-Long Beach, CA	48	2	6,003,886	395	1.20	-24
McAllen-Edinburg-Pharr-Mission, TX	44	88	229,812	258	0.88	-16
San Jose, CA	44	25	888,632	563	1.52	-8
Salinas-Sea Side-Monterey, CA	40	146	120,699	355	1.22	0
El Paso, TX	40	70	291,665	300	0.92	-14
Brownsville-Harlingen-San Benito, TX	38	134	137,429	275	0.90	-17
New York, NY-Northeastern NJ	36	1	8,552,276	454	1.22	-19
Visalia-Tulare-Porterville, CA	33	125	155,595	306	0.95	-7
San Francisco-Oakland-Vallejo, CA	33	6	2,417,558	494	1.38	-10
Fort Lauderdale-Hollywood-Pompano Beach, FL	33	28	799,040	393	1.17	-12
Fresno, CA	30	56	396,336	327	0.98	-8
San Diego, CA	29	15	1,306,175	411	1.19	-13
Santa Barbara-Santa Maria-Lompoc, CA	29	112	176,133	390	1.25	-8
Riverside-San Bernardino, CA	28	14	1,428,397	388	1.07	-11
Ventura-Oxnard-Simi Valley, CA	28	61	362,488	460	1.23	-17
Stockton, CA	27	83	246,980	386	1.04	-14
Houston-Brazoria, TX	26	8	2,191,391	427	1.04	-18
Honolulu, HI	26	55	397,469	393	1.23	-4
Modesto, CA	25	102	203,134	372	1.03	-3

Notes: This table shows a number of statistics for the sample of metropolitan statistical areas with the highest immigrant shares. These statistics are based on the sample of prime-age workers (25-59) from the 2000 Census. Weekly wages are computed from yearly wage income and weeks worked. Local price indices are computed following Moretti (2013). The wage gap is the gap in wage earnings between natives and immigrants (a negative number means that natives' wages are higher), controlling for observable characteristics.

Table 2: Countries with the highest and the lowest real exchange rates

Highest		Lowest	
Norway	1.36	Vietnam	0.20
Japan	1.34	Pakistan	0.21
Bermuda	1.34	Yemen	0.23
Denmark	1.30	Egypt	0.24
Switzerland	1.29	Sierra Leone	0.24
Sweden	1.25	Sri Lanka	0.24
Finland	1.22	Nepal	0.25
United Kingdom	1.10	Indonesia	0.26
France	1.07	Tanzania	0.26
Australia	1.07	Nigeria	0.26

Notes: This table lists the top and bottom 10 countries with the highest and the lowest average real exchange rate over 1990, 2000 and 2010 with respect to the United States according to real exchange rate data from the World Bank.

Table 3: Immigration in large and expensive cities

	Panel A: Relative immigration share						
	(1) OLS	(2) OLS	(3) FE	(4) OLS	(5) OLS	(6) IV	(7) FE
(ln) Population in MSA	0.531***	0.532***	0.769***				
	(0.0540)	(0.0552)	(0.115)				
(ln) City price				8.091***	8.360***	10.32***	1.021**
				(0.683)	(0.738)	(0.937)	(0.462)
Observations	764	764	764	764	764	764	764
R-squared	0.470	0.472	0.972	0.573	0.594	0.561	0.965
F-stat first stage						61.16	
Year FE	no	yes	yes	no	yes	yes	yes
MSA FE	no	no	yes	no	no	no	yes

	Panel B: Wage gap						
	(1) OLS	(2) OLS	(3) FE	(4) OLS	(5) OLS	(6) IV	(7) FE
(ln) Population in MSA	-0.0435***	-0.0419***	-0.0283				
	(0.00445)	(0.00460)	(0.0213)				
(ln) City price				-0.107***	-0.605***	-0.676***	-0.124**
				(0.00608)	(0.0645)	(0.0819)	(0.0564)
Observations	764	764	764	764	764	764	764
R-squared	0.405	0.456	0.777	0.174	0.491	0.485	0.778
F-stat first stage						60.00	
Year FE	no	yes	yes	no	yes	yes	yes
MSA FE	no	no	yes	no	no	no	yes

Notes: This table shows regressions of the relative share of immigrants ($\ln(\frac{\text{Imm}_{c,t}}{\text{Imm}_t}/\frac{\text{Nat}_{c,t}}{\text{Nat}_t})$), in panel A, and the gap in wages between natives and immigrants adjusted for imperfect substitutability between natives and immigrants ($\hat{\phi}_{c,t}$), in panel B, on the size of the city and the city price index. City price indices are computed following Moretti (2013). Column (6) instruments the local price index by the housing supply elasticity estimated in Saiz (2010). This table uses data from the Census 1980-2000 and the combined 2009-2001 ACS. Robust standard errors clustered at the metropolitan area are reported. * significant at the 0.10 level; ** significant at the 0.05 level; *** significant at the 0.01 level.

Table 4: Immigration in large and expensive cities, robustness

			Panel A: Rel. imm share, OLS				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(ln) City price	8.170***	9.370***	10.43***	10.03***	8.314***	6.336***	8.360***
	(0.664)	(0.873)	(1.188)	(0.709)	(0.602)	(0.513)	(0.738)
Observations	764	763	763	764	764	764	764
R-squared	0.612	0.538	0.486	0.637	0.675	0.658	0.594
			Panel B: Rel. imm share, IV				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(ln) City price	10.43***	10.82***	13.08***	12.37***	10.12***	7.815***	10.32***
	(0.875)	(1.164)	(1.515)	(0.936)	(0.772)	(0.677)	(0.937)
Observations	764	763	763	764	764	764	764
F-stat first-stage	60.02	57.86	58.01	55.68	59.66	64.16	61.16
			Panel C: Wage gap, OLS				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(ln) City price	-0.601***	-0.861***	-0.738***	-0.529***	-0.392***	-0.870***	-0.675***
	(0.0573)	(0.115)	(0.106)	(0.0632)	(0.0493)	(0.119)	(0.0698)
Observations	764	561	745	755	748	753	764
			Panel D: Wage gap, IV				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(ln) City price	-0.694***	-0.935***	-0.996***	-0.575***	-0.371***	-1.101***	-0.746***
	(0.0761)	(0.139)	(0.114)	(0.0866)	(0.0853)	(0.139)	(0.0887)
Observations	764	561	745	755	748	753	764
F-stat first-stage	59.17	58.67	60.13	59.58	59.73	59.64	57.46
Sample	Docum.	Undocum.	<HS	HS	SC	C	No Lat. Am.

Notes: This table shows regressions of the relative share, in Panels A and B, and the gap in wages between natives and immigrants adjusted for imperfect substitutability between natives and immigrants ($\hat{\phi}_{c,t}$), in Panels C and D, on the size of the city and the city price index. City price indices are computed following Moretti (2013). Panel A and C show OLS regressions, while panel B and D instrument the local price index by the housing supply elasticity estimated in Saiz (2010). This table uses data from the Census 1980-2000 and the combined 2009-2001 ACS. Column (1) only includes documented immigrants. Column (2) only includes undocumented immigrants. Column (3) restricts the sample to high-school dropouts. Column (4) restricts the sample to high-school graduates. Column (5) restricts the sample to workers with some college. Column (6) restricts the sample to workers with a college degree or more. Column (7) excludes immigrants from Latin American countries. Robust standard errors clustered at the metropolitan area are reported. * significant at the 0.10 level; ** significant at the 0.05 level; *** significant at the 0.01 level.

Table 5: Immigration and heterogeneity: exchange rate variation by country of origin

	Panel A: Rel. imm share, PPML						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(ln) RER	0.141*	0.141*	0.153***	0.145***	0.141*	-0.101	-0.0891*
	(0.0792)	(0.0779)	(0.0445)	(0.0392)	(0.0748)	(0.0665)	(0.0532)
(ln) Population in MSA		0.465***	0.314***	-0.0496			
		(0.0727)	(0.112)	(0.219)			
(ln) Population in MSA x (ln) RER			-0.214***	-0.207***			
			(0.0679)	(0.0508)			
(ln) City price					2.119***	1.877***	-0.269*
					(0.285)	(0.347)	(0.154)
(ln) City price x (ln) RER						-0.356***	-0.352***
						(0.122)	(0.102)
Observations	26,700	26,700	26,700	26,700	26,700	26,700	26,700
	Panel B: Wage gap, OLS						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(ln) RER	0.136***	0.135***	0.0125	0.0113	0.135***	0.0306	0.0322
	(0.0102)	(0.01000)	(0.0162)	(0.0163)	(0.0101)	(0.0200)	(0.0198)
(ln) Population in MSA		-0.0418***	-0.0400***	0.0215			
		(0.00252)	(0.00262)	(0.0387)			
(ln) Population x (ln) RER			0.0339***	0.0342***			
			(0.00407)	(0.00415)			
(ln) City price					-0.341***	-0.332***	-0.0134
					(0.0852)	(0.0827)	(0.119)
(ln) City price x (ln) RER						0.0781**	0.0833***
						(0.0305)	(0.0303)
Observations	16,621	16,621	16,621	16,621	16,621	16,621	16,621
R-squared	0.058	0.075	0.154	0.166	0.069	0.146	0.164
Year FE	yes	yes	yes	yes	yes	yes	yes
Origin FE	no	no	yes	yes	no	yes	yes
MSA FE	no	no	no	yes	no	no	yes

Notes: This table shows regressions of relative immigrant shares and wages on population and city prices, real exchange rates (RER), and their interaction. The regressions are limited to the top 100 MSAs in size and 89 sending countries for the years 1990, 2000, and 2010. Standard errors clustered at the MSA-country of origin level are reported. We weight each observation by the number of individuals in a year-MSA-origin cell. * significant at the 0.10 level; ** significant at the 0.05 level; *** significant at the 0.01 level.

Table 6: Immigration and heterogeneity: Mexican Immigrant Flows by state of origin and destination

	(1) Rel. Flows	(2) (ln) Rel. Flows	(3) Rel. Flows	(4) (ln) Rel Flows	(5) Rel. Flows	(6) (ln) Rel. Flows	(7) Rel. Flows	(8) (ln) Rel. Flows
(ln) GDP pc US x (ln) GDP pc Mex	-0.153**	-0.300***	-0.153**	-0.293***	-0.153*	-0.224***	-0.0685***	-0.230***
	(0.0756)	(0.0791)	(0.0756)	(0.0795)	(0.0775)	(0.0669)	(0.0147)	(0.0775)
(ln) GDP pc US	1.995**	4.756***	2.018*	2.598**				
	(0.962)	(0.905)	(1.020)	(1.009)				
(ln) GDP pc Mex	1.766*	2.869***	1.769*	2.798***				
	(0.896)	(0.991)	(0.896)	(0.994)				
(ln) Pop Mex			0.0117	0.126**				
			(0.00726)	(0.0580)				
(ln) Pop US			-0.0238	2.148***				
			(0.0889)	(0.515)				
Observations	1,581	1,457	1,581	1,457	1,581	1,457	1,550	1,426
R-squared	0.158	0.391	0.159	0.452	0.469	0.826	0.407	0.813
Origin FE	no	no	no	no	yes	yes	yes	yes
Destination FE	no	no	no	no	yes	yes	yes	yes
Including California	yes	yes	yes	yes	yes	yes	no	no

Notes: This table shows the results of regressing the flows of immigrants from origin i to destination j relative to all migrants from Mexican state i on the GDP per capita at destination (j), at origin (i), and the interaction between the two. We also control for total population at origin and destination. The data covers 31 sending Mexican states and 51 receiving US states. Columns (7) and (8) exclude the largest destination state (California) from the regression. Data from the Matricula Consular 2016. Robust standard errors clustered at the destination level are reported. * significant at the 0.10 level; ** significant at the 0.05 level; *** significant at the 0.01 level.

Table 7: Immigrants' wages before and after amnesty

	(1) (ln) Wage	(2) (ln) Wage	(3) (ln) Wage	(4) (ln) Wage	(5) (ln) Wage	(6) (ln) Wage
(ln) Population in MSA x Immigrant	-0.0349***	-0.0443***				
	(0.0118)	(0.0116)				
(ln) Population in MSA x Before 82			0.00954***			
			(0.00318)			
(ln) City price x Immigrant				-0.393**	-0.460***	
				(0.168)	(0.161)	
(ln) City price x Before 82						0.120***
						(0.0308)
Convergence rate (35 - years in US)	-0.00299***	-0.00378***	-0.0163***	-0.0102***	-0.0108***	-0.0207***
	(0.000900)	(0.000977)	(0.00169)	(0.00332)	(0.00272)	(0.00204)
Observations	1,196,666	1,191,573	114,817	1,196,666	1,191,573	114,817
R-squared	0.235	0.238	0.145	0.240	0.242	0.149
Xs	yes	yes	yes	yes	yes	yes
Sample	Before 82	After 82	Immigrants	Before 82	After 82	Immigrants

Notes: These regressions use Census 1990 data. In columns 1 and 4, the comparison is between immigrants arrived prior to 1982 and natives. In columns 2 and 5, the comparison is between immigrants arrived after 1982 and natives. Column 3 and 6, compare immigrants arriving before and after 1982. Figure D.6 in the Appendix shows the regression in Column 6 for each year of arrival. Robust standard errors clustered at the metropolitan are level are reported. * significant at the 0.10 level; ** significant at the 0.05 level; *** significant at the 0.01 level.

Table 8: Immigrants' expenditure

	Panel A: Consumer Expenditure Survey data			
	(1)	(2)	(3)	(4)
	(ln) Total Expenditure	(ln) Total Expenditure	(ln) Total Expenditure	(ln) Total Expenditure
Mexican	-0.325***	-0.382***	-0.149***	-0.226***
	(0.027)	(0.021)	(0.012)	(0.012)
Observations	105,975	105,975	105,975	105,975
R-squared	0.015	0.063	0.301	0.312
Year FE	no	yes	yes	yes
State FE	no	yes	yes	yes
Income	no	no	yes	yes
Characteristics	no	no	no	yes

	Panel B: Consumer Expenditure Survey data			
	(1)	(2)	(3)	(4)
	(ln) Rents	(ln) Rents	(ln) Rents	(ln) Rents
Mexican	-0.222***	-0.299***	-0.097***	-0.182***
	(0.059)	(0.025)	(0.023)	(0.021)
Observations	105,975	105,975	105,975	105,975
R-squared	0.006	0.079	0.226	0.244
Year FE	no	yes	yes	yes
State FE	no	yes	yes	yes
Income	no	no	yes	yes
Characteristics	no	no	no	yes

	Panel C: Census and ACS data			
	(1)	(2)	(3)	(4)
	(ln) Monthly rent	(ln) Monthly rent	(ln) Monthly rent	(ln) Monthly rent
Immigrant	-0.145***	-0.0741***	-0.110***	
	(0.0184)	(0.0146)	(0.0236)	
Immigrant x (ln) City price			0.0383	
			(0.0318)	
(ln) RER				0.0711***
				(0.0155)
(ln) HH income		0.271***	0.270***	0.236***
		(0.00486)	(0.00549)	(0.00551)
Observations	903,825	903,825	903,825	204,276
Year FE	yes	yes	yes	yes
MSA FE	yes	yes	no	yes
Sample	all	all	all	Imm. only

Notes: Panel A shows regressions with log monthly gross rents as dependent variable using Census 1990-2000 and ACS 2005-2011 data of male household heads. Additional controls include dummies for the number of family members living in the household, marital status and age. Panel B shows regressions with log total expenditure as dependent variable using data from the Consumer Expenditure Survey. The income controls included in column 3 are dummies for household income bins. The characteristics added in column 4 include race, occupation, family size and marital status. Standard errors are clustered at the MSA level in panel A and at the state level in panel B. * significant at the 0.10 level; ** significant at the 0.05 level; *** significant at the 0.01 level.

Table 9: Calibrated parameters and structural estimates of the model

Variable	Value	Source
Share of consumption on tradable goods (α_t)	0.4	Components of CPI-U (see text)
Workers' bargaining weight (β)	0.2	Lise et al. (2016)
Share of home goods consumption (α_f)	0.21	Estimated
Sensitivity to local conditions (λ)	0.012	Estimated
Elasticity of substitution home-local goods (σ)	1.61	Estimated
Amenity levels (A_c)		Albouy (2016)
Productivity levels (B_c)		Albouy (2016)
Housing supply elasticities (η_c)		Saiz (2010)
Local agglomeration forces (a)	0.05	Combes and Gobillon (2014)

Notes: This table shows the estimates of the structural parameters of the model. The structural parameters of the model are the set of parameters that minimize the distance between the model and the data. For this exercise we only use data on wages and distributions of workers across locations at the country-of-origin level, taking as given the parameters borrowed from prior literature.

Table 10: Predicted aggregate effects of immigration

	Δ Labor productivity	Δ Native workers' welfare	Δ House owners' welfare
		No agglomeration forces	
Counterfactual 1: 20% increase in population	-0.47	-0.84	3.58
Counterfactual 2: 20% immigrant-induced increase in population	0.64	-0.21	2.65
Difference:	1.11	0.63	-0.93
		Agglomeration forces	
Counterfactual 1: 20% increase in population	0.55	-0.58	3.49
Counterfactual 2: 20% immigrant-induced increase in population	1.85	0.00	2.71
Difference:	1.30	0.58	-0.78

Notes: This table shows the aggregate consequences of new immigration under two different counterfactuals. In Counterfactual 1 we assume that new immigrants consume like natives. In Counterfactual 2 we assume that new immigrants spend 21 percent of their income in their country of origin, as estimated. This table reports the aggregate consequences of these two counterfactuals on three outcomes: average labor productivity, average native worker's welfare, and average house owner's welfare. We report results assuming no agglomeration forces and agglomeration forces of 5%. The difference between Counterfactual 1 and Counterfactual 2 is the effect of immigration on the three outcomes of interest.

A Empirical Appendix

A.1 Return migration

A final and very important reason why immigrants care about price indices in their home country is that many of them likely plan to return home at some point during their lifetime (Dustmann and Gorlach 2016; Lessem 2018; Dustmann and Weiss 2007; Dustmann 2003, 1997).

To the best of our knowledge, there are no large, representative data sets directly documenting return migration patterns. This would require observations in both the destination country and the home country over a certain period of time. While there are some data sets that make this possible, they are generally not very comprehensive.

To obtain a better sense of general return migration patterns in the United States, we turn to Census data. In particular, we can track the size of cohorts of immigrants and natives across Censuses and use information on immigrants' year of arrival to see how many of them are "missing" in the following Census, and thus likely to have returned to their home countries.

The left-hand graph in Figure D.2 plots these survival rates by age cohort. We observe that more than 98% of the natives aged between 25 and 30 in 2000 are still present in the 2010 ACS. This survival rate declines with age. For example, for the population that in 2000 was between 45 and 50 years old, the survival rate decreases to around 94%. When we carry out the same exercise for immigrants who arrived in the United States before 2000, the survival rates decline substantially with respect to natives.[50]

Figure D.2 goes around here

In the graph on the right-hand side, we estimate return migration rates by taking the difference in survival rates between immigrants and natives. This is a good estimate if mortality rates for the same age cohort are similar in both immigrants and natives. We observe that return migration is likely to be very high for younger cohorts and converges to 0 for older cohorts, perhaps reflecting that as immigrants grow old in the host country, their ties to the home country gradually diminish. The estimates show that more than 10% of the immigrant population aged between 25 and 30 in 2000 are no longer in the United States by 2010. We begin the series at age 25, since these immigrants are already likely to be working in the United States. Return migration rates are even higher for younger cohorts.

This means that for a large number of immigrants, future consumption takes place in a country other than the United States – possibly their home country. Thus, given that immigrants are likely to return and to care about future consumption, return migration patterns give additional support to the idea that immigrants partly take into account the price index in their country of origin when choosing their optimal location in the United States.

[50] We use the years 2000 and 2010 because there are strong reasons to suspect that there is some undercount of immigrants in Censuses prior to 2000. For example, the number of Mexican immigrants who claim to have arrived before 1990 in the 2000 Census is larger than the total number of Mexicans observed in the 1990 Census. See also Hanson (2006).

A.2 Robustness to alternative mechanisms

In this subsection, we investigate a number of alternative hypotheses that could potentially drive the patterns we have documented so far. In particular, we show that endogenous population, immigrant networks, human capital, imperfect substitutability to natives, legal status or job finding prospects in larger cities are unlikely explanations for our findings.

A.2.1 Endogeneity of population levels

One concern about the results shown in the main text is that we use the total population in an MSA as a running variable to explain our facts, which obviously includes immigrants (note that his concern only applies to the results where we use population as dependent variable, not prices that we instrument with local housing supply elasticities). Hence, there might some endogeneity between relative outcomes of immigrants and a measure, in which immigrants are also included.

To show that this is not driving our results, we estimate equation (3.2), but with native population, lagged total population and lagged native population instead of total population.

Table F.1 goes around here

Table F.1 shows that using native or lagged population instead results in similar relationships between city size and native-immigrant wage gaps.

A.2.2 Immigrant networks

An alternative explanation for the relationship between immigrants' earnings and city size could be that immigrants earn less in large cities because of the presence of larger immigrant communities there. If immigrants perceive communities of their country of origin as a positive amenity, they could potentially accept lower wages in large, expensive cities because they are compensated through immigrant-network amenities. If this were the only mechanism at play, we would expect the relationship between wage gaps and city size to become stronger over time, which we do not see. On the other hand, Patel and Vella (2013) show that new immigrants tend to choose the same occupations as their compatriots who live in the same region and that this has a positive effect on their earnings. Whichever is the direction of the network effect on wages, it is worth investigating the importance of migrant networks in greater depth.

To do so, we estimate (2.1) again at the skill-city-origin-time level as described in section 3.2.1 but additionally control for the immigrant network. Specifically, we estimate:

$$\ln(\frac{w_{I,k,o,c,t}}{w_{N,k,c,t}}) = \phi_k + \phi_o + \phi_{c,t} + \gamma \ln(\frac{L_{I,k,c,t}}{L_{N,k,c,t}}) + \gamma_2 ImmigNetwork_{o,c,t} + \varepsilon_{i,t}, \tag{A.1}$$

For each origin o, we construct the network as the MSA population share of immigrants from that origin: $ImmigNetwork_{p,c,t} = \frac{Pop_{o,c,t}}{Pop_{c,t}}$. Thus, the newly estimated city-specific wage gap component $\tilde{\phi}_{c,t}$

does not capture any variation in the wage gap across cities that might be due to variation in immigrant networks.[51]

Table F.2 goes around here

Table F.2 shows the results of estimating (3.2) with $\tilde{\phi}_{c,t}$ as dependent variable. Sign and significance of the coefficients remain unchanged, while their magnitudes are somewhat smaller in columns (3) and (6) compared to those in Panel B of Table 3.

A.2.3 Unemployment and job finding rates

So far, we have only considered employed individuals earning a salary in our data samples. However, the location decisions of workers are not only affected by how much they can potentially earn, but also by how long it takes to find a job. Job finding prospects might be even more important for immigrants as their opportunity costs of working are often higher (e.g., they may not be able to rely on relatives or friends during a period without income, and it is harder for them to claim unemployment benefits).[52] Thus, immigrants might opt for locations where they have to spend less time searching for a job. Due to the higher variety of jobs, this might attract immigrants to larger cities. If immigrants settling in these cities are the ones with the higher opportunity cost of working, and if this induces them to accept lower wages or worse job matches than natives, this could explain why the wage gap increases with city size.

If this mechanism is at play, we would expect immigrants to have relatively lower unemployment rates in larger or more expensive cities. We investigate this in panel A of Figure D.3, in which we plot the unemployment rates of immigrants, averaged from CPS monthly data over the period 1995-2005, against city characteristics in the year 2000.[53] For both city size and price index, the relationship is flat, indicating that immigrants do not gain in terms of employment in larger or more expensive cities.

If the transition rates between employment and unemployment (i.e., both job finding and separation rates) are higher in larger cities, this might result in immigrant unemployment rates of similar magnitude as in smaller cities. However, if immigrants care more about finding a job than about the job's duration (to establish an employment history, for instance), then they would still be drawn to larger cities. In panel B, we therefore plot monthly immigrant job finding rates instead of unemployment rates against city characteristics.[54] The plots show a slightly negative relationship, suggesting that unemployment duration actually increases with city size or price index.

[51] We find γ_2 to be statistically significant and equal to -2.3. As argued by Borjas (2015), migrant networks may be detrimental to immigrant wages. Our estimates suggest that a network that is 1% larger is associated with 2% lower wage of immigrants relative to natives. This negative relationship can be interpreted as evidence that immigrant networks are detrimental to immigrant assimilation into the labor market or as evidence to the fact that migrant networks may be a positive amenity for immigrants; thus, when living in larger networks, immigrants may be willing to work for a lower wage.

[52] This is especially the case for newly arrived immigrants who need to establish a history of employment first or for undocumented immigrants who are ineligible for unemployment benefits altogether.

[53] As city prices are only available in 2000 or from 2005 onwards, we chose to average the CPS data during 11 years symmetrically around the year 2000 in order to get a sufficient number of observations of unemployed individuals per city. The results are robust to considering different time periods.

[54] The job finding rate is calculated as the fraction of all unemployed individuals in a given month that is employed in the following month. In order to link individuals across months (whenever possible), we use the person identifier available from IPUMS.

Figure D.3 goes around here

Altogether, the figures indicate that unemployment or job finding rates are unlikely drivers of the location choices and wage gaps of immigrants.

A.2.4 Skewness and kurtosis in larger cities

In this subsection we investigate whether city size or city prices are systematically related to fatter tails of the wage distribution (kurtosis) or larger-than-expected left or right tails (skewness). Eeckhout et al. (2014) show that there seems to be a strong complementarity between high- and low-skilled workers, which can explain fatter tails in larger cities relative to smaller ones in terms of skills. They show that this is the case even when removing all immigrants from their exercise.

To investigate whether the evidence presented in this paper is affected by these fatter tails identified in Eeckhout et al. (2014) we plot the skewness and kurtosis of the distribution of wages (not skills) of natives in each location against city size and city price levels.

Figure D.4 goes around here

Figure D.4 shows that there does not seem to be a systematic relationship between skewness and kurtosis and city size.

A.3 Commuting zones

This section shows that the main relationship between location choices and relative wages between natives and immigrants documented throughout the paper is independent of using MSA-level data or commuting zone data. Commuting zones are equivalent to MSAs when we consider urban population. There are, however, many commuting zones that are rural areas, which are not covered in the MSA data. While in our context it seems quite natural to think about MSAs, some papers have emphasized the use of local labor markets – typically measured by commuting zones – so that rural areas are also included.

The two graphs shown in Figure D.5 show that immigrants concentrate in large commuting zones and that their wages relative to natives are lower there. All other results that we have checked are unchanged when using commuting zones instead of MSAs.

Figure D.5 goes around here

A.4 Home ownership

If immigrants plan on returning to their countries of origin it is likely that ownership rates are lower among them. Ownership rates vary considerably by income and other characteristics. Thus, it may be useful to see if it is indeed the case that home ownership rates are lower among immigrants than *similar-looking* natives. This can be shown with the following regression:

$$\text{Owner}_i = \alpha + \beta \text{Immigrant}_i + \gamma \ln \text{Household Income}_i + \eta_c X_i + \varepsilon_i \tag{A.2}$$

where "Owner" indicates whether the head of household i is a homeowner or not, Immigrant_i is a dummy indicating that household i has at least one immigrant, and X_i denote various household characteristics, like the education level of the head of the household, marital status, the race of the head of the household, the size of the household, MSA fixed effects, occupation fixed effects, and time fixed effects. Thus, β identifies whether immigrants tend to rent rather than own the house in which they live relative to similar-looking natives.

Table F.4 goes around here

The results are shown in Table F.4, using Census and ACS data. It is apparent that immigrants are around 10 percentage points less likely to own the house in which they reside.

B A friction-less spatial equilibrium model

B.1 A standard Rosen-Roback spatial equilibrium model

In any free mobility spatial equilibrium model, natives decide on locations based only on indirect utility, which, when abstracting from amenity levels, depends only on real wages. The free mobility condition implies that real wages will be equalized across locations. We can denote the real wage in city c as $v_c = w_c/p_c$, where w_c is the (nominal) wage in city c and p_c is the price index in this city. Thus, in equilibrium we have:

$$v_c = w_c/p_c = w_{c'}/p_{c'} = v_{c'} \text{ for any } c \text{ and } c' \in C. \tag{B.1}$$

In this context, a spatial equilibrium model is simply a theory that relates wages and prices (or more generally, indirect utility) to population levels in each location: $w_c = w_c(L_c)$ and $p_c = p_c(L_c)$ (or $v_c = v_c(L_c)$). With this in hand, the free mobility condition determines the spatial distribution of people. Denoting by L_c the amount of people in location c, we can implicitly define the distribution of people across locations with the following C equations:

$$w_c(L_c)/p_c(L_c) = w_{c'}(L_{c'})/p_{c'}(L_{c'}) \text{ for any c and c' }, L = \sum_c L_c. \tag{B.2}$$

For an equilibrium to exist we need to make sure that $v_c'(L_c) < 0$ (i.e., that real wages are declining in population).[55]

B.2 A Rosen-Roback spatial equilibrium model with immigration

B.2.1 Basic set-up

What we propose in this paper is that immigrants have an extra good that determines the price index that is relevant to them. To keep things simple, in this version we only consider immigrants from one country of origin, with a price level given by p_j. This means that an immigrant who lives in city c faces a price index given by $p_{jc} = p^I(p_c, p_j)$, where $p^I(.,.)$ is a function homogeneous of degree 1 that combines the local price index in c with the price index in the home country p_j. We assume that $p^I(.,.)$ is increasing in both p_c and p_j. Immigrants, like natives, choose their location by comparing real wages across space. In equilibrium:

$$w_{jc}/p^I(p_c, p_j) = w_{jc'}/p^I(p_{c'}, p_j) \text{ for any } c \text{ and } c' \in C, \tag{B.3}$$

where for the moment we allow immigrants to receive a wage in c different than the native wage w_c. With immigrants, the local price index and local wages are a function of native and immigrant communities. In this case, the standard spatial equilibrium model is modified slightly. In particular, we can define a spatial equilibrium as follows.

[55] With two cities, the proof is almost trivial. For an equilibrium to exist where population is spread across locations, we only need the following: 1) $v_c(L) < v_{c'}(1-L), \forall c, c'$, and $v_c'(.) < 0$. Then the existence of a distribution of people across locations follows from a standard application of Bolzano's theorem.

Definition I. *Given C cities or locations, a spatial equilibrium is characterized by a mapping that determines native wages in a city given its population, a mapping that determines local prices in a city given its population, and a homogenous of degree 1 function $p^I(.,.)$ that determines the immigrant price index given the local price index p_c and the price index at origin p_j, such that the following conditions hold:*

$$\begin{aligned}
\textit{Natives free mobility: } & \frac{w_c(N_c, I_c)}{p_c(N_c, I_c)} = \frac{w_{c'}(N_{c'}, I_{c'})}{p_{c'}(N_{c'}, I_{c'})}, && \forall c, c' \in C \\
\textit{Immigrants free mobility: } & \frac{w_{jc}(N_c, I_c)}{p^I(p_c(N_c, I_c), p_j)} = \frac{w_{jc'}(N_{c'}, I_{c'})}{p^I(p_{c'}(N_{c'}, I_{c'}), p_j)}, && \forall c, c' \in C \\
\textit{Natives clearing condition: } & N = \sum_c N_c \\
\textit{Immigrants clearing condition: } & I = \sum_c I_c
\end{aligned}$$

where N_c and I_c denote native and immigrant populations in location c.

This is a general model. In order to derive some properties we make a number of assumptions that we argue are not strong and very often can be relaxed.

Assumption. ***Perfect substitutability.*** *Natives and immigrants are perfect substitutes in production.*

This assumption means that natives and immigrants can perform the exact same tasks. With perfect competition in the labor market, this necessarily implies that wages are the same (up to a constant) between natives and immigrants and given by: $w_c(N_c, I_c) = w_c(N_c + I_c) = w_c(L_c)$ and $w_{jc'}(N_{c'}, I_{c'}) = w_{jc'}(N_{c'} + I_{c'}) = w_{jc'}(L_{c'})$, where L_c is the total population in c. In Section 4, we depart from perfect competition in the labor market, which allows wages of perfectly substitutable workers to be different in equilibrium.

Assumption. ***Common production technology.*** *The production technology only differs across locations with a technological shifter ($B_c > 0$) that is orthogonal to wages. This is:*

$$w_c(B_c, L_c) = B_c w(L_c), \textit{ and } w_{jc}(B_c, L_c) = B_c w^I(L_c)$$

and $w(.)$ and $w^I(.)$ are decreasing in their arguments, continuous and differentiable.

This assumption simply removes the potential heterogeneity coming from the c-specific functions $w_c(.)$ and $w_{jc}(.)$. Similarly for price indices:

Assumption. ***Common production of housing*** *The production technology for building housing is identical across locations. This is:*

$$p_c(N_c, I_c) = p(N_c, I_c)$$

and $p(.,.)$ is increasing in their arguments, continuous and differentiable.

Note that there is a difference in what we assume for the labor and housing or local goods' market. Assuming that natives and immigrants are perfect substitutes means that the wages schedules only depend on total population L_c. Assuming this for local prices is a bit more sensitive. Immigrants have an extra consumption good, and therefore less of their income is left to consume local goods. Hence, the effect on local prices may be different than that of natives. To keep this possibility, we do not take a stance, for the moment, on how $p(.,.)$ depends on its two arguments.

B.2.2 Immigrant locations and wage gaps

With these assumptions we can derive a number of results. For simplicity we concentrate on the case of just two cities, so that $C = 2$.

Proposition 5. *All else equal, more productive cities (higher B_c) are larger, pay higher wages, and are more expensive.*

Proof. Suppose $B_c > B_{c'}$.

To show that c is larger than c', we need to look at the free mobility condition. From that we have that: $\frac{B_c w(N_c+I_c)}{p(N_c,I_c)} = \frac{B_{c'} w(N_{c'}+I_{c'})}{p(N_{c'},I_{c'})}$, so that $\frac{w(N_c+I_c)}{p(N_c,I_c)} / \frac{w(N_{c'}+I_{c'})}{p(N_{c'},I_{c'})} = \frac{B_{c'}}{B_c}$, but this is $f(N_c, I_c)/f(N_{c'}, I_{c'}) = \frac{B_{c'}}{B_c}$ where $f(.,.)$ is decreasing in N_c and I_c.

To see that larger cities pay higher wages, we only need to realize that natives' wage are given by $w_c = B_c w(N_c, I_c) > B_{c'} w(N_{c'}, I_{c'})$ if and only if $B_c/B_{c'} > w(N_{c'}, I_{c'})/w(N_c, I_c)$, which needs to be the case since N_c is greater than N'_c at equal levels of immigration.

Local prices are increasing in native and immigrant population whenever higher wages generate more demand for local goods.

□

The intuition for this result is simple. When a location is more productive, wages can be higher and still remain competitive. If wages are higher, more workers will choose this location. This will put some pressure on wages, but not enough to make wages lower than in other locations, since workers could then move elsewhere. Similarly, with more workers in the location, local price indices increase. But this effect cannot be too large, since otherwise not so many workers would choose the location, and hence, the pressure on local prices would not be so strong. In other words, better underlying productivity is partly reflected in quantities (i.e., amount of workers in the location) and partly on prices. The local labor-demand elasticity and the local price-index elasticity to population determine how much underlying productivity is reflected in quantities versus prices.

Next, we turn to our central claim. When immigrants have an extra consumption good that is not included in the local price index, then they have a comparative advantage for living in productive locations. If wages partly reflect the value of living in the location (i.e., if wage determination is such that $w_{jc} = w(v_{jc})$), then part of the comparative advantage that immigrants have for living in productive cities is reflected in wages.

Proposition 6. *Under the assumptions stated above, it can be shown that:*

1. *Immigrants concentrate more than natives in highly productive cities*

2. Immigrants' wages are lower than natives' wages in highly productive cities

And these results are stronger for low p_j countries of origin if substitution effects dominate.

Proof. Assume $C = 2$ and suppose that $B_1 > B_2$. With two cities, the definition of a spatial equilibrium is given by the following set of equations.

$$\begin{aligned}
\text{Natives free mobility: } & \frac{B_1 w(N_1 + I_1)}{p(N_1, I_1)} = \frac{B_2 w(N_2 + I_2)}{p(N_2, I_2)} \\
\text{Immigrants free mobility: } & \frac{B_1 w^I(N_1 + I_1)}{p^I(p(N_1 + I_1), p_j)} = \frac{B_2 w^I(N_2 + I_2)}{p^I(p(N_2, I_2), p_j)} \\
\text{Natives clearing condition: } & N = N_1 + N_2 \\
\text{Immigrants clearing condition: } & I = I_1 + I_2
\end{aligned}$$

From these equations we obtain that:

$$\frac{\frac{w(N_1+I_1)}{p(N_1,I_1)}}{\frac{w(N_2+I_2)}{p(N_2,I_2)}} = \frac{\frac{w^I(N_1+I_1)}{p^I(p(N_1+I_1),p_j)}}{\frac{w^I(N_2+I_2)}{p^I(p(N_2,I_2),p_j)}} = \frac{\frac{w^I(N_1+I_1)}{p(N_1+I_1)p^I(1,p_j/p_1)}}{\frac{w^I(N_2+I_2)}{p(N_2,I_2)p^I(1,p_j/p_2)}}$$

Hence:

$$\frac{w(N_1 + I_1)}{w(N_2 + I_2)} = \frac{\frac{w^I(N_1+I_1)}{p^I(1,p_j/p_1)}}{\frac{w^I(N_2+I_2)}{p^I(1,p_j/p_2)}} = \frac{w^I(N_1 + I_1)}{w^I(N_2 + I_2)} \frac{p^I(1, p_j/p_2)}{p^I(1, p_j/p_1)}$$

Which we can re-express as:

$$\frac{w(N_1 + I_1)}{w(N_2 + I_2)} = \frac{w^I(N_1 + I_1)}{w^I(N_2 + I_2)} \frac{1/p^I(1, p_j/p_1)}{1/p^I(1, p_j/p_2)}$$

Taking logs

$$\ln w(N_1 + I_1) - \ln w(N_2 + I_2) = (\ln w^I(N_1 + I_1) - p^I(1, p_j/p_1)) - (\ln w^I(N_2 + I_2) - \ln p^I(1, p_j/p_2)$$

And using $L_c = N_c + I_c$

$$\ln w(L_1) - \ln w(L_2) = (\ln w^I(L_1) - \ln p^I(1, p_j/p_1)) - (\ln w^I(L_2) - \ln p^I(1, p_j/p_2)$$

Finally we have that:

$$[\ln w(L_1) - \ln w^I(L_1)] - [\ln w(L_2) - \ln w^I(L_2)] = -[\ln p^I(1, p_j/p_1)) - \ln p^I(1, p_j/p_2)]$$

Now, since $B_1 > B_2$, then $L_1 > L_2$. This expression says that, holding L_1 and L_2 constant, the gap in wages between natives and immigrants in large locations relative to small locations is proportional to the immigrant-specific price index of living in a large location relative to a small location. Given that the

price index $p^I()$ is increasing in its arguments, this means that large cities have either larger immigrant populations or higher wage gaps, and this is more pronounced the lower p_j is.

□

To gain some intuition on these results, it is worth discussing some extreme cases. One such case is forcing immigrants and natives to receive the same wage in each location. In this case, immigrants want to live in the most expensive city. That is, suppose $p_c > p_{c'}$. Then an immigrant from j prefers to live in c over c' if and only if:

$$w_c/p^I(p_c, p_j) > w_{c'}/p^I(p_{c'}, p_j)$$

which is true if and only if

$$1 > p^I(1, p_j/p_c)/p^I(1, p_j/p_{c'})$$

and this holds since $p^I(.,.)$ is homogeneous of degree one in their two arguments and because natives' mobility condition imposes $w_c/p_c = w_{c'}/p_{c'}$. In turn, given that $p^I(.,.)$ is increasing in both arguments, this last inequality holds only when $p_c > p_{c'}$.

Another extreme case takes place when wages of immigrants completely "exhaust" the comparative advantage that they have in a location. That is, immigrants do not have an incentive to choose c over c' if the immigrant wage function $w^I(.,.)$ is such that

$$w_{jc}/p^I(p_c, p_j) = w_{jc'}/p^I(p_{c'}, p_j)$$

The relative wages in the two locations are therefore

$$w_{jc}/w_{jc'} = p^I(p_c, p_j)/p^I(p_{c'}, p_j) < w_c/w_{c'}$$

The last inequality follows from natives' free mobility condition and $p^I(1, p_j/p_c)/p^I(1, p_j/p_{c'}) < 1$ when $p_c > p_{c'}$. Thus, for a spatial equilibrium with immigrants not concentrating more than natives in the highly productive cities to exist, we must have that immigrants' nominal wages increase *less* with local price levels than natives' wages.

B.2.3 Immigrants and local prices

The final result investigates the effect of immigration on local price indices across locations.

Proposition 7. *The effect of immigration on local prices is ambiguous. On the one hand, immigrants have higher incentives to live in large and expensive cities, putting pressure on local prices in these cities. On the other hand, they consume a smaller fraction of their income locally, reducing the pressure on local prices.*

The intuition for this result is as follows. The demand for local goods by natives is driven by the share of consumption that takes place locally. Hence, aggregate local demand by natives is given by $D_c^N = w_c N_c$, while aggregate demand for local goods from immigrants is given by $D_c^I = (1 - \bar{\alpha}_f) w_c^I I_c$,

where we made the simplifying assumptions that there are no tradable goods, and where $\bar{\alpha}_f$ is the share of immigrant consumption that is related to the home country. Total supply of local goods is given by $F(L_c)$ since natives and immigrants are perfect substitutes. Hence goods market clearing implies that:

$$w_c N_c + (1-\bar{\alpha}_f) w_c^I I_c = p_c F(L_c)$$

Totally differentiating this expression with respect to immigrants and assuming $\bar{\alpha}_f$ is fixed – as it would be with Cobb-Douglas preferences – we obtain:

$$\frac{\partial w_c}{\partial I_c} N_c + w_c \frac{\partial N_c}{\partial I_c} + (1-\bar{\alpha}_f)\frac{\partial w_c^I}{\partial I_c} I_c + (1-\bar{\alpha}_f) w_c^I = \frac{\partial p_c}{\partial I_c} F_c(L_c) + p_c \frac{\partial F(L_c)}{\partial I_c}$$

We can further assume that immigrants do not affect wages, and hence obtain:

$$\frac{\partial p_c}{\partial I_c} = \frac{(1-\bar{\alpha}_f) w_c^I + w_c \frac{\partial N_c}{\partial I_c} - p_c \frac{\partial F(L_c)}{\partial I_c}}{F_c(L_c)}$$

This equation shows that immigrants increase local price indices, if the increased local demand from immigrants ($(1-\bar{\alpha}_f) w_c^I$) is not offset by the potential decrease in demand from natives leaving the location ($w_c \frac{\partial N_c}{\partial I_c}$) and the contribution of immigrants to new local production ($p_c \frac{\partial F(L_c)}{\partial I_c}$).

C Theory Appendix

C.1 Derivation of indirect utility

The utility in location c for an individual i from country of origin j can be written as:

$$\begin{aligned} &\ln U_{ijc} = \rho + \ln A_c + \alpha_t \ln C_{jc}^T + (1-\alpha_t)\frac{\sigma}{\sigma-1} \ln\left(\bar{\alpha}_l (C_{jc}^{NT})^{\frac{\sigma-1}{\sigma}} + \bar{\alpha}_f (C_j^{NT})^{\frac{\sigma-1}{\sigma}}\right) + \varepsilon_{ijc} \\ &\text{s.t. } C_{jc}^T + p_c C_{jc}^{NT} + p_j C_j^{NT} \leq w_{jc} \end{aligned}$$

We can solve the maximization problem in two stages:

- **Stage 1**: Define an auxiliary variable E and find the optimal decisions $C_{jc}^{NT*}(p_c, p_j, E)$ and $C_j^{NT*}(p_c, p_j, E)$ to the following maximization problem

$$\begin{aligned} &\max \ (1-\alpha_t)\frac{\sigma}{\sigma-1} \ln\left(\bar{\alpha}_l (C_{jc}^{NT})^{\frac{\sigma-1}{\sigma}} + \bar{\alpha}_f (C_j^{NT})^{\frac{\sigma-1}{\sigma}}\right) \\ &\text{s.t. } p_c C_{jc}^{NT} + p_j C_j^{NT} = E \end{aligned}$$

  Let

$$\tilde{V}(p_c, p_j, E) = (1-\alpha_t)\frac{\sigma}{\sigma-1} \ln\left(\bar{\alpha}_l (C_{jc}^{NT*})^{\frac{\sigma-1}{\sigma}} + \bar{\alpha}_f (C_j^{NT*})^{\frac{\sigma-1}{\sigma}}\right)$$

- **Stage 2**: Solve for $C_j^{T*}(p_c, p_j, w_{jc})$ and $E^*(p_c, p_j, w_{jc})$ of the maximization problem

$$\begin{aligned}
&\max\ \rho + \ln A_c + \alpha_t \ln C_{jc}^T + \tilde{V}(p_c, p_j, E) \\
&\text{s.t. } C_{jc}^T + E \leq w_{jc}
\end{aligned}$$

Stage 1

$$\begin{aligned}
&\max\ \ (1-\alpha_t)\frac{\sigma}{\sigma-1}\ln\left(\bar{\alpha}_l (C_{jc}^{NT})^{\frac{\sigma-1}{\sigma}} + \bar{\alpha}_f (C_j^{NT})^{\frac{\sigma-1}{\sigma}}\right) \\
&\text{s.t. } p_c C_{jc}^{NT} + p_j C_j^{NT} = E
\end{aligned}$$

The associated Lagrangian is

$$\mathcal{L} = (1-\alpha_t)\frac{\sigma}{\sigma-1}\ln\left(\bar{\alpha}_l (C_{jc}^{NT})^{\frac{\sigma-1}{\sigma}} + \bar{\alpha}_f (C_j^{NT})^{\frac{\sigma-1}{\sigma}}\right) + \lambda(E - p_c C_{jc}^{NT} - p_j C_j^{NT})$$

First-order conditions are given by

$$\begin{aligned}
\frac{\partial \mathcal{L}}{\partial C_{jc}^{NT}} &: \ \frac{(1-\alpha_t)\bar{\alpha}_l (C_{jc}^{NT})^{\frac{-1}{\sigma}}}{\bar{\alpha}_l (C_{jc}^{NT})^{\frac{\sigma-1}{\sigma}} + \bar{\alpha}_f (C_j^{NT})^{\frac{\sigma-1}{\sigma}}} - p_c\lambda = 0 \\
\frac{\partial \mathcal{L}}{\partial C_j^{NT}} &: \ \frac{(1-\alpha_t)\bar{\alpha}_f (C_j^{NT})^{\frac{-1}{\sigma}}}{\bar{\alpha}_l (C_{jc}^{NT})^{\frac{\sigma-1}{\sigma}} + \bar{\alpha}_f (C_j^{NT})^{\frac{\sigma-1}{\sigma}}} - p_j\lambda = 0
\end{aligned}$$

Dividing the two first-order conditions, we obtain the following relationship:

$$\frac{\bar{\alpha}_l}{\bar{\alpha}_f}\left(\frac{C_{jc}^{NT}}{C_j^{NT}}\right)^{\frac{-1}{\sigma}} = \frac{p_c}{p_j} \Rightarrow C_{jc}^{NT} = \left(\frac{\bar{\alpha}_f p_c}{\bar{\alpha}_l p_j}\right)^{-\sigma} C_j^{NT}$$

Using this relationship and the budget constraint, we find

$$\begin{aligned}
C_{jc}^{NT} &= \frac{\left(\frac{p_c}{\bar{\alpha}_l}\right)^{-\sigma}}{p_c\left(\frac{p_c}{\bar{\alpha}_l}\right)^{-\sigma} + p_j\left(\frac{p_j}{\bar{\alpha}_f}\right)^{-\sigma}} E \\
C_j^{NT} &= \frac{\left(\frac{p_j}{\bar{\alpha}_f}\right)^{-\sigma}}{p_c\left(\frac{p_c}{\bar{\alpha}_l}\right)^{-\sigma} + p_j\left(\frac{p_j}{\bar{\alpha}_f}\right)^{-\sigma}} E
\end{aligned}$$

Thus, the maximized objective function is

$$\begin{aligned}
\tilde{V} &= (1-\alpha_t)\frac{\sigma}{\sigma-1}\ln\left(\bar{\alpha}_l\left(\frac{\left(\frac{p_c}{\bar{\alpha}_l}\right)^{-\sigma}}{p_c\left(\frac{p_c}{\bar{\alpha}_l}\right)^{-\sigma} + p_j\left(\frac{p_j}{\bar{\alpha}_f}\right)^{-\sigma}}E\right)^{\frac{\sigma-1}{\sigma}} + \bar{\alpha}_f\left(\frac{\left(\frac{p_j}{\bar{\alpha}_f}\right)^{-\sigma}}{p_c\left(\frac{p_c}{\bar{\alpha}_l}\right)^{-\sigma} + p_j\left(\frac{p_j}{\bar{\alpha}_f}\right)^{-\sigma}}E\right)^{\frac{\sigma-1}{\sigma}}\right) \\
&= (1-\alpha_t)\ln E + (1-\alpha_t)\frac{1}{\sigma-1}\ln\left(p_c\left(\frac{p_c}{\bar{\alpha}_l}\right)^{-\sigma} + p_j\left(\frac{p_j}{\bar{\alpha}_f}\right)^{-\sigma}\right) \\
&= (1-\alpha_t)\ln E - (1-\alpha_t)\ln\bar{p}(\bar{\alpha}_l, \bar{\alpha}_f)
\end{aligned}$$

where $\bar{p}_{jc}(\bar{\alpha}_l, \bar{\alpha}_f) = (\bar{\alpha}_l^\sigma p_c^{1-\sigma} + \bar{\alpha}_f^\sigma p_j^{1-\sigma})^{\frac{1}{1-\sigma}}$

Stage 2

$$\max \rho + \ln A_c + \alpha_t \ln C_{jc}^T + (1-\alpha_t)\ln E + (1-\alpha_t)\frac{1}{\sigma-1}\ln \bar{p}(\bar{\alpha}_l, \bar{\alpha}_f)$$
$$\text{s.t. } C_{jc}^T + E \leq w_{jc}$$

The associated Lagrangian is

$$\mathcal{L} = \rho + \ln A_c + \alpha_t \ln C_{jc}^T + (1-\alpha_t)\ln E - (1-\alpha_t)\ln \bar{p}(\bar{\alpha}_l, \bar{\alpha}_f) + \lambda(w_{jc} - C_{jc}^T - E)$$

The first-order conditions are

$$\frac{\partial \mathcal{L}}{\partial C_{jc}^T} : \frac{\alpha_t}{C_{jc}^T} - \lambda = 0$$
$$\frac{\partial \mathcal{L}}{\partial E} : \frac{(1-\alpha_t)}{E} - \lambda = 0$$

Using these first-order conditions and budget constraints,

$$C_{jc}^T = \alpha_t w_{jc}$$
$$E = (1-\alpha_t) w_{jc}$$

Thus, the optimal choices for consumption can be written as

$$C_{jc}^T = \alpha_t w_{jc}$$
$$C_{jc}^{NT} = \frac{\bar{\alpha}_l^\sigma p_c^{-\sigma}}{\bar{\alpha}_l^\sigma p_c^{1-\sigma} + \bar{\alpha}_f^\sigma p_j^{1-\sigma}}(1-\alpha_t) w_{jc}$$
$$C_j^{NT} = \frac{\bar{\alpha}_f^\sigma p_j^{-\sigma}}{\bar{\alpha}_l^\sigma p_c^{1-\sigma} + \bar{\alpha}_f^\sigma p_j^{1-\sigma}}(1-\alpha_t) w_{jc}$$

This solution can be shown to satisfy the first-order conditions of the original problem. If we let ρ be a constant such that the indirect utility function has no constant, the indirect utility function can be written as

$$\ln V_{ijc} = \ln V_{jc} + \varepsilon_{ijc} = \ln A_c + \ln w_{jc} - (1-\alpha_t)\ln \bar{p}_{jc}(\bar{\alpha}_l, \bar{\alpha}_f) + \varepsilon_{ijc}$$

with $\bar{p}_{jc}(\bar{\alpha}_l, \bar{\alpha}_f) = (\bar{\alpha}_l^\sigma p_c^{1-\sigma} + \bar{\alpha}_f^\sigma p_j^{1-\sigma})^{\frac{1}{1-\sigma}}$.

C.2 Proofs of propositions of the quantitivative model

Assumption Natives only care about local price indices so that $\alpha_f = 0$ and $\alpha_l = \alpha$. Immigrants care about local and foreign price indices so that $\alpha_f \neq 0$ and $\alpha_l + \alpha_f = \alpha$.

Proof. **Proposition 1**

- $\ln w_{jc} = -(1-\beta)\ln A_c + \beta \ln \tilde{B}_c + (1-\beta)(1-\alpha_t)\ln \bar{p}_{jc}$
- $\ln w_{Nc} = -(1-\beta)\ln A_c + \beta \ln \tilde{B}_c + (1-\beta)(1-\alpha_t)\ln p_c$

Taking the difference we get

$$\ln w_{Nc} - \ln w_{jc} = (1-\beta)(1-\alpha_t)\ln p_c - (1-\beta)(1-\alpha_t)\ln \bar{p}_{jc}.$$

Denote $W = \ln w_{Nc} - \ln w_{jc}$. We are interested in the sign of $\frac{\partial W}{\partial \ln p_c}$.

$$\begin{aligned}
W =& (1-\beta)(1-\alpha_t)\ln p_c - (1-\beta)(1-\alpha_t)\frac{1}{1-\sigma}\ln(\bar{\alpha}_l^\sigma p_c^{1-\sigma} + \bar{\alpha}_f^\sigma p_j^{1-\sigma}) \\
\frac{\partial W}{\partial p_c} =& \frac{(1-\beta)(1-\alpha_t)}{p_c} - \frac{(1-\beta)(1-\alpha_t)\bar{\alpha}_l^\sigma p_c^{-\sigma}}{\bar{\alpha}_l^\sigma p_c^{1-\sigma} + \bar{\alpha}_f^\sigma p_j^{1-\sigma}} \\
\frac{\partial W}{\partial p_c} p_c =& (1-\beta)(1-\alpha_t)\frac{\bar{\alpha}_f^\sigma p_j^{1-\sigma}}{\bar{\alpha}_l^\sigma p_c^{1-\sigma} + \bar{\alpha}_f^\sigma p_j^{1-\sigma}}
\end{aligned}$$

As $\partial \ln p_c / \partial p_c = 1/p_c$, we have the wanted derivative, which is always positive:

$$\frac{\partial W}{\partial \ln p_c} = (1-\beta)(1-\alpha_t)\frac{\bar{\alpha}_f^\sigma p_j^{1-\sigma}}{\bar{\alpha}_l^\sigma p_c^{1-\sigma} + \bar{\alpha}_f^\sigma p_j^{1-\sigma}} > 0$$

Also,

$$\frac{\partial^2 W}{\partial \ln p_c \partial p_j} = (1-\beta)(1-\alpha_t)\frac{(\bar{\alpha}_l^\sigma p_c^{1-\sigma} + \bar{\alpha}_f^\sigma p_j^{1-\sigma})(1-\sigma)\bar{\alpha}_f^\sigma p_j^{-\sigma} - \bar{\alpha}_f^\sigma p_j^{1-\sigma}(1-\sigma)\bar{\alpha}_f^\sigma p_j^{-\sigma}}{(\bar{\alpha}_l^\sigma p_c^{1-\sigma} + \bar{\alpha}_f^\sigma p_j^{1-\sigma})^2}$$

Multiplying both sides with p_j and again using $\partial \ln p_j / \partial p_j = 1/p_j$ we get

$$\frac{\partial^2 W}{\partial \ln p_c \partial \ln p_j} = (1-\beta)(1-\alpha_t)(1-\sigma)\frac{\bar{\alpha}_f^\sigma p_j^{1-\sigma}\bar{\alpha}_l^\sigma p_c^{1-\sigma}}{(\bar{\alpha}_l^\sigma p_c^{1-\sigma} + \bar{\alpha}_f^\sigma p_j^{1-\sigma})^2} < 0$$

Thus, the gap in wages between natives and immigrants is increasing in the local price index. Furthermore, the effect of the local price index on the wage gap is larger for lower p_j when $\sigma > 1$, i.e. when consuming locally versus in the country of origin is imperfectly substitutable.

□

Proof. **Proposition 2**

We have that

$$\pi_{jc} = \frac{V_{jc}^{1/\lambda}}{\sum_k V_{jk}^{1/\lambda}} = \left(\frac{V_{jc}}{V_j}\right)^{1/\lambda}$$

Thus,

$$\ln \pi_{jc} - \ln \pi_{Nc} = \frac{1}{\lambda}(\ln V_{jc} - \ln V_{Nc}) - \frac{1}{\lambda}(\ln V_j - \ln V_N)$$

Using the definition of $\ln V_{jc}$ and the expression for the wage gap obtained above, we have

$$\begin{aligned}
\ln V_{jc} - \ln V_{Nc} =& \ln w_{jc} - \ln w_{Nc} - (1-\alpha_t)\left(\ln \bar{p}_{jc} - \ln p_c\right) \\
=& -(1-\beta)(1-\alpha_t)\ln p_c + (1-\beta)(1-\alpha_t)\ln \bar{p}_{jc} - (1-\alpha_t)\left(\ln \bar{p}_{jc} - \ln p_c\right) \\
=& \beta(1-\alpha_t)\ln p_c + \beta(1-\alpha_t)\ln \bar{p}_{jc}
\end{aligned}$$

Note that

$$\begin{aligned}
\ln V_{jc} =& \ln A_c + \ln w_{jc} - (1-\alpha_t)\ln \bar{p}_{jc} \\
=& \ln A_c + \left(-(1-\beta)\ln A_c + \beta \ln \tilde{B}_c + (1-\beta)(1-\alpha_t)\ln \bar{p}_{jc}\right) - (1-\alpha_t)\ln \bar{p}_{jc} \\
=& \beta \ln A_c + \beta \ln \tilde{B}_c - \beta(1-\alpha_t)\ln \bar{p}_{jc}
\end{aligned}$$

Thus,

$$V_{jc} = A_c^{\beta} \tilde{B}_c^{\beta} \bar{p}_{jc}^{-\beta(\alpha_t - 1)}$$

Then,

$$\begin{aligned}
V_j &= \left(\sum_k \left(A_k \tilde{B}_k \bar{p}_{jk}^{(\alpha_t - 1)}\right)^{\frac{\beta}{\lambda}}\right)^{\lambda} \\
V_N &= \left(\sum_k \left(A_k \tilde{B}_k p_k^{(\alpha_t - 1)}\right)^{\frac{\beta}{\lambda}}\right)^{\lambda} = \left(\sum_k \left(\frac{A_k \tilde{B}_k}{p_c^{1-\alpha_t}}\right)^{\frac{\beta}{\lambda}}\right)^{\lambda}
\end{aligned}$$

And from this we have the expression we needed.

□

Proof. **Proposition 3**

Note that

$$\pi_{jc} = \frac{L_{jc}}{L_j} = \left(\frac{V_{jc}}{V_j}\right)^{\frac{1}{\lambda}} = \left(\frac{A_c^{\beta}\tilde{B}_c^{\beta}/\bar{p}_{jc}^{\beta(1-\alpha_t)}}{V_j}\right)^{\frac{1}{\lambda}}$$

Then, the total immigrant population in city c is

$$L_{Ic} = \sum_j L_{jc} = \sum_j L_j \frac{L_{jc}}{L_j} = \sum_j L_j \left(\frac{A_c^{\beta}\tilde{B}_c^{\beta}/\bar{p}_{jc}^{-\beta(1-\alpha_t)}}{V_j}\right)^{\frac{1}{\lambda}}$$

Substituting the expression for V_j, we get

$$L_{Ic} = (A_c\tilde{B}_c)^{\frac{\beta}{\lambda}} \sum_j \frac{L_j/\bar{p}_{jc}^{(1-\alpha_t)\frac{\beta}{\lambda}}}{\sum_k (A_k\tilde{B}_k/\bar{p}_{jk}^{(1-\alpha_t)})^{\frac{\beta}{\lambda}}}$$

For natives,

$$L_{Nc} = \frac{(A_c\tilde{B}_c)^{\frac{\beta}{\lambda}}}{\sum_k (A_k\tilde{B}_k/p_k^{(1-\alpha_t)})^{\frac{\beta}{\lambda}}} L_N/p_c^{(1-\alpha_t)\frac{\beta}{\lambda}} = \frac{(A_c\tilde{B}_c/L_c^{\eta_c\alpha})^{\frac{\beta}{\lambda}}}{\sum_k (A_k\tilde{B}_k/L_k^{\eta_k\alpha})^{\frac{\beta}{\lambda}}} L_N$$

And $L_c = L_{Ic} + L_{Nc}$. □

Proof. **Proposition 4**

Note

$$q = \sum_c \frac{B_c L_c}{L}$$

Thus,

$$q = \sum_c \left[(A_c\tilde{B}_c^{\frac{\beta+\lambda}{\beta}})^{\frac{\beta}{\lambda}} \sum_j \frac{\frac{L_j}{L}/\bar{p}_{jc}^{(1-\alpha_t)\frac{\beta}{\lambda}}}{\sum_k (A_k\tilde{B}_k/\bar{p}_{jk}^{(1-\alpha_t)})^{\frac{\beta}{\lambda}}} \right] + \frac{\sum_c (A_c\tilde{B}_c^{\frac{\beta+\lambda}{\beta}}/L_c^{\eta_c\alpha})^{\frac{\beta}{\lambda}}}{\sum_k (A_k\tilde{B}_k/L_k^{\eta_k\alpha})^{\frac{\beta}{\lambda}}} \frac{L_N}{L}$$

□

D Alternative calibrations of the model

D.1 Effect of alternative calibrations of β and α_t on α_f and σ

In order to estimate α_f and σ (and λ) we take estimates of β and α_t from the literature. However, the literature offers a range of estimates of these two parameters. First, there are alternative values for the workers weight in bargaining. While Lise et al. (2016) suggest that an estimate of 0.2 is reasonable, they also consider estimates ranging from 0.1 to 0.3 or even slightly larger. Second, it is intrinsically hard to measure the share of consumption on tradable goods. A fraction of the inputs used in non-tradables are also tradable, and hence, to some extent, some non-tradables are partially tradable. In the main text we took the conservative estimate of $\alpha_t = 0.4$. However, this number could in principle be larger.

To investigate how much our estimates of α_f and σ would change with alternative assumptions on β and α_t we construct a fine grid (incremental increases of 0.0025 and 0.005, for a total of 30,000 combinations of β and σ) over the interval $[0.1, 0.35]$ x $[0.30, 0.68]$. This interval captures both low and high levels of both β and α_t and, thus, offers an overview of estimates that we would have obtained by assuming reasonable alternative values of these two parameters.

The top-left graph of Figure D.7 shows the histogram of estimates of α_f that we obtain from the 30,000-point grid described above. In a red vertical line we show the baseline estimate that we use in the main text, which lies rather at the upper end but still well inside the range of potential estimates. This graph suggests that α_f is most likely between 0.15 and 0.25.

Figure D.7 goes around here

The graph on the right of Figure D.7 shows the histogram of estimates of σ. Our baseline estimate lies at the mode of the distribution. The range of estimates suggests that σ is between 1.5 and 2.5, well above 1, the limiting case in which there would not be any heterogeneity across countries of origin. The bottom graph in Figure D.7 plots the area covered by our estimates of α_f and σ. Overall, they are not very sensitive to the assumed values of β and α_t.

In the next subsection we set β and α_t close to their upper bounds and show that the main results of the paper are robust to these alternative calibrations of β and α_t.

D.2 Effect of alternative calibrations of β and α_t on quantitative results

In this section, we check the robustness of the predictions of the counterfactual simulation to alternative calibrations of the parameters β and α_t and of the re-estimated parameters α_f, σ, and λ.

First, we set $\beta = 0.3$, from which we obtain $\alpha_f = 0.23$, $\sigma = 1.66$, and $\lambda = 0.02$. Figure D.8 compares the model and the data with this new parameterization and confirms that the model predictions are almost identical to those shown in baseline Figure 5. Figure D.9 shows the predicted changes in the spatial equilibrium resulting from immigration, replicating Figure 8 with the new parameters. All plots are very similar to the baseline figure. Only the changes in the overall population are slightly more pronounced in Figure D.9 because workers are able to retain a higher share of the profit from production,

which means that their wages depend to a larger extent on productivity and to a lower extent on price levels. Hence, highly productive cities become even more attractive to immigrants than previously, implying that cities with high productivity grow more while those with low productivity grow less.

Figures D.8 and D.9 go around here

Table F.7 presents the predicted changes in aggregate variables. As the more productive cities can even attract more immigrants than in the baseline calibration, the positive effects on labor productivity are stronger. In the case with agglomeration forces, productivity goes up by 2.12% due to immigration (compared to 1.85% previously). Also the difference to the counterfactual in which immigrants behave like natives is somewhat larger (1.53 vs 1.30). On the other hand, the effect of immigration on native workers' welfare is smaller and now negative also with agglomeration forces (-0.23%). This is because the larger bargaining power of workers implies that the weight on local price levels in the wages is lower. As a consequence, workers are more affected by rising local prices since the compensation in their wages is reduced. Therefore, a rise in prices due to population growth generally affects welfare more negatively when β is higher. However, the difference between the two counterfactuals shown in the last row of F.7 is more pronounced, which is driven by the stronger increase in overall labor productivity.

Table F.7 goes around here

In the second robustness check, we set $\alpha_t = 0.6$, from which we obtain $\alpha_f = 0.18$, $\sigma = 1.84$ and $\lambda = 0.011$.[56] Figure D.10 shows that also with these parameters, the model replicates well the data. Compared to the baseline, this calibration matches somewhat better the population distribution and somewhat worse the wage distribution across MSAs. Wages rise steeply with city productivity now because the lower share of non-tradable consumption implies that wages depend to a lower extent on non-tradable prices, which in turn are highly positively correlated with productivity.

The predicted changes in the equilibrium outcomes plotted in Figure D.11 are now attenuated, in particular for native population, prices, and native wages. This is because the lower consumption share of non-tradable goods implies that the increase in their demand and thus their prices is smaller, which in turn leads to a smaller increase in natives' wages. Moreover, less natives relocate from more productive to less productive cities because the price increase in the former relative to the latter is less pronounced than in the baseline. Due to the lower weight of non-tradable consumption, the motive of immigrants to choose cities with higher price elasticities of non-tradable supply is reduced. This is why cities at the lower end of the productivity distribution grow less in terms of population and thus the population shift towards high-productivity cities is stronger.

Figures D.10 and D.11 go around here

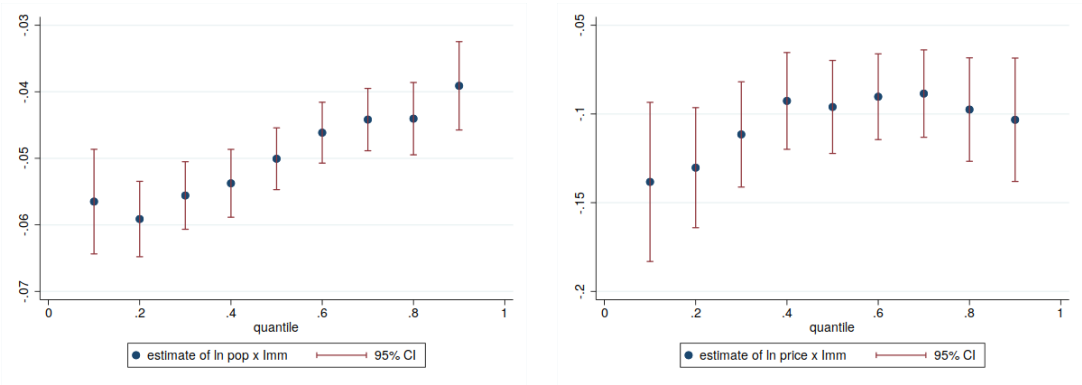
[56] Setting the share of tradable goods to 60% means that we assume non-tradables to consist only of housing, which has a weight of around 40% in the CPI-U.

Due to this stronger population shift towards high-productivity cities, also with this alternative calibration the positive effects on overall labor productivity are stronger than in the baseline, which can be seen in Table F.7. In the case with agglomeration forces, productivity goes up by 2.95% due to immigration (vs 1.85% in the baseline) and the difference to the counterfactual with immigrants behaving like natives is 2.59 ppt (vs 1.30 in the baseline). As non-tradable prices rise less due to their lower weight in the utility, effects on native workers' welfare are more positive. As a result, both with and without agglomeration forces, immigration increases welfare, whereas the difference to the counterfactual with immigrants being identical to natives is somewhat smaller than in the baseline.

In sum, using different parameter values for β and α_t within a reasonable range does not significantly change the effects of immigrants on the distribution of population across cities and aggregate variables predicted by the model. In fact, aggregate effects, in particular those on labor productivity, become rather stronger when setting the parameters closer to their upper bounds.

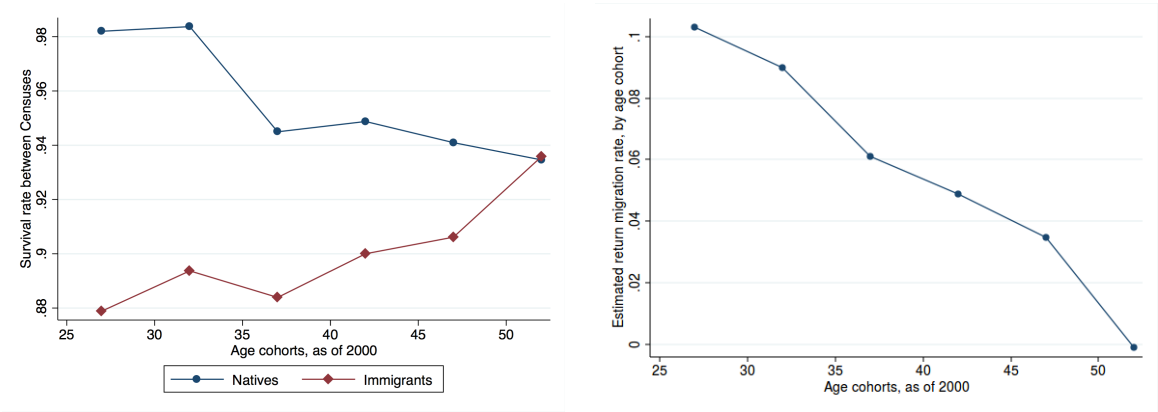
E Figures Appendix

Figure D.1: City size and native-immigrant wage gaps by quantiles



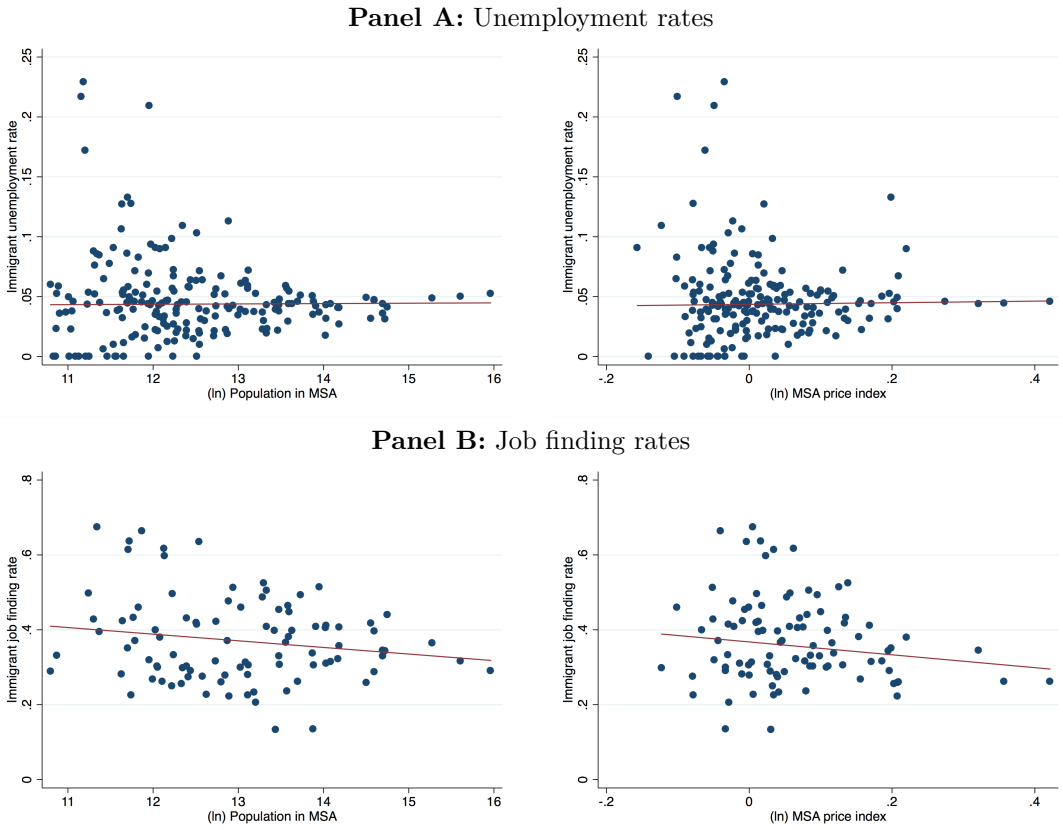
Notes: This graph plots the estimate of the interaction between an immigrant dummy and the (log) population size in the location for each quantile of the wage distribution. For this graph, we use a 20% random sample of the 2000 Census. The left panel plots the city size-wage gap elasticity at each quantile, while the right panel plots the city price-wage gap elasticity.

Figure D.2: Return migration



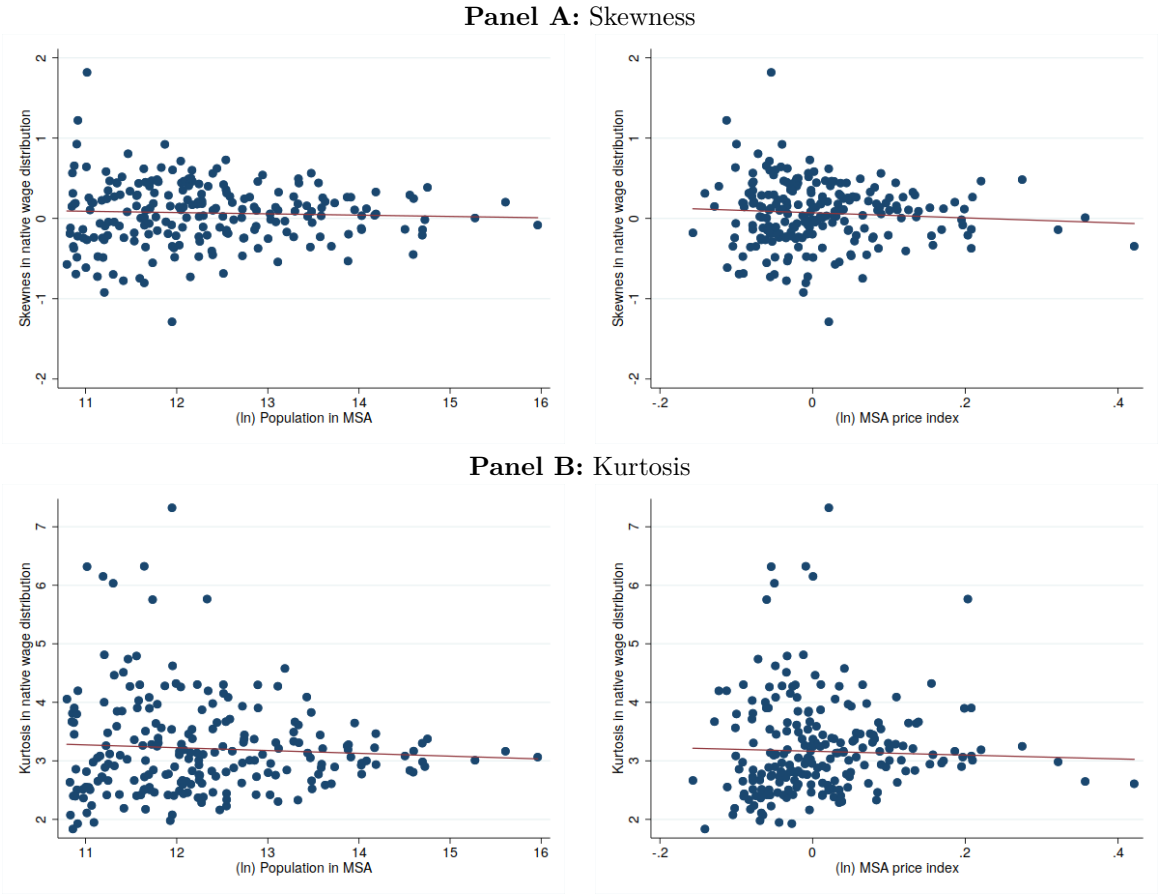
Notes: This figure shows estimates of survival rates and return migration rates by age group. The graph on the left compares the size of the cohort of natives and immigrants who arrived before 2000 in Census years 2000 and ACS 2010. The difference between 2010 and 2000 in the size of the cohorts divided by the initial size of the cohort is an estimate of the cohort survival rate. The graph on the right subtracts the native survival rates from immigrant survival rates to obtain estimates of return migration rates by age group.

Figure D.3: City size, price index, and immigrants' unemployment and job finding



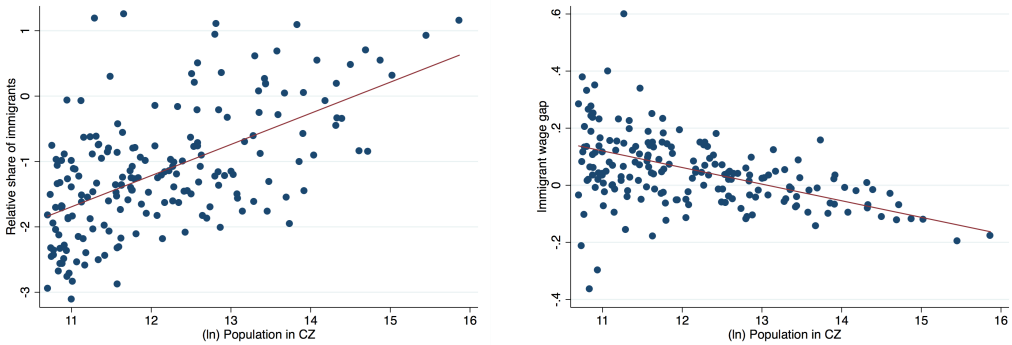
Notes: This figure uses city size and price data from the 2000 Census and data of immigrant workers aged 25 to 59 from the CPS basic monthly files. The rates are calculated for each city that can be matched to the Census data as averages over the period 1995-2005. The job finding rate is the monthly share of unemployed job searchers transitioning to employment.

Figure D.4: City size, price index, and skewness and kurtosis



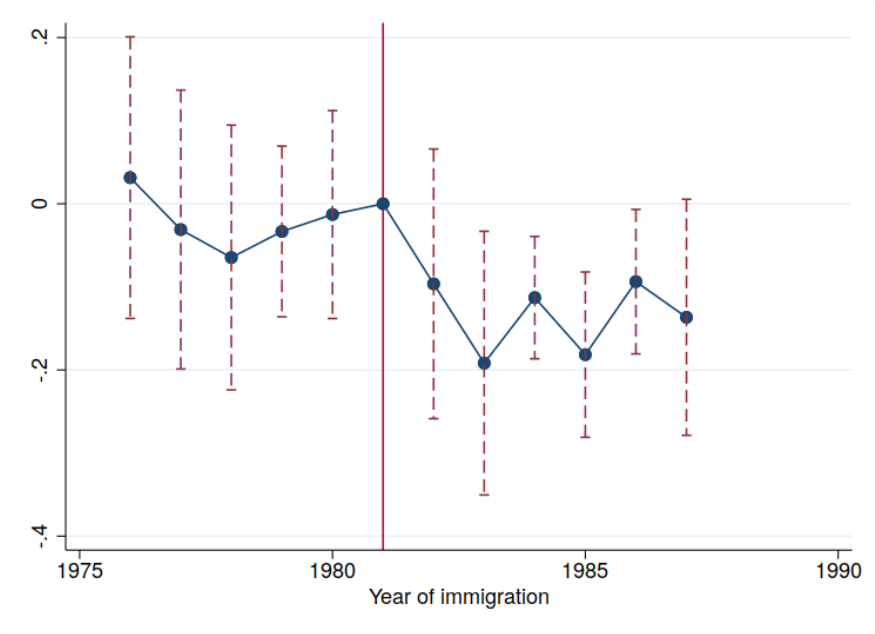
Notes: This figure uses city size and price data from the 2000 Census and computes the within MSA wage skewness and kurtosis.

Figure D.5: Commuting zone size and immigrant distribution



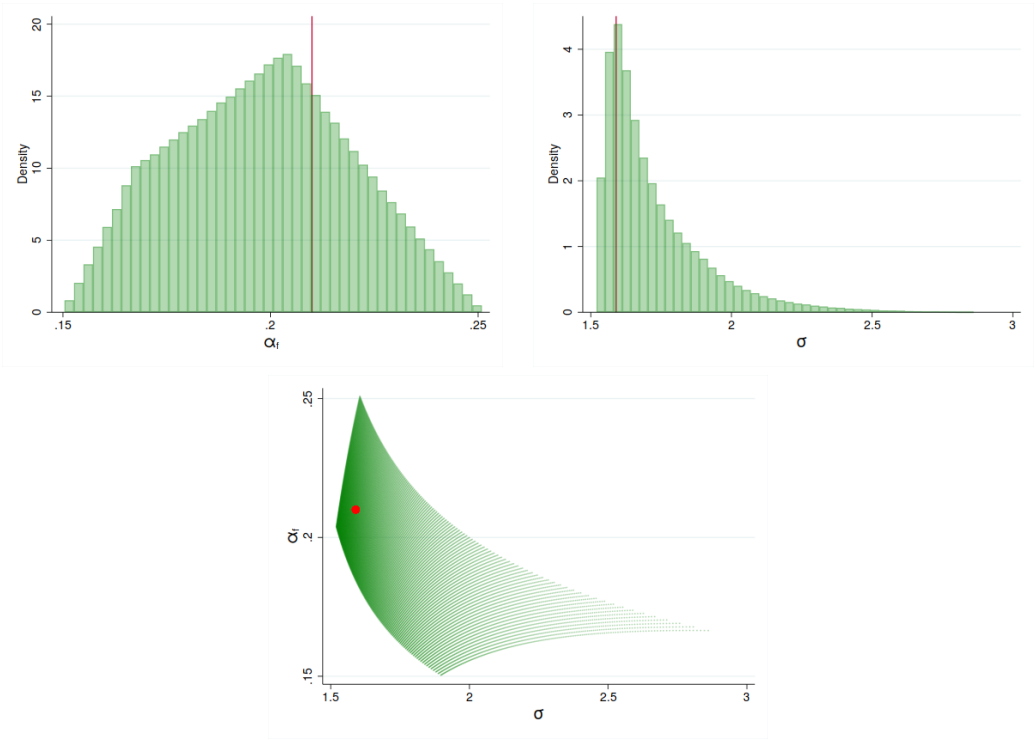
Notes: The figure is based on the sample of prime-age workers (25-59) from the 2000 Census. Each dot represents a different commuting zone. There are 191 different commuting zones in our sample. The red line is the fitted line of a linear regression. The left panel shows the relationship between relative immigrant share and CZ size, while the right panel shows the relationship between native-immigrant wage gaps and the CZ size.

Figure D.6: The effect of the legalization on immigrant wage elasticities to city price pre- and post 1982



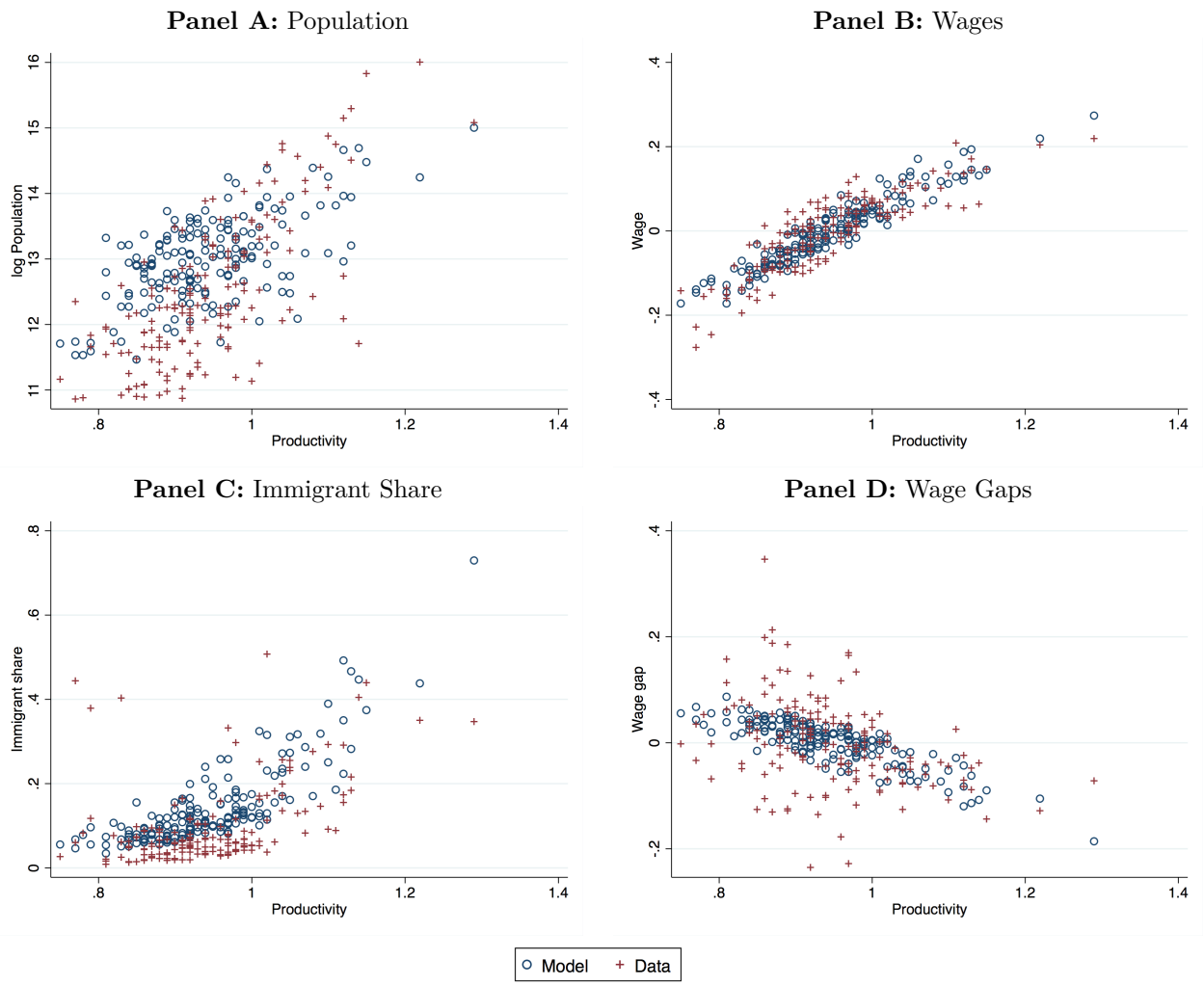
Notes: This graph shows the differential wage elasticity for immigrants arrived in each of the years displayed in the x-axis, with respect to city price, relative to the immigrants arriving in 1981. This follows Column 6 of Table 7. Dashed lines indicate 95% confidence intervals.

Figure D.7: Robustness of estimates of α_f and σ to different β and α_t



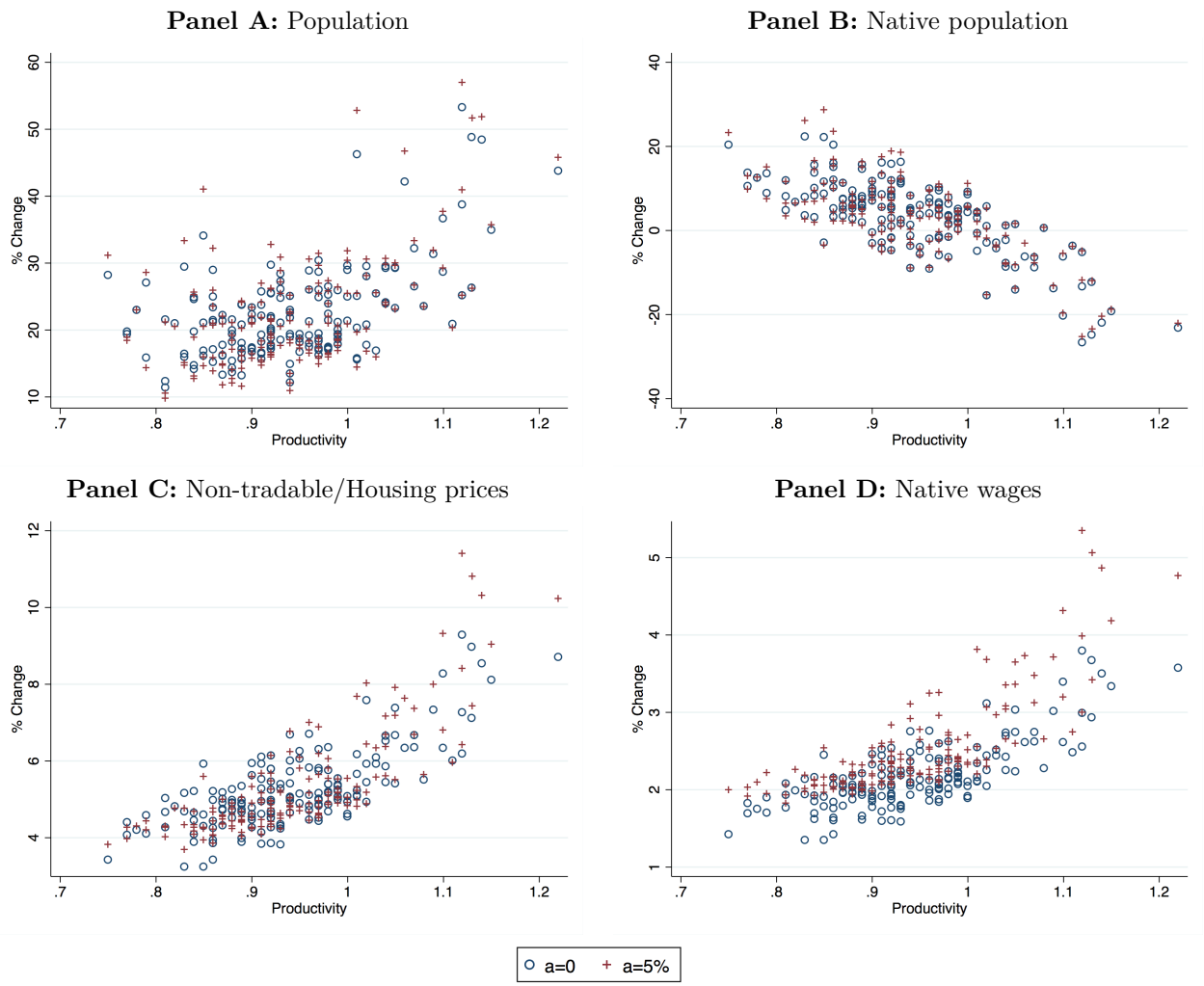
Notes: This figures shows in red the estimates used in the main text (vertical line and red dot). The top left graph shows a histogram of the estimates of α_f that we obtain for a 30,000 point uniform grid for β x $\alpha_t \in [0.1, 0.35]$ x $[0.30, 0.68]$. The top right graph shows a similar histogram for estimates of σ. The bottom graph shows the area covered by these estimates.

Figure D.8: Population and wages at the MSA-level with $\beta = 0.3$



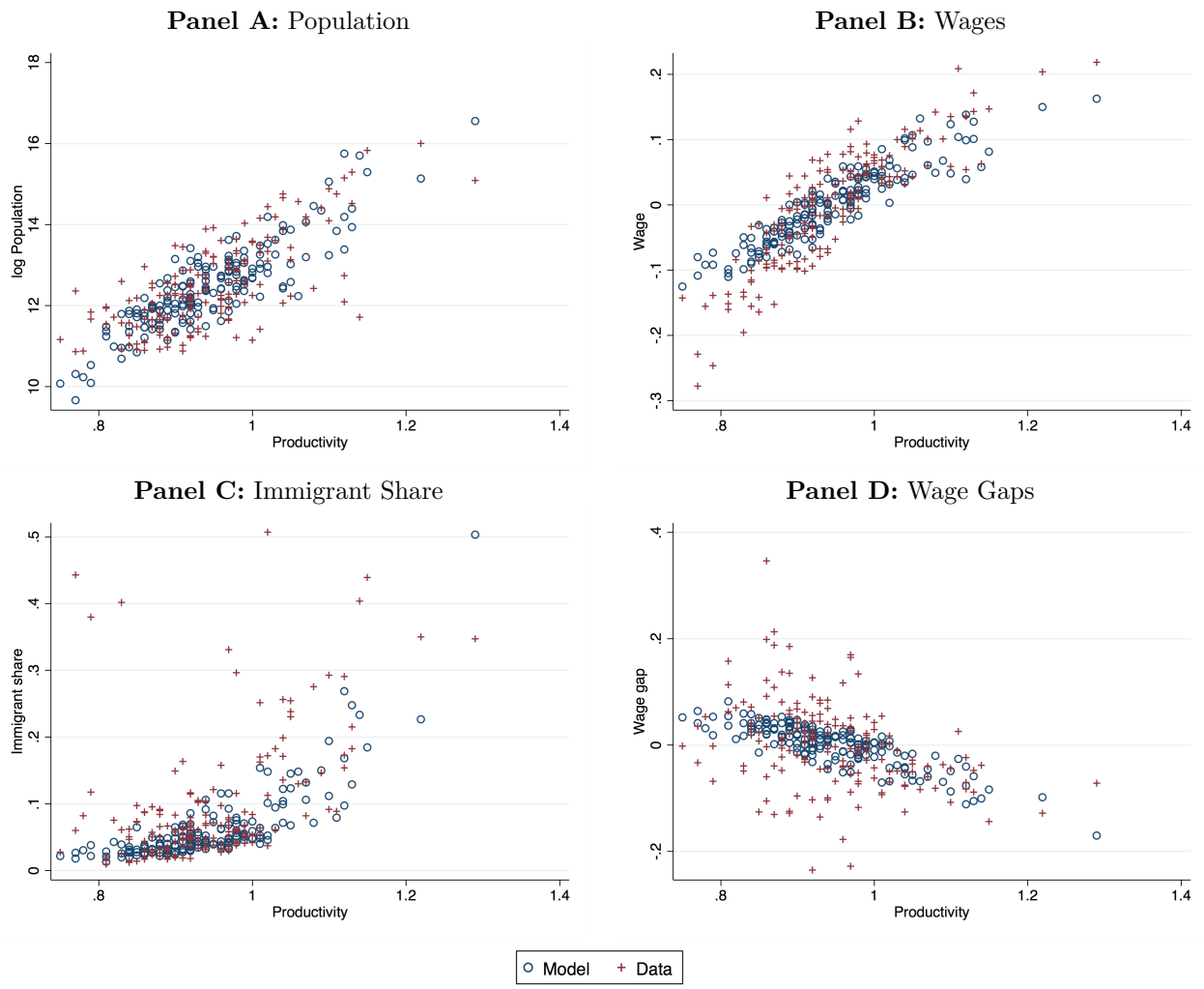
Notes: This figure compares four untargeted moments in the data and the model. The model is estimated using country of origin variation. From these estimates, we aggregate the data generated by the model at the city level to compute the four moments shown in the figure. Each dot represents one of the 168 consolidated metropolitan statistical areas from Albouy (2016).

Figure D.9: Effects of immigration with new immigrants consuming in origin country with $\beta = 0.3$



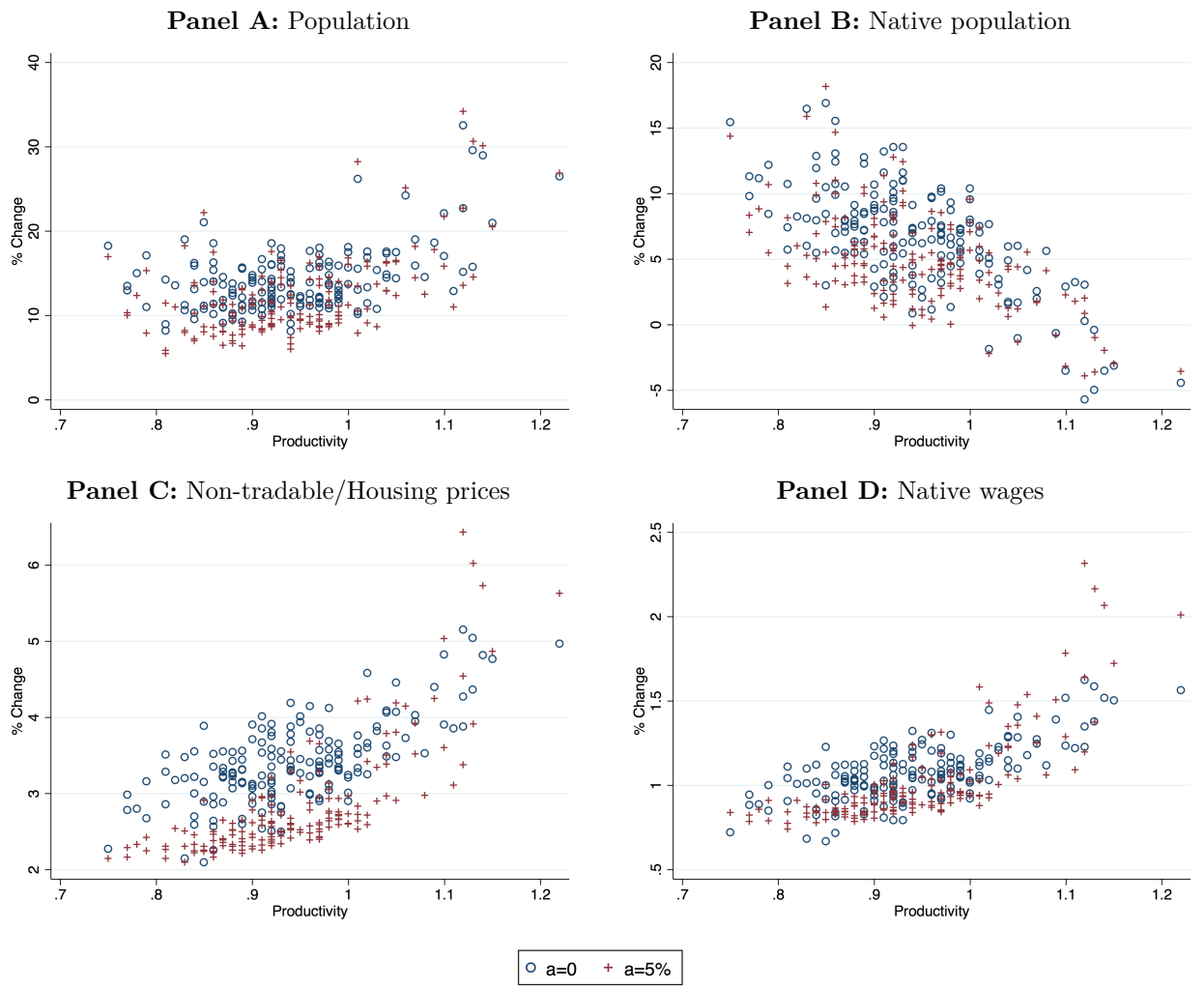
Notes: This figure compares the distribution of selected variables predicted by the model with the actual share of immigrants of 20% and the counterfactual distribution predicted if new immigrants consume like estimated, both with and without agglomeration forces. Each dot represents one of the 168 consolidated metropolitan statistical areas from Albouy (2016) and indicates the percentage difference to the counterfactual.

Figure D.10: Population and wages at the MSA-level with $\alpha_t = 0.6$



Notes: This figure compares four untargeted moments in the data and the model. The model is estimated using country of origin variation. From these estimates, we aggregate to the city level the data generated by the model to compute the four moments shown in the figure. Each dot represents one of the 168 consolidated metropolitan statistical areas from Albouy (2016).

Figure D.11: Effects of immigration with new immigrants consuming in origin country with $\alpha_t = 0.6$



Notes: This figure compares the distribution of selected variables predicted by the model with the actual share of immigrants of 20% and the counterfactual distribution predicted if new immigrants consume as estimated, both with and without agglomeration forces. Each dot represents one of the 168 consolidated metropolitan statistical areas from Albouy (2016) and indicates the percentage difference to the counterfactual.

F Tables Appendix

Table F.1: Wage gaps and city size measurement

	(1) Rel. Imm. Share	(2) Rel. Imm. Share	(3) Rel. Imm. Share	(4) Rel. Imm. Share
(ln) Population in MSA	0.532***			
	(0.0552)			
(ln) Native population in MSA		0.514***		
		(0.0713)		
(ln) Population in MSA (t-10)			0.516***	
			(0.0575)	
(ln) Native population in MSA (t-10)				0.501***
				(0.0718)
Observations	764	764	573	573
R-squared	0.472	0.383	0.443	0.369
Year FE	yes	yes	yes	yes
	(1) (ln) Wage Gap	(2) (ln) Wage Gap	(3) (ln) Wage Gap	(4) (ln) Wage Gap
(ln) Population in MSA	-0.0328***			
	(0.00431)			
(ln) Native population in MSA		-0.0326***		
		(0.00498)		
(ln) Population in MSA (t-10)			-0.0336***	
			(0.00435)	
(ln) Native population in MSA (t-10)				-0.0338***
				(0.00501)
Observations	764	764	573	573
R-squared	0.412	0.376	0.369	0.337
Year FE	yes	yes	yes	yes

Notes: The regression uses data from the Census 1980-2000 and the combined 2009-2001 ACS. * significant at the 0.10 level; ** significant at the 0.05 level; *** significant at the 0.01 level. Standard errors clustered at the metropolitan area level.

Table F.2: Immigrants' wage gap and city characteristics controlling for immigrant networks

	(1) Wage gap OLS	(2) Wage gap OLS	(3) Wage gap FE	(4) Wage gap OLS	(5) Wage gap OLS	(6) Wage gap IV	(7) Wage gap FE
(ln) Population in MSA	-0.0415***	-0.0412***	0.000811				
	(0.00205)	(0.00208)	(0.0274)				
(ln) City price				-0.0837***	-0.336***	-0.366***	-0.0125
				(0.0151)	(0.0796)	(0.0939)	(0.0765)
Observations	16,621	16,621	16,621	16,621	16,621	15,979	16,621
R-squared	0.545	0.549	0.841	0.109	0.343	0.345	0.841
Year FE	no	yes	yes	no	yes	yes	yes
MSA FE	no	no	yes	no	no	no	yes
widstat						46.78	

Notes: The dependent variable is the MSA-specific component of the wage gap estimated by equation (2.1) at the origin country level and additionally controlling for immigrant networks (defined as MSA population share of immigrants from the same origin). The regression uses a sample of prime-age workers (25-59) from the Census 1980-2000 and the combined 2009-2001 ACS. The MSA price indices are computed following Moretti (2013). * significant at the 0.10 level; ** significant at the 0.05 level; *** significant at the 0.01 level. Standard errors clustered at the metropolitan area level.

Table F.3: Remittances

Origin region	Likelihood (%)	Income share (%)	Income share for remit>0 (%)
Latin America	32.54	2.35	8.86
Africa	30.31	2.57	12.17
Asia	25.31	2.81	12.80
Mexico	20.55	2.57	14.02
Europe	12.93	1.25	10.73
Total	24.73	2.24	10.98

Notes: This table uses data from the 2003 New Immigrant Survey (NIS). The NIS is a representative sample of newly admitted, legal permanent residents. Statistics are based on the subsample of immigrants with positive income (from wages, self-employment, assets, or real estate) and with a close relative (parent, spouse, or child) living in the country of origin. Income shares over 200% are dropped.

Table F.4: Immigrants' homeownership rates

	(1) Ownership	(2) Ownership	(3) Ownership	(4) Ownership
Immigrant	-0.193***	-0.116***	-0.137***	
	(0.00937)	(0.00993)	(0.0178)	
(ln) HH income		0.213***	0.215***	0.231***
		(0.00411)	(0.00431)	(0.00686)
(ln) RER				-0.0135**
				(0.00573)
Observations	3,464,960	3,464,960	3,464,960	444,254
Year FE	yes	yes	yes	yes
MSA FE	yes	yes	no	yes
Sample	all	all	all	Imm. only

Notes: This table shows regressions with a dummy for home ownership as dependent variable using Census 1990-2000 and ACS 2005-2011 data. Additional controls include dummies for the number of family members living in the household, marital status and age. Standard errors clustered at the MSA level. * significant at the 0.10 level; ** significant at the 0.05 level; *** significant at the 0.01 level.

Table F.5: Immigrants' expenditures on housing, alternative specifications

Panel A

	(1) ln (rent / HH Income)	(2) ln (rent / HH Income)	(3) ln (rent / HH Income)	(4) ln (rent / HH Income)
Immigrant	0.118***	-0.0741***	-0.110***	
	(0.0130)	(0.0146)	(0.0236)	
Immigrant x (ln) City price			0.0383	
			(0.0318)	
(ln) RER				0.0711***
				(0.0155)
(ln) HH income		-0.729***	-0.730***	-0.764***
		(0.00486)	(0.00549)	(0.00551)
Observations	903,825	903,825	903,825	204,276
Year FE	yes	yes	yes	yes
MSA FE	yes	yes	no	yes
Sample	all	all	all	Imm. only

Panel B

	(1) (rent / HH Income)	(2) (rent / HH Income)	(3) (rent / HH Income)	(4) (rent / HH Income)
Immigrant	0.0407***	-0.0171***	-0.0515***	
	(0.00338)	(0.00343)	(0.00673)	
Immigrant x (ln) City price			0.0374***	
			(0.00790)	
(ln) RER				0.0146***
				(0.00548)
(ln) HH income		-0.220***	-0.219***	-0.251***
		(0.00411)	(0.00384)	(0.00567)
Observations	903,825	903,825	903,825	204,276
Year FE	yes	yes	yes	yes
MSA FE	yes	yes	no	yes
Sample	all	all	all	Imm. only

Notes: These regressions follow Table 8 with the dependent variable in levels. Standard errors are clustered at the MSA level. * significant at the 0.10 level; ** significant at the 0.05 level; *** significant at the 0.01 level.

Table F.6: 20 least and most productive cities

20 cities with lowest productivity				
City name	Productivity	Amenity	Rent prices	HS elasticity
Joplin	-0.25	-0.01	0.85	6.40
Abilene	-0.23	0.00	0.90	3.09
McAllen	-0.23	-0.08	0.80	3.68
Wichita Falls	-0.22	0.00	0.94	3.87
Killeen	-0.21	0.03	1.01	4.59
Brownsville	-0.21	-0.06	0.85	2.40
Johnstown	-0.19	-0.07	0.72	1.84
Johnson City	-0.19	-0.02	0.84	1.35
Springfield	-0.19	0.01	0.92	3.60
Fayetteville	-0.18	0.03	1.04	2.71
Alexandria	-0.17	-0.03	0.82	7.15
Ocala	-0.17	-0.01	1.01	1.73
El Paso	-0.17	-0.04	0.90	2.35
Lubbock	-0.16	-0.01	0.95	4.33
Billings	-0.16	0.01	0.93	3.06
Altoona	-0.16	-0.04	0.82	2.18
Pensacola	-0.16	0.01	0.98	1.48
Longview	-0.16	-0.05	0.90	4.75
Columbia	-0.15	0.01	0.95	7.84
Sharon	-0.15	-0.04	0.86	2.42

20 cities with highest productivity				
City name	Productivity	Amenity	Rent prices	HS elasticity
San Francisco	0.29	0.14	2.11	0.70
New York	0.22	0.03	1.63	0.77
Los Angeles	0.15	0.08	1.54	0.67
Monterey	0.14	0.14	1.64	1.10
Boston	0.13	0.05	1.67	0.86
Chicago	0.13	0.01	1.40	0.82
Washington-Baltimore	0.12	-0.01	1.50	1.47
Hartford	0.12	-0.02	1.29	1.50
Santa Barbara	0.12	0.18	1.71	0.89
Detroit	0.11	-0.05	1.22	1.33
San Diego	0.10	0.12	1.56	0.67
Philadelphia	0.10	-0.04	1.34	1.63
Seattle	0.09	0.06	1.45	0.98
Stockton	0.08	-0.00	1.19	2.07
Minneapolis	0.07	-0.02	1.33	1.45
Denver	0.07	0.05	1.40	1.57
Atlanta	0.06	-0.03	1.45	2.55
Las Vegas	0.05	-0.02	1.38	1.39
Modesto	0.05	-0.01	1.17	2.17
West Palm Beach	0.05	0.02	1.44	0.83

Notes: The first two variables are *Trade Productivity* and *Quality of Life* from Albouy (2016). Rent prices are calculated following Moretti (2013) and refer to the year 2000. Housing supply elasticities are taken from Saiz (2010).

Table F.7: Predicted aggregate effects of immigration, alternative parameter estimates

	Parameters estimated with $\beta = 0.3$, $\alpha_t = 0.4$		
	Δ Labor productivity	Δ Native workers' welfare	Δ House owners' welfare
	No agglomeration forces		
Counterfactual 1: 20% increase in population	-0.44	-1.34	3.47
Counterfactual 2: 20% immigrant-induced increase in population	0.87	-0.53	2.28
Difference:	1.31	0.81	-1.18
	Agglomeration forces		
Counterfactual 1: 20% increase in population	0.59	-0.97	3.40
Counterfactual 2: 20% immigrant-induced increase in population	2.12	-0.23	2.39
Difference:	1.53	0.74	-1.01
	Parameters estimated with $\beta = 0.2$, $\alpha_t = 0.6$		
	Δ Labor productivity	Δ Native workers' welfare	Δ House owners' welfare
	No agglomeration forces		
Counterfactual 1: 20% increase in population	-0.59	-0.53	6.48
Counterfactual 2: 20% immigrant-induced increase in population	1.48	0.05	2.69
Difference:	2.06	0.58	-3.79
	Agglomeration forces		
Counterfactual 1: 20% increase in population	0.36	-0.23	6.18
Counterfactual 2: 20% immigrant-induced increase in population	2.95	0.21	3.09
Difference:	2.59	0.44	-3.10

Notes: This table shows the aggregate consequences of immigration under two different counterfactuals. In Counterfactual 1 we assume that new immigrants consume like natives. In Counterfactual 2 we assume that new immigrants spend 21 percent of their income in their country of origin, as estimated. This table reports the aggregate consequences of these two counterfactuals on three outcomes: average labor productivity, average native worker's welfare, and average house owner's welfare. We report results assuming no agglomeration forces and agglomeration forces of 5%. The difference between Counterfactual 1 and Counterfactual 2 is the effect of immigration on the three outcomes of interest.