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The Effects of Immigration on U.S. Wages and Rents: A General Equilibrium Approach.

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Non-Technical Abstract

In this paper we document a strong positive correlation of immigration flows with changes in average wages and average house rents for native residents across U.S. states. Instrumental variables estimates reveal that the correlations are compatible with a causal interpretation from immigration to wages and rents of natives. Separating the effects of immigrants on natives of different schooling levels we find positive effects on the wages and rents of highly educated and small effects on the wages (negative) and rents (positive) of less educated. We propose a model where natives and immigrants of three different education levels interact in production in a central district and live in the surrounding region. In equilibrium the inflow of immigrants has a positive productive effect on natives due to complementarities in production as well as a positive competition effect on rents. The model calibrated and simulated with U.S.-states data matches most of the estimated effects of immigrants on wages and rents of natives in the period 1990-2005. This validation suggests the proposed model as a useful tool to evaluate the impacts of alternative immigration scenarios on U.S. wages and rents.

Key Words: Immigration, Wages, Rents, Housing Prices, U.S. States.
JEL Classification Codes: F22, J61, R23.

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1 Introduction

The literature on the economic impact of immigrants on U.S. natives has been, so far, overwhelmingly dominated by a labor market perspective and a "partial equilibrium" approach. Others things equal, economists have argued, an increase in the supply of foreign-born workers in a certain skill group depresses the wages of native workers of like skill (Borjas, 2003, Borjas, 2006, Borjas and Katz, 2005). Because of complementarities, however, immigration also increases the wage of U.S.-born workers with different skills. Recent empirical evidence has suggested that rents for U.S.-born individuals have risen significantly more in those metropolitan areas that received a larger inflow of immigrants (Saiz, 2003, 2006), though studies that focussed on the group of less educated, low income natives who are more likely to compete with less educated immigrants for housing, have not found a significant effect of immigration on the rents of those individuals (Greulich, Quigley and Raphael, 2004). We have argued elsewhere (Ottaviano and Peri, 2005a, 2006b) that considering labor market interactions between workers of different education and experience levels, and accounting for imperfect substitutability between foreign-born and U.S.-born workers, the *average* effect of immigrants on wages of U.S.-born workers is positive; more educated workers receive the largest part of that positive average effect and the group of workers with no high school diploma suffers a small wage decline. The impact of immigration on wages and rents (house prices) are by far the two most important market channels through which immigration affects the real income of U.S. residents.[1] While Cortes (2006) showed significant effects of immigration on the price of non-tradeable services (such as housekeeping, baby-sitting and gardening) across U.S. cities, the share of expenditures in those services is too low for those effects to have significant welfare implications. For the average American, personal and housekeeping services constituted 2% of total expenditures, while housing expenses (shelter) constituted 20% to 30% according to the 2005 Consumer Expenditure Survey (published by the Bureau of Labor Statistics). To have a reasonable assessment of the impact of immigration on the real income of U.S.-born individuals, therefore, one should begin considering the impact of immigration on wages and rents jointly. Moreover, to address the relevant issues of distributional effects in addition

[1] Another relevant channel through which immigrants may affect natives' income is through fiscal effects in the form of higher or lower tax burdens for natives. Depending on whether immigrants use welfare more or less than natives and pay lower or higher taxes than natives, immigration may imply a redistribution in the recipient country, though these effects are often hard to measure and identify.

to average effects, one needs to consider native and immigrant workers with different levels of skills, as those imply different income levels and housing choices and, more importantly, because immigrants are unevenly distributed across schooling groups. This paper offers a novel approach to analyzing and measuring the effects of immigration. It considers the effect on the joint labor and housing market equilibrium in a setting with skill-differentiated workers, thereby isolating skill-specific and location-specific outcomes.[2]

The paper first analyzes some empirical features of the relation between immigration and wages/rents across U.S. states and their metropolitan residents, using census data from 1970-2000 and the American Community Survey data for 2005. We find that there was a positive, stable and very significant relation between the inflow of foreign-born and the change in average wage and average house prices (rents) for natives across U.S. states. These two positive average effects are robust to variable definitions, to the chosen sample and to the method of estimation used. In particular, we construct a supply-driven shift of immigrants across U.S. states based on the tendency of new immigrants to settle where previous immigrants from their country already live (for personal preferences, information and insurance reasons). Using this instrument for immigrant supply we show that the positive and significant correlation is not only driven by demand (pull) factors and survives the instrumental variables estimation. An inflow of immigrants is associated in the long run with higher average wages and average rents of natives and with a small migration of natives out of the state. Moreover, measuring the effect on workers/dwellers with high education (college), medium education (high school) or low education (no degree) we find that immigration had the largest positive wage effect on highly educated, while it had a small negative effect on the wages of less educated. At the same time, the rents (house prices) of the highly educated were highly sensitive to immigration while the rents of the least educated were relatively insensitive to immigration.

To explain these facts we model the behavior of U.S. natives as workers in an open local economy (city or state) with a central business district (CBD) where production takes place, and a linear residential district where people live that is symmetrically distributed around its center.[3] Individuals

[2]In previous work (Ottaviano and Peri 2005b and 2006a) we considered the joint effect of immigrants on average wages and average rents across U.S. cities. However, distinct from this paper, we adopted a representative agent approach, did not model the source of productivity effects, and did not analyze the residential choice and equilibrium.

[3]Here the assumption of a linear local economy organized around a CBD is made for simplicity. As we will see, it is enough for our purposes being able to generate a model of residential location that reasonably fits the observed response of U.S. wages and rents to immigration. Brueckner et al (1999) show that accounting for the heterogeneity of

are producers and consumers of a tradable good and of a local service, as well as consumers of housing services. U.S.-born individuals can move out of the region if immigrants decrease their real income or into the region if immigrants increase it. This model allows us to analyze the consequences of migration on wages, rents and employment of natives in each group in general equilibrium. Importantly, we consider heterogeneous native and foreign-born individuals in three groups, according to their schooling level. This allows us to capture the average as well as the relative changes in wages, rents and real income for natives of low, intermediate or high levels of schooling, accounting for their complementarity in production and for the fact that they stratify in different housing locations. The model considers the representative metropolitan population of a state in the U.S. and simulates the effect of the 1990-2005 migration flow on wages, prices, house values and real income of U.S. natives. Calibrating parameter values with estimates from the literature, the model matches the response of average wages, house prices and the migration of natives to the inflow of international migrants remarkably well. We also derive empirical predictions from the model for the impact of immigration on each education group's wage, housing price and housing income. Again the simulated results match remarkably well with the estimated elasticities, except for the effects of immigration on the wages/rents of less educated individuals as those elasticities are larger in the simulated model than in the data.

This validation suggests the proposed model as a useful tool for policy analysis aimed at the evaluation of the impacts of alternative immigration scenarios on U.S. wages and rents. We analyse several types of scenarios. In the first, we use our calibrated model to assess the effects of immigration on the average U.S. state without the undocumented migrants. In this scenario we use the estimates by Passel (2005) and attribute all undocumented to the group of least educated immigrants. The low skill inflow would be reduced to roughly one third of the actual one without significantly altering the inflows of medium and high skill migrants. In the second type of scenarios, we ask what would have happened to the average U.S. state if this had alternatively experienced the same immigration patterns as some states at the center of the immigration debate (namely, California, New Jersey, New Mexico, New York and Texas). Overall, the simulated scenarios stress the crucial role played

the spatial distribution of amenities within cities allows one to replicate the multiplicity of location patterns observed in reality without significantly affecting the properties of the simple monocentric model that are relevant for the present analysis.

by the matching between native and immigrant skills in terms of both the average effect and their distribution across skill groups. They also reveal the importance of a general equilibrium approach to evaluating the effects of immigration as the associated shocks are absorbed not only in the wages of the natives but also in their rents and employment levels.

To summarize, three main results are obtained from the model and match the empirical findings. First, due to complementarities between natives and immigrants in the production of the tradeable and of the non-tradable goods, the overall production effects of immigrants on natives is positive, on average. Second, immigration, particualrly of more educated people, increases the competition for housing and the complementarities in production attract native workers and both facts increase housing prices and rents. Such an increase is larger for the houses of medium and highly educated who live in the most desirable locations. Finally, even at the lowest skill level, natives have higher ownership rates of houses than foreign-born. Consequently, each group of natives receives a positive housing income effect from immigrants so that house owners in each group of education have a positive transfer from immigrants. Workers can arbitrage away the real effects on wages by moving across states and therefore the only net effects on the real income of natives are the housing income effects. The individuals who lose more from immigration are less educated native workers who rent their house. Some of them move out because their wage does not increase by much (or decreases by a little) and their rent increases, substantially affecting their real income. On the other hand for less educated workers who own their houses, the positive housing income effect is larger than the small negative real wage effect. We also find that in the model, as in the data, the migratory response of native workers to immigration is quite moderate.

The rest of the paper is organized as follows: Section 2 reviews the previous literature on the regional effects of immigration on wages and housing prices. Section 3 presents new empirical estimates of the effects of immigration on wages, house prices and internal migration of natives, considering average effects as well as effects by education group. Section 4 presents the model that describes the effect of immigrants on wages, housing prices and the location choice of natives. Section 5 calibrates and simulates the equilibrium of the model: in particular, we validate the responses of wages, house prices and the location of natives to the immigration flows of a typical U.S. state during the 1990-2005 period, on average as well as for each skill group. The resulting match with the estimated elasticity is reasonably good: the elasticities of average wage, rents and employment are exactly in the estimated range and four out of six elasticities across education groups also match the estimated ranges. This validation allows us to use the proposed model as a useful tool to evaluate the impacts of alternativeand couterfactual immigration scenarios. Section 6 concludes the paper.

2 Literature Review

Our paper provides a coherent approach to analyzing the most important market-effects of immigration on U.S. natives: labor markets and housing markets effects. Hence, our work also brings together two different strands of the literature. On one hand, a long empirical tradition (Card, 1990, 2001, 2007) has looked at state or metropolitan area wages to see whether they were systematically affected by immigration, and has found little evidence of that. Even when considering the migratory response of natives (Card and Di Nardo, 2000) such a "regional" approach did not detect relevant effects of immigrants on native wages. Recent articles (such as Borjas, Freeman and Katz, 1997, Borjas 2003) have raised some doubts on such an approach arguing that the migratory response of natives and small sample bias may reduce the estimates of the effects of migrants on wages (Borjas, 2006). On the other hand, Albert Saiz (Saiz, 2003, 2006) and our previous work (Ottaviano and Peri, 2005a) have shown that the price of housing in metropolitan areas across the U.S. are systematically positively correlated with immigration flows. Immigrants are concentrated in few states and live primarily in metropolitan areas. As the effect of the migrant inflow is not fully offset by out-migration of natives, migrants increase the demand and price of housing. In theory, in the long run, this effect should simply lead to more housing construction, though in practice land regulation and scarcity of desirable locations generate an increase in the value of land and houses in most typical immigrant destinations (this mechanism is illustrated in Gyourko et al., 2005). A study by Greulich, Quigley and Raphael (2004) that focuses on the effect of immigration on the rents of the specific set of U.S.-born who are more likely to compete for rents with immigrants (mostly in the lower income range), does not find much of an effect of immigration on this group, suggesting that the migration and housing supply response could indeed offset the inflow of immigrants.

The wage and housing price channels are both very important to understand the effects of immigration on the welfare of native individuals and it is clear that they need to be analyzed together. As Robak (1982) showed, to analyze a spatial equilibrium in which individuals equate consumption wages across locations we need to consider both wages and local prices. The response of natives to immigration in a U.S. state (or city) depends on how wages change relative to local prices, and the price of housing is the most relevant in determining local prices as spending for housing represents between 20 and 30% of total current expenditures for Americans. Hence, wages, housing prices and the location response of natives need to be analyzed within the same equilibrium model. Moreover, increasing wage dispersion over recent decades (Autor, Katz and Kearny, 2005) has been accompanied by increasing housing price dispersion across states and metropolitan areas (Gyourko, Meyer and Sinai, 2005). This suggests that an important adjustment mechanism for a local economy may involve house prices increasing or decreasing with wages in response to immigration, keeping "consumption" wages more stable across locations with little response of inter-city migration. Finally, we incorporate a second "price effect" of immigration in our theoretical model. This could be called a "consumption variety" effect. In local non-tradable services such as restaurants and entertainment (accounting for a 15% and 20% share of average U.S. individual expenditure in 2005) the presence of foreign-born workers and the differentiated varieties of services that they provide add to the diversity of consumption and have a positive economic value. The benefits from increased variety in consumption (so celebrated in the trade and growth literature) are often mentioned by the migration literature but never modeled and measured seriously, in contrast to the price effects of increased consumption varieties in traded goods (e.g. Feenstra, 1994, Broda and Weinstein, 2006). Our work provides a framework and a first step to quantify those variety effects in the context of local services provided by immigrants.

3 The Empirical Evidence

3.1 Aggregate Wages and Aggregate House Prices

The point of departure of our analysis is some striking empirical measures of the aggregate impact of immigration on average wages and rents (house prices) of natives. Previous literature has focussed on the issue of *relative* wages of natives, considering immigration as a shift in the relative supply of less skilled workers (Borjas 2003, Card, 2001, 2007) while some articles have discredited the regional approach somewhat, claiming that labor mobility of natives would drastically attenuate any effect on wages (Borjas, Freeman and Katz, 1997, Borjas 2006). Despite these critiques of the "area approach," we begin by considering the average wages of natives, the average house rents (prices) of natives and their association with immigration at the state level. There are three reasons why these correlations are particularly interesting and contain a lot of information on the "production" and "consumption" value of immigration for natives. First, differences in productivity and wages across states produced by differences in immigration rates need not be eliminated by internal migration of natives if they also cause corresponding changes in the value and price of housing. That is, the positive (negative) productivity effects may be offset by more (less) expensive housing, *barely affecting real wages.* Second, in Ottaviano and Peri (2006b) we showed that there is a mechanism, represented by complementarities in production, through which immigrants may raise the average wage of natives even when immigrants of each particular skill type still have a negative partial effect, *ceteris paribus*, on the wages of natives. If overall immigrants are imperfect substitutes for natives, the positive wage effects across skill groups are larger than the negative wage effects within skill group producing a positive average effect. Such positive "complementarity" effects would be captured best by aggregate empirical evidence at the state level and could be lost in an approach that only focuses on effects "by skill". Finally, in previous work (Ottaviano and Peri, 2005a, 2006a) we document the positive correlation between native wages/house prices and immigration across U.S. metropolitan areas; similarly, Saiz (2006) documents such a correlation for house prices across U.S. cities. Here we want to show that the positive correlation is found across states, across their metropolitan areas, and that this correlation is robust across specifications and over time. Moreover, by constructing a supply-driven shift of immigration across U.S. states we want to show that such positive correlations are compatible with genuine "effects" of immigration and not the spurious result of unobservable state-specific demand shocks.

3.1.1 OLS Correlations

The data used for the empirical analysis are constructed using individual records from the Integrated Public Use Microdata Samples of the U.S. Census collected and homogenized by Ruggles et al. (2006).

We use the 1% Form 1 state sample for 1970, the 5% state sample for 1980, 5% state sample for 1990, 5% census sample for 2000 and the 1 in 100 random sample for the American Community Survey for 2005. The units of observation are alternatively all residents of 50 U.S. states plus DC, or residents in metropolitan areas within the U.S. states. For all employment and wage data we select people in the 17 to 65 age range who worked at least one week and received positive salary. For population data we selected all individuals residing in a state in the 17 to 65 age range. For all housing data, rent, housing value and house characteristics we selected records relative to individuals who are head of households. The aggregate data on employment and population by state are constructed by weighting each individual by the sample weight (variable PERWT). The average data on wages, rents and value of houses are constructed averaging across individuals using their personal weight as well. All current dollar values are converted to constant 2000 dollar values using the consumption price index (CPI-U) deflator (available at the U.S. Department of Labor, Bureau of Labor Statistics, http://www.bls.gov/cpi/). In our empirical analysis we consider as foreign-born those individuals who are not born in the U.S. or its territories overseas and who were not citizens at birth. First we show the correlation between immigration and increase in the average wages of U.S.-born workers at the state level in Table 1, as well as in Figure 1. The coefficients in Table 1 represent the estimates of the parameter γ_{wage} from the following regression:

$$\frac{\Delta \overline{w}_{jt}^{H}}{\overline{w}_{jt}^{H}} = \alpha_t + \gamma_{\text{wage}} \left(\frac{\Delta F_{jt}}{F_{jt} + H_{jt}} \right) + \beta_0 \left(\frac{\Delta H_{jt}}{F_{jt} + H_{jt}} \right) + \varepsilon_{jt} \tag{1}$$

where $\overline{w}_{jt}^{H}$ is the average wage of U.S.-born (Home) workers in state j and Census year t, $\Delta \overline{w}_{jt}^{H}$ is its change over the period between Census t and the following one, α_t are period fixed effects, F_{jt} is the total employment of foreign-born in state j and year t and ΔF_{jt} is the net change between Census t and the following one; similarly H_{jt} is total employment of U.S. natives in state j and ΔH_{jt} is its inter-Census change. Finally ε_{jt} is a random zero-mean state-period shock. An OLS estimate of (1) can be no more than a correlation as we are regressing wages on employment and potentially mixing demand and supply shifts. One important thing, however, is that we are already controlling for the change in employment of native workers. Demand shocks that generically attract workers to the state would be captured by the coefficient β_0 (not reported in the table and usually close to zero and statistically insignificant) while γ_{wage}captures only the co-movement of native wages with movements in immigrant employment, orthogonal to native employment γ_{wage}. Given that both changes are measured in percentage terms γ_{wage} can be interpreted as an elasticity: when immigration increases state employment by one percent the wage of natives in that state would increase by γ_{wage} percent. Whether measuring wage in yearly or weekly terms and whether using all workers or male only to calculate average wages, the first row of Table 1 always shows very significant positive estimates of γ_{wage} between 0.45 and 0.5. Figure 1 represents the partial correlation between $\frac{\Delta \overline{w}_{jt}^H}{\overline{w}_{jt}^H}$ and $\left(\frac{\Delta F_{jt}}{F_{jt}+H_{jt}}\right)$ after controlling for change in native employment, and shows a clear positive correlation with no evidence of nonlinearity or outliers driving the result. Row 4 of Table 1 shows the elasticity estimates when we consider only workers in the metropolitan areas of each state (identified by the METRO variable in the IPUMS) and the immigration into the corresponding metropolitan areas. In that specification, one unit of observation is the aggregate of all metropolitan residents within each of the 50 US states plus DC. The complementarity effects and the housing price effects could be stronger in metropolitan areas since productive interactions are intense and land is scarce there. The coefficient estimated on metropolitan workers only is significant and close to (possibly slightly higher than) the one estimated using all workers. We performed a number of other checks (not reported and available upon request) using sub-samples of states (e.g. excluding California, or the top 3 receivers of immigration) and sub-periods (1980-2000 only) confirming the remarkable robustness of this estimate.

Table 2 and Figure 2 report a similar analysis for the effect of immigration on the price of houses of native individuals. The first row of Table 2 shows the partial correlation between immigration and change in house prices (rents) obtained by estimating the parameter $\gamma_{\text{house price}}$ in the following regression:

$$\frac{\Delta \overline{r}_{jt}^H}{\overline{r}_{jt}^H} = \alpha_t + \gamma_{\text{house price}} \left(\frac{\Delta F_{jt}}{F_{jt}+H_{jt}}\right) + \beta_1 \left(\frac{\Delta H_{jt}}{F_{jt}+H_{jt}}\right) + \varepsilon_{jt} \tag{2}$$

where $\overline{r}_{jt}^H$ is the average rent (or house price) of U.S.-born individuals in state j and Census year t and $\Delta \overline{r}_{jt}^{us}$ is its change over the period following Census t. The other variables are as defined above, except that now we measure F_{jt} and H_{jt} as foreign- and U.S.-born population of working age residing in state j in year t, rather than employment. We still control for native's population change so that the correlation $\gamma_{\text{house price}}$ indicates the association of house prices of natives to immigration changes orthogonal to changes in native population. Row 1 of Table 2 shows an elasticity of rents to immigration between 0.60 and 0.82 and very significant. Figure 2 illustrates the partial correlation estimated in column 2 row 1 and confirms that there is a discernible positive association, not apparently driven by outliers or odd nonlinearity. Row 4 of Table 2, restricted to the metropolitan areas of each state, shows similar elasticity estimates for rents, however the estimated elasticitiesof house prices are often more volatile and imprecisely estimated, still always positive and often around one. For rents and house prices we notice that the estimated elasticities are larger and more significant when we use the data relative to metropolitan areas only. This is reasonable and consistent with the idea that immigration has a particularly strong effect on city rents because of the presence of land regulation and limited availability of desirable locations. Including data from the whole state dilutes this effect. We also perform estimation using mediansand averages as we are concerned that the strict top-coding of the census for monthly rents and value of housing may eliminate a large upper tail of the price distribution and bias the average estimates. There seems to be no systematic difference, however, between the estimates using the median and those using the average rent and house price.

3.1.2 Supply Shocks and Instrumental Variables Estimates

The possibility that unobservable demand/productivity shocks in states may be correlated with immigration of foreign-born (and certainly with native immigration) induce possible correlation between the variable $\frac{\Delta F_{jt}}{F_{jt}+H_{jt}}$ and the residuals of equations (1) and (2) so that the elasticities γ cannot be interpreted as the effect of an exogenous change (supply shift) in immigration on wages and house prices. In order to identify the γ'sas measuring the impact of immigration on native wages and rents, we need to identify shifts in immigration across states and periods due to supply (push) factors rather than demand (pull) factors. This is done in the literature (originally the idea is from Card, 2001, subsequently used in Lewis, 2005, Ottaviano and Peri, 2005a, 2006a and Saiz, 2006, among others) by using the facts that immigrants tend to settle disproportionately where other people of the same nationality already reside and that different nationalities had very different immigration rates to the U.S. during the 1970-2005 period. Technically, we consider the composition of the foreign-born population by state and country of origin in 1970 and attribute to each group the net immigration rate (by nationality and period) for the whole U.S. over each inter-Census period. This allows us to construct an "imputed" population for foreign-born by country of origin and state in each subsequent census year (1980, 1990, 2000 and 2005). Aggregating across nationalities in each state for each of the census years following 1970 we obtain an imputed foreign-born population that we use as an instrument for the actual foreign-born population. Let us call F_{cjt} the population of foreign-born from country c in state j and year t. The total population of foreign-born from country c in the whole U.S. in year t will be denoted simply as $F_{ct} = \sum_j F_{cjt}$. Its change between Census year t and Census year $t+n$ will be denoted as $\Delta F_{ct,t+n}$ and the growth rate of that group at the national level, between t and $t+n$ will be denoted as $g_{ct,t+n} = \Delta F_{ct,t+n}/F_{ct}$. We identify 56 foreign countries of origin covering more than 99% of all U.S. immigrants during the 1970-2005 period.[4] The imputed foreign-born population for state j in year $1970+n$, where n can be 10, 20, 30 and 35 is given by the following expression:

$$\widehat{F}_{jt+n} = \sum_{c=1}^{56} F_{cj1970}(1 + g_{c1970,1970+n}) \tag{3}$$

We then use the change in foreign-born calculated using the imputed data as an instrument for the actual change. Namely, the variable $\frac{\Delta \widehat{F}_{jt+n}}{\widehat{F}_{tt+n}+H_{jt+n}}$ is used as an instrument for $\frac{\Delta F_{jt+n}}{F_{tt+n}+H_{jt+n}}$.Rows 2 of Tables 1 and 2 show the instrumental variable estimates of the coefficients γ_{wage} and $\gamma_{\text{house price}}$, and rows 3 show the first stage coefficient and F-test for the instrument. Similarly Rows 5 and 6 show IV estimates and first stage coefficients for the metropolitan samples across states. All IV regressions include period dummies, and exclude the potentially endogenous change in native employment (population). The instrument should isolate the supply-driven changes in immigration only. The imputed change of foreign-born turns out to be a good instrument at the state level with a partial R^2 of around 0.4 and and F larger than 20. The point estimates for γ_{wage} using the IV technique range between 0.34 and 0.56, depending on the sample and wage definition, and are always significantly positive. The IV estimates for $\gamma_{\text{house price}}$ obtained using rent data range between 0.64 and 0.81. When we use data on house prices, the elasticity are less precisely estimated, always positive

[4]The census data include undocumented immigrants residing on the national territory. While there may be some undercounting of undocumented immigrants due to difficulties in locating those people recent studies estimate that such undercounting was small (less than 10% of all undocumented might have been missed).

and in some cases as large as 2.4. This may be due to the larger volatility of prices which also depend on the expectation of future appreciation, while rents, the cost of use, should be related more closely to fundamentals. All in all, the IV estimates confirm and reinforce the OLS estimates. Immigration produces a positive effect on the wages of native workers with elasticities in the $0.35-0.55$ range and a positive effect on housing expenditure with elasticities roughly between $0.6-0.8$ when estimated on rents. One further test that the instruments seem to be working in the expected direction is shown in Table 3. The table shows the elasticity of native population or native employment to changes in immigrant population (or employment). Interestingly, while the OLS estimates (first column) are positive and significant, proving that natives and immigrants' populations both respond to common (demand) shocks by moving together into and out of states, the response of natives to supply-driven immigration shocks is negative, however quite small and not significantly different from 0. We can rule out that the IV estimates are equal to the OLS ones at the 1% confidence level, implying that unobservable demand shocks are driving, in part, both types of immigration to a given state. On the other hand we can also rule out that one immigrant worker displaces one native worker in terms of employment (by pushing the native out of the state) which would imply a coefficient of -1 in the IV regression. We cannot rule out that supply-driven immigration shocks have no effects on theemployment of natives, by simply increasing the total supply of workers in the state. Immigrants only induce a mild out-migration response of natives, if at all, and certainly a much smaller response than one-for-one . This fact, along with the positive effect on average wage and house prices is one of the robust regularities that our simple model should explain.

3.2 Wage and House Prices by Skill Group

The average effect of immigration received little attention in the past as economists focussed on its distributional (relative) effects, increasingly so as immigration has become skewed towards less skilled workers and as native unskilled workers have fared rather poorly (in terms of wages) in the U.S. economy (Ottaviano and Peri, 2006b). Here we extend our empirical analysis to identify the correlation between immigration and wages or rents of natives in different schooling groups. Schooling is a very important aspect of workers' skill. On theone hand, workers of different schooling levels generally compete for different jobs, so that the impact of immigrants with low education is more severe on wages of less educated natives, while highly educated natives mostly experience positive complementarity effects. On the other hand, differences in education are very closely correlated to differences in income and in the housing markets in which individuals compete. The houses demanded by less educated immigrants are in more direct competition with those demanded by less educated natives. Hence in this section we analyze the effects of immigrants on the wages and house prices of the native population by education group. The most parsimonious and meaningful way of doing this is to divide natives and immigrants into three education groups: those with low education (no degree), those with intermediate education (high school degree) and those with higher education (college degree). The presence and inflow of immigrants is proportionally larger in the low and high education groups than in the medium education group. Figure 3 shows the percentage of foreign-born workers in each of the three education groups for the U.S. and for states that receive large percentages of immigrants. The prevailing pattern of immigration is a U-shape across the three skill levels in aggregate as well as for the individual states. This implies that an appropriate model of immigration should bifurcate education into at least three groups (low, medium and high). At the same time, the location and type of house bought and rented by the group of individuals with a low level of education within a state or a metropolitan area tend to be quite different than those purchased and rented by medium or highly educated people. Several recent papers (Gyourko et al., 2005, Van Nieuwerburgh and Weil, 2006) have shown an increasing tendency to housing segregation by skill/income and have explained the increased dispersion in house prices and rents via sorting of individual and increasing wage (income) dispersion. As a consequence, the effect of immigration on house prices may be different across levels of the skill distribution.

3.2.1 Rent Effects in a Segmented Housing Market

We begin analyzing the impact of immigration on housing prices by education group. Table 4 reports the coefficients obtained by estimating rent regressions such as (2) separately for each education group.[5] All variables are defined as above, including the instrument, though now we only consider natives and immigrants in the specific education group when calculating the dependent and the explanatory variable and when constructing the imputed immigration. Column 1 reports the results

[5] We also performed a SUR estimation and a pooled estimation across schooling groups allowing separate elasticity by skills, which produced very similar results

for the high school dropout group, Column 2 for the high school graduate group and Column 3 for the college graduate group. The instruments are constructed by using the initial (1970) foreign population in a state by schooling and country of origin and equating its inter-Census growth to the overall growth of that education-nationality group in the U.S. due to immigration. In this case, our instrument captures the fact that a state starting out with many Mexicans would experience large supply-driven growth of the low education group among foreign-born, as most recent Mexican migration consisted of high school dropouts. On the other hand, a state hosting many Indians or Chinese in 1970 would experience a supply-driven increase of highly educated foreign-born as those countries experienced significant recent migration of college educated. We report the estimates of $\gamma_{\text{house price}}$ using OLS (and controlling for native population changes) or IV methods using housing price or rent per room as the dependent variable. The first four rows of Table 3 refer to the whole state sample and the last four to the sample including only metropolitan areas. First, notice that the instruments are better predictors of the change in low skill immigration than of the changes in other education groups (due to stronger co-location and lower state-to-state mobility of less educated immigrants). Second, for all estimates the impact of immigrants on prices/rents of housing for the group of less educated is small and insignificant, while the impact on prices of housing for medium and highly educated natives is positive and significant. The average elasticity of native high school dropout rents to immigrants in the same schooling group is 0.2 while for the other two groups it is in the 0.6-2.3 range. These results are consistent with previous findings of significant average effects of immigration on rents of native residents (Saiz, 2003) but small effects for the rents of the low income group (less educated) who are likely to compete with less educated immigrants for housing (Greulich et al 2003). Given the very large increase in less educated foreign-born who crowded the market for this type of housing and given that the out-migration of natives in this group has been very moderate and in line with average migration patterns ($\gamma_{\text{population}}$ for high school dropouts is estimated to be around -0.20 with a standard error of 0.3 using the IV method) such a low price response seems to suggest elastic house supply for this group. On the other hand, the effect on housing prices for more educated natives is quite large, implying that the supply of houses for those people might be constrained by the availability of desirable metropolitan locations. As our elasticities capture the long-run responses of prices, a plausible explanation could be that the land for better housing is a limited portion of cities, closer to the business districts and whose price is more sensitive to density (Gyourko et al, 2005), while the low quality housing is on the "marginal land" farther from the business district and whose price is less elastic to distance and hence less sensitive to a further expansion of the city to the outskirts.

3.2.2 Wage Effects by Education

It is well known that immigration should reduce the wages of the group of workers with low education in relative terms, given the large relative inflow of immigrants with like education. If there is imperfect substitutability between natives and immigrants, however, because of differential occupational and job choice, then the possibility of an overall positive effect on natives may emerge. Still some groups may be gaining more and othersmay suffer wage losses (Ottaviano and Peri, 2006b). Here we analyze how the average positive effect of immigrants (estimated in Table 1 and described above) is the combination of different effects of immigrants on native wages in each education group. Let us emphasize that we are estimating a reduced-form elasticity. The experiment does not consist of changing the supply of immigrants of one skill group, keeping all others constant. That exercise would identify a partial elasticity of wage and has been done in previous work (e.g. Borjas, 2006). Here we identify the total effect associated to a supply-driven change in immigration on wages of workers by education group. As a state that receives many unskilled immigrants in one group is likely to receive immigrants in the other education groups as well, the impact on the wage of a specific group is a mixture of the direct competition and indirect complementarity effect, and hence it need not be negative. Table 5 shows the IV estimates of the following three equations:

$$\frac{\Delta \overline{w}_{jt}^{Hk}}{\overline{w}_{jt}^{Hk}} = \alpha_t + \left(\gamma_{\text{wage}}\right)_k \left(\frac{\Delta F_{jt}^k}{F_{jt}^k + H_{jt}^k}\right) + \varepsilon_{kjt} \text{ for } k = Low,\ Medium,\ High \tag{4}$$

where k is an index capturing the schooling level of workers. We use $\left(\frac{\Delta \widehat{F}_{jt}^k}{\widehat{F}_{jt}^k + H_{jt}^k}\right)$ where immigrant stocks and flows are imputed as described in section 3.1.2 above and then used as an instrument for $\left(\frac{\Delta F_{jt}^k}{F_{jt}^k + H_{jt}^k}\right)$. We calculate average wages of each group (dependent variable) for either all individuals (first row) or on males only (second row). The estimated coefficients in Table 5 can be interpreted as follows: in response to an immigration shock over the 1970-2005 period, the wages of native dropouts experienced a negative notsignificant effect while the other two groups experienced positive significant effects. An increase in high school dropouts by ten percent due to immigration would be associated with a one percent decrease in the wages of native high school dropouts. A ten percent increase in the group of high school graduates implies a two percent increase in the wages of high school graduates and a ten percent increase college graduates implies a 5% increase in the wages of U.S.-born college graduates. The actual immigration flows, however, were not a homogeneous 10% in each skill group. In the period 1990-2005, for instance, total immigration caused a 21% increase in high school dropout employment, an 8.2% increase in high school graduate employment and an 11.3% increase in college graduate employment. The average increase of employment due to immigrants was 11.1%.[6] That would correspond to a -2.2% change in wages of the low skill group, a +1.6% change in the wages of the medium skill group and a +4.4% change in the wages of the high skill group. Averaging these effects by using the weights of each group in wages we obtain a positive average effect of 2.3%, confirming the positive aggregate effect on average wage of U.S.-born workers originating from imperfect substitutability between native- and foreign-born workers. The positive average effect estimated in the aggregate wage (Table 1) is due to a relative effect that penalizes the low education group (as it received an inflow of immigrants twice as large in percentage terms as the other two groups did) and rewards the other two groups. The estimates are not precise enough to rule out equal positive effects on the two groups of intermediate and high schooling levels. Interestingly, the above estimates are compatible with the effects of immigration on wages estimated in Ottaviano and Peri (2006b) and are similar to those obtained in a recent paper by Kugler and Yuksel (2006). The last paper uses the displacement effect generated by Hurricane Mitch in countries such as Honduras, Nicaragua, Guatemala and El Salvador as a "push"-shock for immigration to the U.S. The authors evaluate the effect on U.S. wages by skill, finding essentially no effects on low skill workers and positive and significant effects on the wages of U.S. workers with high school and college education. The elasticities estimated above provide a complete empirical assessment of the impact of immigration on wages and rents of workers of 3 different levels of education. The next section presents a model that can qualitatively and quantitatively explain the bulk of these effects.

[6] Proportions across skill groups were similar in previous decades.

4 The Model

We consider a small open economy with heterogeneous individuals who supply labor and consume a homogenous tradable good, differentiated local (nontradable) goods and housing. The heterogeneity of individuals, relevant for their production and consumption characteristics, has two dimensions. Individuals in the economy, whose total number is denoted by W, are differentiated both horizontally in terms of origin (home-born H and foreign-born F) and vertically in terms of skill (schooling) level (low L, medium M, high S). This gives rise to six categories that are summarized in the following table:

	Home	Foreign	Total
Low skill	L_H	L_F	L
Medium skill	M_H	M_F	M
High skill	S_H	S_F	S
Total	H	F	W

Each worker inelastically supplies one unit of labor to the production of the homogeneous tradable good Y and one unit of labor to the production of the varieties of the differentiated tradable good X. We think of Y as summarizing most of the goods and services in the U.S. while X is a composite basket of local services whose supply particularly benefits from 'ethno-cultural' diversity, such as restaurants, retail trade and entertainment. We will refer to X and Y as the 'ethnic' and 'non-ethnic' goods respectively. In the production of Y, efficiency units of labor may vary across skill level and place of origin. In the production of X, they vary only across place of origin. Specifically, we call $1/(\tau_k \tau_{kh})$, with $k \in \{L, M, S\}$ and $h \in \{H, F\}$, the efficiency units of a worker of ethnicity h with skill level k in non-ethnic production. Analogously, we call $1/\tau_{Xh}$ the efficiency units of a worker of ethnicity h in ethnic production ($1/\tau_{Xh}$ can be also interpreted as a quality parameter).

The economy also has an internal spatial dimension. It consists of a 'central business district' (henceforth, CBD) where individuals work and a linear 'residential district' (henceforth, RD) where they live outside of work. Apart from housing that is offered at the place of residence, all other market transactions take place in the CBD, which occupies no land and is therefore a zero-measure point in space. Each individual satisfies all her housing needs by occupying a fixed lot of land and commutes to the CBD to work and to buy goods. While the lot size is fixed and normalized to unity for all individuals, commuting cost vary across skills depending on different values attached to commuting time. In particular, a member of group $k \in \{L, M, S\}$ located at distance d from the CBD incurs a commuting cost $\theta_k (d)^{\psi_k}$ where $\theta_L < \theta_M < \theta_S$ and $\psi_L \leq \psi_M \leq \psi_S$ are used to capture the different values of commuting time across skill groups. Land belongs to a separate group of landlords who do not work and spend their rents in the city, though they do not demand any land for themselves. Landlords are differentiated in terms of origin with origin h owning a share ω_h of the city land so that $\omega_H + \omega_F = 1$. Land has no use other than for residential purposes.[7]

4.1 Preferences

Leaving the skill and origin indices implicit to alleviate notation whenever this does not generate confusion, each individual of skill k and origin h has utility:

$$U = y^{\alpha} x^{\beta} \tag{5}$$

with

$$x = \left[\left(\frac{x_H}{\tau_{XH}} \right)^{\frac{\gamma-1}{\gamma}} + \left(\frac{x_F}{\tau_{XF}} \right)^{\frac{\gamma-1}{\gamma}} \right]^{\frac{\gamma}{\gamma-1}} \tag{6}$$

where y is the individual's consumption of the non-ethnic good, x_H and x_F are the consumptions of the domestic (home) and foreign varieties of the ethnic good, $\gamma > 1$ is their elasticity of substitution, $\alpha > 0$ and $\beta > 0$ are the expenditure shares of the non-ethic and ethnic goods, respectively, with $\alpha + \beta = 1$.

[7]As we will see, in equilibrium this set-up support a pattern of residential location in which richer individuals dwell closer to the city center. Even though some U.S. central cities do have rich enclaves, typically high-income residents tend to live in the suburbs. Brueckner et al (1999) present an amenity-based theory of residential location in which the relative location of different income groups depends on the spatial pattern of amenities in a city. When, as in our case, the center has a strong amenity advantage over the suburbs, the rich are likely to live at central locations. When the center's amenity advantage is weak or negative, the rich are likely to live in the suburbs. Hence, their richer set-up ties location by income to a city's idiosyncratic characteristics. While providing an important insight, such extension is not crucial for our forecoming analysis as what matters from an empirical point of view will be the rent gradient from the location of amenities (our CBD) and not the monocentricity of the residential pattern per se.

4.2 Technology

All markets are perfectly competitive. The non-ethnic good is chosen as the numeraire; it is freely traded and its price p_Y is set in the external market. This good is supplied according to the following technology:

$$Y = AC$$

where A is a total factor productivity term and C is a composite labor input that combines all skill levels and worker origins:

$$C = \left[\left(\frac{C_L}{\tau_L} \right)^{\frac{\delta-1}{\delta}} + \left(\frac{C_M}{\tau_M} \right)^{\frac{\delta-1}{\delta}} + \left(\frac{C_S}{\tau_S} \right)^{\frac{\delta-1}{\delta}} \right]^{\frac{\delta}{\delta-1}} \tag{7}$$

where each composite input C_k $(k = L, M, S)$ is itself a CES combination of home-born and foreign-born workers of education k:

$$C_k = \left[\left(\frac{k_H}{\tau_{kH}} \right)^{\frac{\sigma k-1}{\sigma_k}} + \left(\frac{k_F}{\tau_{kF}} \right)^{\frac{\sigma_k-1}{\sigma_k}} \right]^{\frac{\sigma_k}{\sigma_k-1}} \tag{8}$$

The parameter $\delta > 1$ is the elasticity of substitution between workers of different skills while $\sigma_k > \delta > 1$ is the elasticity of substitution between workers of home and foreign origins sharing the same level of skill k. The underlying idea is that workers are imperfectly substitutable not only *between* skill groups but also *within* skill groups because different origins imply differences in specific productive abilities (i.e., due to different sets of skills in each group from cultural or selection reasons). The imperfect substitutability across skill (education) groups is documented in the labor literature (Katz and Murphy, 1992, Hamermesh, 1993, Ciccone and Peri, 2005) and the imperfect substitutability between native- and foreign-born is documented in the immigration literature (Ottaviano and Peri, 2006b, Peri and Sparber, 2007).

The ethnic good is non-tradable outside of the small open economy. The production of ethnic variety h requires τ_{Xh} units of labor h per unit of output. Hence total supply per variety is given by:

$$X_h = h/\tau_{Xh} = (L_h + M_h + S_h)/\tau_{Xh} \tag{9}$$

4.3 Equilibrium

In characterizing the equilibrium of the model we bring the labor market for production in sector Y to the forefront.

4.3.1 Labor supply

Let us call z_{kh} the individual income net of urban costs (i.e., rental plus commuting costs), p_{Xh} the wage that a worker of origin h earns in the production of ethnic good X so that $\tau_{Xh}p_{Xh}$ is the price of ethnic variety h, and P_X the exact price index of the ethnic composite good:

$$P_X = \left[\phi_{XH}\left(p_{XH}\right)^{1-\gamma} + \phi_{XF}\left(p_{XF}\right)^{1-\gamma}\right]^{\frac{1}{1-\gamma}} \tag{10}$$

where $\phi_{Xh} \equiv \left(\tau_{Xh}\right)^{1-\gamma}$. Then maximization of (5) subject to the budget constraint $p_y y_{kh} + P_X x_{kh} = z_{kh}$ gives demands:[8]

$$p_y y_{kh} = \alpha z_{kh},\ P_X x_{kh} = \beta z_{kh},\ x_{kh} = \phi_{XH}\left(p_{Xh}\right)^{-\gamma}\left(P_X\right)^{\gamma-1}\beta z_{kh} \tag{11}$$

Indirect utility is therefore equal to:

$$V_{kh} = \alpha^{\alpha}\beta^{\beta}\frac{z_{kh}}{\left(p_Y\right)^{\alpha}\left(P_X\right)^{\beta}} \tag{12}$$

where V_{kh} is the utility level for workers of skill k and ethnicity h which isfixed to some exogenous level determined by the average utility that a worker of type k and ethnicity h would enjoy if she migrated elsewhere.

In the RD workers are symmetrically located around the CBD, i.e. $(S + M + L)/2$ of them on each side of the CBD. In equilibrium workers have to be indifferent about their residential distance

[8] We have specified the subscript kh for the variables x and y to make clear that the levels of consumption of the two goods and the indirect utility of individuals depends on their income z_{kh} that varies with skill and ethnicity.

from the CBD with workers who value commuting time more located closer to the CBD (Fujita and Thisse, 2002). Given our assumptions, this implies a segregated equilibrium in which skills endogenously separate in six quarters (three on each side of the CBD) with higher skills residing closer to the CBD.

Since the lot size is normalized to one, the border between S and M is at distance $S/2$ from the CBD, the border between M and L is at distance $(S+M)/2$, the end of the residential district is at distance $(S+M+L)/2$. Accordingly, the most remote L resident is located at that distance and incurs a commuting cost equal to $\theta_L\left[(S+M+L)/2\right]^{\psi_L}$. Since land has no alternative use other than for residential purposes, land rent is nil for that resident $r_L\left((S+M+L)/2\right)=0$. If located at generic distance $d\in((S+M)/2,(S+M+L)/2)$, the L-skill worker would instead incur urban costs consisting of land rent $r_L(d)$ and commuting cost $\theta_L\left(d\right)^{\psi_L}$. Indifference then requires land rents to offset any commuting cost differential $r_L(d)=\theta_L\left[(S+M+L)/2\right]^{\psi_L}-\theta_L\left(d\right)^{\psi_L}$. Accordingly, wherever they are located in their quarter, all L workers face the same urban costs:

$$g_L=r_L(d)+\theta_L\left(d\right)^{\psi L}=\theta_L\left[(S+M+L)/2\right]^{\psi_L} \tag{13}$$

Analogously, M workers have to be indifferent between locating at distance $(S+M)/2$ where they pay the marginal rent $r_M((S+M)/2)=r_L((S+M)/2)$ or at any other distance $d\in(S/2,(S+M)/2)$ in their quarter. This requires the land rent differential to offset any commuting cost differential $r_M(d)-r_L((S+M)/2)=\theta_M\left[(S+M)/2\right]^{\psi_M}-\theta_M\left(d\right)^{\psi_M}$. Hence, using (13), we obtain

$$g_M=r_M(d)+\theta_M\left(d\right)^{\psi_M}=g_L+\theta_M\left[(S+M)/2\right]^{\psi_M}-\theta_L\left[(S+M)/2\right]^{\psi_L} \tag{14}$$

Finally, when applied to the S group, a similar procedure allows us to write:

$$g_S=g_M+\theta_S\left(S/2\right)^{\psi_S}-\theta_M\left(S/2\right)^{\psi_M} \tag{15}$$

Hence, the net income of a worker of skill k and origin h amounts to:

$$z_{kh}=w_{kh}+p_{Xh}-g_k \tag{16}$$

where w_{kh} is the wage from non-ethnic production and p_{Xh} is the income from ethnic production.

Given the individual rents $r_k(d)$ implied by (13), (14) and (15), in equilibrium total land rents paid by the three skill groups add up to the following:

$$\begin{array}{c} R_L = 2\int_{(S+M)/2}^{(S+M+L)/2} r_L(d)\mathrm{d}d = L\, g_L - \frac{2\theta_L}{\psi_L+1}\left[\left(\frac{S+M+L}{2}\right)^{\psi_L+1} - \left(\frac{S+M}{2}\right)^{\psi_L+1}\right] \\ R_M = 2\int_{S/2}^{(S+M)/2} r_M(d)\mathrm{d}d = M\, g_M - \frac{2\theta_M}{\psi_M+1}\left[\left(\frac{S+M}{2}\right)^{\psi_M+1} - \left(\frac{S}{2}\right)^{\psi_M+1}\right] \\ R_S = 2\int_0^{S/2} r_S(d)\ d = S\, g_S - \frac{2\theta_S}{\psi_S+1}\left(\frac{S}{2}\right)^{\psi_S+1} \end{array} \tag{17}$$

with home- and foreign-born landlords in each skill group receiving shares ω_H and $1-\omega_H$ respectively. Aggregate income is therefore equal to:

$$Z = \sum_{k,h} z_{kh}k_h + \sum_k R_h \tag{18}$$

Given supply (9) and demand (11), market clearing for the ethnic good requires:

$$X_h = h = \phi_{Xh}\left(p_{Xh}\right)^{-\gamma}\left(P_X\right)^{\gamma-1}\beta Z \tag{19}$$

Together with (12), (13), (14), (15), (17) and (16), (19) gives us enough equations to characterize the equilibrium relations between w_{kh} and k_h; that is, the non-ethnic labor supplies. Intuition is served by using (16) together with (12) to write non-ethnic inverse labor supply as:

$$w_{kh} = \widetilde{V}_{kh}\left(P_X\right)^{\beta} - p_{Xh} + g_k \tag{20}$$

with $\widetilde{V}_{kh} \equiv V_{kh}\alpha^{-\alpha}\beta^{-\beta}\left(p_Y\right)^{\alpha}$ where $p_Y = 1$ by our choice of numeraire. Condition (20) shows that the local supply of workers k_h increases with their wage w_{kh} and is shifted by changes in the outside option $\widetilde{V}_{kh}$, the price index of non-tradables P_X, ethnic earnings p_{Xh} and urban costs g_k. When the outside option, the non-tradable prices and urban costs increase and the earnings from ethnic services decreases, a given local supply of workers k_h can only be maintained provided they are offered higher non-ethnic wages.

4.3.2 Labor Demand

Turning to firms in the non-ethnic sector, profit maximization requires:

$$p_Y A = P_C \tag{21}$$

where:

$$P_C = \left(\phi_L P_L^{1-\delta} + \phi_M P_M^{1-\delta} + \phi_S P_S^{1-\delta}\right)^{\frac{1}{1-\delta}} = \left(\sum_k \phi_k P_k^{1-\delta}\right)^{\frac{1}{1-\delta}} \tag{22}$$

$$P_k = \left[\phi_{kH}\left(w_{kH}\right)^{1-\sigma_k} + \phi_{kF}\left(w_{kF}\right)^{1-\sigma_k}\right]^{\frac{1}{1-\sigma_k}} = \left[\sum_h \phi_{kh}\left(w_{kh}\right)^{1-\sigma_k}\right]^{\frac{1}{1-\sigma_k}} \tag{23}$$

are the price indices associated with the quantity indices C and C_k/τ_k, respectively, σ_k is the ethnic elasticity of substitution within skill level k while $\phi_k \equiv (\tau_k)^{1-\delta}$ and $\phi_{kh} \equiv (\tau_{kh})^{1-\sigma_k}$ capture productivity differences across groups.

The exact aggregation properties of the above quantity and price indices ensure that $\sum_k P_k C_k = P_C C$ and $\sum_h w_{kh} k_h = P_k C_k$. Exploiting these properties, profit maximization also implies:

$$P_k C_k = \phi_k \left(\frac{P_k}{P_C}\right)^{1-\delta} P_C C \tag{24}$$

$$w_{kh} k_h = \phi_{kh} \left(\frac{w_{kh}}{P_k}\right)^{1-\sigma_k} P_k C_k \tag{25}$$

These expressions can be easily manipulated to produce, respectively:

$$\phi_k \left(\frac{P_k}{P_C}\right)^{1-\delta} = \phi_k^{\frac{1}{\delta}} \left(\frac{C_k}{C}\right)^{\frac{\delta-1}{\delta}} = \frac{\phi_k^{\frac{1}{\delta}} C_k^{\frac{\delta-1}{\delta}}}{\phi_L^{\frac{1}{\delta}} C_L^{\frac{\delta-1}{\delta}} + \phi_M^{\frac{1}{\delta}} C_M^{\frac{\delta-1}{\delta}} + \phi_S^{\frac{1}{\delta}} C_S^{\frac{\delta-1}{\delta}}} \tag{26}$$

$$\phi_{kh} \left(\frac{w_{kh}}{P_k}\right)^{1-\sigma_k} = \phi_{kh}^{\frac{1}{\sigma_k}} \left(\frac{k_h}{C_k}\right)^{\frac{\sigma_k-1}{\sigma_k}} = \frac{\phi_{kh}^{\frac{1}{\sigma_k}} k_h^{\frac{\sigma_k-1}{\sigma_k}}}{\phi_{kH}^{\frac{1}{\sigma_k}} k_H^{\frac{\sigma_k-1}{\sigma_k}} + \phi_{kF}^{\frac{1}{\sigma_k}} k_F^{\frac{\sigma_k-1}{\sigma_k}}} \tag{27}$$

Demand for labor of skill k and origin h can be derived by merging (21), (24), (25), (26) and (27). This gives:

$$w_{kh} = p_Y A \cdot C^{\frac{1}{\delta}} \cdot \phi_k^{\frac{1}{\delta}} \left(C_k\right)^{-\frac{\sigma_k-\delta}{\delta\sigma_k}} \cdot \phi_{kh}^{\frac{1}{\sigma_k}} \left(k_h\right)^{-\frac{1}{\sigma_k}} \tag{28}$$

which is a labor demand schedule showing the wage w_{kh} as a downward sloping function of employment k_h. Moreover, for given k_h firms are willing to pay higher wages if C grows or C_k falls. In the former case, a proportionate increase of employment across skills raises all groups' productivity due to complementarities in production. In the latter, a proportionate increase of the employed of a certain skill across origins reduces the productivity of workers of that skill as more workers of that skill are combined with a given stock of workers of different skill (since $\delta < \sigma_k$).

5 From Theory to Numbers: Calibration, Validation and Simulation

When putting the demand (28) and the supply (20) of non-ethnic labor together, our model yields no general prediction on the impact of immigration on rents and wages of home-born workers. The reason for this is the presence of several countervailing effects on both the supply and demand sides. Immigration alters non-tradable prices, urban costs and earnings from ethnic services; it affects the balance between the complementarities and substitutability of workers in ethnic and non-ethnic production. We therefore ask a more specific question: *What are the implied effects of the observed immigration to an average U.S. local economy when our model is calibrated to average U.S. data and uses estimated parameter values?*

In so doing we start by calibrating the model to the conditions in the U.S. in the year 1990, assuming that at that time the local economy was in equilibrium. We then take the immigration flows of foreign-born during the period 1990-2005 as an exogenous shock and see how the calibrated model reacts. In the simulations we focus on the 'long-run' effects of immigration on U.S.-born residents, namely the impact on wages and rents of native workers of different education levels once they have adjusted by moving in or out of the local economy to maintain their pre-immigration utility.

Formally, we proceed as follows. The substitution of (10) and (13)-(18) in (19), (28) and (20) gives us a system of 14 equations. We take the values of k_h's that describe the distribution of natives and foreign-born by skill among U.S. metropolitan workers as initially given and equal to their value in 1990. Standardizing total employment to 1, the values we use are as follows: $L_H = 0.10$, $M_H = 0.54$,

$S_H = 0.25$ so that $H = 0.89$, and $L_F = 0.035$, $M_F = 0.044$, $S_F = 0.027$ so that $F = 0.106$. We then impose that for each skill group the share of urban costs in gross income mirrors its observed value λ, that is:

$$k\, g_k = \lambda \sum_h (w_{kh} + p_{Xh})\, k_h$$

The Consumer Expenditure Survey, available from Bureau of Labor Statistics (2005) allows us to calculate the share of income spent on housing services plus local transportation by the average U.S. family and we take this as estimate of the parameter λ, capturing the share of urban costs in a family's income.[9] The conditions above give us three additional equations and bring the number of equations to 17. We simultaneously solve this system to find the 17 endogenous variables (six w_{kh},for $k = S, M, L$ and $h = H, F$, two p_{Xh}, for $h = H, F$,six V_{kh} for $k = S, M, L$ and $h = H, F$ and three θ_k,for $k = S, M, L$). By so doing we get the initial values of w_{kh} and p_{Xh} that we use to construct real wages and real rents and the calibrated values for V_{kh} (indirect utility for each group) and θ_k (unit cost of commuting for each group) that we maintain henceforth.

Once we calculate the initial equilibrium relative to year 1990 as described above, we let the supply of foreign-born of each skill increase in percentage terms to mirror the inflow of foreign-born as experienced by the average U.S. state over the period 1990-2005. This inflow is described by the following changes in foreign-born employment in the average U.S. state: $\Delta F/(F + H) = 0.11$, $\Delta L_F/(L_F + L_H) = 0.244$, $\Delta M_F/(M_F + M_H) = 0.082$, $\Delta S_F/(S_F + S_H) = 0.116$.[10] In the long-run native workers can move in response to immigrant inflows. Therefore in the new equilibrium the k'_H are determined endogenously using the corresponding supply function. This gives us a system of 11 equations (two price equations, 19, six labor demand equations, 28, and three labor supply equations, 20, for native workers only) that can be solved in the 11 unknowns (six w_{kh}'s for $k = S, M, L$ and $h = H, F$, two p_{Xh}'s for $h = H, F$, and three k_H's for $k = S, M, L$). In order to translate the effect of immigration on the price of land into the income of foreign and native land owners we assume that the land of each type (skill group) is owned by U.S.- and foreign-born individuals in the same proportion as house ownership shares in the group. The data from Census 1990 allows us to calculate

[9] The share of housing costs as of year 2000 was in the range of 0.15-0.20 and the share of transport costs was 0.10-0.20. We use a value of 0.3 as a reasonable approximation of the sum of those two, measuring the share of family expenditure in urban costs that account for housing and commuting.

[10] These numbers refer to changes in the metropolitan population (i.e. employment in urban areas) only and fit the logic of the theoretical model.

the ownership rate by education group for natives and immigrants. Hence, as the ownership rate in each group is higher among natives than among immigrants (see Figure 4) the share of land in each group assigned to natives is larger than their fraction in the population. This assumption implies that the ownership of rental houses in each skill group mirrors the overall ownership of houses in that group. Low skilled natives and foreign-born landlords own houses in the low-skilled district and rent them out to low-skilled native and immigrant workers. Following these assumptions as of 1990, 11% of the the stock of existing houses for low skilled belonged to foreign-born (and 89% to natives), 5% of medium skill-houses belonged to foreign born (and 95% to natives) and 8% of the high-skilled houses belonged to foreign-owned and the remaining 92% to natives.

The parameters of the utility function are obtained using the property of the Cobb-Douglas functional form which implies that the share of household expenditures on non-tradable services is equal to β. The Consumer Expenditure Survey, available at Bureau of Labor Statistics (2005) allows us to calculate the share of income spent by the average U.S. family on "food outside the house" and "entertainment". We interpret those two sectors as those local (nontradeable) services in which ethnic diversity matter most. Hence we can obtain an estimate of β from their share in expenditures, which ranges from 0.15 to 0.20 for the average U.S. household. We choose $\beta = 0.15$ as a base-value.[11] The parameter λ that captures the share of household expenditures on residential costs (housing + commuting) is chosen to be 0.30 as described above. The estimates of the elasticity of substitution between home and foreign-born workers in production of Y that we use are in the range of the estimates obtained in Ottaviano and Peri (2006) for the U.S. and in Peri (2007) for the state of California. We use values of 5 and 6 (for the aggregate U.S. the Ottaviano and Peri, 2006, estimates can be as high as 10 while for California that parameter is usually 5 or smaller)[12] considering a scenario with $\sigma_k = 5$ for each education group, one with $\sigma_k = 6$ for each education group and one where we allowed closer substitutability in the group of less educated workers $\sigma_L = 10$. As for the substitutability between the non-tradable services provided by the U.S. and foreign born, we assume that it would be within the range of the substitutability of natives and foreign-born in production of

[11] We checked the robustness of results for $\beta = 0.2$. The variables of interest are not sensitive to this parameter. Simulations are available upon request.

[12] We also used our state panel data, three education groups and the imputed immigration instrumental variable to calculate the relative wage elasticity of natives and immigrants. We estimate values for $(1/\sigma)$ in the vicinity of 0.15, significantly different from 0. This implies values of σ in the vicinity of 6 and significantly imperfect substitutability between natives and foreign-born workers of same education level.

Y. Hence we use the value of 7 (we also used values of 6 and 8 with very similar results). Finally, the elasticity of transport costs to distance from the central business district is taken from the literature. There are several studies estimating the rent gradient of residential houses as a function of their distance to the central city location. Those studies identify a smaller and less precisely estimated elasticity of housing price to distance from the center of the region, as distance increases. In our model the group of high and medium educated individuals are closer to the central business district so that for them we use the estimates found in the recent study by Osland et al. (2007), in line with previous studies and implying $\psi_S = 0.50$ and $\psi_M = 0.50$. For less educated individuals, farther from the center we use a range of values for their elasticity of rents to distance from the center. Those values range from low, $\psi_S = 0.05$, following the notion that farther from the center distance matters less for rents (as argued in Osland et al., 2007) to large, $\psi_S = 0.6$. As we will see below, using very low elasticities for ψ_S implies that the model does not match the effect of immigration on rents of less educated workers very well. We prefer a relatively high elasticity with the downside of slightly over-predicting the long-run effect on wages of less educated workers.

In the production of the traded good (7) we assume an elasticity between skill groups of $\delta = 2$ which is consistent with most of the literature.[13] The relative efficiencies of the factors $(1/\tau_k)$ are chosen to match the average U.S. wage premia in 1990 between education groups, given their relative supplies and the elasticity of substitution δ. Standardizing the efficiency of low skilled native workers workers $(\tau_L = 1)$ we can obtain the other values by using the formula: $\ln\left(\frac{\tau_L}{\tau_k}\right) = \frac{\delta}{\delta-1}\left[\ln\left(\frac{w_k}{w_L}\right) + \frac{1}{\delta}\ln\left(\frac{E_k}{E_L}\right)\right]$, where w_k is the average national wage for native workers of education k, and E_k is the total supply of native workers of education group k. The relative efficiency of foreign- to U.S.-born both in any skill group and in the production of local services has been set equal to 1.

5.1 Average Effects

Table 6 and 7 summarize the results of the simulations over the range of parameter values described above. Table 6 reports the effects of immigration on average variables: wages, rents, employment and housing income, obtained by aggregating the three education groups. Table 7 reports the effects on wages, rents and housing income relative to each skill group. The upper part of Table 6 shows the

[13] E.g. Katz and Murphy (1992), Hamermesh (1993), Angrist (1995), Ciccone and Peri (2005).

choices for the key parameters, and the differences across columns reflect the elasticity of substitution between natives and immigrants in the production of Y, and the elasticity of rents to distance for the group of less educated workers. The first parameter regulates the strength of the complementarity effects of immigrants on natives (the smaller the elasticity the larger the effect) and the second regulates the sensitivity of housing prices to distance for less educated workers. The rest of Table 6 is organized as follows. The three rows labelled "Long-Run Elasticity" present the simulated long-run elasticity of average wage, rents and employment for natives. The following section labelled "Long-Run Percentage Effects of Immigration" translates the elasticities into predicted percentage effects given the actual immigration flow between 1990 and 2005. The last column of Table 6 is labelled "Empirical Estimates". In the first ten rows it reports the parameter estimates and their sources, while in the following rows, corresponding to each variable (wages, house rents, employment) it shows the elasticity estimates from Section 3 above. A comparison of the simulated values (column 1 to 4) with the range of estimated values (reported in the last column) allows us to assess how successful the model is at quantitatively matching the effects identified by our empirical analysis. Considering Column (I), that uses an elasticity of substitution of 5 between native and foreign-born and $\psi_L = 0.6$, the model predicts that a long-run inflow of immigrant workers equal to 1% of employment increases wages of natives by 0.34%, on average. This positive effect is due to complementarities in production. At the same time, that inflow of immigrants produces and increase of housing prices equal to 0.68% because it increases competition for desirable housing (near the CBD) and indirectly for land at any distance from the CBD. These wage and rent effects (in the long run) accrue with the following dynamics: as immigrants flow into the state, the average productivity of workers increases and house prices increase as well. Given our model, the short-run impact on housing costs and wages produces a small increase in the average real wage of natives. If workers are free to move and assuming that they were in equilibrium in 1990 they will flow into the state to take advantage of higher consumption wages. Immigration causes an increase of native employment due to inflow from other states by 0.36%. This inflow shifts up land and house prices at any given distance from the CBD and therefore pushes out the boundary of the region. The simulated effect of immigration on the rents plotted against the distance from the CBD is reported in Figure 5. The lower (red) line represents the rent level before the immigration shock and the kinks represent the boundaries between different quarters inhabited by people of different skills. The upper line is the rent after immigration. The increased value of central land shifts the rent for all groups, but as we move away from the business district the effect is smaller. Hence the new equilibrium is reached with immigration of natives and expansion of the boundaries of the city area. While real wages for each group return to the pre-immigration level, as a consequence of natives arbitraging away real wage differences with the rest of the country, the real income of natives (i.e., worker wages plus house rental income to landlords) increases as land is now worth more. Housing income accrues to landlords who are primarily natives and this accounts for their higher income.

Three things must be noted about the simulation results. First, the effect on the cost of housing affects natives through two channels: on theone hand, it increases the cost of living, and on the other, it increases rent paid to house owners (i.e., landlords). While the first effect hurts the real income of natives, the second helps it as natives own houses in much larger proportions than foreign-born. The idea of separate landlords in the model helps us to separate these two effects on native residents. As immigrant destination cities become more expensive due to higher rents, workers of all skills are hurt, though house owners of all skill levels enjoy an offsetting positive income effect. The second thing to notice is that the change in wages and house prices on impact (not reported) result in a positive effect on real wages that attracts (a small fraction of) additional natives to the immigrant receiving area. The third observation is that the housing income of natives in real terms increases after the adjustment (by 0.67%). This fact coupled with the zero-change in the real wage of natives due to their ability to move, implies that the change in total income to natives in the locality is positive, and ultimately captures the increased value of land because of higher population and higher production. Relative to 1990-2005 immigration, we see that the long-run average increase in native wage due to immigration is 3.8%, the increase in rent (and owner income) for the average house is 7.6% and the increase in employment/population of the city is almost 4%. Notice that the simulations of Column (I) are within the range of estimated elasticities (and percentage effects) in the last column. Our simple model explains why immigration increases average wages and rents in the long-run and produces very reasonable average effects, compatible with our estimates.

The results reported in Column (II) are obtained from a simulation of the economy assuming that the σ elasticities equal 6 rather than 5. The main changes implied by this higher substitutability between native- and foreign-born is a smaller effect on wages and house value in the long-run, accompanied by a smaller inflow of natives to the state. On impact (not reported), average real wages of natives increase slightly, so only a small group moves into the state. In the long-run, real income from rents to native landlords increases by 6.45%. Column (III) restores the value $\sigma = 5$ and decreases the elasticity of rents to distance for the less educated group to 0.4. This reduces the response of rents and wages in equilibrium to the immigration inflow, while inducing the higher inflows of natives (4.67% of employment) to re-establish equilibrium. Such variation does not seem to move the elasticities in the right direction as the response of wages and rents is now relatively small while the native migration response is relatively large. Finally, specification (IV) shows that reducing the distance-elasticity of rent for less educated to 0.05 and increasing their elasticity of substitution with natives to 10, the average effect on house prices and rent is excessively small and the effect on migration becomes quite large. While the differences are not too large in order of magnitude, the simulations seem to suggest that the parameter choices in Column (I) best fit the estimated elasticities.

Comparing the simulated elasticities of Column (I) to the estimated ones we can say that our model does a good job in explaining the effect of immigration on average wages and average rents: the simulated elasticities for both variables are in the range of the estimated ones. Even considering the highest values in the range, the simulated model explains 60-80% of those effects. The "complementarity" story explains the bulk of the average wage and rent effects estimated in section 3.1 . Finally, the simulations produce migration responses of natives that are positive but not too large. They are closer to our OLS estimates than to our IV estimates but are certainly compatible with both once we account for the standard errors.

5.2 Effects by Skill

Table 7 presents the effects of immigration on the wages, rents and real rent income of natives in different skill groups. We report the long-run elasticity of (nominal) wages and rents to immigration and the percentage effect on real rental income for landlords. The first six rows present elasticities that can be directly compared to those estimated in section 3. As in Table 6, for ease of comparison the range of empirical estimates is reported in the last column of the table. The specifications (I) through (IV) mirror those of Table 6 in that they use the same parameter combinations in the simulations.

Column (I) uses the specification that performed best in matching the average effects. All in all, this is also the best specification to account for the elasticity of education-specific wages and rents, with the exception of the less educated group. Simulation (I) yields elasticities of wages and rents for the group with intermediate education (M) that are within the estimated range, for the group of highly educated (S) the estimates are very close to the lower boundary of the range, and for the group of less educated (L) they are too large. The model predicts an excessively positive reaction of wages and rents of less educated natives to immigration. While increasing the substitutability of workers (specifications II and IV) and decreasing the sensitivity of rents to distance (specifications III and IV) reduces the wage effect to be close to the estimated range (essentially close to 0) it also increases the rent response in the wrong direction (large increase in rent of less educated). The estimated small response of the rent of less educated workers to immigration, in spite of large inflows of immigrants in the group, may be due to worsening housing quality consumed by natives, an increase in the supply of houses at a given distance to the center or to other factors not captured in the model.

Finally, the last three rows of Table 7 show that in the long run, native landlords in any skill group experienced a significant increase in their total real income from rents. As workers arbitrage away the effect of immigration on real wages in the long-run by moving, the positive effect on housing income is the only remaining long-run net effect in the city. While the simulated housing income effect is likely to be too large for the group of less educated (as the simulations overstate the rent change relative to the estimates), for the other two groups those increases in real income are quite close to the actual ones. Hence house ownership is another channel through which natives with any level of education may benefit from immigration. The simulation says that if the average less educated native worker is also the average owner of dwellings rented by immigrants in that group (as, for instance, she sublets to them) then she will have a substantial positive effect on her income through the supplemental rent income received. To the extent that less educated older natives own dwellings in parts of cities where the increased demand from immigrants has contributed to making rents quite high (such as San Francisco or New York, for instance), this is certainly a relevant source of income and transfer from immigrants to natives that has been unaccounted for to date.

5.3 Counterfactuals Scenarios

Overall Tables 6 and 7 show that our simple model matches remarkably well some key moments in the data that are not used for calibration. This validation suggests that the model can be used as a useful tool for policy analysis when the aim is the evaluation of the impacts of alternative immigration scenarios on U.S. wages and rents. As an illustration, in Table 8 we report the results for several counterfactual scenarios. In the first (column II), we use our calibrated model to assess the effects of immigration on the average U.S. state removing the undocumented from the pool of immigrants. In this scenario we make the extreme assumption that the undocumented immigrants over the period 1990-2005 were concentrated in the group of workers with no high school diploma. This is certainly an overstatement as Passel (2005) reports that between 25 and 35% of unauthorized immigrants as of 2005 had a high school degree or more. Our assumption implies that, not allowing the undocumented, the inflow of less educated is reduced to roughly one third of the actual one while the inflows of medium and high skill migrants are not altered. In the second type of scenarios (columns III-VII), we ask what would have happened to the average U.S. state if this had alternatively experienced the same immigration patterns as some key states at the center of the immigration debate. These are California (column III), New Jersey (column V), New Mexico (column VII), New York (column VI) and Texas (column IV).[14] For ease of comparison, Column (I) reports the results for the actual average immigration flows from the benchmark columns I of Tables 6 and 7.

With respect to the actual average inflows, the California scenario is biased towards high skill immigrants. The "documented only", the New York and the New Jersey ones even more so. All entail a smaller overall shock with respect to California, especially in the case of New York. In general in the scenarios with larger immigration of highly educated the outcomes are a weaker positive reaction of average native wages, but a larger positive effect on wages of less educated and a stronger positive reaction of average natives rents. As the housing market among highly educated drives the average effect, inflow of highly educated workers has stronger positive effect on average rents The decomposition of the wage and rent effects by skill groups shows that competition in the housing market gets tougher in the states with highly educated immigrants (scenario V and VI) and the percentage increase in rents of the two more educated groups is much higher than for less educated

[14] As before, in all scenarios we consider the changes in the metropolitan population only.

ones. At the same time nominal wages of less educated increase by more than for more educated triggering inflow of less educated natives. The states that receive more highly educated immigrants tend to end up, for complementariety reasons with more less educated natives as well. Incidentally this differential attraction of natives by skill group is the reason that the effect on average wage of natives in those states that received more highly educated immigrants is smaller than the wage effect for each skill group (composition shifted towards more educated). To the contrary for those states receiving less educated immigrants the average wage effect for natives is larger than for each individual group (composition shifted towards more educated). In the California scenario vis-a-vis New York or New Jersey, a lot of low-skill immigrants arrived and this explains why the corresponding results are milder than in the New York and the New Jersey scenarios. In this respect, the "documented only", (II) is an intermediate scenario. Turning to New Mexico, the state with the strongest immigration of less educated, in relative terms, we observe impact on average wages and rents opposite to the New Jersey one. The large inflow of less educated induced immigration mainly of highly educated natives (for complementariety reasons) and still the effects on average rents and rents of the two most educated groups were milder than in scenario I. The large positive average wage effect is the combination of positive complementariety effects and attraction of highly educated natives. Finally, the Texas scenario is roughly a scaled-up version of the actual one. As it retains a fairly similar distribution across skill groups, the corresponding results are the closest to those in column I.

All in all, the simulated scenarios stress the crucial role played by the matching between native and immigrant skills in terms of both the average effect and their distribution across skill groups. They also emphasize the important effects on rents of highly educated immigration: in some states (such as California and New-York) the simulated values (close to 10% increases) suggest that immigration of highly skilled could be considered an important cause of the housing boom of the nineties. They also reveal the importance of a general equilibrium approach to evaluating the effects of immigration as the associated shocks are absorbed not only in the wages of the natives but also in their rents and employment levels.

6 Conclusions

This paper revisits the so called "area analysis" approach to immigration in a number of ways. First, it extends the focus of analysis from the labor market (only) to the housing market and the migratory response of natives. Second, it proposes a general equilibrium integrated approach to understanding the effects of immigrants on wages, prices and rents for the average individual as well as for individuals in each skill group. Third, it allows for a more accurate and complete welfare analysis of immigration on U.S. natives. Usually only the simple wage effects are considered while this paper, by defining real wages, prices and housing income, accounts for the combined local price effects and rent effects on the income of native individuals. Fourth, we combine a regression approach that empirically identifies a set of elasticities that characterize the impact of immigration on wages and rents and a simulation approach with a simple model of rational native agents responding to changes in skill supplies due to immigration. We analyze the predicted variations of wages and prices between equilibria before and after immigration, and the results that we obtain are novel primarily in two respects. On one hand, we document empirically and explain theoretically the existence of a strong positive *average* correlation between immigration and wages/housing prices for natives. On the other, we analyze the effects on wages and rents for native workers of differing education levels. Specifically, the group of low skilled workers experiences a small negative wage effect from immigrants and a small positive rent effect. For those less skilled workers who own their house the positive house value effect more than compensates for their decreasing nominal wages. For more skilled workers, immigration produces a positive effect on their wages and a large positive effect on the price of their house. As most native workers in this group own their house, the long-run effect of immigration for this group's real income is strongly positive. Our results are long-run effects since native workers are free to arbitrage away real wage differentials by moving. In this case, the most relevant long-run effect accruing to the local open economy is in the form of higher rents and higher house values. Finally we use our model to evaluate the effect on wages and rents of some counterfactual scenarios.

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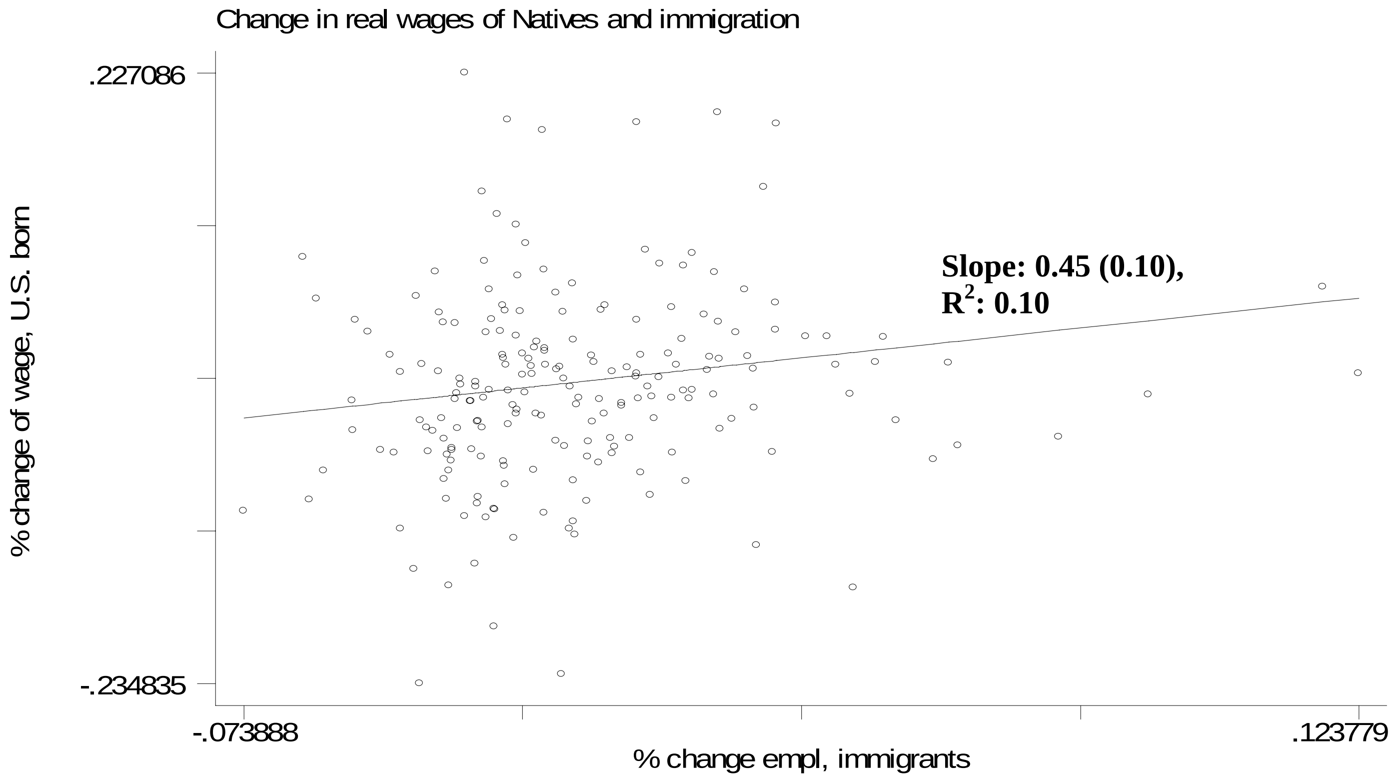
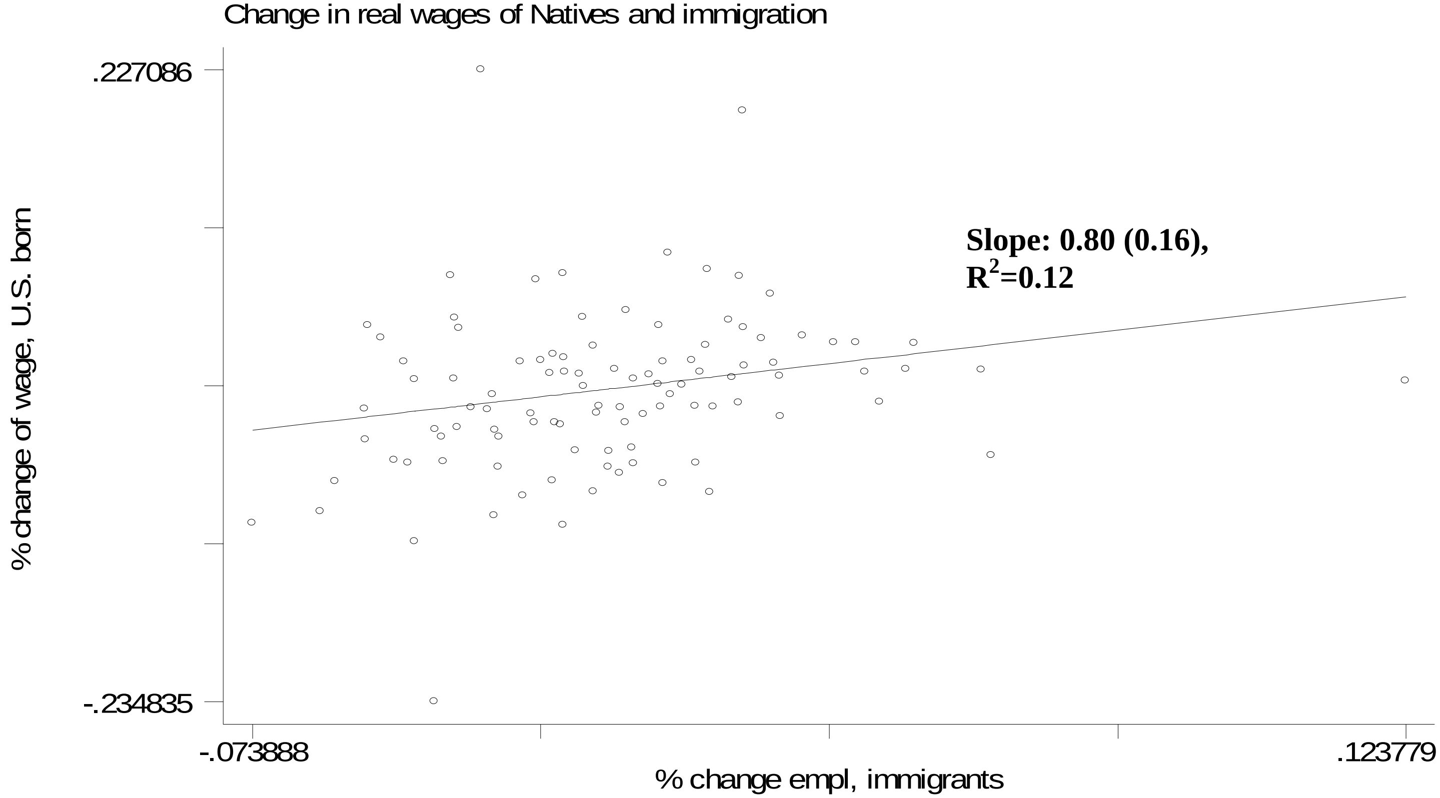
Figures and Tables

Figure 1
Immigration and Changes in the Average Wage of U.S. Natives
U.S. states, decade changes 1970-2000 and 2000-2005.



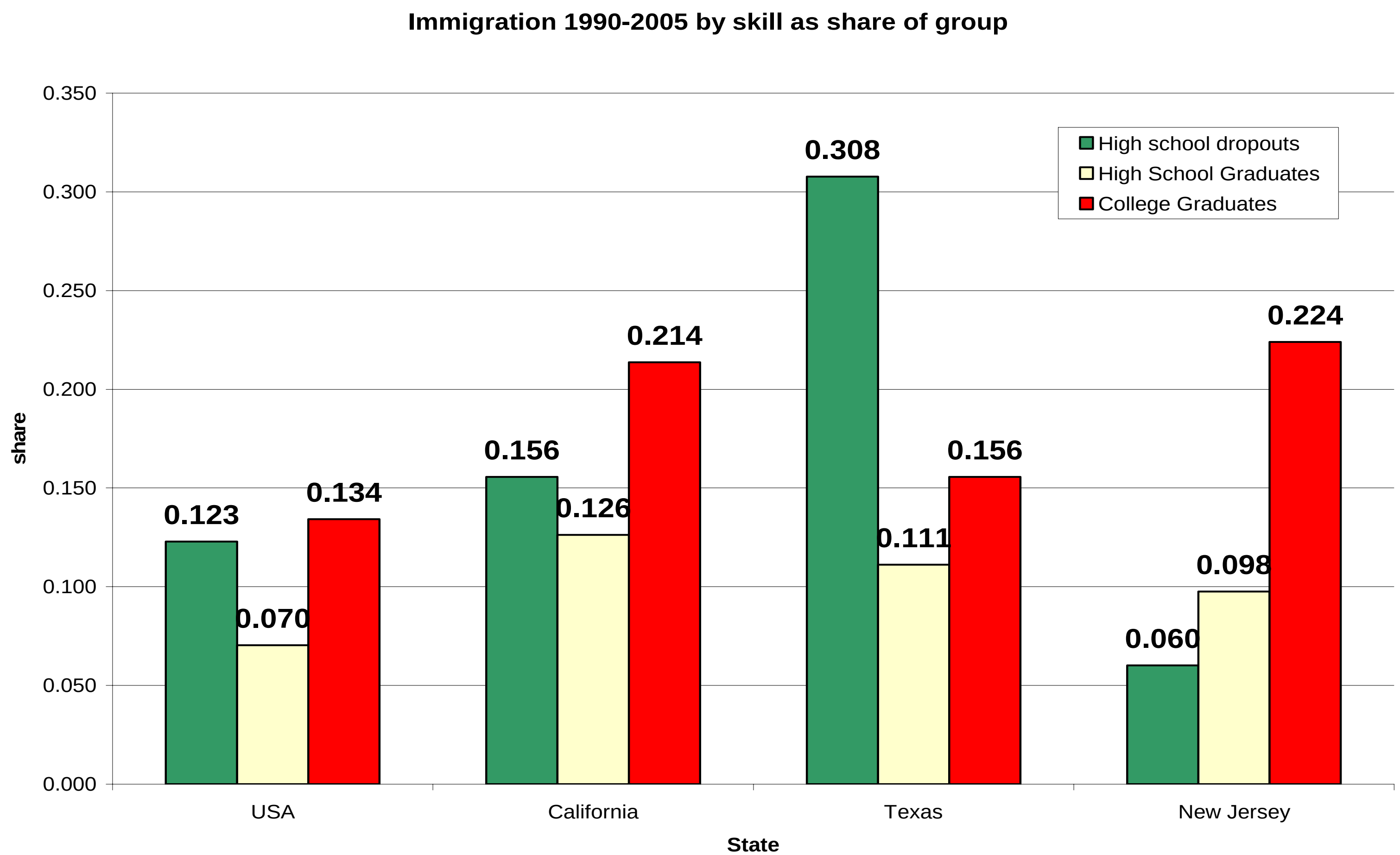
Notes: The units of observation are the 50 U.S. states and DC during the periods 1970-80, 1980-90, 1990-2000 and 2000-2005 for a total of 204 observations. The vertical axis measures the percentage change in average weekly wage in constant 2000 U.S. $ for U.S.-born males, 17 to 65 years of age, cleaned of the common period-specific average. The horizontal axis measures the change in foreign-born employment as percentage of initial total employment cleaned of the common period-specific average.

Figure 2
Immigration and Changes in the Median Rent of U.S. Natives
U.S. states, decade changes 1970-2000 and 2000-2005.



Notes: The units of observation are the 50 U.S. states and D.C. during the periods 1970-80, 1980-90, 1990-2000 and 2000-2005 for a total of 204 observations. The vertical axis measures the percentage change in rent per room in constant 2000 U.S. $ for U.S.-born head of households, cleaned of the common period-specific average. The horizontal axis measures the change in foreign-born population as percentage of initial total employment cleaned of the common period-specific average.

Figure 3:
Net Immigration (1990-2005) as Share of the 1990 Population by Group: Three Education Groups



Notes: Each bar of the graph represents the change in foreign-born workers by education group (net immigration) during the 1990-2005 period as a percentage of the total population in the group.

Figure 4:
Ownership of Residential Space, 1990

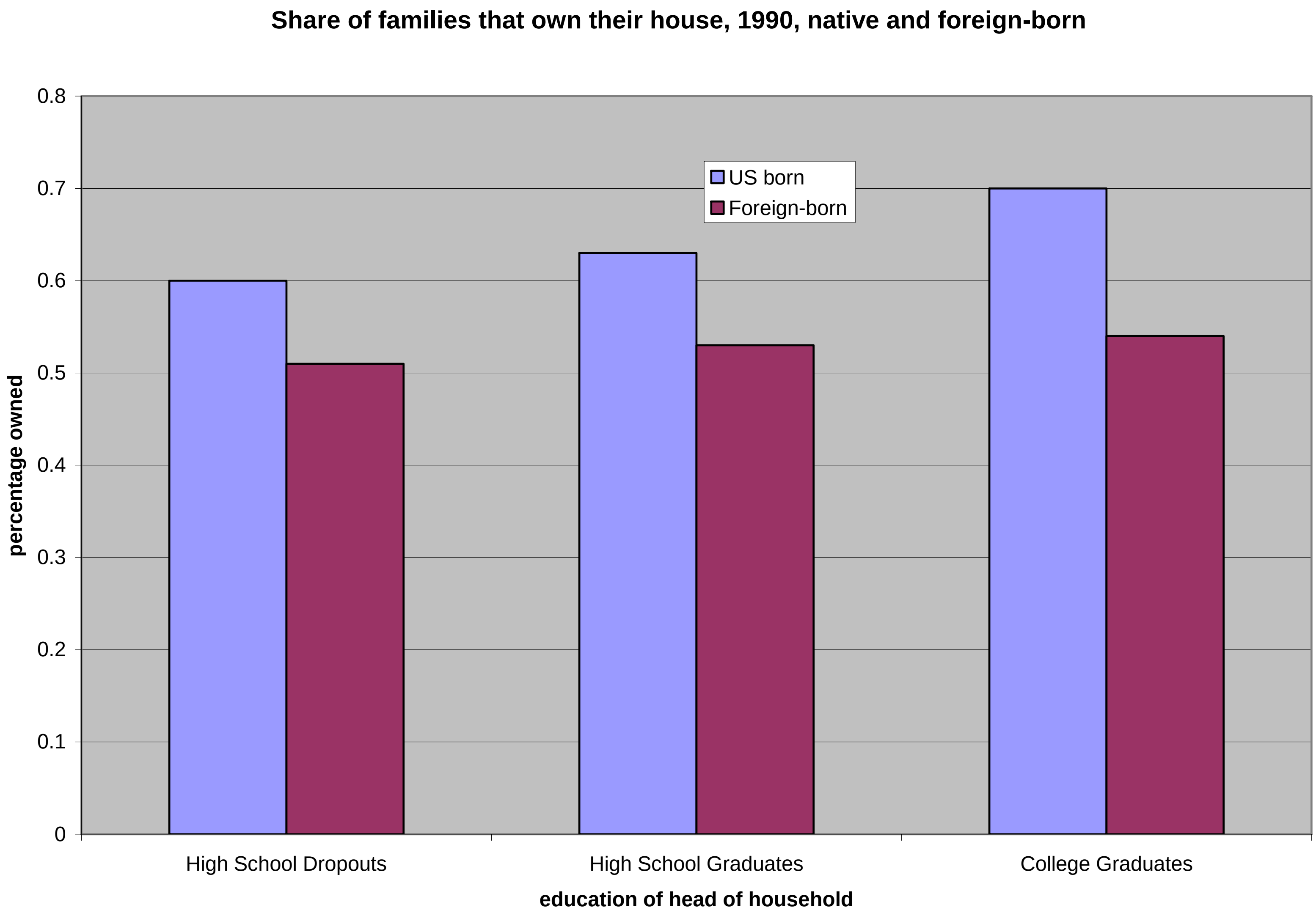
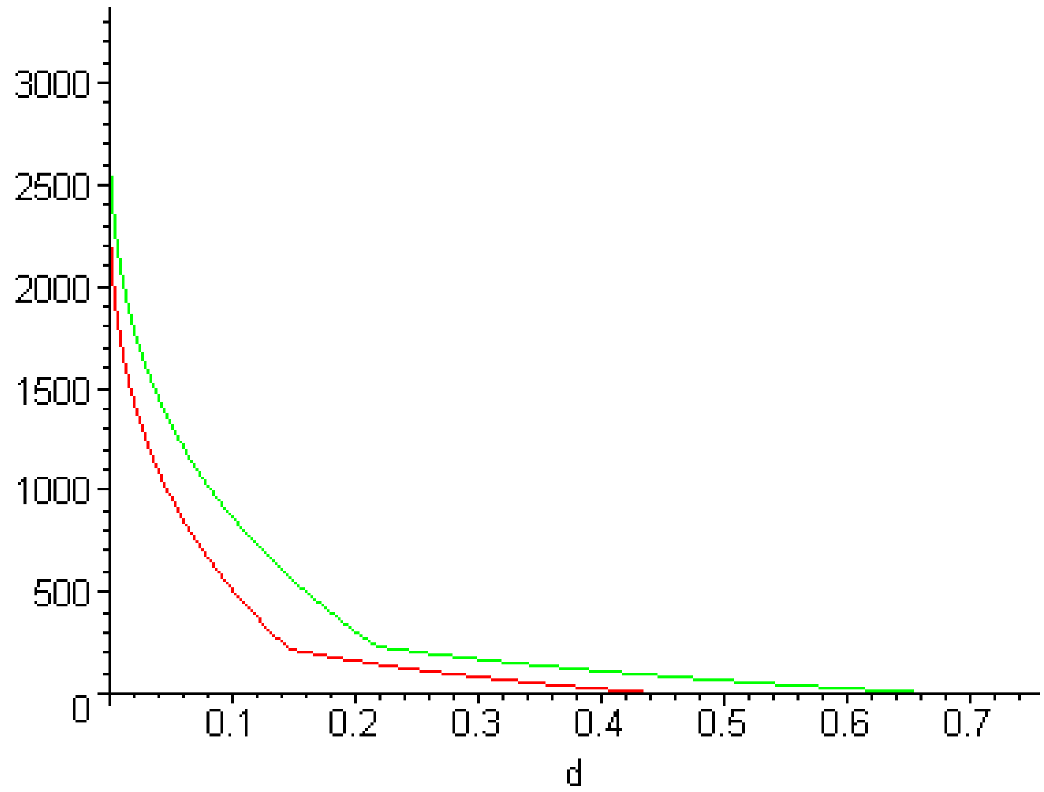


Figure 5
Simulated Rent-Gradient Before (red) and After (green) an Immigration Shock



Note: Rent as a function of distance from the central business district (d). The red line corresponds to the simulated rent function in 1990 using the parameters in Column (I) of Table 6. The green line corresponds to the simulated rent function after immigration 1990-2005 and after the adjustment of native workers.

Table 1
Estimates of the Elasticity of Average Wage of Natives to Immigration,
Panel of U.S. States plus DC: 1970-80, 1980-90, 1990-2000 and 2000-2005 Changes

γ_{wage}	Weekly Wages		Yearly Wages	
Specification	**1**	**2**	**3**	**4**
Sample	**Male Only**	**All Workers**	**Male Only**	**All Workers**
		Whole State		
OLS, controlling for change in native employment	0.45** (0.10)	0.51** (0.10)	0.45** (0.11)	0.49** (0.09)
IV, imputed supply-driven immigrants as instrument	0.35** (0.16)	0.34** (0.16)	0.43** (0.10)	0.42** (0.20)
First stage coefficient and F-test	0.47** (0.09) 26.65	0.47** (0.09) 26.65	0.47** (0.09) 26.65	0.47** (0.09) 26.65
		Metropolitan Areas Only		
OLS, controlling for change in native employment	0.53** (0.11)	0.56** (0.12)	0.55** (0.10)	0.57** (0.11)
IV, imputed supply-driven immigrants as instrument	0.51** (0.27)	0.56** (0.21)	0.44* (0.19)	0.56** (0.27)
First stage coefficient and F-test	0.18** (0.03) 22.7	0.16** (0.03) 22.4	0.18** (0.03) 22.7	0.16** (0.03) 22.4
Observations	204	204	204	204

Notes: Units of observation: 50 U.S. states plus DC during the periods 1970-80, 1980-90, 1990-2000 and 2000-2005. Observations are weighted by the employment of that cell in each regression. Dependent variable: percentage change in the real (CPI deflated) average wage of natives, between 17 and 65 years of age. Explanatory variable: change of foreign-born employment as percentage of initial employment in the state. All regressions include period fixed effects. The OLS estimates control for the change in native employment as percentage of total initial employment. The IV estimates use as instruments the imputed change in foreign-born population 17-65 as percentage of initial population in the age-range. The method to construct imputed foreign-born population changes by state is described in the main text. The top three rows include workers in the whole state while those in the bottom three rows include only workers in metropolitan areas of each state. Each coefficient results from a separate estimation. We report heteroskedasitcity-robust standard errors in parentheses.

Table 2
Estimates of the Elasticity of Rent/House Value of Natives to Immigration, U.S. States plus DC: 1970-80, 1980-90, 1990-2000 and 2000-2005 Changes

$\gamma_{house\ price}$	**Dependent Variable: Rent per room**		**Dependent Variable: Housing Price per room**	
Specification	**1**	**2**	**3**	**4**
Measure of Dependent Variable:	**Average**	**Median**	**Average**	**Median**
Whole State				
OLS, controlling for change in native population	0.60**	0.80**	0.82	0.64
	(0.18)	(0.16)	(0.49)	(0.44)
IV, imputed supply-driven immigrants as instrument	0.64**	0.67**	0.65	1.80
	(0.15)	(0.11)	(0.42)	(1.02)
First stage coefficient and	0.47**	0.47**	0.47**	0.47**
	(0.09)	(0.09)	(0.09)	(0.09)
F-test	26.65	26.65	26.65	26.65
Metropolitan Areas Only				
OLS, controlling for change in native population	0.76**	0.70**	1.5**	1.3*
	(0.18)	(0.14)	(0.42)	(0.72)
IV, imputed supply-driven immigrants as instrument	0.81*	0.75*	2.2*	2.4*
	(0.24)	(0.19)	(0.96)	(1.2)
First stage coefficient and	0.16**	0.16**	0.16**	0.16**
	(0.03)	(0.03)	(0.03)	(0.03)
F-test	22.4	22.4	22.4	22.4
Observations	204	204	204	204

Notes: Unit of observation: 50 U.S. states plus DC during the periods 1970-80, 1980-90, 1990-2000 and 2000-2005. Observations are weighted for the employment in that cell in each regression. Dependent variable: percentage change in the real (CPI deflated) median/average rent per room or real median/average house price of native head of households, between 17 and 65 years of age. Explanatory variable: change of foreign-born population as percentage of initial population in the state (age 17-65). The OLS estimates control for the change in native population as percentage of total initial population. The IV estimates use as instruments the imputed change in foreign-born population 17-65 as percentage of initial population in the age-range. Method to construct imputed foreign-born population changes by state is described in the main text. The top three rows include workers in the whole state, while those in the bottom three rows include only workers in metropolitan areas of each state. Each coefficient results from a separate estimation. We report heteroskedasitcity-robust standard errors in parentheses.

Table 3
Estimates of the Elasticity of U.S.-born Population/Employment of Natives to Immigration
U.S. States plus DC: 1970-80, 1980-90, 1990-2000 and 2000-2005 Changes

Specification	**1**	**2**	**3**
		Whole State	
	OLS 1970-2005	**IV 1970-2005**	**IV 1970-2000**
Population	0.57*	-0.37	-0.35
	(0.44)	(0.26)	(0.24)
Employment	0.38*	-0.39	-0.38
	(0.20)	(0.27)	(0.27)
Fist stage IV,	Not applicable	0.50**	0.55*
coefficient		(0.10)	(0.09)
F-test		26.3	36
Observations	204	204	153

Notes: Unit of observation: 50 U.S. states plus D.C during the periods 1970-80, 1980-90, 1990-2000 and 2000-2005. Observations are weighted for the employment in that cell in each regression. Dependent variable: Change in population (employment) of natives between 17 and 65 years as percentage of initial total population (employment) in the state. Explanatory Variable: change in population (employment) of foreign-born between 17 and 65 as percentage of initial population (employment) in the state. The IV estimates use as instruments the imputed change in foreign-born population 17-65 as percentage of initial population in the age-range. Method to construct imputed foreign-born population changes by state is described in the main text. Each coefficient results from a separate estimation. We report heteroskedasitcity-robust standard errors in parentheses.

Table 4
Estimates of the Elasticity of Rent/House Value of Natives to Immigration, by Native Skill
U.S. States plus DC: 1970-80, 1980-90, 1990-2000 and 2000-2005 Changes

Specification	**1**	**2**	**3**
Group, by Education	**Low Education (High School Dropouts)**	**Medium Education (High School Graduates)**	**High Education (College Graduates)**
Metropolitan Areas Only			
Median housing price per room	0.15	1.9*	1.2
OLS	(0.50)	(0.9)	(0.7)
Median rent per room	0.30	0.90**	0.87**
OLS	(0.20)	(0.30)	(0.44)
Median rent per room	0.14	0.87	2.3**
IV	(0.37)	(0.66)	(1.1)
First stage	0.23**	0.09**	0.15**
coefficient and F-test	(0.04)	(0.01)	(0.7)
	32	28	4.7
Whole State			
Median rent per room	0.24	0.52	1.21**
OLS	(0.37)	(0.60)	(0.37)
Median housing price per room	0.29	1.55**	1.87**
IV	(0.29)	(0.96)	(0.69)
Median rent per room	0.24	0.62*	1.1**
IV	(0.37)	(0.70)	(0.37)
First stage	0.63**	0.31**	0.70**
coefficient and F-test	(0.03)	(0.07)	(0.27)
	351	19	7.8
Observations	204	204	204

Notes: Unit of observation: 50 U.S. states plus DC during the periods 1970-80, 1980-90, 1990-2000 and 2000-2005. Observations are weighted for the population in the cell in each regression. Dependent variable: yearly percentage change in the median real rent per room or real median price per room of native head of households. The mean and median are constructed including individuals between 17 and 65 years of age, with schooling level described by the column header. Explanatory variable: change of foreign-born population as percentage of initial population in the state and in the education group (age 17-65). The OLS estimates control for the change in native population in the education group as percentage of total initial population in the group. The IV estimates use as instruments the imputed change in foreign-born population 17-65 in the education group as percentage of initial population in the age-range. The top three rows include workers in the whole state, those in the bottom three rows include only workers in metropolitan areas of each state. Each coefficient results from a separate estimation. We report heteroskedasitcity-robust standard errors in parentheses.

Table 5
Estimates of the Elasticity of Wages of Natives to Immigration,
Separated by Skill of Worker
U.S. States plus DC: 1970-80, 1980-90, 1990-2000 and 2000-2005 Changes

Specification	**1**	**2**	**3**
Method:	**Low Education**	**Medium Education**	**High Education**
	Whole State		
IV, weekly wages All U.S.-born workers	-0.10 (0.11)	0.20** (0.09)	0.50** (0.20)
IV, weekly wages males, U.S.-born workers	-0.08 (0.09)	0.23** (0.11)	0.42** (0.20)
First stage coefficient and F-test	0.64** (0.18) 11	0.29** (0.05) 25	0.67** (0.15) 19
Observations	204	204	204

Notes: Unit of observation: 50 U.S. states plus D.C during the periods 1970-80, 1980-90, 1990-2000 and 2000-2005. Observations are weighted for the employment of that cell in each regression. Dependent Variable: yearly percentage change in the average wage of natives, between 17 and 65 years of age, with schooling as in the column header. Explanatory Variable: change of foreign-born employment as percentage of initial employment in the state and schooling group as in the header. All regressions include period fixed effects. The IV estimates use as instruments the imputed change in foreign-born population 17-65 in a schooling group as percentage of initial population in the education-state group. Method to construct imputed foreign-born population changes by state is described in the main text. Each coefficient results from a separate estimation. We report heteroskedasitcity-robust standard errors in parentheses.

Table 6
Simulated Long-Run Average Impact of Immigration 1990-2005:
Elasticity of Wages, Housing Values and Population of Natives

	(I)	(II)	(III)	(IV)	Empirical Estimates
Parameter Values					
share spent in housing + commuting	**0.30**	**0.30**	**0.30**	**0.30**	0.15-0.2 housing 0.1-0.15 commuting Source BLS (2005)
β (share spent in entertainment-food)	**0.15**	**0.15**	**0.15**	**0.15**	0.15-0.2 Source BLS (2005)
γ (elasticity of substitution ethnic goods)	**7**	**7**	**7**	**7**	Between 5 and 10 By analogy with σ
δ (elasticity of substitution education groups)	**2**	**2**	**2**	**2**	1.5-2.2 Source: Ciccone and Peri (2005)
ψ_L	**0.60**	**0.60**	**0.40**	**0.05**	Imprecisely Estimated
ψ_M	**0.50**	**0.50**	**0.50**	**0.50**	Around 0.50 Source: Osland et al (2007)
ψ_S	**0.50**	**0.50**	**0.50**	**0.50**	Around 0.50 Source: Osland et al (2007)
σ_L	**5**	**6**	**5**	**10**	5 to 10 Source: Ottaviano and Peri (2006)
σ_M	**5**	**6**	**5**	**5**	5 to 10 Source: Ottaviano and Peri (2006)
σ_S	**5**	**6**	**5**	**5**	5 to 10 Source: Ottaviano and Peri (2006)
Long-Run Elasticity					
$\gamma_{\text{wage natives}}$	**0.345**	**0.312**	**0.283**	**0.178**	**0.34 to 0.56**
$\gamma_{\text{rent natives}}$	**0.680**	**0.580**	**0.632**	**0.540**	**0.60 to 0.81**
$\gamma_{\text{employment natives}}$	**0.359**	**0.130**	**0.420**	**0.532**	**-0.35 to 0.38**
Long-Run Percentage Effects of Immigration					
Average Wage of Natives	**3.84**	**3.47**	**3.16**	**1.98**	**3.7% to 6.2%**
Average Rent of Natives	**7.56**	**6.45**	**7.03**	**6.01**	**6.7% to 9%**
Total Employment of Natives	**3.99**	**1.44**	**4.67**	**5.93**	**-3.8 %to 4.2%**

Note: Total immigration in the 1990-2005 period: $\Delta F/(F+H)$=11.1%, distributed as $\Delta L_F/(L_F+L_H)$= 24.4%, $\Delta M_F/(M_F+M_H)$= 8.2%, $\Delta S_F/(S_F+S_H)$= 11.6%. Simulations are described in the main text. The elasticities are relative to the percentage change in the group due to immigration.

Table 7
Simulated Long-Run Impact of Immigration by Skill:
Elasticity of Wages, Housing Values and Population of Natives

	(I)	(II)	(III)	(IV)	Empirical Estimates
Parameter Values: Same as Above					
Long-Run Elasticities					
$\gamma_{\text{wage natives}}$ Low Skills	**0.255**	**0.210**	**0.168**	**0.007**	**-0.08 to -0.10**
$\gamma_{\text{wage natives}}$ Medium Skills	**0.206**	**0.168**	**0.199**	**0.187**	**0.20 to 0.23****
$\gamma_{\text{wage natives}}$ High Skills	**0.210**	**0.171**	**0.103**	**0.192**	**0.42 to 0.50****
$\gamma_{\text{rent price natives}}$ Low Skills	**0.573**	**0.464**	**0.767**	**1.020**	**0.15 to 0.30**
$\gamma_{\text{rent price natives}}$ Medium Skills	**0.610**	**0.517**	**0.616**	**0.606**	**0.62 to 1.90****
$\gamma_{\text{rent price natives}}$ High Skills	**0.638**	**0.542**	**0.638**	**0.635**	**0.87 to1.87****
Long-Run Percentage Effects of Immigration					
Real Rent Low Skills	**6.33**	**5.22**	**8.60**	**11.62**	**Not observed**
Real Rent Medium Skills	**6.74**	**5.81**	**6.92**	**7.01**	**Not observed**
Real Rent High Skills	**7.05**	**6.09**	**7.16**	**7.33**	**Not observed**

Note: Total immigration in the 1990-2005 period: $\Delta F/(F+H)$=11.1%, distributed as $\Delta L_F/(L_F+L_H)$= 24.4%, $\Delta M_F/(M_F+M_H)$= 8.2%, $\Delta S_F/(S_F+S_H)$= 11.6%. The elasticities are relative to the percentage change in the group due to immigration.

Table 8
Simulated Long-Run Impact of Immigration:
Counterfactual scenarios

	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)
Simulated Long-Run Average Impact of Immigration							
Long-Run Elasticity							
$\gamma_{\text{wage natives}}$	**0.345**	**0.267**	**0.290**	**0.348**	**0.218**	**0.215**	**0.422**
$\gamma_{\text{rent natives}}$	**0.680**	**0.848**	**0.759**	**0.635**	**0.902**	**0.924**	**0.523**
$\gamma_{\text{employment natives}}$	**0.359**	**0.618**	**0.463**	**0.293**	**0.667**	**0.720**	**0.140**
Long-Run Percentage Effects of Immigration							
Average Wage of Natives	**3.84**	**2.42**	**3.95**	**5.06**	**2.72**	**2.25**	**4.72**
Average Rent of Natives	**7.56**	**7.70**	**10.32**	**9.25**	**11.23**	**9.65**	**5.84**
Total Employment of Natives	**3.99**	**5.61**	**6.29**	**4.27**	**8.30**	**7.52**	**1.56**
Simulated Long-Run Impact of Immigration by Skill							
Long-Run Elasticities							
$\gamma_{\text{wage natives}}$ Low Skills	**0.255**	**0.312**	**0.276**	**0.239**	**0.319**	**0.331**	**0.206**
$\gamma_{\text{wage natives}}$ Medium Skills	**0.206**	**0.259**	**0.228**	**0.192**	**0.268**	**0.278**	**0.159**
$\gamma_{\text{wage natives}}$ High Skills	**0.210**	**0.265**	**0.234**	**0.195**	**0.278**	**0.287**	**0.160**
$\gamma_{\text{rent price natives}}$ Low Skills	**0.573**	**0.340**	**0.358**	**0.595**	**0.158**	**0.200**	**0.853**
$\gamma_{\text{rent price natives}}$ Medium Skills	**0.610**	**0.716**	**0.632**	**0.584**	**0.675**	**0.717**	**0.550**
$\gamma_{\text{rent price natives}}$ High Skills	**0.638**	**0.766**	**0.684**	**0.604**	**0.771**	**0.802**	**0.537**
Long-Run Percentage Effects of Immigration							
Real Rent Low Skills	**6.33**	**2.88**	**4.68**	**8.66**	**1.65**	**1.79**	**9.70**
Real Rent Medium Skills	**6.74**	**6.29**	**8.41**	**8.49**	**8.06**	**7.17**	**6.30**
Real Rent High Skills	**7.05**	**6.74**	**9.10**	**8.78**	**9.26**	**8.06**	**6.16**

Note: (I) Actual U.S. immigration in the 1990-2005 period: $\Delta L_F/(L_F+L_H)$= 24.4%, $\Delta M_F/(M_F+M_H)$= 8.2%, $\Delta S_F/(S_F+S_H)$= 11.6%; (II) Without the undocumented (estimates by Passel, 2006): 6.6%, 8.2%, 11.6%; (III) California scenario: 18%, 11%, 17%; (IV) Texas scenario: 34%, 11%, 14%; (V) New Jersey scenario: 3%, 10%, 21%; (VI) New York scenario: 1%, 9%, 17%; (VII) New Mexico scenario: 38%, 8%, 7%.