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▶ **Immigrants' Residential Choices and their Consequences**

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Immigrants' Residential Choices and their Consequences

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Abstract

This paper investigates the causes and effects of the spatial distribution of immigrants across US cities. We document that: a) immigrants concentrate in large, high-wage, and expensive cities, b) the earnings gap between immigrants and natives is higher in larger and more expensive cities, and c) immigrants consume less locally than natives. In order to explain these findings, we develop a simple quantitative spatial equilibrium model in which immigrants consume (either directly, via remittances, or future consumption) a fraction of their income in their countries of origin. Thus, immigrants not only care about local prices, but also about price levels in their home country. Hence, if foreign goods are cheaper than local goods, immigrants prefer to live in high-wage, high-price, and high-productivity cities, where they also accept lower wages than natives. Using the estimated model we show that current levels of immigration have reduced economic activity in smaller, less productive cities by around 3 percent, while they have expanded the activity in large and productive cities by around 4 percent. This has increased total aggregate output per worker by around .15 percent.

JEL Categories: F22, J31, J61, R11.

Key words: Immigration, location choices, spatial equilibrium.

1 Introduction

We mainly consume where we live. However, some of the goods are not produced locally. Both local non-tradable and tradable goods constitute the main elements of the price index that people face when living in a particular location. Since Krugman (1991), and the large literature that followed, this has constituted the basis for thinking about the distribution of people across space.

While this simplification of how people consume may be good for most of the population, immigrants spend a considerable fraction of their income in their home country. For example, using German data, Dustmann and Mestres (2010) estimate that immigrants send around 8 percent of their disposable income back to their home countries, and this share is even larger for immigrants that plan on returning home. Thus, for immigrants not only does the local price index matter, but also the price index in their home country.

Local price indexes vary considerably across US cities. For instance, local price indexes in New York City are around 20 percent higher than the national average – mainly due to housing.[1] At the same time, nominal incomes are also much higher in New York than in smaller, lower-price-index cities. These higher wages "compensate" for the higher living costs, as predicted in the Rosen (1974) - Roback (1982) spatial equilibrium model.

Given that immigrants care both about local prices and prices in their countries of origin while natives may only be concerned with local prices, natives and immigrants potentially have different incentives in choosing which metropolitan area to live in.[2] For example, for an immigrant it may be particularly advantageous to live in a city like New York. All else being equal, for immigrants in New York City, the income left after paying for local goods is likely to be higher than in a smaller, lower-wage, less expensive city.[3] In this paper, we show how this mechanism affects the residential choices of natives and immigrants in the United States both empirically and quantitatively through the lens of a model.

In the first part of the paper, we use a number of different data sets to document three novel and very strong empirical regularities in the United States. First, we document that over the last decades, immigrants have been concentrated in large and expensive cities. Second, we document that the gap in earnings between natives and immigrants is *greatest* in these larger and more expensive cities. And third, immigrants consume less than natives locally. These patterns are extremely robust. Importantly, they only attenuate for immigrants that come from rich countries where price indexes are similar to those in the United States and for immigrants that have spent a considerable amount of time in the United States. We also show that these patterns *cannot* be explained by immigrant networks, differences in human capital between natives and immigrants, or imperfect immigrant-native substitutability within narrowly defined education groups.

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[1]See Table 1. San Jose's local price index is around 50 percent above the national average. Local prices of tradable goods tend to be lower in large cities once the diversity of products available is taken into account (Handbury and Weinstein (2015)). We do not take this into account in this paper. It is worth mentioning though that this does not compensate for the cost of housing which represents a much higher share of total consumption.

[2]A paper that also uses differences in preferences to understand differences across regions is Atkin (2013). Our focus is however very different than his since we study the spatial distribution of immigrants and natives based on the preferences for consuming in their country of origin, while Atkin (2013) studies how acquired local preferences affect nutrition and welfare of migrants.

[3]Davis and Ortalo-Magne (2011) show that the fraction of income spent on housing – the largest part of local consumption – is remarkably constant across metropolitan areas.

In the second part of the paper, we explain these strong empirical regularities with a simple quantitative spatial equilibrium model with free labor mobility across cities, and we use the model to investigate the role that immigration plays in shaping the distribution of economic activity across locations and, through this mechanism, its contribution to the general equilibrium. In the model, natives consume only locally, whereas immigrants also consume in their home country and therefore also care about price levels in their home country.[4] Hence, if home-country goods are cheaper than local goods, an immigrant needs a lower compensation in his nominal wage in order to move to an expensive city. This implies that immigrants concentrate in expensive cities and that, if wages partly reflect the value of living in a city, the native–immigrant wage gap is increasing in the local price index.[5] Some degree of substitutability between home and local goods allows this mechanism to be stronger for immigrants coming from poorer countries, which is in line with the data.[6]

We estimate the key parameters of the model to match population and wage data in the US using the method of simulated moments and we complement these estimates with parameters from previous literature to perform quantitative exercises (specifically, we use Albouy (2016), Combes and Gobillon (2014), and Saiz (2010)). In particular, we find that the parameter governing immigrant's weight for the home country is around 40 percent. This means that the distribution of immigrants across locations and their wages relative to those of natives is consistent with immigrants consuming as much as 40 percent of their income in their country of origin. This estimate suggests that the home country is economically very important to immigrants and has a very strong influence on where immigrants decide to settle and their wages, which in turn has important consequences for the host country.

We use our estimated model to compute the counterfactual distribution of population, wages and economic activity when immigrants do not care about consuming in their home country. This allows us to quantify how immigrant location choices may affect host countries. Our main finding is that there is a significant redistribution of economic activity from small and unproductive to large and productive cities as a consequence of immigrants' location choices.[7] With current levels of immigration, we show that low-productivity cities lose as much as 3 percent of output, while more productive ones gain as much as 4 percent. We also show that some natives who would otherwise live in these more productive cities are priced-out from the housing market, and that natives who live in large, more productive cities have *higher* nominal incomes than they would without immigration. In sum, immigration contributes to increasing *nominal* inequalities across metropolitan areas. In aggregate, we estimate that current levels of immigration expand total output per capita by around .15 percent.[8] We conclude our analysis by exploring how these changes in economic activity across space affect natives' welfare. There are essentially three groups of natives: workers, land owners, and firm owners. On the one hand, the model

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[4]There are various interpretations of what consuming in the home country really means. It could be that immigrants spend a fraction of their time in the home country, or that they send remittances to their relatives, or that they save for the future while intending to return to their country of origin. All these are equivalent from the point of view of the model.

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

[6]We also show in the paper that within Mexican immigrants, the patterns that we document are stronger for those who are closer to the Mexican - US border than further away, in line with the idea that the ties of the Mexicans closer to the border to their home country may be stronger.

[7]Large and expensive cities are so, in the context of our model, because they are more productive. See Albouy (2016).

[8]This estimate depends, to some extent, on the agglomeration forces assumed in the model.

suggests that native workers in large and expensive cities lose in terms of welfare because immigrants' location choices put pressure on housing markets that is not compensated by the higher nominal incomes. On the other hand, land and firm owners in large cities gain from immigration.

This paper extends the seminal work of Borjas (2001). In Borjas (2001), immigrants "grease the wheels" of the labor market by moving into the most favorable local labor markets. Within a spatial equilibrium framework, this means that they pick cities whose wages relative to living costs and amenity levels are highest. Thus, in his context, immigrants do not necessarily choose the highest nominal wage or more productive cities. 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 has also important implications for empirical studies that study the effects of immigration on the labor market by comparing different metropolitan areas (see among others Card (1990), Altonji and Card (1991), Borjas et al. (1997), Card (2005), Lewis (2012), Llull (2017), Glitz (2012), Borjas and Monras (2017), Monras (2015b), Dustmann et al. (2017), Ruist et al. (2016)).[9] In particular, it provides a strong reason why there is a positive correlation between wage levels and immigrant shares across metropolitan areas.

This paper is also related to a large body of recent work. Recent developments in quantitative spatial equilibrium models include Redding and Sturm (2008), Ahlfeldt et al. (2014), Redding (2014), Albouy (2009), Fajgelbaum et al. (2016), Notowidigdo (2013), Diamond (2015), Monras (2015a), and Monte et al. (2015) among others, and have been used to explore neighborhoods within cities, spatial consequences of taxation, local shocks, endogenous amenities, the dynamics of internal migration, and commuting patterns.[10] However, only Monras (2015b) and Piyapromdee (2017) use a spatial equilibrium model to study immigration. Relative to these papers, we uncover novel facts that we use to understand general equilibrium effects of immigration that were unexplored until now. In fact, much of the literature on immigration ignores general equilibrium effects. Many studies in this literature compare different local labor markets, some that receive immigrants and some that do not (see Card (2001)), or different skill groups (see Borjas (2003)). Neither of these papers, or the numerous ones that followed them, are well suited to explore general equilibrium effects of immigration. There are only a handful of papers using cross-country data to speak to some of the general equilibrium effects of immigration (see for example Di Giovanni et al. (2015)). Within-country general equilibrium effects are, thus, completely under-explored in the immigration literature.

In what follows, we first describe our data. We then introduce a number of facts describing immigrants' residential choices, incomes, and consumption patterns. In section 4, we build a model that rationalizes these facts. We estimate this model in Section 5, and we use these estimates to study the contribution of immigration to the spatial distribution of economic activity.

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[9]Dustmann et al. (2016) provide a recent review of this literature.
[10]Redding and Rossi-Hansberg (Forthcoming) provide a recent literature review.

2   Data

For this paper, we rely on various publicly available data sets for the United States. For the labor market variables, we mainly use the US Censuses, the American Community Survey (ACS) and the Current Population Survey (CPS), all available on Ruggles et al. (2016) and widely used in previous work. For the consumption results we combine a number of data sets that allow us to (partially) distinguish consumption patterns between natives and immigrants. These include the New Immigrant Survey and Consumption Expenditure Survey. We describe these various data sets in what follows.

2.1   Census, American Community Survey, and Current Population Survey data

First, we use CPS data to compute immigrant shares, city size, and average (composition-adjusted) wages at high frequency. The CPS data are gathered monthly, but the March files contain more detailed information on yearly incomes, country of birth, and other variables that we need. Thus, we use the March supplements of the CPS to construct yearly data. In particular, we use information on the current location – mainly metropolitan areas – in which the surveyed individual resides, 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 define immigrants as individuals who are born outside the United States and do not have American parents. This information is only available after 1994, and so we only use CPS data for the period 1994-2011. To construct composition-adjusted wages, we use Mincerian wage regressions where we include racial categories, marital status categories, five-year age categories, four educational categories, and occupation and metropolitan-area fixed effects. The four education categories are: high school dropouts, high school graduates, some college, and college graduation or more.

Second, we use the Census of population data for the years 1980, 1990, and 2000. These data are very similar to the CPS, except that the sample size is significantly larger – from a few tens of thousands of observations to a few million observations. After 2000, the US Census data are substituted on Ipums by the American Community Survey (ACS). The ACS only contains metropolitan area information after 2005 and so we use these data. Again, the structure of these data is very similar to the Census and CPS data. Our treatment of the variables is identical in each case.

We also use these data to compute local price indexes. To do so, we follow Moretti (2013) and we apply his code to ACS and Census data as he does. From that, we obtain a local price index for each of the metropolitan areas in our sample. CPS does not contain a number of variables that are used for this computation – particularly housing price information – which explains why we do not compute local price indexes using CPS data.

To give a sense of the metropolitan areas driving most of the variation in our analysis, Table 1 reports the metropolitan areas with the highest immigrant share 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 metropolitan areas with high levels of immigration are also large, 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

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: Statistics are based on the sample of prime-age male workers (25-59) from the Census 2000. Weekly wages are computed from yearly wage income and weeks worked. Local price indexes are computed following Moretti (2013). The wage gap is the gap in earnings between natives and immigrants, controlling for observable characteristics.

notable outliers, which are mostly metropolitan areas in California and Texas relatively close to the US-Mexico border.

2.2 New Immigrant Survey and Consumer Expenditure Survey data

To explore whether immigrants consume less locally than natives we employ different data sets. First, we use data from the New Immigrant Survey to document remittance behavior. While not a large data set, it is the only data set that we know that has information on both the income and the amount remitted at the individual or household level for immigrant residing in the US.

The second data set that we use is the Consumer Expenditure Survey, which is maintained by the Bureau of Labor Statistics and has been widely used to document the consumption behavior in the US. The survey is a representative sample of US households and contains detailed information on consumption expenditures and household characteristics. Unfortunately, among the recorded household characteristics there is no information on birth place or citizen status, which is what usually allows to identify immigrants. Instead we need to rely on one of the Hispanic categories that identifies households of Mexican origin.

We use the files of the Consumption Expenditure Survey for the years 2003 to 2015 as these samples allow the identification of Mexican households. The data set contains around 30,000 households per year, of which around 7 percent are of Mexican origin.

3 Stylized facts

In this section, we document a series of facts about immigrants' location choices and wages, and we discuss their potential importance for total output in the United States. We then document immigrants' consumption behavior.

3.1 Cities, labor market outcomes, and immigrants

3.1.1 Immigrants' location choices and city size

The first fact that we document in this paper is that immigrants tend to live in larger and more expensive cities in greater proportions than natives. This is something that was known to some extent in the literature (see for example Eeckhout et al. (2014) and Davis and Dingel (2012)), but we document this fact using a much larger number of data sets and we expand the existing literature by showing that there is also a strong relationship between immigrant shares and local price indexes.

A simple way to document this fact is to regress the distribution of immigrants relative to the distribution of natives on city size or price level. In order to do so, we define the relative immigrant distribution as the share of immigrants living in city c divided by the share of natives living in city c and regress this measure (in logs) on the size or price level of city c. More specifically we run the following regression:

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

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. When the subscript c is omitted, the variables represent the total number of immigrants or natives in a particular time period. $P_{c,t}$ is either the total amount of people in the city or its price level. We run separate regressions for each year.

Figure 1 shows these relationships using data from the Census 2000. In the left panel, we observe that, even if there is some variance in the immigrant distribution across metropolitan areas, there is a clear positive relationship between immigrants and city size. This relationship is statistically significant. The relationship between immigrant share and price indexes is even stronger and the linear fit better, as shown in the right panel of Figure 1.[11] While there are some exceptions, mainly along the US-Mexico border, a city with a 1 percent higher local price index is associated with an increase of around 7 percent in the relative immigrant distribution.

In Figure 2 we investigate how these relationships have evolved over time. To show this, we first run a linear regression following equation 3.1 for each of the years displayed along the x-axis of the figure against the city size or the price index, and we then plot the various estimates and confidence intervals for these elasticities. In other words, we estimate the relationships shown in Figure 1 for every year and plot the estimates.

The left panel of Figure 2 shows that the relationship between the relative immigrant distribution and city size has been positive since the 1980s. This relationship has become slightly stronger over time.

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

Figure 1: City size, price index, and immigrant distribution
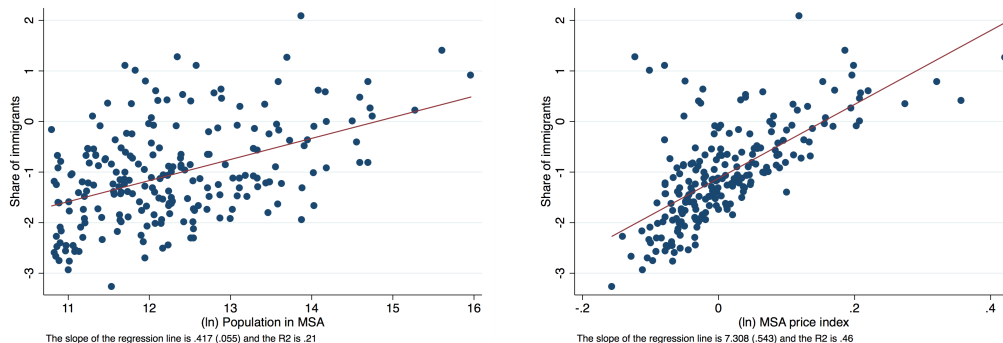
Notes: The figure is based on the sample of prime-age male workers (25-59) from the Census 2000. The MSA price indexes are computed following Moretti (2013). Each dot represents a different MSA. There are 219 different metropolitan areas in our sample.

Figure 2: Evolution of the relationship between immigrant distribution and city size and city price indexes
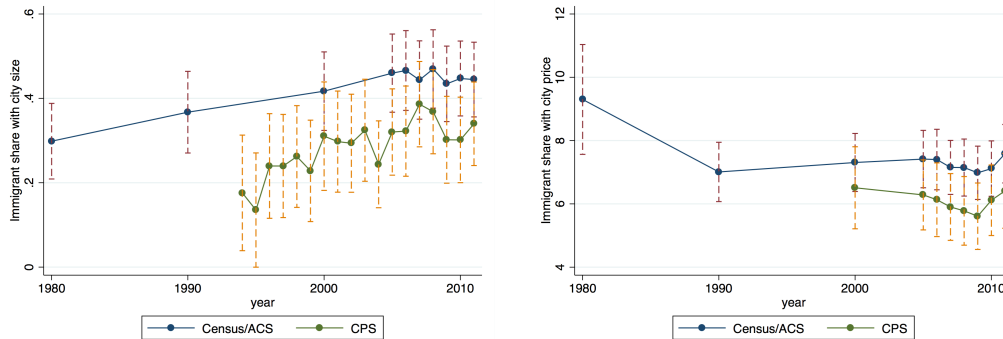
Notes: This figure uses Census/ACS and CPS data from 1980 to 2011 to estimate the relationship between the share of immigrants among all US immigrants relative to share of natives among all US natives living in a city and and its size and price. Price indexes can only be computed when Census/ACS data are available. Each dot represents the corresponding estimate of the elasticity of the relative immigrant distribution, city size, and city prices for each corresponding year. Vertical lines represent 95 percent confidence intervals.

While in 1980 the elasticity was around 0.3 percent, it has increased over the years to reach almost 0.5 percent when using the Census data. We observe a similar trend in the CPS data, but estimates are smaller and noisier, most likely because of measurement error. The elasticity of immigrant shares and local price indexes first decreased from around 9 to 7 percent between 1980 and 1990 but remained relatively stable since then.

We can summarize these two figures as follows:

Fact 1. *Immigrants concentrate in large and expensive cities much more than natives.*

3.1.2 Wages, city size, and local price indexes

It is a well-known fact that wages are higher in larger cities (see for example Baum-Snow and Pavan (2012)). Moreover, this relationship has also become stronger over time. In this section, we document this fact with our data. We show results using both the average (composition-adjusted) wages of natives

alone, and natives together with immigrants.

To illustrate this fact, we use again various cross-sectional regressions and plot the estimates for each of the years. More specifically we run regressions of the following type:

$$\ln w_{c,t} = \alpha_t + \beta_t \ln P_{c,t} + \varepsilon_{c,t} \tag{3.2}$$

where as before $P_{c,t}$ is either the total amount of people in the city or its price level and where $w_{c,t}$ is a measure of local wages.

In Figure 3, we show the evolution of the city size premium using Census data (left) and CPS data (right). We can compute this premium using natives and immigrants, or focusing on native wages alone. In both cases, we always obtain positive and significant estimates. The city size–wage premium has increased in the United States since 1980, although it has remained flat in the last 20 years or so (Baum-Snow and Pavan, 2012). Census estimates are slightly larger than CPS estimates, again, a consequence of measurement error in CPS data. A remarkable finding is that the city size premium is significantly smaller when combining both natives and immigrants in computing average wages. We will come back to this point later.

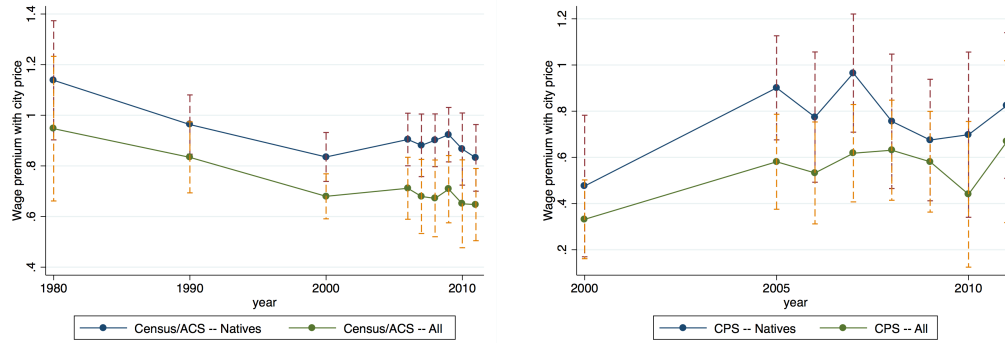Figure 3: Evolution of city size premium
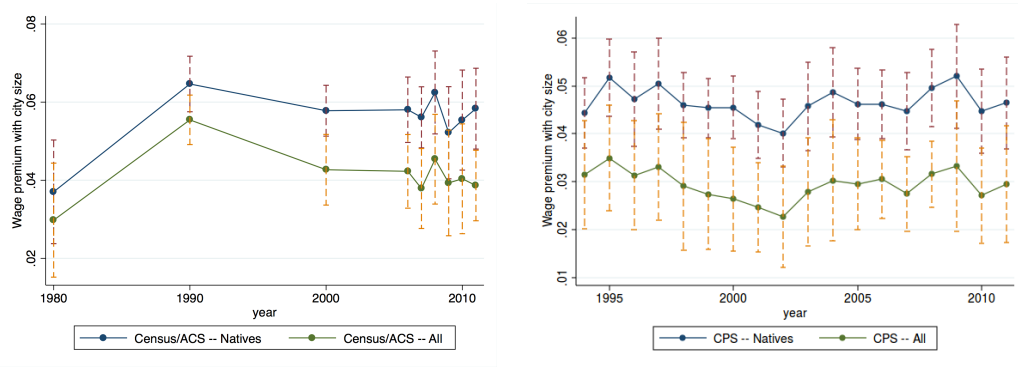
Notes: This figure uses Census/ACS and CPS data from 1980 to 2011 to estimate the relationship between wage levels and city size. Each dot represents the corresponding estimate of the elasticity of immigrant shares, city size, and city prices for each corresponding year. CPS data only starts reporting the place of birth in 1994. Vertical lines represent 95 percent confidence intervals.

In Figure 4, we repeat the exercise using price levels instead of city size. We obtain very similar patterns. The city price wage premium is just less than 1. This means that an increase in the price level translates almost one for one to the wages paid in the city. If anything, this relationship has declined over the last 30 years or so. This is mainly due to the increase in price levels, as can be seen in Figure A.1 in the Appendix. Again, as was the case with the city size–wage premium, when we also use immigrants to compute it, we see that the relationship is less strong than if we only use natives. This is true, both when we use ACS/Census data and when we use CPS data.

We can summarize this fact as:

Fact 2. *Wages are higher in large and more expensive cities. Both the city size–wage premium and the city price–wage premium are higher when wages are computed using the native population only.*

Figure 4: Evolution of city price level premium

Notes: This figure uses Census/ACS and CPS data from 1980 to 2011 to estimate the relationship between wage levels and city prices. Price indexes can only be computed when Census/ACS data are available. Each dot represents the corresponding estimate of the elasticity of immigrant shares, city size, and city prices for each corresponding year. CPS data start reporting the place of birth only in 1994. Vertical lines represent 95 percent confidence intervals.

3.1.3 Immigrant wage gaps

In Figures 3 and 4, we observe that the city size and city price premiums seem to be significantly smaller when using immigrants to compute average wages. In this subsection, we investigate this further. To do so, we compute the gap in wages between natives and immigrants as a function of city size and city prices.

As before, we show the results in two steps. In Figure 5, we show the estimates using data from the Census 2000. In the left panel, we plot the difference in wages between natives and immigrants in our sample of metropolitan areas against the size of these cities. The relationship is negative and strong. The estimate is -.038, meaning that if a city is 10 percent larger, the gap in wages between natives and immigrants is 0.38 percent larger.

Figure 5: Wage gaps, city size, and price indexes
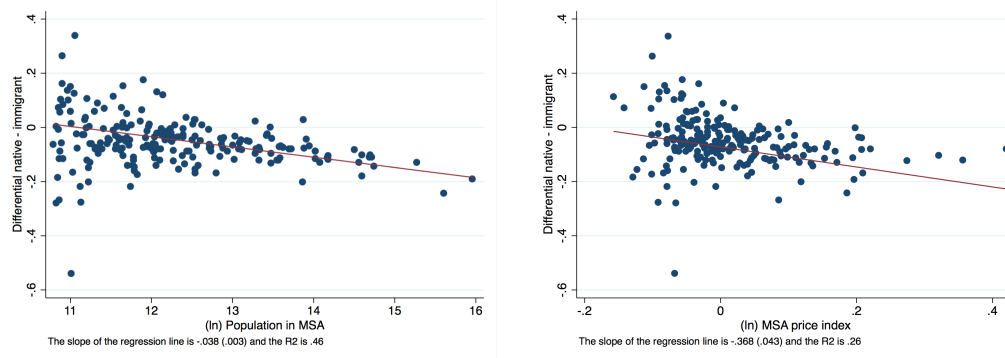
Notes: This figure uses data from the Census 2000 to show the relationship between native–immigrant wage gaps and city sizes and prices. Each dot represents the gap in earnings between natives and immigrants in a metropolitan area. The red line is the fitted line of a linear regression.

Moreover, the relationship between native–immigrant wage gaps and city sizes is very tight. The R squared is around .46, and the standard errors of the estimate are small. In fact, this relationship is

extremely robust in the data. We run regressions of the type:

$$\ln w_{i,c,t} = \alpha_t + \beta_t Imm_{i,c,t} * \ln P_{c,t} + \gamma_t \ln P_{c,t} + \eta X_{i,c,t} + \varepsilon_{i,c,t} \tag{3.3}$$

where i indexes individuals, c indexes cities, t indexes years, Imm is an indicator variable for i being an immigrant, $\ln P$ indicates city size or city prices, and X captures observable individual characteristics. In all our estimates, we always obtain a negative β that remains highly statistically significant no matter what type of data or variation we use, as shown in Section 3.1.5.

One way to see that this relationship between native–immigrant wage gaps and city size is very stable is shown in Figure 6. As before, we show the estimates using both Census and CPS data over a number of years between 1980 and 2011. The relationship remains tight at around .035 through the entire period in both data sets.

Figure 6: Evolution of Wage gaps, city size, and price indexes
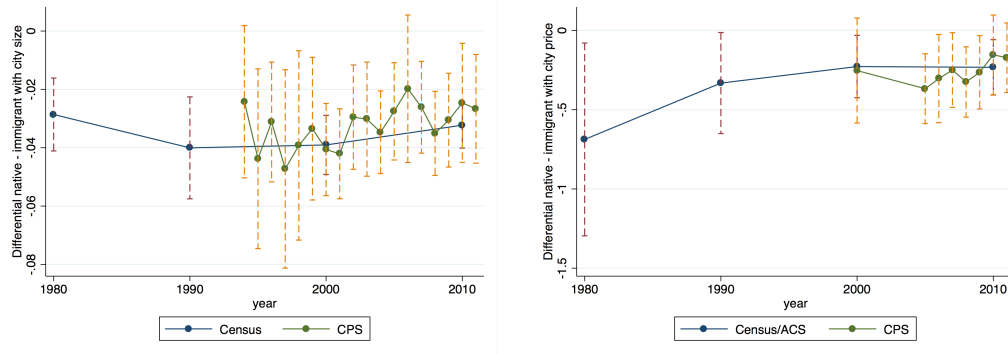
Notes: This figure uses Census and CPS data from 1980 to 2011 to estimate the relationship between native–immigrant wage gaps and city size and prices for each year. Each dot represents an estimate of the native–immigrant wage gap elasticity with city size and city price index. Vertical lines represent 95 percent confidence intervals.

The right panels of Figures 5 and 6 show the relationship between native–immigrant wage gaps and local price levels. We also observe a negative and tight negative relationship. If anything, it seems that over time, this relationship has become a little less strong, but remains at around -.36.

To the best of our knowledge, this is the first paper to document this very strong feature of the data in the United States. It suggests that, for whatever reasons, immigrants that live in larger, more expensive cities are paid less relative to natives than immigrants that live in smaller, less expensive cities. This is not driven by immigrant legal status. In Appendix Figure A.2, we show that we obtain a similar relationship for documented and undocumented immigrants. It is also not driven by the composition of immigrants across US cities. In Figures 5 and 6, we control for observable characteristics, which include education, race, marital status, and occupations, etc. Furthermore, we checked that this relationship prevails for each education group independently by running separate regressions by education category, as reported in Section 3.1.5.

We can summarize this fact as follows:

Fact 3. *Immigrants are paid, on average, lower wages than natives. The gap in wages between immigrants and natives increases with city size. Over time, this gap has been stable.*

3.1.4 Immigrant heterogeneity

Heterogeneity by country of origin price index

Our main hypothesis is that this relationship emerges because immigrants have more incentives than natives to live in large, more expensive cities that pay, on average, higher nominal wages. To explore whether the data are in line with this hypothesis, we rely on immigrant heterogeneity: some immigrants come from rich countries, with price levels similar to the ones in the US which gives them less incentives to consume in their home countries. This should result in a flatter relationship between immigrant-native wage gaps and relative immigrant shares for immigrants coming from countries of origin with price levels comparable to those in the United States.

Figure 7 shows the same plots as Figures 1 and 5 but restricting the sample of immigrants to those coming from either Germany or the United Kingdom. We select these two countries because they have similar price levels to the United States and because there are large numbers of German and British immigrants in the United States. We observe in Panel A of Figure 7 that there is no relationship between native–immigrant wage gaps for these two countries, city size, or prices. Similarly, immigrants from Germany or the UK are less concentrated into larger and more expensive cities relative to natives than other immigrants, as can be seen by comparing the smaller coefficients on the fitted lines in Panel B of Figure 7 relative to the fitted line in Figure 1.[12]

We can summarize this fact as follows:

Fact 4. *Immigrants from richer countries of origin are paid, on average, similar or even higher wages than natives. For these immigrants, the gap in wages with natives **does not** increase with city size. Moreover, relative to other immigrants, immigrants from higher income countries are less concentrated in large and expensive cities.*

Heterogeneity within Mexican immigrants

An alternative source of heterogeneity is potentially provided by Mexicans, the main immigrant group in the United States. While many Mexicans live close to the Mexican border, there are many who live further away. For Mexicans close to the Mexican border, it may be easier to have strong ties to Mexico. These ties may take various forms. For them, it may be easier to spend larger fractions of time in Mexico and it may be easier to stay in close touch with family members not in the United States, and thus the weight of their home country may be larger. We can use this insight to see whether the relationship in the wage gap between Mexicans and natives, and of this gap with city size, is stronger for Mexicans close to the border.[13]

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[12]In Appendix B.5, we explore this further by extending the regression 3.3 as follows:

$$\ln w_{i,c,t} = \alpha + \beta_1 Imm_{i,c,t} * \ln Pop_{c,t} * Z_{i,t} + \beta_2 Imm_{i,c,t} * \ln Pop_{c,t} + \gamma \ln Pop_{c,t} + \eta X_{i,c,t} + \delta_{ct} + \varepsilon_{i,c,t} \qquad (3.4)$$

where $Z_{i,t}$ are various variables that capture the price levels in the country of origin of immigrant i. In particular, we use the GDP per capita reported in the Penn World Tables. The estimate of β_1 is always positive and significant.

[13]Cities close to the Mexican border are defined as locations belonging to California, Arizona, New Mexico, or Texas, which are the 4 states that share a border with Mexico.

Figure 7: Wage gaps, relative immigrant shares, city size, and price indexes, selected countries
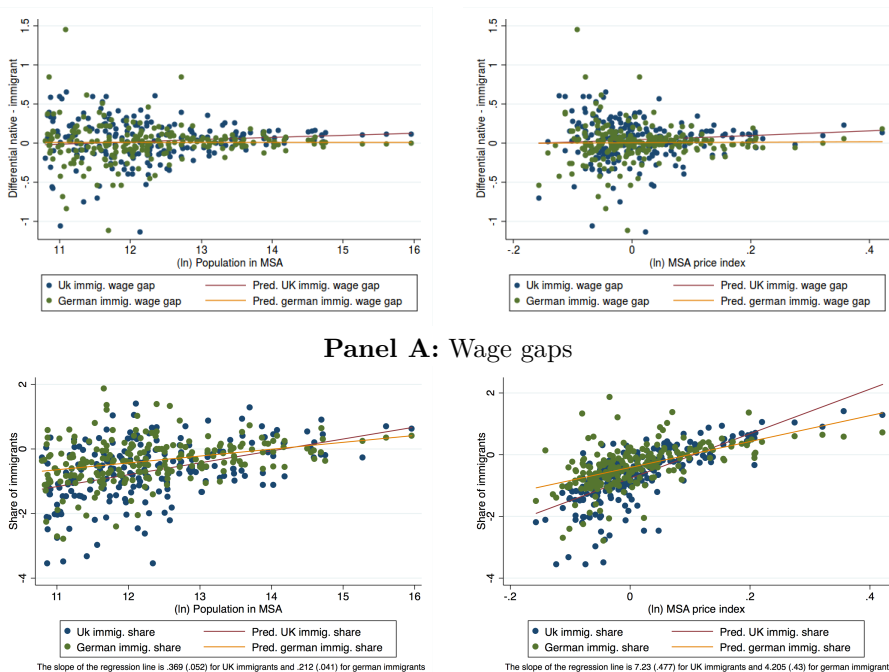
Panel A: Wage gaps

Panel B: Relative immigrant shares

Notes: This figure uses data from the Census 2000 to show the relationship between native–immigrant wage gaps, city sizes, and prices for a selected set of countries of origin. Each dot represents the gap in earnings between natives and immigrants in a metropolitan area. The UK and Germany are selected on the basis of being countries of origin with high price levels and large immigrant populations in the United States.

Table 2 shows these results. Panel A shows that Mexicans close to the Mexican border earn less relative to natives than Mexicans further away. Importantly this relationship emerges even when we control for the number of years that Mexicans have been in the US. This relationship emerges both when comparing Mexicans of all education groups to natives (columns (1) and (2)) and when concentrating on the sample low-skilled workers (columns (3) and (4)). This could suggest that, given that a larger part of the consumption of Mexicans close to the border is likely to be related to prices in Mexico, this allows Mexicans close to the border to accept lower wages. There are also alternative explanations for these results, so it is worth emphasizing that we take them just as suggestive evidence that the mechanism that we posit in this paper may be relevant for explaining these patterns in wages of immigrants of the same country of origin.

Panel B of Table 2 shows that the gap in wages between Mexicans and natives decreases faster with city size in locations close to the Mexican border than in locations further away. This relationship is what we use in section 5 to estimate the model and obtain the importance of the home country in host country local consumption. It is suggestive, thus, that not only Mexicans earn less closer to the border than further away (Panel A), but also that the relationship between Mexican-native wage gaps and city size is stronger closer to the border than further away (Panel B).[14]

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[14]We have done a similar exercise where we compare large and small Mexican households to see whether these patterns are also stronger for smaller Mexican households, presumably more attached to Mexico, than for larger ones. The results indicate

Table 2: Mexican - native wage gaps and distance to Mexico

	Panel A			
	(1)	(2)	(3)	(4)
	Wage	Wage	Wage	Wage
	All workers	All workers	Low-skilled	Low-skilled
VARIABLES	OLS	OLS	OLS	OLS
Immigrant premium	-0.439***	-0.317***	-0.429***	-0.330***
(Mexican immigrants only)	(0.0417)	(0.0221)	(0.0400)	(0.0310)
Sample	Border states	Non-border states	Border states	Non-border states
Observations	62,784	245,634	28,375	91,648
R-squared	0.447	0.398	0.323	0.287
	Panel B			
	(1)	(2)	(3)	(4)
	Wage	Wage	Wage	Wage
	All workers	All workers	Low-skilled	Low-skilled
VARIABLES	OLS	OLS	OLS	OLS
(ln) Population in MSA	0.0272	0.0346**	0.0271	0.0166
	(0.0249)	(0.0143)	(0.0323)	(0.0236)
(ln) Population in MSA x Immigrant	-0.0421***	-0.0329***	-0.0313***	-0.0265***
(Mexican immigrants only)	(0.00797)	(0.00989)	(0.00875)	(0.00800)
Sample	Border states	Non-border states	Border states	Non-border states
Observations	62,784	245,634	28,375	91,648
R-squared	0.448	0.398	0.324	0.288

Notes: These regressions only report selected coefficients. The complete set of explanatory variables is specified in equation 3.3, and is expanded by including the years that Mexicans have been in the US. Metropolitan area fixed effects and year fixed effects are also included in the regression. These regressions use CPS data for the years 1994 - 2011. Low-skilled are defined as having college degree or less. Robust standard errors, clustered at the metropolitan area level, are reported. One star, two stars, and three stars represent statistical significance at .1, .05, and .01 confidence levels.

3.1.5 Robustness to alternative hypotheses

In this subsection we investigate a number of alternative hypotheses that can either reinforce our results or that could potentially explain them. As we show in this section, alternative stories cannot explain the patterns in the data that we document. Moreover, we show that for groups of immigrants that are probably less attached to their home countries, these results attenuate.

Immigration longevity in the US

According to Dustmann and Mestres (2010), immigrants that do not intend to return to their countries of origin remit a smaller fraction 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 interpreted the early gap in wages between natives and immigrants as the lack of skills specific to the receiving country. While this is certainly a possibility, it does not explain why this gap is increasing in city size. However, we can use the insights from the immigrant assimilation literature to see whether the relationship between city size and city price level is stronger for newly arrived immigrants than for older ones. For this, we can use the information of the years that migrants have spent in the United States and distinguish those with less than or more than 20 years of residence in the United States.

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that the patterns are indeed stronger for for small Mexican households, in line with the idea of this paper.

We plot the two groups in Figure 8. The Figure shows that the negative relationship between city size and city prices and native–immigrant wage gaps is less strong for older immigrants than for newer ones. This difference is statistically significant.

Figure 8: Wage gaps, city size, and price indexes, new and old immigrants
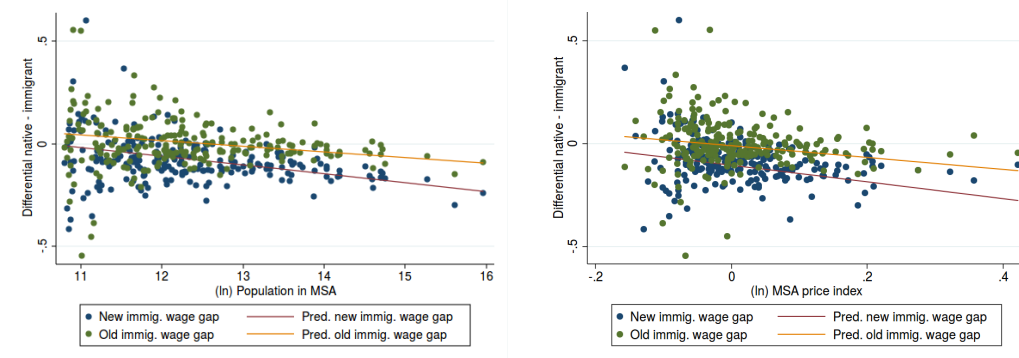
Notes: This figure uses data from the Census 2000 to show the relationship between the wage gaps of new (≤ 20 years in the United States) and old (> 20 in the United States) immigrants to natives, city sizes, and prices. The fitted line for the relationship between new immigrants and city size or city price index is significantly more negative than for old immigrants.

Immigration networks

The results shown so far strongly suggest that immigrants earn less relative to natives in more expensive cities. We argue in this paper that this is related to immigrants' consumption share in their countries of origin. An alternative would be that immigrants earn less in large cities because in large cities there are large immigrant communities. If immigrants perceive communities of their country of origin as a positive amenity, they could potentially accept lower wages in large and 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 – but it is still worth investigating the importance of migrant networks in some more depth.

To investigate this alternative, we extend the basic regression framework introduced in equation 3.3 to compute the estimates shown in Figures 5 and 6 to incorporate immigrant networks. Specifically, we estimate:

$$\ln w_{i,c,t} = \alpha + \beta_1 Imm_{i,c,t} * \ln Pop_{c,t} + \gamma_1 \ln Pop_{c,t} + \beta_2 \text{Immigrant Network}_{i,c,t} \\ + \gamma_1 \text{Immigrant Network}_{i,c,t} * \ln Pop_{c,t} + \eta X_{i,c,t} + \delta_{ct} + \varepsilon_{i,c,t}$$

(3.5)

where we measure the size of the network as $\text{Immigrant Network}_{i,c,t} = \frac{Pop(i)_{c,t}}{Pop_{c,t}}$. That is, for each individual i, we compute the number of individuals from the same country of origin that at time t live in city c. For natives, this measure of immigrant networks takes a value of 0. Thus, β_2 measures the relative wages of immigrants and natives, given the various sizes of the network, while β_1 measures whether there is still a negative premium for immigrants in large cities, conditional on the role of migration networks.

Table 3 shows the results. In column (1), we only include the size of the migration network. As suggested in Borjas (2015), migrant networks may be detrimental to immigrant wages. Our estimates

Table 3: Wage gaps and immigration networks

VARIABLES	(1) Wage OLS	(2) Wage OLS	(3) Wage OLS	(4) Wage OLS	(5) Wage OLS
migrant network x (ln) Population, in MSA		-0.252***			-0.0944**
		(0.0699)			(0.0384)
migrant network in MSA	-0.976***	2.522***		-0.451***	0.865*
	(0.0802)	(0.884)		(0.0403)	(0.496)
(ln) Population in MSA	0.0306***	0.0342***	0.0423***	0.0397***	0.0399***
	(0.0117)	(0.0120)	(0.0156)	(0.0133)	(0.0132)
Immigrant premium			0.278***	0.356***	0.266***
			(0.102)	(0.0619)	(0.0731)
(ln) Population in MSA x Immigrant			-0.0310***	-0.0347***	-0.0283***
			(0.00770)	(0.00461)	(0.00548)
Observations	360,970	360,970	360,970	360,970	360,970
R-squared	0.413	0.414	0.417	0.418	0.418
Xs	yes	yes	yes	yes	yes
Year FE	yes	yes	yes	yes	yes
MSA FE	yes	yes	yes	yes	yes

Notes: This table shows estimates of the native–immigrant wage gap and how it changes with city size, controlling for immigration networks. Immigration networks are measured as the relative size of the immigrant population of each different country of origin with respect to the host metropolitan area. GDP origin is GDP per capita in the country of origin. These estimates use CPS data from 1994 to 2011.

suggest that a 1 percentage point larger network is associated with almost 1 percent lower wages. This negative relationship can be interpreted as evidence that immigrant networks are detrimental to immigrant assimilation into the labor market, or to the fact that migrant networks may be a positive amenity for immigrants, and thus, when living in larger networks, immigrants may be willing to work for a lower wage. In column (2), we investigate whether the size of the network is more or less important in large cities. As the results show, it seems that immigrant networks seem to be associated with lower immigrant wages, especially in larger cities. In column (3), we replicate the results already shown: wages of immigrants are lower than natives, especially in large cities. Columns (4) and (5) show that this negative premium of immigrants in large cities remains even when we control for immigration networks. In column (4), we include in our baseline regression a control for the size of the network, while in column (5) we also include the interaction of the size of the network and city size. In both cases, these controls do not change our estimate of the relative wage gap between immigrants and natives, and city size.

Something that is somewhat potentially related to immigration networks and that may also contribute to explain our results is the fact that the rate of learning in large relative to small cities may be different (see the important work by de la Roca and Puga (2017)). Perhaps wage gaps are larger in large cities because it takes time to learn the skills necessary to thrive in these larger cities. If immigrants stayed less time in large cities, this could generate the wage gap results that we obtain. To investigate this we extend our baseline regression by including the (ln) years that immigrants have been in the US and the interaction of this with city size. As shown in column (5) of Table A.1 in Appendix B.3, this cannot explain our results either.

Thus, while immigrant networks seem to play a role in determining wage levels, it does not seem to be the case that they can account for the patterns in the data that we described in previous sections.

Immigrants' human capital and immigrant-native substitutability

A potential alternative story that could explain why immigrants earn on average lower wages in large cities may be that immigrants with lower levels of human capital concentrate in larger cities, at least relative to natives. To investigate this further we separate our sample of immigrants and natives into four education groups and we investigate whether within these education groups we obtain the same immigrant-native wage gaps that we have documented.

Table 4 reports these results. The interaction of city size and the immigrant dummy that identifies the elasticity of native-immigrant wage gaps and city size fluctuates from around 2 percent to around 3.5 percent for all education groups, even after controlling for other observable characteristics. Thus, the results reported so far suggest that there is a mechanism that is independent of human capital levels.

Table 4: Immigrant - native wage gaps and human capital

VARIABLES	(1) Wage All	(2) Wage <HS	(3) Wage HS	(4) Wage SC	(5) Wage C
Immigrant premium	0.262*	0.115	0.239*	0.328***	0.186*
	(0.144)	(0.0765)	(0.128)	(0.0978)	(0.104)
(ln) Population in MSA	0.0438***	0.0371	0.0200	0.0338*	0.0644***
	(0.0167)	(0.0262)	(0.0235)	(0.0179)	(0.0180)
(ln) Population in MSA x Immigrant	-0.0337***	-0.0186***	-0.0305***	-0.0346***	-0.0201***
	(0.0110)	(0.00544)	(0.00949)	(0.00726)	(0.00745)
Observations	360,970	39,537	101,885	94,124	125,424
R-squared	0.382	0.224	0.262	0.269	0.310
Xs	yes	yes	yes	yes	yes
Year FE	yes	yes	yes	yes	yes
MSA FE	yes	yes	yes	yes	yes

Notes: These regressions only report selected coefficients. The complete set of explanatory variables is specified in equation 3.3. Columns (2) to (5) show results by education group (high school dropout, high school graduate, some college, college). Column (1) shows the entire sample. Robust standard errors, clustered at the metropolitan area level, are reported. One star, two stars, and three stars represent statistical significance at .1, .05, and .01 confidence levels.

An alternative explanation of these results is that immigrants and natives are imperfect substitutes (Ottaviano and Peri (2012)). This would generate a negative relationship between native - immigrant wage gaps and the number of immigrants (relative to natives) in a location. It is not clear why immigrants, in this alternative story, systematically cluster in large and more expensive cities, but there could be an unknown factor that accounts for this. In order to investigate whether this is what is driving our results we use equation 3.5 but substituting the "migration network" variable by the share of immigrants within each education group in each metropolitan area.[15]

Table 5 shows that when controlling for the relative supply of immigrants within education we obtain the same relationship between immigrant-native wage gaps as with our baseline estimates. Column (1) in Table 5 shows that there is a negative relationship between wage gaps and immigrant shares. This

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[15]Alternatively we can use the share of immigrants in the metropolitan area. This usually results in smaller estimates. See discussions in Card (2001), Borjas (2003), Card (2009), Borjas and Monras (2017), and Dustmann et al. (2016).

Table 5: Wage gaps and imperfect native - immigrant substitutability

VARIABLES	(1) Wage OLS	(2) Wage OLS	(3) Wage OLS	(4) Wage OLS	(5) Wage OLS
Share of immigrants (by edcode) x (ln) Population, in MSA		-0.0763***			-0.0386***
		(0.0106)			(0.00842)
Share of immigrants (by edcode)	-0.249***	0.805***		-0.108***	0.427***
	(0.0384)	(0.137)		(0.0260)	(0.114)
(ln) Population in MSA	0.0360***	0.0500***	0.0423***	0.0416***	0.0478***
	(0.0128)	(0.0149)	(0.0156)	(0.0137)	(0.0145)
Immigrant premium			0.278***	0.302***	0.226**
			(0.102)	(0.0982)	(0.0913)
(ln) Population in MSA x Immigrant			-0.0310***	-0.0323***	-0.0270***
			(0.00770)	(0.00735)	(0.00685)
Observations	360,970	360,970	360,970	360,970	360,970
R-squared	0.411	0.411	0.417	0.418	0.418
Xs	yes	yes	yes	yes	yes
Year FE	yes	yes	yes	yes	yes
MSA FE	yes	yes	yes	yes	yes

Notes: This table shows estimates of the native–immigrant wage gap and how it changes with city size, controlling for immigrant supply. Immigrant supply shocks are measured as the relative size of the immigrant population in each metropolitan area and each of the four education codes previously reported. These estimates use CPS data from 1994 to 2011.

is consistent with immigrants and natives being imperfect substitutes within narrowly defined education groups. In column (2) we show that this relationship seems to be stronger in larger cities, something that may explain our baseline results, shown in column (3) for convenience. Columns (4) and (5) show that this is not the case. The interaction of the immigrant identifier and city size is unchanged by the inclusion of the share of immigrants in the metropolitan area within education groups, and, if anything, this regression suggests that an important part of the role that previous papers have attributed to imperfect native-immigrant substitutability may in fact be explained by the endogenous location choice of immigrants.

3.2 Immigrant consumption and return migration patterns

In this paper we argue that one way to explain the distribution of immigrants across US cities and their wages relative to natives is that immigrants spend a fraction of their income in their host country. In this section we document this importance of the home country by analyzing remittance behavior, housing expenditures, consumption expenditures, and return migration patterns. All of these are in line with our hypothesis that part of the consumption of immigrants takes place in the country of origin.

3.2.1 Remittances

Dustmann and Mestres (2010) document that immigrants in Germany remit around 10 percent of their income. While data of the same quality does not exist for the US, we can use the New Immigrant Survey to document the remittances behavior of immigrants in the US. Table 6 reports the frequency, the share of income and the share of income for those immigrants that remit for a number of different origins. There is quite some variation in the frequency of remitting across origins. For example, 20 percent of immigrants from Mexico, and as much as 32 percent of immigrants from other Latin American countries seem to be remitting part of their income to their home countries. This number is significantly lower for

immigrants from European countries.

Table 6: Remittances

Origin region	Frequency (%)	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	12.8
Mexico	20.55	2.57	14.02
Europe	12.93	1.25	10.73
Total	24.73	2.24	10.98

Notes: Data come from the 2003 NIS, a representative sample of newly admitted legal permanent residents. Statistics are based on a subsample of immigrants with positive income (from wages, self-employment, assets or real estate) and with a close relative (parent, spouse or children) living in the origin country. Income shares over 200% are dropped.

For the entire population of immigrants, immigrant remittances represent between around 2 to 3 percent of income. For those who remit, this number logically increases to between 10 and 15 percent, which is an estimate that is closer to the one provided in Dustmann and Mestres (2010). All in all, the numbers for the US seem broadly consistent with this prior literature.

3.2.2 Expenditures on housing

One way to explore whether immigrants consume different local goods than natives is to investigate housing expenditures. If immigrants spend a fraction of their income in home goods, they should (potentially) spend a lower fraction of their income on housing. This should hold for immigrants relative to natives of the same income group and with similar characteristics. Note that differences in characteristics of the immigrant and native population are going to translate into heterogeneity in expenditures on housing that are not related to having a country of origin where to consume. This is why it is important to control for personal characteristics and household income to make immigrants and natives "comparable". We use two alternative data sets to show that immigrants consume less on housing relative to "comparable" natives.

The first piece of evidence comes from Census data, which can be used to compute "Monthly Rents" and total household income, and at the same time identifies the country of birth of each individual. We can thus use the following regression equation:

$$\ln \text{Monthly Rents}_i = \alpha + \beta \text{Immigrant}_i + \gamma \ln \text{Household Income}_i + \eta X_i + \varepsilon_i \qquad (3.6)$$

to investigate whether households with at least one immigrant consume less than natives once we control for household income. Note that an important disadvantage of these data is that we can only use renters.

A different type of data that contains expenditure on housing is the Consumer Expenditure Survey. The main draw back of these data is that we cannot identify country of birth of each individual. Instead we need to rely on the identification of Hispanics from Mexico (which should be highly correlated with Mexican-born individuals, which, in turn, is one of the main immigrant groups). In these data moreover,

we do not have a continuous measure of household income. Instead, we have 9 different categories, that we can use in our estimation. In particular we run regressions of the following type:

$$\ln \text{Housing Expenditure}_i = \alpha + \beta \text{Mexican}_i + \sum_j \gamma_j \text{Household Income category } j_i + \eta X_i + \varepsilon_i \quad (3.7)$$

where "Housing expenditure" is the reported expenditure on housing and "Mexican" identifies households of Mexican origin.

Results are reported in panels A and B of Table 7. In panel A, we show that immigrants pay on average around 3 to 4 percent less in rental prices than similarly looking natives. In column (1) we use the full sample of households in the Census and ACS. Using this sample we have that, once we control for personal characteristics, and, very importantly, for household income, immigrant households pay around 4 percent lower monthly rents. The estimates are similar when we only include households whose income comes mainly from wages, in column (2), and when we restrict to households whose wage monthly income is above their monthly rents.

Table 7: Immigrants' expenditure on housing

	Panel A: Census and ACS data			
	(1)	(2)	(3)	(4)
	(ln) monhtly rent	(ln) monhtly rent	(ln) monhtly rent	(ln) monhtly rent
VARIABLES	OLS	OLS	OLS	OLS
Immigrant indicator	-0.0491***	-0.0438***	-0.0267**	-0.0202*
	(0.0133)	(0.0128)	(0.0120)	(0.0109)
Total household income	0.147***	0.179***	0.279***	0.386***
	(0.00303)	(0.00401)	(0.00485)	(0.00624)
Observations	2,869,862	2,089,411	2,716,515	2,416,819
Sample	Full	workers	rent<income	2*rent<income
Controls	yes	yes	yes	yes
	Panel B: Consumption Expenditure Survey data			
	(1)	(2)	(3)	(4)
	(ln) Housing Expenditure	(ln) Housing Expenditure	(ln) Housing Expenditure	(ln) Housing Expenditure
VARIABLES	OLS	OLS	OLS	OLS
Mexican indicator	-0.222***	-0.012	-0.124***	-0.059***
	(0.009)	(0.008)	(0.010)	(0.009)
Observations	105,975	105,975	105,975	105,975
R-squared	0.006	0.184	0.218	0.278
Controls	none	income	pers. characteristics	all

Notes: Panel A of this table shows regressions of (ln) monthly gross rents on (ln) total household income and observable characteristics which include race, occupation, metropolitan area of residence, family size, and marital status. Year fixed effects are also included. Data from US Census and ACS from 1980 to 2011 is used. Sample full uses all possible observations. Sample "workers" uses the observations used to estimate wages (in the last part of the paper). Sample "rent<income" restricts sample to households whose total income is larger than total rent (i.e. 12 times the monthly rent). Sample "2*rent<income" restricts the sample to workers earning twice as much as total rents. Panel B of this table shows regressions of (ln) housing expenditure on a number of personal characteristics. This first column does not control for any observables. Column 2 controls for income categories. Column 3 controls for personal characteristics, time and state fixed effects. Column 4 includes all the controls. Standard errors clustered at the metropolitan area level.

Panel B reports the results using Consumer Expenditure Survey data. In column 1 we show the regression of housing expenditure on a dummy indicating whether the household is of Mexican origin. The unconditional regressions shows that it is indeed the case that households of Mexican origin consume less on housing. This, however, could simply reflect that they tend to earn less, or that their observable characteristics – like education or residential choices – are such that these type of households tend, on

average, to consume less on housing. In the second column, we include income categories. This reduces the coefficient and makes it not significantly different from zero. Column 3 shows that controlling for other personal characteristics and for time and state fixed effects is important. Mexican origin households tend to be systematically different than natives households, both in terms of education, residential choices, marital status and a number of other dimensions. When in column 4 we control for both income and personal characteristics we see that Mexican households consume relatively less on housing compared to similarly looking native households. This is our preferred estimate and aligns very well with the Census estimates.

3.2.3 Total Expenditure

While it seems clear that immigrants spend less on housing than natives, it may be that they use this income on some other local goods or instead that they save it for future consumption. To explore this we can use the Consumption Expenditure Survey data and compare total local expenditure by Mexican households relative to all other households, following panel B in Table 7. More specifically we can use the following specification:

$$\ln \text{Total Expenditure}_i = \alpha + \beta \text{Mexican}_i + \sum_j \gamma_j \text{Household Yearly Income category } j_i + \eta X_i + \varepsilon_i \quad (3.8)$$

where "Total Expenditure" is quarterly total expenditure at the household level, and where as before we can identify "Mexican" households and control for household income categories.

Table 8: Immigrants' total expenditure, Consumer Expenditure Survey

	(1)	(2)	(3)	(4)
	(ln) Total Expenditure	(ln) Total Expenditure	(ln) Total Expenditure	(ln) Total Expenditure
VARIABLES	OLS	OLS	OLS	OLS
Mexican indicator	-0.325***	-0.091***	-0.198***	-0.115***
	(0.008)	(0.007)	(0.009)	(0.008)
Observations	105,975	105,975	105,975	105,975
R-squared	0.015	0.285	0.220	0.342
Controls	none	income	pers. characteristics	all

Notes: This table shows regressions of (ln) total expenditure on a number of personal characteristics and an indicator for Mexican households. This first column does not control for any observables. Column 2 controls for income categories. Column 3 controls for personal characteristics, time and state fixed effects. Column 4 includes all the controls. Standard errors clustered at the metropolitan area level.

The results are reported in Table 8. Mimicking the results of panel B in Table 7, we show that, unconditionally, Mexicans seem to consume around 27 percent less than other households. This may be because they earn less or because they have different characteristics than natives that explain consumption patters. When controlling for both in Column (4) we see that Mexican households consume around 10 percent less than other households. This is consistent with the remittances sent to their home countries, or with higher savings for future consumption. We investigate whether future consumption in the home country is a potential important channel in the following section.

Figure 9: Return migration
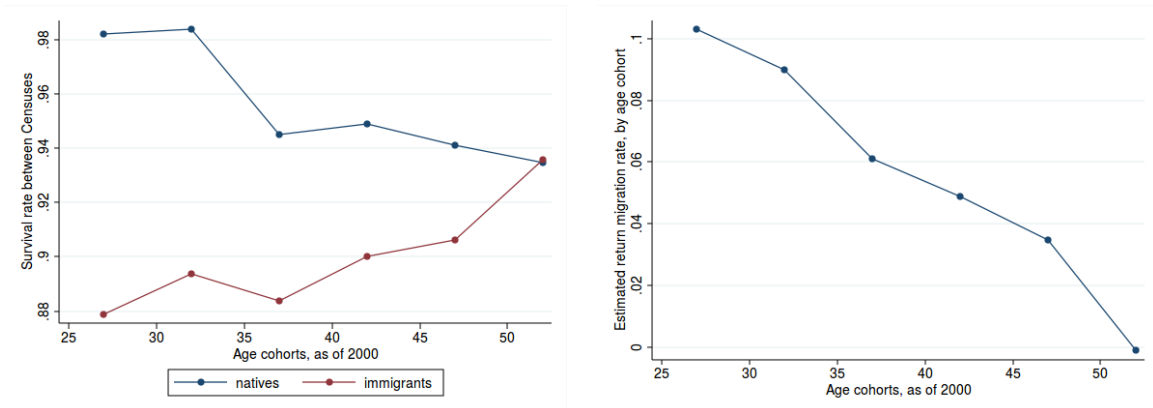
Notes: This figure shows estimates of survival rates and return migration rates by age group. The graph on the left compares the size of native and immigrants (who arrived before 2000) in Census years 2000 and ACS 2010 to estimate survival rates by age group. The graph on the right subtracts native survival rates from immigrant survival rates to obtain estimates of return migration rates by age group.

3.2.4 Return Migration

A final very important reason why immigrants care about price indexes in their home country is that many of them likely plan on returning home at some point during their life time.

To the best of our knowledge there are no large and representative data sets to directly document return migration patterns. This would require observations both at the destination country and at the home country over a certain period of time. While some data sets exist that allow to do this, they are in general not very comprehensive.

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

The left hand side graph of Figure 9 plots these survival rates by age cohort. For example, we observe that more than 98 percent of the natives who were between 25 and 30 years old in 2000 are still present in the 2010 American Community Survey. This survival rate declines with age. For example, for the population that in 2000 were between 45 and 50 years old, the survival rate decreases to around 94 percent. When we do the same exercise for immigrants that arrived to the US before 2000 the survival rates decline substantially.[16]

In the graph on the right hand side we estimate return migration rates by taking the difference of survival rates between immigrants and natives. This is a good estimate if mortality rates for the same age cohort are similar between immigrants and natives. We observe in this graph of Figure 9 that return migration is likely to be very high for younger cohorts and it converges to 0 for older cohorts. This is, more than 10 percent of the immigrant population who was between 25 and 30 years old in 2000 are no

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[16]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 that in the Census 2000 claim to have arrived before 1990 is larger than the total amount of Mexicans observed in the 1990 Census. See also Hanson (2006).

longer in the United States by 2010. We start the series at age 25 since those are already likely to be working in the US. Return migration rates are even higher for younger cohorts.

This means that for a large fraction 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, the return migration patterns give additional support to the idea that immigrants partly take into account the price index in their origin country when choosing their optimal location in the US.

4 Model

In this section, we introduce a simple model with frictional labor markets that helps to rationalize the facts documented in Section 3. There are two crucial elements to the model. First, labor markets are not perfectly competitive. Under perfect competition, differences in wages of workers who are perfect substitutes in the production function would be competed away. This is well known in the discrimination literature since Becker (1957). Wage differences for similar workers can, instead, be sustained in equilibrium when there are frictions in the labor market (Black (1995)). Second, we embed the frictional labor markets into a standard quantitative spatial equilibrium model. In order to accommodate the heterogeneity in immigrants from different countries of origin we allow for some degree of substitution between home country and local consumption.

4.1 Location choices

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

$$U_{ijc} = \rho + \ln A_c + \alpha_t \ln C_{jc}^T + (1 - \alpha_t) \frac{\sigma}{\sigma - 1} \ln \left(\frac{\alpha_l}{\alpha_l + \alpha_f} (C_{jc}^{NT})^{\frac{\sigma-1}{\sigma}} + \frac{\alpha_f}{\alpha_l + \alpha_f} (C_j^{NT})^{\frac{\sigma-1}{\sigma}} \right) + \varepsilon_{ijc}$$

where α_t denotes the shares of consumption devoted to tradable goods, and where α_l and α_f denote the weight of consumption in local non-tradables 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 non-tradables and foreign non-tradables. Note that there are alternative interpretations for what C_j^{NT} really means. It could mean 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 potential different 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 have.[17]

Importantly, the various α_i govern the expenditure shares 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

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[17]Moreover, it is very plausible that the importance of each of these channels is different between different types of immigrants. For instance, remittances may be more relevant for less skilled immigrants while future consumption may be more relevant for more skilled immigrants. We do not attempt in this paper to address this heterogeneity.

formally below.

For the rest, 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. A_c denotes local amenities.

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

$$p^T C_{jc}^T + p_c C_{jc}^{NT} + p_j C_j^{NT} \leq w_{jc}.$$

We define $\alpha_t + \alpha_l + \alpha_f = 1$ and the auxiliary parameters $\bar{\alpha}_l = \frac{\alpha_l}{\alpha_l + \alpha_f}$ and $\bar{\alpha}_f = \frac{\alpha_f}{\alpha_l + \alpha_f}$. By utility maximization we then obtain the following indirect utility of living in each location (derivation in Appendix A.1):

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

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 gives:

$$\pi_{jc} = \frac{V_{jc}^{1/\lambda}}{\sum_k V_{jk}^{1/\lambda}} = \left(\frac{V_{jc}}{V_j}\right)^{1/\lambda}, \tag{4.1}$$

where $V_j = (\sum_k V_{jk}^{1/\lambda})^{\lambda}$. This is the share of workers from country 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 indexes will attract more people.

4.2 Firms' technology

Firms' technology is given by the following linear production function for tradables:

$$Q_c^T = B_c L_c \tag{4.2}$$

where $L_c = \sum_i L_{icj}$ is the sum of all the workers that live in c and come from origin j. B_c is the technological level of the city c. 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 $a \geq 0$. We will come back to this point in Section 5, but we ignore it in the presentation of the model to keep it simple.[18]

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 they receive, 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 across all the

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[18]For the model to have a solution, we need to make sure that $a < min\{\eta_c\}$ where η_c is the elasticity of housing supply that we introduce in Section 4.4.

cities of hiring workers is given by $\bar{w}$. Note that we can choose to use this as the numeraire. Using this, we obtain that wages are relatively close to 1. Thus, using a Taylor expansion, 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.

4.3   Labor market

Labor markets are not competitive. Firms and workers meet and 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 does not depend anymore on the initial taste shock drawn and that his outside option to working is receiving an indirect utility of zero.[19] That is, a worker choosing city c will benefit from the local indirect utility.

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 the various workers from country of origin j living in location c:

$$\ln w_{jc} = -(1 - \beta) \ln A_c + \beta \ln \tilde{B}_c + (1 - \beta)(1 - \alpha_t) \ln \bar{p}_{jc} \tag{4.3}$$

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

4.4   Housing market

There are congestion forces because housing supply is inelastic. This gives the standard relationship between local prices and city size:

$$\ln p_c = \eta \ln L_c$$

This determines local price indexes of non-tradable goods in the model. Note that η could potentially be city-specific. When we estimate the model in Section 5, we allow η to vary by city. To make the exposition of the model simpler, we omit this in this section.

4.5   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. The difference between natives and immigrants is the weight they give to local and foreign price indexes:

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[19]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.

Assumption 5. *Natives only care about local price indexes so that $\alpha_f = 0$ and $\alpha_l = \alpha$. Immigrants care about local and foreign price indexes so that $\alpha_f \neq 0$ and $\alpha_l + \alpha_f = \alpha$.*

Proposition 6. *Under assumption 5 and the assumptions made on the modeling choices, there is a positive gap in wages between natives and immigrants. This gap is increasing in the local price index and the effect of the local price index is larger when p_j is low. The wage gap is given by the following expression:*

$$\ln w_{Nc} - \ln w_{jc} = (1-\beta)(1-\alpha_t) \ln p_c - (1-\beta)(1-\alpha_t) \ln \bar{p}_{jc} \tag{4.4}$$

Proof. Appendix A.2 □

It is worth noting that in the model, differences in the price index of origin do not play a direct role in the special case of $\sigma = 1$ as then we have a Cobb-Douglas utility function that combines local and foreign non-tradable goods consumption. The result of this maximization problem is that the demand for each good is a constant fraction of total income. If instead we assume that there is a high degree of substitutability between local and home consumption, we obtain the result that the share of consumption of immigrants in countries of origin with higher price indexes is lower, and hence, the difference in the importance of local price indexes for immigrants and natives decreases.

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

Proposition 7. *Under assumption 5, and the assumptions made on the modeling choices, immigrants concentrate in expensive cities. The spatial distribution of immigrants relative to natives is given by:*

$$\ln \frac{\pi_{jc}}{\pi_{Nc}} = \frac{1}{\lambda} \left(\beta(1-\alpha_t) \ln p_c - \beta(1-\alpha_t) \ln \bar{p}_{jc} \right) + \ln \frac{\sum_k \left(A_k \tilde{B}_k / L_k^{\eta(1-\alpha_t)} \right)^{\frac{\beta}{\lambda}}}{\sum_k \left(A_k \tilde{B}_k / \bar{p}_{jk}^{(1-\alpha_t)} \right)^{\frac{\beta}{\lambda}}} \tag{4.5}$$

Proof. Appendix A.2 □

These two propositions are linked directly to the facts that we document in Section 3. They show the concentration of immigrants and the fact that immigrants receive lower wages than natives in expensive cities. If the relationship between local prices and population is positive (which is given by the inelastic supply of housing), these two propositions also show the relationship between city sizes and immigrants' location choices and wages.

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

$$L_c = (A_c \tilde{B}_c)^{\frac{\beta}{\lambda}} \sum_j \frac{L_j / \bar{p}_{jc}^{(1-\alpha_t)\frac{\beta}{\lambda}}}{\sum_k (A_k \tilde{B}_k / \bar{p}_{jk}^{(1-\alpha_t)})^{\frac{\beta}{\lambda}}} + \frac{(A_c \tilde{B}_c / L_c^{\eta(1-\alpha_t)})^{\frac{\beta}{\lambda}}}{\sum_k (A_k \tilde{B}_k / L_k^{\eta(1-\alpha_t)})^{\frac{\beta}{\lambda}}} L_N \tag{4.6}$$

Proof. Appendix A.2 □

Note that this proposition also means that immigrants make large cities even larger. That is, because they care relatively 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 either they are productive (B_c) or pleasant to live in (A_c). Thus, conditional on amenity levels, immigration concentrates population in more productive cities.

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

Proposition 9. *All else equal, the aggregate output per capita increases with the share of immigrants in the economy. Aggregate output per capita is given by the expression:*

$$q = \sum_c \left[(A_c \tilde{B_c}^{\frac{\beta+\lambda}{\beta}})^{\frac{\beta}{\lambda}} \sum_j \frac{\frac{L_j}{L} / \bar{p}_{jc}^{(1-\alpha_t)\frac{\beta}{\lambda}}}{\sum_k (A_k \tilde{B_k} / \bar{p}_{jk}^{(1-\alpha_t)})^{\frac{\beta}{\lambda}}} \right] + \frac{\sum_c (A_c \tilde{B_c}^{\frac{\beta+\lambda}{\beta}} / L_c^{\eta(1-\alpha_t)})^{\frac{\beta}{\lambda}}}{\sum_k (A_k \tilde{B_k} / L_k^{\eta(1-\alpha_t)})^{\frac{\beta}{\lambda}}} \frac{L_N}{L} \quad (4.7)$$

Proof. Appendix A.2 □

What this proposition really means is that, holding total population constant, if there are more immigrants, total output is higher.

5   Estimation of the model, and output and welfare analysis

In this section, we estimate the model presented in section 4. For each country of origin there are two key equations that the model generates, from which we can obtain four key structural parameters (that we assume to be common across immigrants of different countries of origin). The first key parameter is the weight of home country goods, the second is the elasticity of substitution between home country goods and local goods, the third is the sensitivity of migrant location choices to local conditions, and the fourth is the share of consumption on non-tradables.[20]

5.1   Model Estimation

To obtain the four key parameters we use for each country of origin two different moments of the data. We estimate the model using 2000 Census data and OECD price level data. From OECD data we obtain price levels in a smaller number of countries than the ones that can be identified in the US Census, so we estimate the model on these countries.[21] We use the model to obtain the key moments that are observable in the data. In particular we use the relationship between wage gaps and local price indexes and between relative immigrant shares and local price indexes that the model generates at the country

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[20]An alternative strategy would have been to use the suggestive evidence of how much the home country matters for immigrants shown in Section 3.2, and estimate the model using this information in conjunction with the labor market data. We prefer the alternative of estimating the model using exclusively labor market data as we believe that it highlights better the economic importance of the mechanism that we study in this paper.

[21]All major countries of origin are covered in OECD data. In particular we can use 38 countries of origin for the year 2000. Alternatively we can use GDP per capita as a proxy of price levels and expand the number of countries of origin. Results are similar when we do so.

of origin - metropolitan area level. Those are the targeted moments. More specifically we use equations 4.4, and 4.6 to estimate $\{\alpha_t, \bar{\alpha}_f, \sigma, \lambda\}$.

For this we need to fix β, the productivity and amenity levels across cities, and the force of local agglomeration forces. We rely on prior literature for these parameters. For the productivity and amenity levels, we use Albouy (2016). In a model similar to ours, but where the role of immigrants is not taken into account, Albouy (2016) estimates productivities and amenity levels for 168 (consolidated) metropolitan areas in our sample, which are the ones that we use in what follows.[22] For the housing supply elasticities, we rely on Saiz (2010).[23] We fix $\beta = .3$. This is not a crucial assumption since fixing α_t at .3 – consistent with our estimates – would deliver a β estimate close to .3. Unfortunately we cannot separately identify α_t and β. Finally we use an estimate of local agglomeration forces that is consistent with the consensus in the literature (see Combes and Gobillon (2014)).

We estimate the model using the method of simulated moments. In particular, we construct a grid for the two parameters of the model that enter non-linearly ($\bar{\alpha}_f$ and σ) and we estimate the equations 4.4, and 4.6 using each value of this grid. We then compute the distance from the model predictions to the data to chose α_t, $\bar{\alpha}_f$, σ, and λ that best fit the data. It is reassuring that we obtain an interior solution in our grid, meaning that we are attaining at least a local minimum which is a global minimum given the constraints the we impose on the parameters.[24]

Once we fix this set of parameters we use the model to perform counterfactuals. Table 9 shows the main estimates. Most remarkably, we obtain that the data is consistent with $\bar{\alpha}_f = 0.57$. This is, for immigrants the weight of the home country is 57 percent of non-tradable good consumption, which means that the share of consumption on home country non-tradable goods is around 40 percent. Put differently, when combining all the motives that explain why immigrants take into account their country of origin's price index, we obtain an estimate that is an order of magnitude larger than the evidence presented in Section 3.2 using data on consumption, which suggested that immigrants spend around 10 to 15 percent of their income directly on home country goods.

5.2 Immigration and economic activity

5.2.1 Comparison Model vs. Data

Once we have all the parameters, both the ones that we directly estimate and the ones borrowed from the literature, we can compare the quantitative predictions of our model with the data. Using untargeted moments of the data should serve as a way to see that our model can quantitatively match some of the key features of metropolitan-level cross-sectional US data. We show this in what follows. In general, we obtain better fit for the moments related to wages than for the distribution of people across locations. In principle we could fit the data better by targeting some of the untargeted aggregate moments that we

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[22]An alternative would be to allow these underlying amenities to depend on migration networks. This may change the estimation of the model, and would probably make the model closer to the data as suggested by the evidence presented in Section 3.1.5. We abstract from this in the paper to highlight our mechanism.

[23]Saiz (2010) reports housing supply elasticities at the PMSA, so we use Albouy (2016) crosswalk between PMSAs and CMSAs.

[24]We force $\bar{\alpha}_f$ to be between 0 and 1 and $\sigma > 0$.

Table 9: Model estimates

Variable	Estimate	Source
Share of consumption on tradable goods	0.30	Estimated
Workers' bargaining weight	0.3	Calibrated
Share of home goods consumption (among non-tradable gods)	0.57	Estimated
Sensitivity to local conditions	0.06	Estimated
Elasticity of substitution home-local goods	1.05	Estimated
Amenity levels		Albouy (2016)
Productivity levels		Albouy (2016)
House price supply elasticity		Saiz (2010)
Local agglomeration	0.05	Combes and Gobillon (2014)

Notes: This table shows the estimates of the parameters $\bar{\alpha}_f$, α_t, λ, and σ when using the stated parameters in the papers cited under "Source". The estimates are based on simulated method of moments.

show in what follows. We preferred, however, to only use the moments directly implied by our mechanism even at the cost of fitting the data less well.

In Figure 10, we plot a number of variables against the underlying productivity levels in each city taken from Albouy (2016). We show in this Figure moments that are not targeted by our estimation. This is, our estimation of the model is at the city-country of origin level, while the moments in Figure 10 are the metropolitan area level. The underlying productivity is the primitive parameter that drives our results on both location and wage gaps. In general we do a much better job at explaining the wage data than we do with the population data.[25] The top-left graph of Figure 10 shows that the distribution of population across US cities in the model is slightly less concentrated in large cities than in the data. In both cases, there is a positive relationship but the positive relationship between city size and productivity is less strong in the model. Another difference between the model and the data is that there is more dispersion in the data than in the model. This is not surprising since the only source of dispersion in the model is the differences in amenities across locations of similar productivity, while in the data the sources of heterogeneity may come from other channels. Instead, the model does a good job at obtaining the relationship between wages and productivity. This is shown in the top-right graph of Figure 10. Again, the relationship is similar even if there is more dispersion in the data than in the model.

The same happens with the two main targets of the model when aggregating them at the city level. This is, the model, which is estimated at the country of origin – metropolitan area level, delivers a positive relationship between immigrant shares and productivity at the city level that mimics the relationship in the data. As before though, the model delivers a somewhat less strong relationship than the data. It is interesting to see that there are some important outliers in terms of immigrant shares. These smaller metropolitan areas with a high share of immigrants are always close to the Mexican border. This is something that the model cannot match, but that we have already discussed in Section 2. Similarly, the model is capable of generating a negative relationship between native - immigrant wage gaps at the city level that is similar to the one observed in the data and that is at the root of the main findings of this

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[25]This is mainly a consequence of our estimate of λ. We could match the data better by adding the distribution of the native population as an additional target in our estimation. Note also that λ could potentially be different between natives and immigrants (see Cadena and Kovak (2016) and Monras (2015a) for discussions on this issue), which could also be used to improve the fit of the model.

Figure 10: Model and data, untargeted moments

Notes: This figure compares the data and the model. Each dot represents a city. We use the 168 consolidated metropolitan areas used in Albouy (2016). See the text for the details on the various parameters of the model. In this figure, we assume that the endogenous agglomeration forces are 5 percent (i.e., $a = 0.05$).

paper.

Overall, it seems that our estimated model is quantitatively similar to the data, and can thus be used to perform some counterfactual experiments that should help to shed light on the importance of immigrants in a number of outcomes.

5.2.2 The distribution of economic activity and general equilibrium

The main counterfactual exercise that we do is to examine what happens if, keeping total population constant, we increase the share of immigrants (holding constant the distribution of countries of origin). This uses equation 4.6, previously introduced. That is, in this equation, we first compute the distribution of population across metropolitan areas assuming that there are no immigrants, and we then do the same exercise with current immigration levels of around 15 percent. We do this exercise both with and without agglomeration forces (i.e., with $a = 0$ and $a > 0$ in equation 4.2).

In Figure 11, we plot the change in a number of outcome variables between the predictions of the model with and without immigrants. Effectively, this measures the role of migration on the economy through their residential choices.

It is apparent from Figure 11 that migration makes more productive cities larger. This is the basis of the output gains that come from the differential location choices of immigrants relative to natives. The graph shows how the most productive metropolitan areas in the United States are as much as 2–3 percent larger as a result of current immigration levels than they would have been in the case that immigrants had decided on residential locations in the way natives do. These gains are slightly larger when there are positive agglomeration forces.

Figure 11: Effect of immigrants
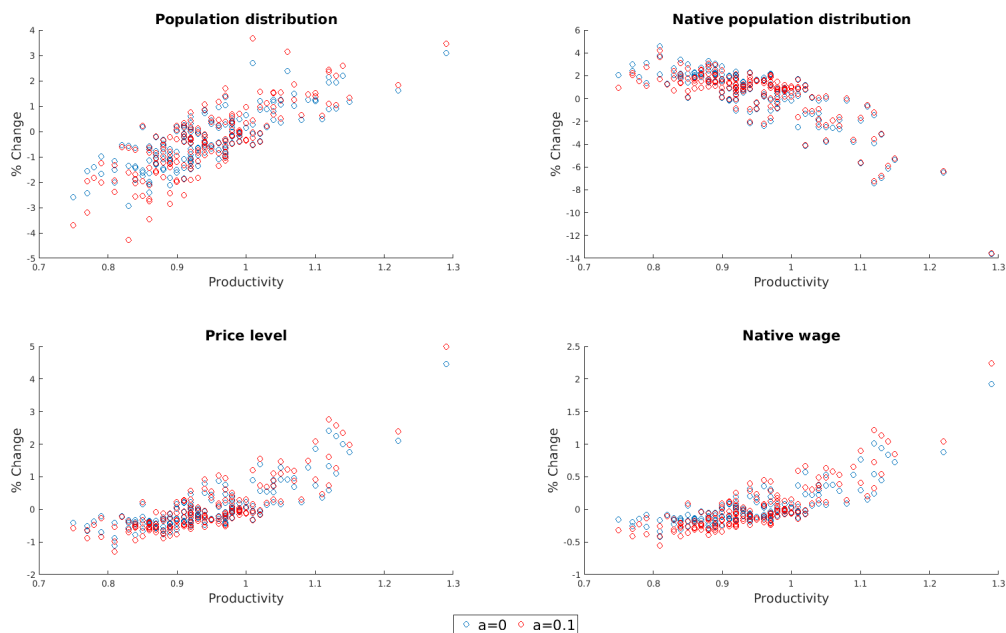
Notes: This figure compares the model with and without agglomeration forces. Each dot represents a city. We use the 168 consolidated metropolitan areas used in Albouy (2016). See the text for the details on the various parameters of the model.

As a result of the strong preference of immigrants for more productive cities and the pressure that this decision puts on local price indexes – which can be seen in the bottom-left graph of Figure 11 –, natives are displaced from more productive cities into less productive ones, as can be seen in the top-right graph of Figure 11. In fact, current levels of migration can potentially account for an important fraction of the increase in local price indexes in more productive cities.

The bottom-right graph of Figure 11 shows what happens to the wages of natives, which move in the same direction as the city price levels. With agglomeration forces, both positive and negative changes are more pronounced than the price-level changes because we have additional effects of population on wages through productivity.

In Figure 12, we investigate the effect of immigration on output. Two things stand out. First, immigration moves economic activity from low-productivity locations to high-productivity ones. These gains are even greater when there are agglomeration forces. These output gains in more productive cities are in the order of 4 percent. Second, immigration induces overall output gains. The gain in size of the most productive cities translates into output gains for the entire country, even if low-productivity places lose out.

The magnitude of these overall gains depends crucially on agglomeration forces. We show this in the right graph of Figure 12. Immigration shares, at around 20 percent, translate into total output gains per capita in the range of .08 to .15 percent. Thus, immigration results in overall gains and, perhaps more prominently, important distributional consequences, particularly between more and less productive

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locations.

Figure 12: Effect of immigrants on the distribution of output and on total output
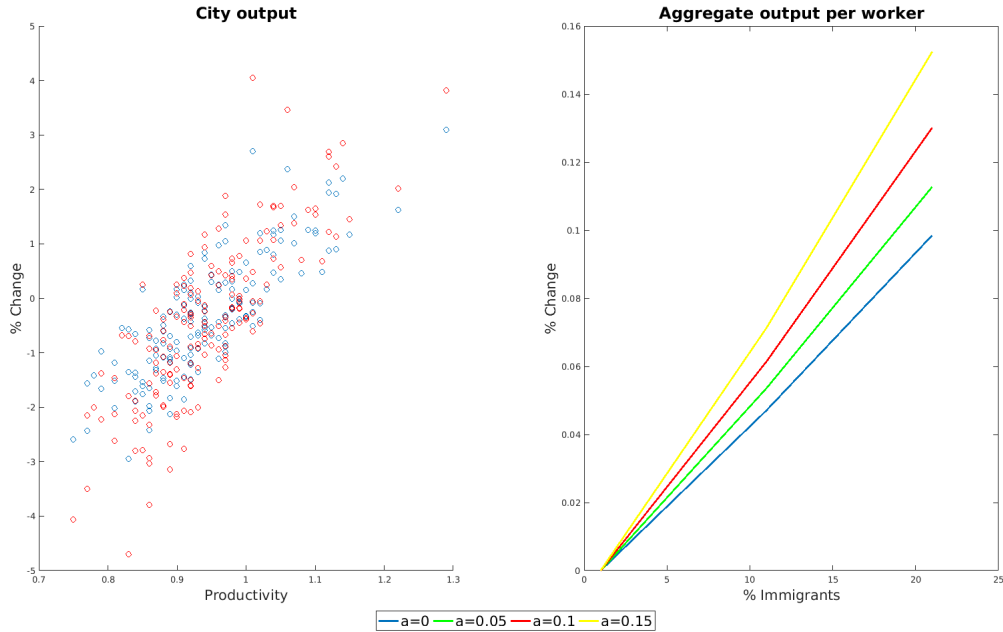
Notes: This figure compares the model with and without agglomeration forces. Each dot, in the graph on the left, represents a city. We use the 168 consolidated metropolitan areas used in Albouy (2016). See the text for the details on the various parameters of the model. The graph on the right shows the relationship between total output and aggregate immigrant share predicted by the model.

5.2.3 Discussion on welfare consequences

While it is easy to talk about wages, local price indexes, and the distribution of economic activity and population across locations using the model, it is a little bit harder to use the model to obtain clear results on the effect that migration has on welfare. The difficulties come from the fact that there are essentially three different types of agents in the model and the consequences of immigration are heterogeneous among them.

The first type of agent in the model, which has been the focus for most of the paper, are workers. While native workers in large and more productive cities gain in terms of wages with immigration, they lose in terms of welfare. This is a consequence of the fact that we are using a spatial equilibrium model and we need to impose that congestion forces dominate agglomeration forces. Higher levels of immigration result in higher nominal wages in more productive cities relative to less productive cities, but the increase in local price indexes is larger than the change in nominal wages. This ensures that a unique spatial equilibrium exists both with high and low levels of immigration, but it also implies that native workers in more productive cities lose out relative to native workers in less productive cities with higher levels of immigration.

Something very different happens to firm owners and landowners. While we haven't modeled them explicitly, it is quite clear that firms and landowners in more productive cities gain, relative to less

productive cities. This is the case because firms in the model do not pay land rents (something we could include) and because immigrants put pressure on housing costs.

Thus, whether immigration increases welfare in high- relative to low-productivity areas depends crucially on what we assume in terms of who owns the land and who owns the firms. Given that these are simply assumptions, we prefer not to make overall welfare calculations.

6   Conclusion

This paper begins by documenting that immigrants concentrate in larger and more expensive cities and that their earnings relative to natives are lower in these cities. These are very strong patterns in the US data. We obtain these results using a number of specifications, time periods, and data sets. They are also robust to controlling for immigration networks and only disappear or attenuate for immigrants who come from countries of origin of similar levels of development or who have spent more time in the United States.

Taking all this evidence together, we posit that these patterns emerge because, for an important proportion of immigrants' income, consumption is not affected by local price indexes, 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 higher incentive to live in high-nominal-income locations than natives.

We build a quantitative spatial equilibrium model with frictions in the labor market to quantify the importance of this mechanism. We estimate the model and show that the differential location choices of immigrants relative to natives have two consequences. First, they move economic activity from low-productivity places to high-productivity places. Second, this shift in the patterns of production induces overall output gains. We estimate these gains to be in the order of .15 percent of output per capita with current levels of immigration.

This paper extends some of the insights in the seminal contribution of Borjas (2001). Borjas (2001)' main argument is that immigrants choose the locations where demand for labor is higher, thus contributing to dissipating arbitrage opportunities across local labor markets. We show in this paper that immigrants systematically choose not just 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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A   Proofs

A.1   Derivation of indirect utility

Consider the following utility in location c for an individual i from country of origin j:

$$U_{ijc} = \rho + \ln A_c + \alpha_t \ln C_{jc}^T + (1 - \alpha_t)\frac{\sigma}{\sigma - 1} \ln \left(\frac{\alpha_l}{\alpha_l + \alpha_f}(C_{jc}^{NT})^{\frac{\sigma-1}{\sigma}} + \frac{\alpha_f}{\alpha_l + \alpha_f}(C_j^{NT})^{\frac{\sigma-1}{\sigma}} \right) + \varepsilon_{ijc}$$

s.t. $C_{jc}^T + p_c C_{jc}^{NT} + p_j C_j^{NT} \leq w_{jc}$

Let

$$\bar{\alpha}_l = \frac{\alpha_l}{\alpha_l + \alpha_f}$$

$$\bar{\alpha}_f = \frac{\alpha_f}{\alpha_l + \alpha_f}$$

Also, we take note of the following relationships:

$$\bar{\alpha}_l + \bar{\alpha}_f = 1$$

$$\alpha_t + \alpha_l + \alpha_f = 1$$

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

$$U_{ijc} = \rho + \ln A_c + \alpha_t \ln C_{jc}^T + (1 - \alpha_t)\frac{\sigma}{\sigma - 1} \ln \left(\bar{\alpha}_l(C_{jc}^{NT})^{\frac{\sigma-1}{\sigma}} + \bar{\alpha}_f(C_j^{NT})^{\frac{\sigma-1}{\sigma}} \right) + \varepsilon_{ijc}$$

s.t. $C_{jc}^T + p_c C_{jc}^{NT} + p_j C_j^{NT} \leq w_{jc}$

Note that

$$\lim_{\sigma \to 1}(1 - \alpha_t)\frac{\sigma}{\sigma - 1} \ln \left(\bar{\alpha}_l(C_{jc}^{NT})^{\frac{\sigma-1}{\sigma}} + \bar{\alpha}_f(C_j^{NT})^{\frac{\sigma-1}{\sigma}} \right) = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

$$= (1 - \alpha_t) \lim_{\sigma \to 1} \frac{\frac{\bar{\alpha}_l(C_{jc}^{NT})^{\frac{\sigma-1}{\sigma}} \ln C_{jc}^{NT} \frac{1}{\sigma^2} + \bar{\alpha}_f(C_j^{NT})^{\frac{\sigma-1}{\sigma}} \ln C_j^{NT} \frac{1}{\sigma^2}}{\bar{\alpha}_l(C_j^{NT})^{\frac{\sigma-1}{\sigma}} + \bar{\alpha}_f(C_j^{NT})^{\frac{\sigma-1}{\sigma}}}}{\frac{1}{\sigma^2}} \quad \text{by l'Hopital}$$

$$= (1 - \alpha_t) \lim_{\sigma \to 1} \frac{\bar{\alpha}_l(C_{jc}^{NT})^{\frac{\sigma-1}{\sigma}} \ln C_{jc}^{NT} + \bar{\alpha}_f(C_j^{NT})^{\frac{\sigma-1}{\sigma}} \ln C_j^{NT}}{\bar{\alpha}_l(C_j^{NT})^{\frac{\sigma-1}{\sigma}} + \bar{\alpha}_f(C_j^{NT})^{\frac{\sigma-1}{\sigma}}}$$

$$= (1 - \alpha_t) \left(\bar{\alpha}_l \ln C_{jc}^{NT} + \bar{\alpha}_f \ln C_j^{NT} \right)$$

$$= \alpha_l \ln C_{jc}^{NT} + \alpha_f \ln C_j^{NT}$$

Thus,

$$\lim_{\sigma \to 1} U_{ijc} = \rho + \ln A_c + \alpha_t \ln C_{jc}^T + \alpha_l \ln C_{jc}^{NT} + \alpha_f \ln C_j^{NT} + \varepsilon_{ijc}$$

which is the utility function using the Cobb-Douglas aggregation, possibly with a different ρ.

We solve the 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

$$\max \ (1-\alpha_t)\frac{\sigma}{\sigma-1}\ln\left(\bar{\alpha}_l(C_{jc}^{NT})^{\frac{\sigma-1}{\sigma}} + \bar{\alpha}_f(C_j^{NT})^{\frac{\sigma-1}{\sigma}}\right)$$

$$\text{s.t. } p_c C_{jc}^{NT} + p_j C_j^{NT} = E$$

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

$$\max \ \rho + \ln A_c + \alpha_t \ln C_{jc}^T + \tilde{V}(p_c, p_j, E)$$

$$\text{s.t. } C_{jc}^T + E \leq w_{jc}$$

Stage 1

$$\max \ (1-\alpha_t)\frac{\sigma}{\sigma-1}\ln\left(\bar{\alpha}_l(C_{jc}^{NT})^{\frac{\sigma-1}{\sigma}} + \bar{\alpha}_f(C_j^{NT})^{\frac{\sigma-1}{\sigma}}\right)$$

$$\text{s.t. } p_c C_{jc}^{NT} + p_j C_j^{NT} = E$$

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

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

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

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

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

$$C_j^{NT} = \frac{\left(\frac{p_j}{\bar{\alpha}_f}\right)^{-\sigma}}{p_c\left(\frac{p_c}{\bar{\alpha}_l}\right)^{-\sigma} + p_j\left(\frac{p_j}{\bar{\alpha}_f}\right)^{-\sigma}} E$$

Thus, the maximized objective function is

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

$$= (1 - \alpha_t)\ln E + (1 - \alpha_t)\frac{1}{\sigma - 1}\ln\left(p_c\left(\frac{p_c}{\bar{\alpha}_l}\right)^{-\sigma} + p_j\left(\frac{p_j}{\bar{\alpha}_f}\right)^{-\sigma}\right)$$

$$= (1 - \alpha_t)\ln E - (1 - \alpha_t)\ln \bar{p}(\bar{\alpha}_l, \bar{\alpha}_f)$$

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 constraint,

$$C_{jc}^T = \alpha_t w_{jc}$$

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

Thus, the optimal choices for consumption can be written as

$$C_{jc}^T = \alpha_t w_{jc}$$

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

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

It can be shown that this solution satisfies the first order conditions of the original problem.

If we let ρ be a constant such that the indirect utility function has no constant, then the indirect utility function can be written as

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

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

A.2 Proofs of propositions

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

Proof. **Proposition 1**

- $\ln w_{jc} = -(1 - \beta) \ln A_c + \beta \ln \tilde{B}_c + (1 - \beta)(1 - \alpha_t) \ln p_{jc}$

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

Thus,

$$\ln w_{Nc} - \ln w_{jc} = (1 - \beta)(1 - \alpha_t) \ln p_c - (1 - \beta)(1 - \alpha_t) \ln p_{jc}$$

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

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

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

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

Also,

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

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

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 low p_j. $\square$

Proof. **Proposition 2**

Recall 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

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

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,

$$V_j = \left(\sum_k \left(A_k \tilde{B}_k \bar{p}_{jk}^{(\alpha_t - 1)}\right)^{\frac{\beta}{\lambda}}\right)^\lambda$$

$$V_N = \left(\sum_k \left(A_k \tilde{B}_k p_k^{(\alpha_t - 1)}\right)^{\frac{\beta}{\lambda}}\right)^\lambda = \left(\sum_k \left(\frac{A_k \tilde{B}_k}{p_c^{1 - \alpha_t}}\right)^{\frac{\beta}{\lambda}}\right)^\lambda$$

In equilibrium, $p_c = L_c^\eta$. Thus,

$$\ln V_j - \ln V_N = -\lambda \ln \frac{\sum_k \left(A_k \tilde{B}_k / L_k^{\eta(1 - \alpha_t)}\right)^{\frac{\beta}{\lambda}}}{\sum_k \left(A_k \tilde{B}_k / \bar{p}_{jk}^{(1 - \alpha_t)}\right)^{\frac{\beta}{\lambda}}}$$

Hence,

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

Denote $M = \ln \frac{\pi_{jc}}{\pi_{Nc}}$. Then,

$$
\begin{aligned}
\frac{\partial M}{\partial p_c} &= \frac{1}{\lambda}\left(\frac{\beta(1 - \alpha_t)}{p_c} - \frac{\beta(1 - \alpha_t)\bar{\alpha}_l^\sigma p_c^{-\sigma}}{\frac{\bar{\alpha}_l^\sigma}{p_c^{\sigma - 1}} + \frac{\bar{\alpha}_f^\sigma}{p_j^{\sigma - 1}}}\right) \\
&= \frac{\beta(1 - \alpha_t)}{\lambda} \frac{\frac{\bar{\alpha}_f^\sigma}{p_j^{\sigma - 1}}}{\frac{\bar{\alpha}_l^\sigma}{p_c^{\sigma - 1}} + \frac{\bar{\alpha}_f^\sigma}{p_j^{\sigma - 1}}} > 0
\end{aligned}
$$

This tells us that the distribution of immigrants relative to natives is higher in more expensive cities. □

Proof. **Proposition 3**

Note

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

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,

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

And $L_c = L_{Ic} + L_{Nc}$. □

Proof. **Proposition 4**

Note

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

Thus,

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

□

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B   Supplementary evidence

B.1   Price indexes and city size

Figure A.1: City size and price index
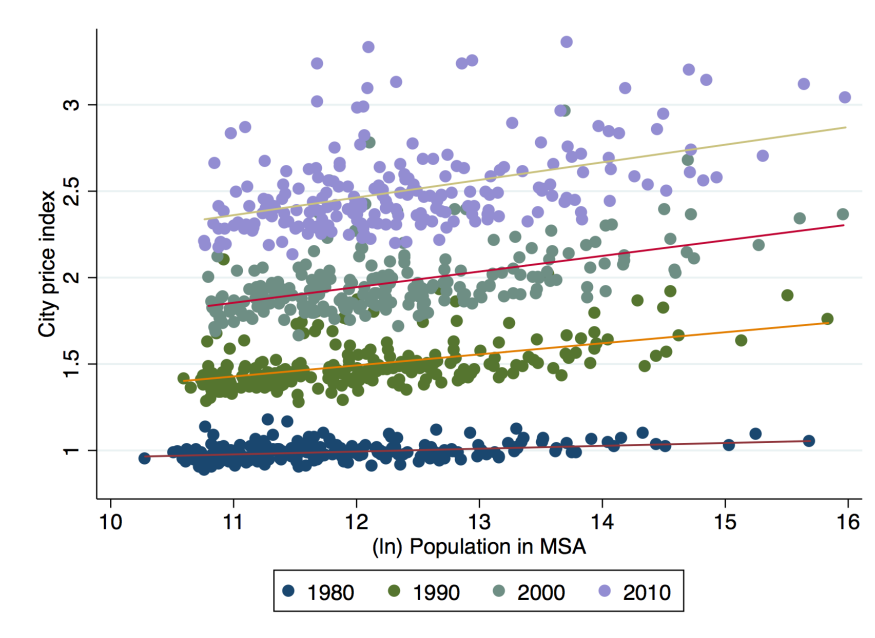
Notes: MSA populations are based on the sample of prime-age male workers (25-59) from the Census 2000. The MSA price indexes are computed following Moretti (2013). Each dot represents a different MSA-year combination. We have 219 different metropolitan areas in our sample.

B.2   Undocumented immigrants

Figure A.2: Wage gaps, city size, and price indexes (Census 2000)
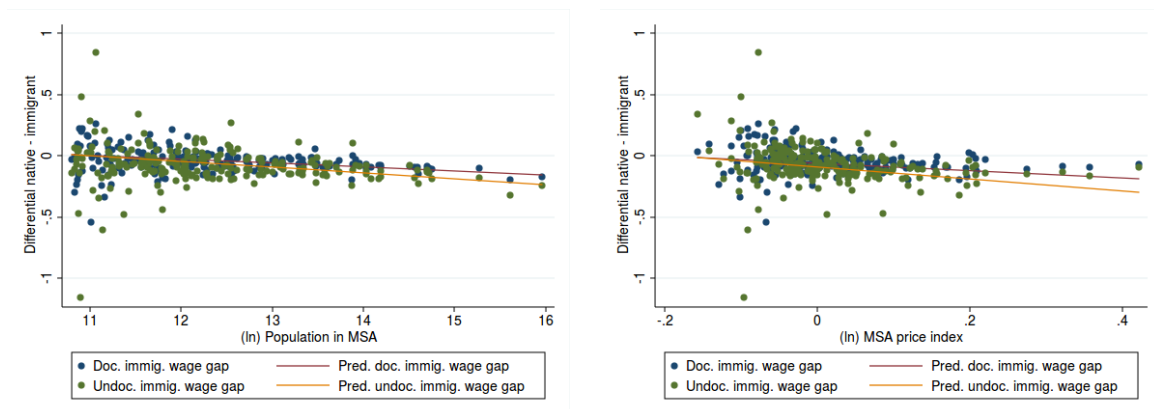
Notes: This figure uses data from the Census 2000 to show the relationship between the wage gaps of documented and undocumented immigrants to natives, city sizes, and prices. Each dot represents one of the 219 different metropolitan areas in our sample.

B.3 Baseline wage regression

Table A.1: Baseline wage regression

VARIABLES	(1) Wage OLS	(2) Wage OLS	(3) Wage OLS	(4) Wage OLS	(5) Wage OLS
Immigrant premium	0.318	0.323**	0.320**	0.278***	0.344
	(0.249)	(0.144)	(0.145)	(0.102)	(0.256)
(ln) Population in MSA	0.0597***	0.0446***	0.0446***	0.0423***	0.0462***
	(0.00463)	(0.00308)	(0.00308)	(0.0156)	(0.0157)
(ln) Population in MSA x Immigrant	-0.0474**	-0.0340***	-0.0338***	-0.0310***	-0.0480**
	(0.0183)	(0.0106)	(0.0107)	(0.00770)	(0.0191)
Observations	360,970	360,970	360,970	360,970	356,143
R-squared	0.051	0.407	0.408	0.417	0.416
Xs	no	yes	yes	yes	yes + learn
Year FE	no	no	yes	yes	yes
MSA FE	no	no	no	yes	yes

Notes: These regressions only report selected coefficients. The complete set of explanatory variables is specified in equation 3.3. In column (5) we include (ln) year in the US and its interaction with city size. We loose a few observations in this column because of lack of data and misrecording of the is variable in CPS data. Robust standard errors, clustered at the metropolitan area level, are reported. One star, two stars, and three stars represent statistical significance at .1, .05, and .01 confidence levels.

B.4 Wage regression by subsample

Table A.2: Heterogeneity by immigrant subsample

VARIABLES	(1) Wage P<US P	(2) Wage P>US P	(3) Wage GDP<US GDP	(4) Wage GDP>US GDP	(5) Wage German	(6) Wage UK	(7) Wage Doc.	(8) Wage Undoc.	(9) Wage New	(10) Wage Old
Immigrant premium	0.285**	0.0462	0.309***	0.0271	-0.309	0.117	0.236**	0.393***	0.297**	0.283***
	(0.126)	(0.0728)	(0.110)	(0.0842)	(0.363)	(0.212)	(0.0944)	(0.145)	(0.131)	(0.105)
(ln) Population in MSA	0.0353***	0.0402***	0.0359***	0.0377***	0.0310**	0.0316**	0.0417***	0.0339***	0.0416***	0.0336**
	(0.0129)	(0.0152)	(0.0132)	(0.0140)	(0.0123)	(0.0126)	(0.0155)	(0.0128)	(0.0153)	(0.0131)
(ln) Population in MSA x Immigrant	-0.0324***	-0.0104**	-0.0331***	-0.0139**	0.0219	-0.00276	-0.0271***	-0.0412***	-0.0349***	-0.0270***
	(0.00944)	(0.00474)	(0.00830)	(0.00555)	(0.0258)	(0.0150)	(0.00708)	(0.0108)	(0.00982)	(0.00783)
Observations	326,175	298,257	352,619	295,245	287,419	287,959	334,360	313,504	337,139	310,725
R-squared	0.413	0.385	0.416	0.386	0.382	0.382	0.391	0.416	0.417	0.387
Xs	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
MSA FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

Notes: These regressions only report selected coefficients. The complete set of explanatory variables is specified in equation 3.3. The first four columns show results of regressions with the immigrant sample being restricted to immigrants from origin countries with a lower or higher average price level (P) or GDP than the US (average over the sample period 1994-2011). The last four columns show results of regressions with the immigrant sample being restricted to the indicated subgroup. Robust standard errors, clustered at the metropolitan area level, are reported. One star, two stars, and three stars represent statistical significance at .1, .05, and .01 confidence levels.

B.5 Country of origin heterogeneity

Table A.3: Heterogeneity by countries of origin

VARIABLES	(1) Wage OLS	(2) Wage OLS	(3) Wage OLS	(4) Wage OLS	(5) Wage OLS	(6) Wage OLS
(ln) GDP origin	0.0141***	-0.0488	-0.118***	0.0166***	-0.0334	-0.0936**
	(0.00480)	(0.0296)	(0.0395)	(0.00321)	(0.0265)	(0.0363)
(ln) Population in MSA		-0.0293	-0.0622***		0.0167	-0.0333
		(0.0202)	(0.0210)		(0.0279)	(0.0242)
(ln) Population in MSA x (ln) GDP origin		0.00436**	0.00805***		0.00342*	0.00712***
		(0.00196)	(0.00184)		(0.00178)	(0.00171)
Observations	74,076	74,076	74,076	74,076	74,076	74,076
R-squared	0.445	0.445	0.461	0.459	0.459	0.472
Xs	yes	yes	yes	yes	yes	yes
Year FE	yes	yes	yes	yes	yes	yes
MSA FE	no	no	no	yes	yes	yes
Country origin FE	no	no	yes	no	no	yes
Sample	migrants	migrants	migrants	migrants	migrants	migrants

VARIABLES	(1) Wage OLS	(2) Wage OLS	(3) Wage OLS	(4) Wage OLS	(5) Wage OLS	(6) Wage OLS
(ln) GDP origin	0.0316***	0.0376***	-0.0375	0.0368***	0.0364***	-0.0331
	(0.00989)	(0.00996)	(0.0232)	(0.00949)	(0.00945)	(0.0220)
(ln) Population in MSA		0.0447***	0.0461***		0.0429***	0.0394***
		(0.00310)	(0.00324)		(0.0159)	(0.0130)
(ln) Population in MSA x Immigrant		-0.0859***	-0.111***		-0.0776***	-0.103***
		(0.0250)	(0.0235)		(0.0185)	(0.0195)
(ln) Population in MSA x (ln) GDP origin		0.00579**	0.00840***		0.00520***	0.00792***
		(0.00228)	(0.00204)		(0.00176)	(0.00179)
Observations	360,970	360,970	360,970	360,970	360,970	360,970
R-squared	0.402	0.408	0.413	0.417	0.418	0.422
Xs	yes	yes	yes	yes	yes	yes
Year FE	yes	yes	yes	yes	yes	yes
MSA FE	no	no	no	yes	yes	yes
Country origin FE	no	no	yes	no	no	yes
Sample	All	All	All	All	All	All

Notes: This table shows the relationship between native–immigrant wage gaps and the per capita GDP in the country of origin. The table at the top only uses immigrants, while the bottom table combines natives and immigrants. These regressions only report selected coefficients. The complete set of explanatory variables is specified in equation 3.4. Robust standard errors, clustered at the metropolitan area level, are reported. One star, two stars, and three stars represent statistical significance at .1, .05, and .01 confidence levels.