Immigrants' Residential Choices and their Consequences

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Abstract

Where do immigrants choose to settle and what are the consequences of their location choices for economic activity and welfare? This paper provides a new perspective on these questions by investigating the causes and effects of the spatial distribution of immigrants across US cities. We document that, over the last decades: a) immigrants have increasingly concentrated in large, high-wage, and expensive cities, and b) the earnings gap between immigrants and natives is higher in larger and more expensive cities. This relationship between city characteristics and the wage gap is stronger for immigrants from low-income countries and those who have spent fewer years in the United States and is robust in controlling for immigration networks. In order to explain these findings, we develop a simple spatial equilibrium 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 cities, where they also accept lower wages than natives. Given that large and more expensive cities tend to be more productive, immigrant location choices move economic activity toward more productive cities, which results in total output gains. We estimate that current levels of immigration increase total aggregate output per worker by around .15 percent. We also discuss welfare implications.

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 significant 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 are almost 50 percent higher than the national average – mainly due to housing. 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. 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, the income left after paying for local goods is likely to be higher than in a smaller, lower-wage, less expensive city.[1] 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 US Census and Current Population Survey (CPS) data merged with price indexes at the metropolitan statistical area (MSA) level from Moretti (2013) to document two very strong empirical regularities in the United States. First, we document that over the last decades, immigrants are (increasingly) concentrated in large and expensive cities. And second, we document that the gap in earnings between natives and immigrants is *greatest* in these larger and more expensive cities. These patterns are extremely robust. Importantly, they only attenuate for immigrants that have spent a considerable amount of time in the United States but disappear altogether for immigrants that come from rich countries where price indexes are similar to those in the United States. We also show that these patterns do not seem to be explained by immigrant networks. Even when we consider the size of the local network and its potential influence on the earnings of immigrants, immigrants in larger and more expensive cities earn relatively less than natives.

In the second part of the paper, we explain these strong empirical regularities with a simple spatial equilibrium model with free labor mobility across cities, and we use the model to quantitatively investigate the role that immigration plays in shaping the distribution of economic activity across locations and,

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[1] 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.

through this mechanism, its contribution to the general equilibrium. In this model, natives consume only locally, whereas immigrants also consume in their home country and therefore also care about price levels in their home country.[2] 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 the native–immigrant wage gap is increasing in the local price index.[3]

We structurally estimate the key parameters of the model to match US data, and we complement these estimated parameters 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 includes direct consumption while visiting the home country, remittances, or future savings for those immigrants planning on returning home. Thus, 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 which, in turn, has important consequences for the host country.

In particular, we find that there is a significant redistribution of economic activity from unproductive to productive cities as a consequence of immigrant location choices.[4] 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. In aggregate, we estimate that current levels of immigration expand total output per capita by around .15 percent.[5] 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 suggests that native workers in large and expensive cities lose in terms of welfare. Immigrant location choices put pressure on housing markets and natives are priced out of large cities. 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. In the context of a spatial equilibrium model, this means that they pick cities whose wages relative to living costs and amenity levels are highest. Thus, in this 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. This paper is also related to a large body of recent work. Recent developments in quantitative spatial equilib-

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[2]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.

[3]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).

[4]Large and expensive cities are probably so because they are more productive. See Albouy (2016).

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

rium models include Redding and Sturm (2008), Ahlfeldt et al. (2014), Redding (2014), Albouy (2009), Notowidigdo (2013), Diamond (2015), Monras (2015a), and Monte et al. (2015) among others, and have been used to explore spatial consequences of taxation, local shocks, endogenous amenities, the dynamics of internal migration, and commuting patterns. 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 and incomes. 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.

2 Data

For this paper, we rely on various publicly available data sets for the United States. We mainly use three different data sets to compute wages, population, immigrant population, and the various variables that we use in the paper. All these data sets are available on Ruggles et al. (2016).

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. 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 wage data refer to the previous year.

Second, we use the Census of population data for the years 1980, 1990, and 2000. This 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

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 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.

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 compute price levels in the countries of origin, we use data from the OECD. To compute the per capital GDP in each country of origin, we use the Penn World Tables.

To give a sense of the metropolitan areas driving most of the variation in our analysis, Table 1 reports the metropolitan areas with 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. There are a few notable outliers in this general description. The outliers are generally metropolitan areas in California and Texas that are relatively close to the US-Mexico border.

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.

3.1 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 plot the share of immigrants against the size of the metropolitan area or its price level. Figure 1 plots these relationships using data from Census 2000. In the left panel, we observe that, even if there is some variance in immigrant shares across metropolitan areas, there is a clear positive relationship between immigrants and city size. This relationship is statistically significant.

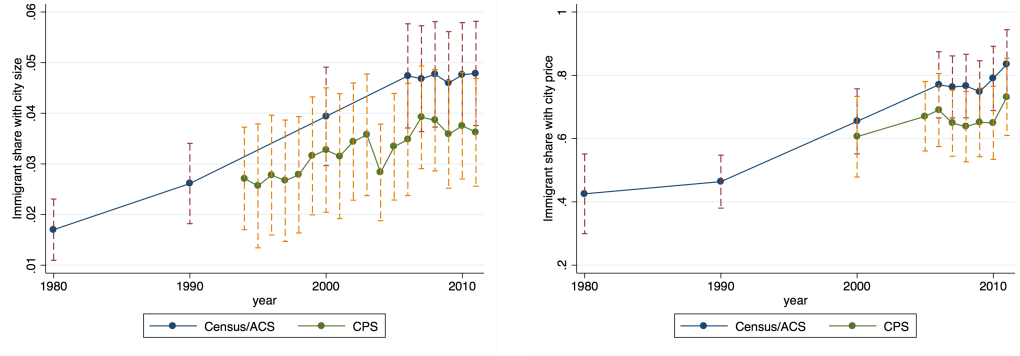Figure 1: City size, price index, and immigrant share
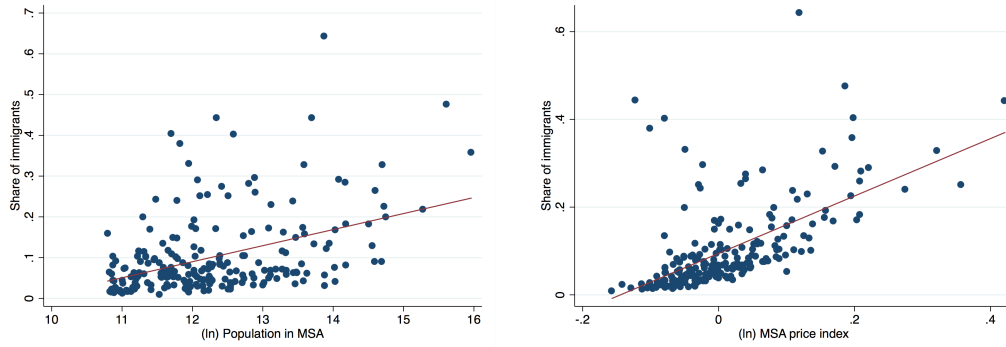
Notes: The figure is based on the sample of prime-age male workers (25-59) from Census 2000. The MSA price indexes are computed following Moretti (2013). Each dot represents a different MSA. There are 219 different metropolitan areas in our sample.

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. While there are some exceptions, mainly along the US-Mexico border, a city with a 1 percent higher local price index is associated with around .7 extra percentage points in the immigrant share.

In Figure 2 we investigate how these relationships have evolved over time. To show this, we first run a linear regression 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 immigrant shares and city size has been positive since the 1980s. This relationship has become stronger over time. While in 1980 the elasticity was less than 2 percent, it has increased over the years to reach almost 5 percent. The left panel of Figure 2 shows both the estimates using Census data and using CPS data. We observe how we obtain similar trends, but estimates using CPS data are smaller and noisier because of measurement error. The elasticity of immigrant shares and local price indexes has also increased over time. The estimate in 1980 is around .4 and it has increased to around .8.

Figure 2: Evolution of the relationship between immigrant share 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 and city size and city price. 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. Vertical lines represent 95 percent confidence intervals.

We can summarize these two figures as follows:

Fact 1. *Immigrants concentrate in large and expensive cities. Over time, immigrants have been increasingly concentrated in these cities.*

## 3.2   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.

In spatial equilibrium, more expensive cities compensate these higher costs of living through higher nominal wages, and large cities tend to be expensive. It is this extra rent that migrants can use to consume in their home countries that gives them have an advantage over natives in high-price, high-nominal-wage cities, as is made explicit later in Section 4.

To illustrate this fact, we use again various cross-sectional regressions and plot the estimates for each of the years. 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. Census estimates are slightly larger than CPS estimates, again, a consequence of measurement error in CPS data. It is also remarkable 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.

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
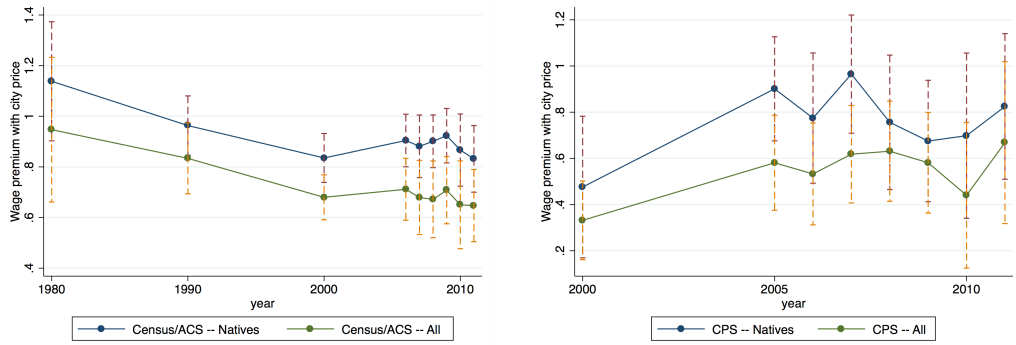
Figure 3: Evolution of city size premium
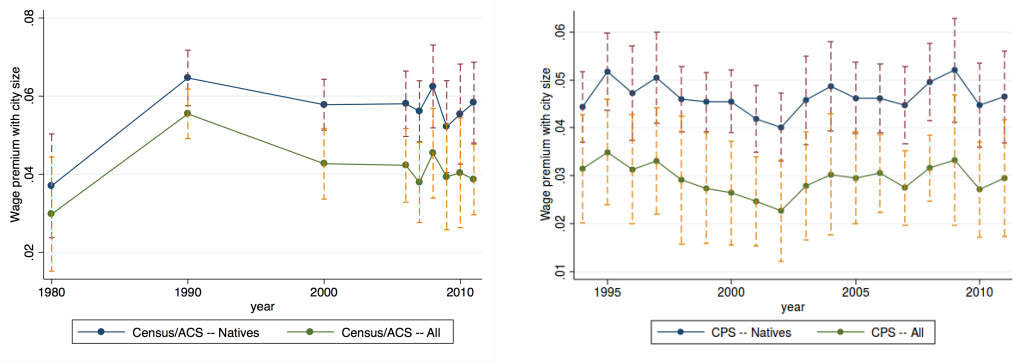
to compute it, we see that the relationship is less strong than if we only use natives. This is true, both when we use ACS/Census data and when we use CPS data.

Figure 4: Evolution of city price level premium

We can summarize this fact as:

Fact 2. *Wages are higher in large and more expensive cities. 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). In contrast, the city price–wage premium has declined slightly over the last 30 years.*
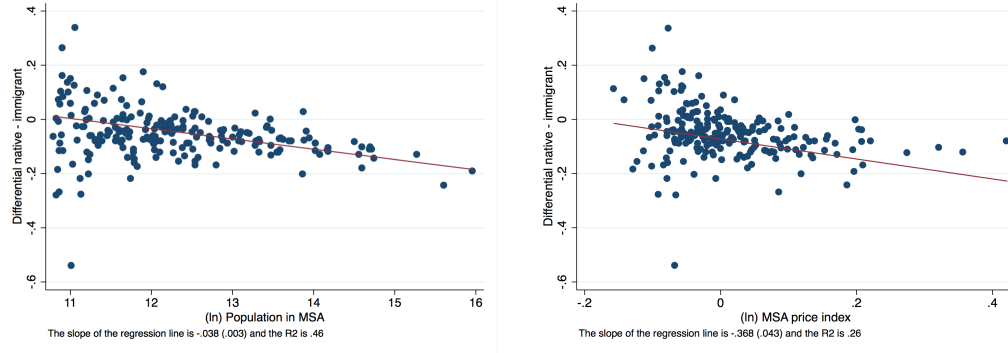
3.3   Immigrant wage gaps

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

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prices.

As before, we do so in two steps. In Figure 5, we show the estimates using data from 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, then the gap in wages between natives and immigrants is 3.8 percent larger.

Figure 5: Wage gaps, city size, and price indexes

Notes: This figure uses data from 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:

$$\ln w_{i,c,t} = \alpha + \beta Imm_{i,c,t} * \ln Pop_{c,t} + \gamma \ln Pop_{c,t} + \eta X_{i,c,t} + \delta_{ct} + \varepsilon_{i,c,t} \tag{3.1}$$

where i indexes individuals, c indexes cities, and t indexes years, where Imm is an indicator variable for i being an immigrant, $\ln Pop$ indicates city size, X captures observable individual characteristics, and δ captures various types of year and city fixed effects. 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.

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.

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 than natives relative to 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

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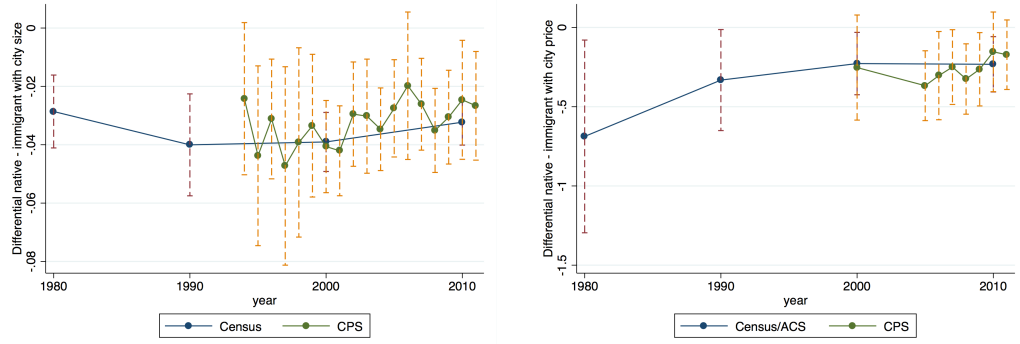
Notes: This figure uses Census and CPS data from 1980 to 2011 to estimate the relationship between native–immigrant wage gaps and city size and prices for each year. Each dot represents an estimate of the native–immigrant wage gap elasticity with city size and city price index. Vertical lines represent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

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.

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.*

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 show two different exercises.

One simple way to see whether the high nominal wages play an important role in pushing immigrants to live in larger and more expensive cities *and* accepting lower wages in those cities, is to do the same exercise with immigrants coming from countries of origin with price levels comparable to those in the United States. For them, there should not be a negative relationship between native–immigrant wage gaps, city size, or city prices.

Figure 7 shows the same plots as Figure 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 Figure 7 that there is no relationship between native–immigrant wage gaps for these two countries, city size, or prices. In Appendix A.5, we explore this further by extending the regression 3.1 as follows:

$$\ln w_{i,c,t} = \alpha + \beta_1 Imm_{i,c,t} * \ln Pop_{c,t} * Z_{i,t} + \beta_2 Imm_{i,c,t} * \ln Pop_{c,t} + \gamma \ln Pop_{c,t} + \eta X_{i,c,t} + \delta_{ct} + \varepsilon_{i,c,t} \quad (3.2)$$

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.

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.*

Figure 7: Wage gaps, city size, and price indexes, selected countries
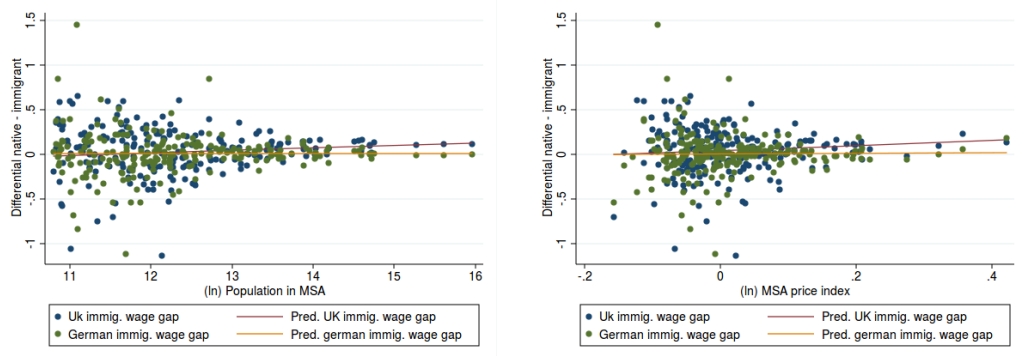
Notes: This figure uses data from Census 2000 to show the relationship between native–immigrant wage gaps, city sizes, and prices for a selected set of countries of origin. Each dot represents the gap in earnings between natives and immigrants in a metropolitan area. The UK and Germany are selected on the basis of being countries of origin with high price levels and large immigrant populations in the United States.

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.

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.

3.4   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 the share of consumption that immigrants do 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

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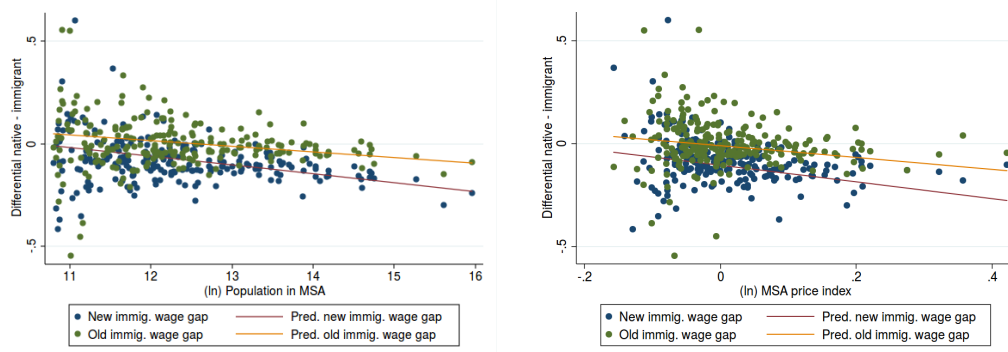
Notes: This figure uses data from Census 2000 to show the relationship between the wage gaps of new ($\leq$ 20 years in the United States) and old ($>$ 20 in the United States) immigrants to natives, city sizes, and prices. The fitted line for the relationship between new immigrants and city size or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

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 – but it is still worth investigating the importance of migrant networks in more depth.

To investigate this alternative, we extend the basic regression framework introduced in equation 3.1 to compute the estimates shown in Figures 5 and 6 to incorporate immigrant networks. Specifically, we estimate:

$$
\begin{aligned}
\ln w_{i,c,t} = {} & \alpha + \beta_1 Imm_{i,c,t} * \ln Pop_{c,t} + \gamma_1 \ln Pop_{c,t} + \beta_2 \text{Immigrant Network}_{i,c,t} \\
& + \gamma_1 \text{Immigrant Network}_{i,c,t} * \ln Pop_{c,t} + \eta X_{i,c,t} + \delta_{ct} + \varepsilon_{i,c,t}
\end{aligned}
\tag{3.3}
$$

where we measure the size of the network as 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 2 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 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

Table 2: Wage gaps and immigration networks

VARIABLES	(1) Wage OLS	(2) Wage OLS	(3) Wage OLS	(4) Wage OLS	(5) Wage OLS	(6) Wage OLS	(7) Wage OLS	(8) Wage OLS
Migrant network in MSA	-0.976*** (0.0802)	2.522*** (0.884)		-0.451*** (0.0403)	0.865* (0.496)		-0.483*** (0.0436)	1.069** (0.462)
(ln) Population x migrant network, in MSA		-0.252*** (0.0699)			-0.0944** (0.0384)			-0.111*** (0.0358)
(ln) Population in MSA x Immigrant			-0.0310*** (0.00770)	-0.0347*** (0.00461)	-0.0283*** (0.00548)			
(ln) Population in MSA x (ln) GDP origin						-0.00313*** (0.000804)	-0.00352*** (0.000422)	-0.00269*** (0.000472)
Observations	360,970	360,970	360,970	360,970	360,970	360,970	360,970	360,970
R-squared	0.413	0.414	0.417	0.418	0.418	0.418	0.418	0.418
Xs	yes	yes	yes	yes	yes	yes	yes	yes
Year FE	yes	yes	yes	yes	yes	yes	yes	yes
MSA FE	yes	yes	yes	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.

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 gap between immigrants, natives, and city size. In columns (6) and (7), we investigate whether the inclusion of migrant networks changes any of the results on heterogeneity of immigrant populations, discussed in Section 3.3 and Appendix A.5. Again, migration networks do not change any of our conclusions.

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.

3.5 Immigrants' location choices and total output

Why is it important that immigrants contribute to reducing city size–wage premiums? In a standard spatial equilibrium model in the tradition of Rosen (1974) and Roback (1982), larger cities pay higher wages because the cost of living in them is higher. Congestion in the housing market is probably the main source of congestion forces, although there may also be congestion in the labor market or other markets. These congestion forces are compensated for by agglomeration forces.

Firms locate wherever the unit cost of production is lowest. Production costs likely include capital, land, and labor, as well as other inputs. Labor is usually one of the most important inputs in the production process, usually accounting for more than 50 percent of total costs. In larger cities, labor costs are, as we have seen, higher. Firms locate and operate in larger cities because of the higher productivity levels in them, a likely consequence of the various agglomeration forces at play together with possibly higher underlying productivity levels (Duranton and Puga, 2004).

Thus, by locating in larger and more expensive cities, immigrants are moving to the places where underlying productivity is greatest. They are able to do so more than natives because they care relatively less about the local price index. Through this mechanism, immigrants expand the size of the cities where operation is more efficient, increasing the overall output in the country. It is important to note that this argument goes beyond the (in some ways) simpler "greasing the wheels" of the labor market effect uncovered in Borjas (2001). There, migrants decide the best location in terms of labor market

opportunities. Locations offering the best opportunities, in the context of a spatial equilibrium model, could potentially be an unproductive, low-wage but relatively high-amenity or very low-cost location.

The key difference between the point we make in this paper and the one in Borjas (2001) is that we take into account the reasons why immigrants systematically choose to move to the high-wage, high-productivity cities much more than natives do. Thus, immigrants can potentially contribute substantially to expanding the production possibility frontier of the United States.

To see the potential importance that this has, we plot in Figure 9 the average (composition-adjusted) wage of natives alone, and natives together with immigrants against city size and city prices. The decrease in the slope of the fitted line is a direct representation of potential output gains for the United States.

Figure 9: Wage levels, city size, and price indexes
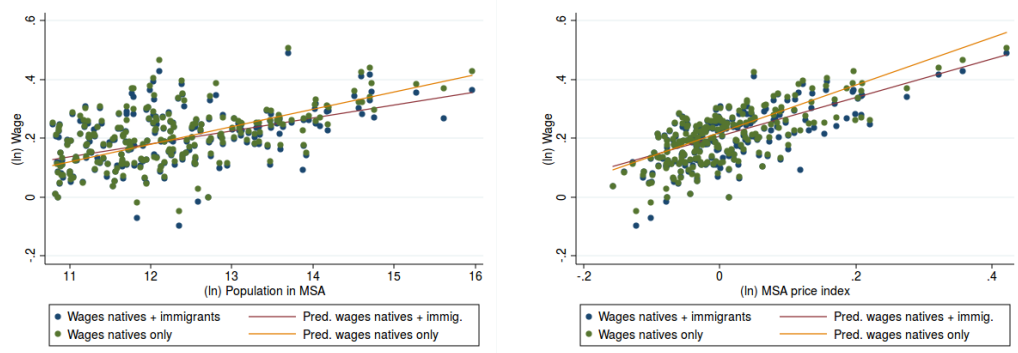
Notes: This figure uses data from Census 2000 to show the relationship between wage levels and city sizes and prices. Wage levels are computed using both natives and immigrants, or using natives alone.

With the raw data, however, it is difficult to precisely quantify how much migrants contribute to overall output. We cannot observe the counterfactual wage premium in large cities that would prevail if immigrants were not in the United States. For this counterfactual exercise, we need to develop and estimate a spatial equilibrium model. We do this in what follows.

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.

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4.1 Location choices

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

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

where α_k denotes the share of consumption devoted to tradable goods, local non-tradable goods/housing costs, and foreign non-tradable goods, and where C^T, C^{NT} denotes the amount of consumption in tradable and non-tradable goods. Note that there are alternative interpretations for what C^{NT} in the home country really means. It could mean consumption in non-tradables in the home country, remittances sent to relatives, or future consumption in the home country.

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: $p^T C_{jc}^T + p_c C_{jc}^{NT} + p_j C_j^{NT} \leq w_{jc}$. The result of this maximization problem is that the demand for each good is a constant fraction of total income governed by α_k. From this, we obtain the indirect utility of living in each location:

$$\ln V_{ijc} = \ln V_{jc} + \varepsilon_{ijc} = \ln A_c + \ln w_{jc} - \alpha_l \ln p_c - \alpha_f \ln p_j + \varepsilon_{ijc} = \ln A_c + \ln w_{jc} - \ln P_{jc}(\alpha_l, \alpha_f) + \varepsilon_{ijc}$$

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:

$$\pi_{jc} = \frac{V_{jc}^{1/\lambda}}{\sum_k V_{jk}^{1/\lambda}} \tag{4.1}$$

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:

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

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.[6]

---

[6]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

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 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:

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

where $V_j = (\sum_k V_{jk}^{1/\lambda})^\lambda$ is the expected value of looking for a suitable city in the economy. That is, if a worker ends up choosing city c they will benefit from the local indirect utility. The alternative is given by the expected utility they would have got in the economy.

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:

$$\ln w_{jc} = -(1 - \beta) \ln A_c + \beta \ln \tilde{B}_c + (1 - \beta) \ln P_{jc} + (1 - \beta) \ln V_j \tag{4.3}$$

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

we introduce in Section 4.4.

immigrants is the weight they give to local and foreign price indexes:

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 is given by the following expression:*

$$\ln w_{Nc} - \ln w_{jc} = (1-\beta)\alpha_f \ln p_c + \frac{(1-\beta)\lambda}{\beta} \ln \frac{\sum_k (A_k B_k / L_k^{\eta\alpha})^{\frac{\beta}{\lambda}}}{\sum_k (A_k B_k / L_k^{\eta\alpha_l})^{\frac{\beta}{\lambda}}} \tag{4.4}$$

Proof. From:

$$\ln w_{jc} = -(1-\beta)\ln A_c + \beta \ln B_c + (1-\beta)\ln P_{jc} + (1-\beta)\ln V_j$$

We obtain:

$$\ln w_{jc} = -(1-\beta)\ln A_c + \beta \ln B_c + (1-\beta)\alpha_l \ln p_c + (1-\beta)\alpha_f \ln p_j + (1-\beta)\ln V_j$$

$$\ln w_{Nc} = -(1-\beta)\ln A_c + \beta \ln B_c + (1-\beta)\alpha \ln p_c + (1-\beta)\ln V_j$$

and

$$\ln w_{Nc} - \ln w_{jc} = (1-\beta)(\alpha_f \ln p_c - \alpha_f \ln p_j) + (1-\beta)(\ln V_N - \ln V_j)$$

To find V_N and V_j, we can use its definition together with the fact that

$$V_{jc} = A_c^\beta \tilde{B}_c^\beta V_j^{1-\beta} P_{jc}^{-\beta}$$

to obtain:

$$V_N = \left(\sum_c \left(\frac{A_c \tilde{B}_c}{P_{jc}}\right)^{\frac{\beta}{\lambda}}\right)^{\frac{\lambda}{\beta}} = \left(\sum_c \left(\frac{A_c \tilde{B}_c}{L_c^{\eta\alpha}}\right)^{\frac{\beta}{\lambda}}\right)^{\frac{\lambda}{\beta}} = \left(\sum_c \left(\frac{A_c \tilde{B}_c}{L_c^{\eta\alpha}}\right)^{\frac{\beta}{\lambda}}\right)^{\frac{\lambda}{\beta}}$$

and

$$V_j = \left(\sum_c \left(\frac{A_c \tilde{B}_c}{P_{jc}}\right)^{\frac{\beta}{\lambda}}\right)^{\frac{\lambda}{\beta}} = \left(\sum_c \left(\frac{A_c \tilde{B}_c}{L_c^{\eta\alpha_l} p_j^{\alpha_f}}\right)^{\frac{\beta}{\lambda}}\right)^{\frac{\lambda}{\beta}} = p_j^{-\alpha_f}\left(\sum_c \left(\frac{A_c \tilde{B}_c}{L_c^{\eta\alpha_l}}\right)^{\frac{\beta}{\lambda}}\right)^{\frac{\lambda}{\beta}}$$

Hence,

$$\ln w_{Nc} - \ln w_{jc} = (1-\beta)(\alpha_f \ln p_c - \alpha_f \ln p_j) + (1-\beta)\alpha_f \ln p_j + \frac{\lambda}{\beta} \ln \frac{\sum_c (A_c \tilde{B}_c / L_c^{\eta\alpha})^{\frac{\beta}{\lambda}}}{\sum_c (A_c \tilde{B}_c / L_c^{\eta\alpha_l})^{\frac{\beta}{\lambda}}}$$
$$= (1-\beta)\alpha_f \ln p_c + (1-\beta)\frac{\lambda}{\beta} \ln \frac{\sum_c (A_c \tilde{B}_c / L_c^{\eta\alpha})^{\frac{\beta}{\lambda}}}{\sum_c (A_c \tilde{B}_c / L_c^{\eta\alpha_l})^{\frac{\beta}{\lambda}}}$$

$$\tag{4.5}$$

$\square$

It is worth noting that in the model differences in the price index of origin do not play a direct role. This is a consequence of assuming a Cobb-Douglass utility function that combines local and foreign non-tradable goods consumption. If instead we assume that there is some degree of substitutability between

local and home consumption, we then 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:*

$$\ln \frac{\pi_{jc}}{\pi_{Nc}} = \frac{1}{\lambda} \beta \alpha_f \ln p_c + \ln \frac{\sum_c (A_c \tilde{B}_c / L_c^{\eta \alpha})^{\frac{\beta}{\lambda}}}{\sum_c (A_c \tilde{B}_c / L_c^{\eta \alpha_l})^{\frac{\beta}{\lambda}}} \tag{4.6}$$

Proof. From

$$\pi_{jc} = \frac{V_{jc}^{1/\lambda}}{\sum_k V_{jk}^{1/\lambda}}$$

and

$$\ln V_{jc} + \varepsilon_{ic} = \ln A_c + \ln w_{jc} - \ln P_{jc}(\alpha_l, \alpha_f) + \varepsilon_{ijc}$$

We have that

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

Using the definition of V_{jc} and the expressions for V_N and V_j from above, we have:

$$\ln \pi_{jc} - \ln \pi_{Nc} = \frac{1}{\lambda}(\ln w_{jc} - \ln w_{Nc} - \alpha_f(\ln p_j - \ln p_c) + \alpha_f \ln p_j + \frac{\lambda}{\beta} \ln \frac{\sum_c (A_c \tilde{B}_c / L_c^{\eta \alpha})^{\frac{\beta}{\lambda}}}{\sum_c (A_c \tilde{B}_c / L_c^{\eta \alpha_l})^{\frac{\beta}{\lambda}}})$$

We can now use equation 4.4 to obtain

$$\ln \frac{\pi_{jc}}{\pi_{Nc}} = \frac{1}{\lambda} \beta \alpha_f \ln p_c + \ln \frac{\sum_c (A_c \tilde{B}_c / L_c^{\eta \alpha})^{\frac{\beta}{\lambda}}}{\sum_c (A_c \tilde{B}_c / L_c^{\eta \alpha_l})^{\frac{\beta}{\lambda}}}$$

$\square$

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 immigrant 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).

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

$$L_c = \frac{(A_c B_c / L_c^{\eta\alpha})^{\frac{\beta}{\lambda}}}{\sum_k (A_k B_k / L_k^{\eta\alpha})^{\frac{\beta}{\lambda}}} L_N + \frac{(A_c B_c / L_c^{\eta\alpha_l})^{\frac{\beta}{\lambda}}}{\sum_k (A_k B_k / L_k^{\eta\alpha_l})^{\frac{\beta}{\lambda}}} \sum_j L_j \tag{4.7}$$

Proof. From

$$\pi_{jc} = \frac{L_{jc}}{L_j} = \frac{V_{jc}^{1/\lambda}}{V_j^{1/\lambda}} = \frac{(A_c^\beta \tilde{B}_c^\beta)^{1/\lambda}}{(L_c^{\eta\alpha_l\beta} p_j^{\eta\alpha_f\beta} V_j^\beta)^{1/\lambda}}$$

We can calculate the total immigrant population in city c as

$$L_{Ic} = \sum_j L_{jc} = \sum_j L_j \frac{L_{jc}}{L_j} = \sum_j L_j \frac{(A_c^\beta \tilde{B}_c^\beta)^{1/\lambda}}{(L_c^{\eta\alpha_l\beta} p_j^{\alpha_f\beta} V_j^\beta)^{1/\lambda}}$$

So

$$L_{Ic} = \left(\frac{A_c B_c}{L_c^{\eta\alpha_l}}\right)^{\frac{\beta}{\lambda}} \sum_j \frac{L_j}{(p_j^{\alpha_f} V_j)^{\frac{\beta}{\lambda}}}$$

Substituting V_j we get

$$L_{Ic} = \frac{(A_c B_c / L_c^{\eta\alpha_l})^{\frac{\beta}{\lambda}}}{\sum_k (A_k B_k / L_k^{\eta\alpha_l})^{\frac{\beta}{\lambda}}} \sum_j L_j$$

For natives, we have that $\alpha_l = \alpha$ and thus

$$L_{Nc} = \frac{(A_c B_c / L_c^{\eta\alpha})^{\frac{\beta}{\lambda}}}{\sum_k (A_k B_k / L_k^{\eta\alpha})^{\frac{\beta}{\lambda}}} L_N$$

and $L_c = L_{Ic} + L_{Nc}$ □

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 write the aggregate output per capita in the economy as:

$$q = \frac{L_N}{L} \frac{\sum_c (A_c B_c^{\frac{\beta+\lambda}{\beta}} / L_c^{\eta\alpha})^{\frac{\beta}{\lambda}}}{\sum_k (A_k B_k / L_k^{\eta\alpha})^{\frac{\beta}{\lambda}}} + \frac{\sum_j L_j}{L} \frac{\sum_c (A_c B_c^{\frac{\beta+\lambda}{\beta}} / L_c^{\eta\alpha_l})^{\frac{\beta}{\lambda}}}{\sum_k (A_k B_k / L_k^{\eta\alpha_l})^{\frac{\beta}{\lambda}}}$$

From this expression, we obtain that output per capita is increasing in total immigrant share. We can express this in the following proposition.

Proposition 9. *Under the aforementioned assumptions, aggregate output per capita increases the share of immigrants in the economy.*

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

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5 Output gains and welfare analysis

In this section, we estimate the model presented in section 4. There are three key equations in the model, from which we can obtain three key structural parameters. The first key parameter is the worker's weight in the bargaining process. Second, we obtain the share of consumption that immigrants effectively consume in their countries of origin (either directly, via remittances, or via saving for the future). We obtain this parameter from the relationship between local price indexes and native–immigrant wage gaps. And third, we estimate the sensitivity of internal migration to local changes. For this, we essentially use the distribution of immigrants and natives across locations. The rest of the parameters of the model are taken from the literature.

5.1 Key parameters

To obtain the first key parameter, we use the relationship between wages and city size and prices. That is, the model predicts that higher housing/local prices are going to be compensated through higher nominal incomes. In particular, we obtain that

$$\ln w_{Nct} = \alpha_{ct} + (1 - \beta)\alpha \ln p_{ct} + \nu_{ct} \tag{5.1}$$

or, if we use city size:

$$\ln w_{Nct} = \alpha_{ct} + (1 - \beta)\alpha\eta \ln L_{ct} + \nu_{ct} \tag{5.2}$$

From this regression, we obtain an estimate of $(1 - \beta)\alpha$. In order to recover β we need to know α. α is the weight of native consumption on local goods. The most important part of this is housing. Davis and Ortalo-Magne (2011) estimate that housing accounts for around 25 percent of total income, and that there is small dispersion across metropolitan areas. The income left after paying for housing rents is spent on either tradable goods or local non-tradable goods. For an estimate of this split, we can use employment in tradable versus non-tradable industries. Mian and Sufi (2014) report that the ratio of non-tradable to tradable employment is almost 2. Thus, $\alpha \approx 0.7$ is probably a good estimate. With this in mind, we can look at estimates of $(1 - \beta)\alpha$, which are shown in Table 3. We see that estimates are stable across specifications and data sets and suggest that $(1 - \beta)\alpha$ is around .4. If α is around .7, then β is around .43. This means that firms have slightly higher bargaining power than workers.[7]

The second key parameter that we need to estimate is α_f. This is the share of consumption that immigrants do in their countries of origin. To estimate this parameter, we can use the following equation:

$$\ln w_{ct}^N - \ln w_{ct}^j = \alpha_t + (1 - \beta)\alpha_f \ln p_{ct} + \delta_{jt} + \nu_{jct} \tag{5.3}$$

This equation comes directly from the model but we have added the time subscripts that give us extra variation. An alternative is to use the positive relationship between city size and local price indexes and use city size instead of city price in the regression:

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[7]There are other ways of approaching this estimation. We can, alternatively, use an estimate of β in the literature. We think, though, that the estimates of consumption shares are more reliable since they are easier to observe.

Table 3: Wage level and price indexes, structural estimation

CPS data

VARIABLES	(1) Wage Level OLS	(2) Wage Level OLS	(3) Wage Level OLS	(4) Wage Level OLS	(5) Wage Level OLS	(6) Wage Level OLS
Local price index	0.437*** (0.0486)	0.651*** (0.0639)	0.345** (0.143)			
City size				0.0454*** (0.00478)	0.0454*** (0.00476)	0.0493** (0.0198)
Observations	1,190	1,190	1,190	1,190	1,190	1,190
R-squared	0.342	0.469	0.725	0.321	0.329	0.725
Year FE	no	yes	yes	no	yes	yes
MSA FE	no	no	yes	no	no	yes

Census/ACS data

VARIABLES	(1) Wage Level OLS	(2) Wage Level OLS	(3) Wage Level OLS	(4) Wage Level OLS	(5) Wage Level OLS	(6) Wage Level OLS
Local price index	0.411*** (0.0436)	0.785*** (0.0580)	0.530*** (0.0966)			
City size				0.0551*** (0.00425)	0.0550*** (0.00426)	0.164*** (0.0479)
Observations	1,752	1,752	1,752	1,752	1,752	1,752
R-squared	0.358	0.646	0.943	0.504	0.506	0.938
Year FE	no	yes	yes	no	yes	yes
MSA FE	no	no	yes	no	no	yes

Notes: These estimates use wage data (natives only) from the CPS, Census, and ACS data for the years 2000 and 2005-2010. Census and ACS data are always used to compute price indexes, hence the year selection. We can match 219 metropolitan areas in CPS data.

$$\ln w_{ct}^N - \ln w_{ct}^j = \alpha_t + (1 - \beta)\alpha_f \eta \ln L_{ct} + \delta_{jt} + \nu_{jct} \tag{5.4}$$

Table 4 reports the results of this estimation, both for CPS and Census/ACS data. The estimates indicate that $(1-\beta)\alpha_f \approx .25$, so that $\alpha_f \approx .39$. This suggests that the weight that migrants give to their home country is quite large. If anything, this estimate would seem too large. Dustmann and Mestres (2010) suggests that the share of income that immigrants send back as remittances is a little less than 10 percent, on average. This can be interpreted as a lower bound for α_f. To the share of remittances, we need to add potential time spent at home and potential funds saved for future consumption in the home country. This future consumption, in the case of return migrants, is consumption that also takes into account the home price index. Thus, we consider our estimates as reasonable, given these considerations.

The third key parameter that we need to estimate is the sensitivity of internal migration to local conditions $(1/\lambda)$. For this, we use the following equation:

$$\ln \frac{\pi_{jct}}{\pi_{Nct}} = \alpha_t + \frac{1}{\lambda}\beta\alpha_f \ln p_{ct} + \delta_{jt} + \nu_{jct} \tag{5.5}$$

Or, using the housing supply elasticity:

$$\ln \frac{\pi_{jct}}{\pi_{Nct}} = \alpha_t + \frac{1}{\lambda}\beta\alpha_f \eta \ln L_{ct} + \delta_{jt} + \nu_{jct} \tag{5.6}$$

Table 5 shows the results using both CPS and ACS/Census data. The estimates fluctuate around 3 and

Table 4: Migrants and price indexes, structural estimation

CPS data

VARIABLES	(1) Wage Gap OLS	(2) Wage Gap OLS	(3) Wage Gap OLS	(4) Wage Gap OLS	(5) Wage Gap OLS	(6) Wage Gap OLS	(7) Wage Gap OLS	(8) Wage Gap OLS
Local price index	0.243*** (0.0652)	0.266** (0.117)	0.296*** (0.0944)	0.306*** (0.0989)				
City size					0.0348*** (0.00869)	0.0354*** (0.00893)	0.0348*** (0.00759)	0.0353*** (0.00818)
Observations	4,755	4,755	4,755	4,755	4,755	4,755	4,755	4,755
R-squared	0.014	0.014	0.132	0.222	0.024	0.029	0.142	0.232
Year FE	no	yes	yes	yes	no	yes	yes	yes
CO FE	no	no	yes	yes	no	no	yes	yes
CO trends	no	no	no	yes	no	no	no	yes

Census/ACS data

VARIABLES	(1) Wage Gap OLS	(2) Wage Gap OLS	(3) Wage Gap OLS	(4) Wage Gap OLS	(5) Wage Gap OLS	(6) Wage Gap OLS	(7) Wage Gap OLS	(8) Wage Gap OLS
Local price index	0.174*** (0.0460)	0.255** (0.123)	0.238** (0.104)	0.234** (0.105)				
City size					0.0376*** (0.00606)	0.0376*** (0.00612)	0.0349*** (0.00502)	0.0350*** (0.00522)
Observations	51,348	51,348	51,348	51,348	51,348	51,348	51,348	51,348
R-squared	0.017	0.021	0.191	0.222	0.055	0.060	0.222	0.254
Year FE	no	yes	yes	yes	no	yes	yes	yes
CO FE	no	no	yes	yes	no	no	yes	yes
CO trends	no	no	no	yes	no	no	no	yes

Notes: These estimates use wage data from the CPS, Census, and ACS data for the years 2000 and 2005-2010. Census and ACS data are always used to compute price indexes, hence the year selection. In CPS data, we can match 219 metropolitan areas and we can use wage gaps between natives and immigrants from 112 different countries of origin. In Census and ACS data, we can use 219 metropolitan areas and 125 countries of origin. Thus, each data point is defined by a year, a metropolitan area, and a country of origin. Note that the significantly smaller CPS micro-level sample size means that there are a larger number of metropolitan area–country of origin pairs without information.

4. This regression allows us to recover $1/\lambda$. The estimates suggest that λ is around 0.04.

5.2   Rest of the parameters

We rely on prior literature for the rest of the parameters. For the productivity and amenity levels, we use Albouy (2016). In a model similar to ours, but where he does not take into account the role of immigrants, 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. For the housing supply elasticities, we rely on Saiz (2010).[8] Finally, for agglomeration forces we rely on Combes and Gobillon (2014).

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

Table 5: Migrants and price indexes, structural estimation

CPS data

VARIABLES	(1) Rel. Imm Share OLS	(2) Rel. Imm Share OLS	(3) Rel. Imm Share OLS	(4) Rel. Imm Share OLS	(5) Rel. Imm Share OLS	(6) Rel. Imm Share OLS	(7) Rel. Imm Share OLS	(8) Rel. Imm Share OLS
Local price index	2.157***	3.856***	3.337***	3.419***				
	(0.331)	(0.701)	(1.037)	(1.103)				
City size					0.156*	0.155*	0.106	0.114
					(0.0797)	(0.0787)	(0.114)	(0.121)
Observations	4,755	4,755	4,755	4,755	4,755	4,755	4,755	4,755
R-squared	0.055	0.113	0.306	0.330	0.025	0.028	0.242	0.265
Year FE	no	yes	yes	yes	no	yes	yes	yes
CO FE	no	no	yes	yes	no	no	yes	yes
CO trends	no	no	no	yes	no	no	no	yes

Census/ACS data

VARIABLES	(1) Rel. Imm Share OLS	(2) Rel. Imm Share OLS	(3) Rel. Imm Share OLS	(4) Rel. Imm Share OLS	(5) Rel. Imm Share OLS	(6) Rel. Imm Share OLS	(7) Rel. Imm Share OLS	(8) Rel. Imm Share OLS
Local price index	1.853***	4.412***	4.406***	4.419***				
	(0.303)	(0.668)	(0.689)	(0.698)				
City size					0.203***	0.203***	0.208***	0.208***
					(0.0729)	(0.0725)	(0.0733)	(0.0737)
Observations	51,348	51,348	51,348	51,348	51,348	51,348	51,348	51,348
R-squared	0.049	0.135	0.272	0.276	0.042	0.044	0.190	0.194
Year FE	no	yes	yes	yes	no	yes	yes	yes
CO FE	no	no	yes	yes	no	no	yes	yes
CO trends	no	no	no	yes	no	no	no	yes

Notes: These estimates use wage data from the CPS, Census, and ACS data for the years 2000 and 2005-2010. Census and ACS data are always used to compute price indexes, hence the year selection. In CPS data, we can match 219 metropolitan areas and we can use native and immigrant distributions from 112 different countries of origin. In Census and ACS data, we can use 219 metropolitan areas and 125 countries of origin. Thus, each data point is defined by a year, a metropolitan area, and a country of origin. Note that the significantly smaller CPS micro-level sample size means that there are a larger number of metropolitan areas–country of origin pairs without information.

5.3 The role of immigration in determining economic activity across locations and for the aggregate economy

5.3.1 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. This 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.

In Figure 10, we plot a number of variables against the underlying productivity levels in each city taken from Albouy (2016). The underlying productivity is the primitive parameter that drives our results on both location and wage gaps. The top-left graph of Figure 10 shows that the distribution of population across US cities in the model and in the data match reasonably well. In both cases, there is a positive relationship of similar magnitude. The main 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. Similar considerations apply to the relationship between wages and productivity in the model and in the data. 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.

Figure 10: Model and data
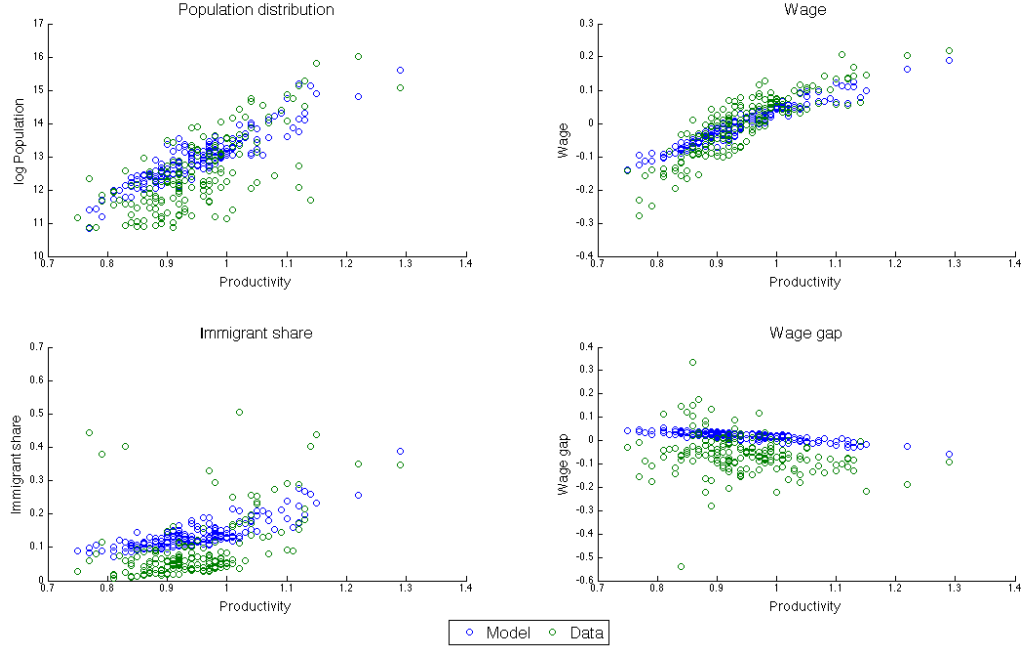
The same happens with the two main targets of the model, namely the distribution of immigrants across space and the wage gaps of immigrants and natives. These graphs are shown in the bottom part of Figure 10. It is interesting to see that there are some important outliers in terms of immigrant shares. 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.

In all, it seems that our estimate 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.

5.4   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. This uses equation 4.7, 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.

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Figure 11: Effect of immigrants
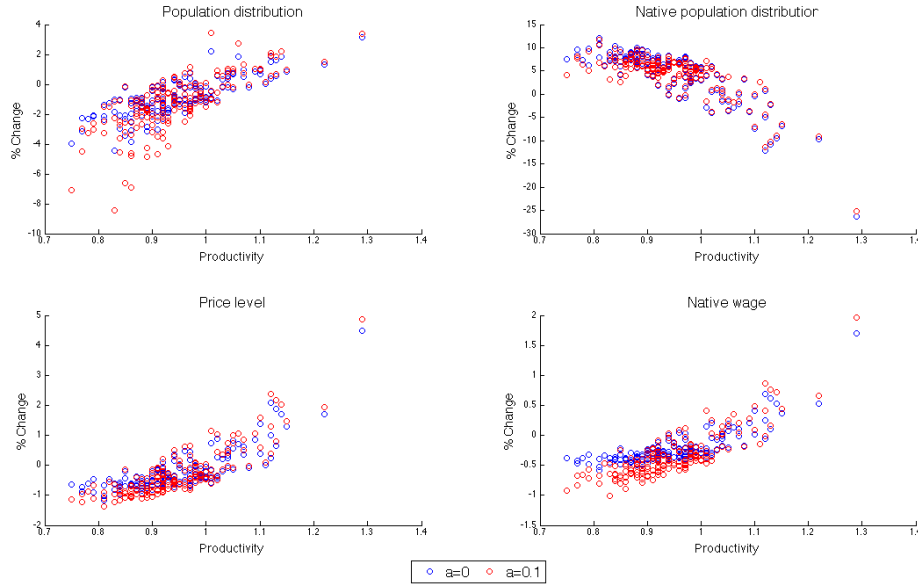
It is apparent from Figure 11 that migration makes more productive cities larger. This is the basis of the output gains that come from the differential location choices of immigrants relative to natives. The graph shows how the most productive metropolitan areas in the United States are as much as 2–3 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.

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 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 .14 to .2 percent. Thus, immigration results in overall gains, but in potentially important distributional consequences, particularly between more and less productive locations.

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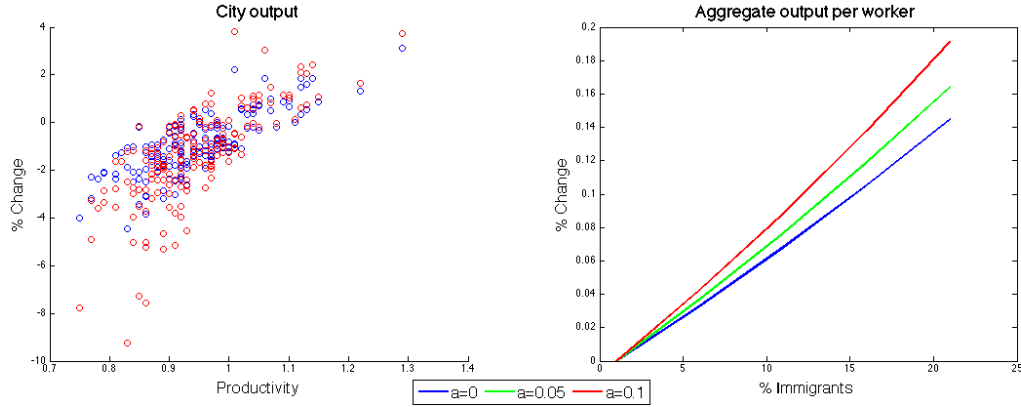
Notes: This figure compares the model with and without agglomeration forces. Each dot, in the graph on the left, represents a city. We use the 168 consolidated metropolitan areas used in Albouy (2016). See the text for the details on the various parameters of the model. The graph on the right shows the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

5.5   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 agent in the model and the consequences of immigration are heterogeneous among them.

The first type of agent in the model, which have 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 in 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   Supplementary evidence

A.1   Price indexes and city size

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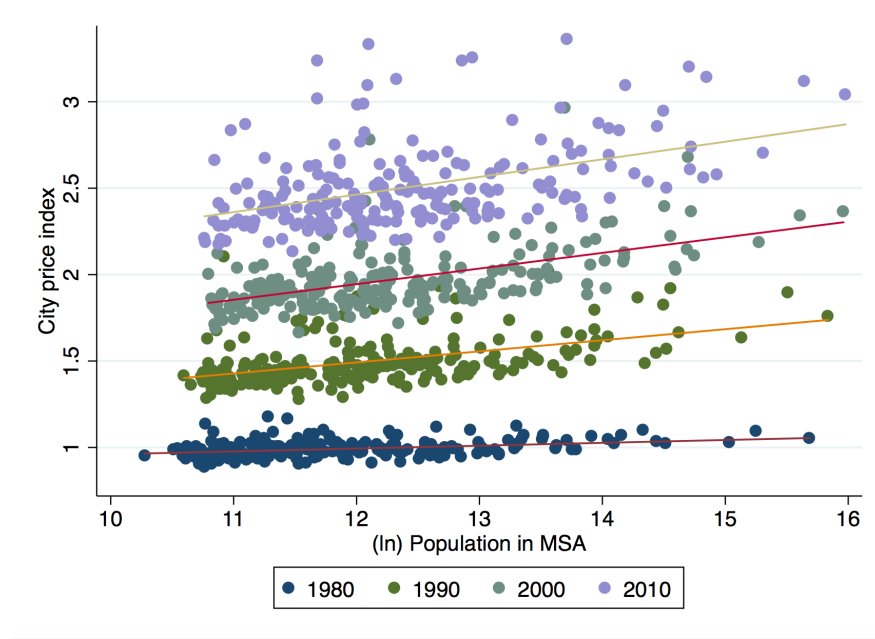
Notes: MSA populations are based on the sample of prime-age male workers (25-59) from Census 2000. The MSA price indexes are computed following Moretti (2013). Each dot represents a different MSA-year combination. We have 219 different metropolitan areas in our sample.

A.2   Undocumented immigrants

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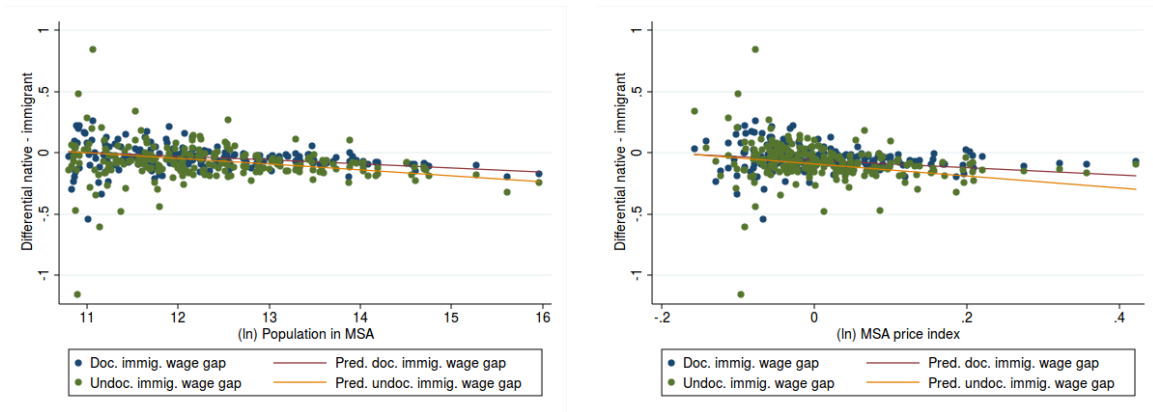
Notes: This figure uses data from Census 2000 to show the relationship between the wage gaps of documented and undocumented immigrants to natives, city sizes, and prices. Each dot represents one of the 219 different metropolitan areas in our sample.

A.3 Baseline wage regression

Table A.1: Baseline wage regression

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

Notes: These regressions only report selected coefficients. The complete set of explanatory variables is specified in equation 3.1. 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 .001 confidence levels.

A.4 Wage regression by subsample

Table A.2: Heterogeneity by subsample

VARIABLES	(1) Wage Men	(2) Wage Women	(3) Wage <HS	(4) Wage HS	(5) Wage SC	(6) Wage C
Immigrant premium	0.262*	0.145	0.115	0.239*	0.328***	0.186*
	(0.144)	(0.131)	(0.0765)	(0.128)	(0.0978)	(0.104)
(ln) Population in MSA	0.0438***	0.0256**	0.0371	0.0200	0.0338*	0.0644***
	(0.0167)	(0.0111)	(0.0262)	(0.0235)	(0.0179)	(0.0180)
(ln) Population in MSA x Immigrant	-0.0337***	-0.0183*	-0.0186***	-0.0305***	-0.0346***	-0.0201***
	(0.0110)	(0.0100)	(0.00544)	(0.00949)	(0.00726)	(0.00745)
Observations	360,970	345,734	39,537	101,885	94,124	125,424
R-squared	0.382	0.299	0.224	0.262	0.269	0.310
Xs	yes	yes	yes	yes	yes	yes
Year FE	yes	yes	yes	yes	yes	yes
MSA FE	yes	yes	yes	yes	yes	yes

Notes: These regressions only report selected coefficients. The complete set of explanatory variables is specified in equation 3.1. Columns (3) to (6) show results by education group (high school dropout, high school graduate, some college, college). 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 .001 confidence levels.

Table A.3: 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.
Immigrant premium	0.285**	0.0462	0.309***	0.0271	-0.309	0.117	0.236**	0.393***
	(0.126)	(0.0728)	(0.110)	(0.0842)	(0.363)	(0.212)	(0.0944)	(0.145)
(ln) Population in MSA	0.0353***	0.0402***	0.0359***	0.0377***	0.0310**	0.0316**	0.0417***	0.0339***
	(0.0129)	(0.0152)	(0.0132)	(0.0140)	(0.0123)	(0.0126)	(0.0155)	(0.0128)
(ln) Population in MSA x Immigrant	-0.0324***	-0.0104**	-0.0331***	-0.0139**	0.0219	-0.00276	-0.0271***	-0.0412***
	(0.00944)	(0.00474)	(0.00830)	(0.00555)	(0.0258)	(0.0150)	(0.00708)	(0.0108)
Observations	326,175	298,257	352,619	295,245	287,419	287,959	334,360	313,504
R-squared	0.413	0.385	0.416	0.386	0.382	0.382	0.391	0.416
Xs	yes	yes	yes	yes	yes	yes	yes	yes
Year FE	yes	yes	yes	yes	yes	yes	yes	yes
MSA FE	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 3.1. 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 .001 confidence levels.

A.5 Country of origin heterogeneity

Table A.4: 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 3.2. 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 .001 confidence levels.