Gains from "Diversity": Theory and Evidence from Immigration in U.S. Cities

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Abstract

The recent empirical literature generally finds negative (or weakly negative) effects of the inflows of immigrants on the wages and employment of US-born workers within a skill group. Our paper begins by revealing an empirical regularity apparently at odds with these findings: in a panel of city-level data over time (1970-2000) the inflows of immigrants has a robust positive association with average wages, employment and value of housing of US-born citizens. Using instrumental variables correlated with inflow of immigrants but orthogonal to any city-specific shock we proceed to show that this correlation is likely to be, at least in part, causal. We reconcile these two findings by showing that if foreign-born workers provide skills (and produce services) that are not perfectly substitutable for those provided by US-born workers then migration generates overall gains (average positive effects) as well as distributional effects that hurt, in relative terms, some skill groups (negative relative effect). We provide a simple model that quantifies the impact of immigrants on average wages of US-born workers. For an increase in foreign-born worker of 6% of the initial US employment (as experienced by the US in the 1990-2000 decade) the average wages of US workers increase by 2% of their levels. We then simulate a more complete model of open city-economies that, using structural parameter values, reproduces fairly well the response of average wages, price of housing and internal migration of US-born to an immigration shock.

Key Words: Diversity, Complementarity, Foreign-Born, Cities, General Equilibrium.
JEL Codes: F22, J61, J31, R13, Z10

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1 Introduction

The current literature on the effects of immigrants on labor market outcomes of US born has not reached a wide consensus yet. The debate, however, is dominated by two positions. The first emphasizes the negative effect of immigrant flows on the wages (and the employment) of US natives with similar skills and it is associated with George Borjas (Borjas 1994, 2001, 2003, Borjas, Friedman and Katz 1997). The second denies that there are large and relevant consequences of immigrant flows on the internal migration and on the wages of native workers and is associated with David Card, John di Nardo and other coauthors (Butcher and Card 1991, Card 1990, 2001, Card and Di Nardo, 2000). To be more precise the labor literature, rather than arguing for a negative (or negligible) overall effect of immigration, argues that the negative effect on wages is redistributed to the capital factor and the debate is wether this redistribution is large or small [1]. This paper intends to argue, with a simple theoretical model and with empirical evidence, for a third position, namely that the flow of immigrants into the United States generates positive and significant gains to productivity and wages of US born workers. Such an effect is certainly accompanied to a redistributive effect, we argue, but is nevertheless important and large. While the existing literature has focussed on the estimation of wage elasticities in narrowly defined labor markets in which foreign-born are considered as perfect substitutes for US born workers, we take a somewhat different approach. We assume (and test) that foreign born workers are different from Natives and in this "diversity" they complement, and benefit, US-born workers. Primarily, Foreign-born provide somewhat different "abilities" to general production (even within an education-experience cell). Secondarily they are specialized in the production of some varieties of non-tradable services[2] which increase the choice of local consumers because they are different from those produced by US born workers. These complementarities with skills and services provided by US-born workers, make the inflow of immigrants beneficial to the productivity of natives. Still, controlling for this positive generalized effect, as foreign born are unevenly distributed across education and experience groups their inflow into the US also determines a change in relative wages of natives so that some group of US-born will enjoy smaller benefits than others (hence potentially negative relative effects).

The theoretical foundation of gains from migration that we propose is therefore very simple and similar to the one behind the analysis of gains from trade. Two features of foreign-born workers generate these gains. The first source of gains stems from the fact that the distribution of immigrants across observable skills (education and experience) is different from the one of natives. If,

[1] A recent paper by Davis and Weinstein (2005) argues that when migration is driven by technological superiority of a country there is an adverse impact on the receiving country through terms of trade. Their attempt to quantify this effect is extremely interesting and they have the merit of being interested in general equilibrium effect . We leave to further versions of this work a more careful comparison with their frame and results.

[2] Restaurants, specialty food stores and entertainment services seem to us the service sectors in which the presence of foreign-born is most valuable to the variety of consumption.

as it has been the case for the last two decades, immigrants keep flowing in large numbers especially among those skill groups in which they are relatively over-represented (namely low skills and very high skills), then this has a beneficial effect on the average wage of US born workers, (increasing wages of skill groups in which US-born are relatively abundant). The second source of gains comes from differences in abilities (due to different training, different culture, different language and abilities) which make foreign born a different "type" of workers from US born workers and imply imperfect substitutability even within an education-experience group. If production benefits from the variety of factors then productivity of US born workers as a whole benefits from the variety of skills brought by immigrants. As we will see, a small degree of differentiation between foreign and US-born is enough to generate non-trivial gains to US-born. Just to clarify the comparison with trade, the first effect described is reminiscent of the gains from comparative advantages (relative scarcity of factors) while the second is reminiscent of gains from varieties.

We first present aggregate evidence, from US metropolitan areas, that the average wage and total employment of US born workers, as well as the value of their houses, are positively associated with flows of foreign-born workers. At the same time there is no evidence of aggregate out-migration of native workers in response to inflows of immigrants. The effects of increased immigration are therefore positive and non negligible. This association survives the use of instrumental variables which should be exogenous to city-specific shocks which may generate spurious correlation. We construct the instrument by using the initial share of foreign-born workers in a city, grouped by country of origin, and attributing to each group the average immigration rate for that nationality into the US in each decade (1970-2000). First adopted by Card (2001), such instrument is correlated with actual immigration in the city if new immigrants tend to settle, at least for a while, where country-fellows already live. On the other hand this "constructed" variable it is independent of any city-shock, and in particular totally orthogonal to any economic determinant of immigration into the city during the considered decades.

We then present our explanation for this positive correlation. First, considering a simple CES production function for the aggregate US economy we show how complementarity between Foreign-born and US-born workers generates productivity gains and higher wages for the last group when the first group grows bigger because of immigration. Then, using a more articulate model of production and consumption across cities we show how immigrants affect positively wages of natives and the value of their houses and generate a small (if any) migration reaction of US-born workers. In considering the open-city model we also include the provision, by foreign born, of some varieties of local services (restaurants, entertainment) which are not perfect substitutes for the varieties provided by US-born. This, therefore, would increase the choice and the utility of people living in the city. Given the crucial role played, in our model, by the substitutability between Foreign and US workers in production we estimate this parameter directly. We obtain a value between 6 and 8 which, as endogeneity may bias this estimate up, is likely to be an upper bound so that values of 3 or

4 (especially within the group of College educated workers) are not implausible. These values are close to the elasticity of substitution between workers in different cohorts of (five years of) experience within an education group (estimated by Card and Lemieux 2001). This seems very reasonable: a US-born (and educated) college graduate and a German-born (and educated) college graduate with the same experience do not seem more similar to (and substitutable for) each other (in terms of abilities, work-attitude, creativity, priorities) than two US-born college graduate who only differ because they are five years apart in their working experience. These estimates allow us to simulate the effect of immigrants' inflow on average wages and average house-values of American-born. The long-run effect that we obtain from simulating our model are very close to those previously estimated with the data from US metropolitan areas 1970-2000. While the existing literature has focussed on the own elasticity of demand, emphasizing that an inflow of immigrants has a negative effect on relative wages of the group receiving the largest inflow (low skill workers for the US during the 1970-2000 period) we show that, due to imperfect substitutability between immigrants and US-born workers, the same inflow of immigrants has an average positive effect on the productivity of the other groups and, ultimately, on the average wage of American-born workers.

The paper is organized as follows: section 2 presents the robust positive correlation between average wages of US. born, average value of housing and inflow of immigrants across 86 US metropolitan areas for the period 1970-2000 as well as ours and existing estimates of elasticity of U.S. wages to immigrants. Section 3 presents a simple aggregate production function and illustrates the key mechanism through which the average positive effect of foreign-workers on US wages operates. In particular we can calculate analytically the elasticity of average wage of US workers to a change in supply of foreign workers. Section 4 enriches the production side of our model with a consumption side and considers the general equilibrium model within a small open city subject to an immigrant shock. Using the estimated parameter values and values taken from the literature we are able to simulate the model generating effects of immigrants on wages, rents and internal migration of US-born workers that are fairly close to those that we measured in section 2. Section 6 concludes the paper.

2 Empirical Regularities: Average effects and Relative effects of the Inflow of Immigrants

In previous work (Ottaviano and Peri 2004) we suggested that changes in the average wage and average rent of US-born workers in 160 metropolitan areas across the US were significantly and positively correlated with the flows of immigrants in the city during the 1970-1990 period. In this section we extend that evidence to the 1970-2000 period and we strengthen it, including also the growth of employment of US born workers among the variables analyzed. At the same time, using an instrument that captures the exogenous variation of immigrants'

flows across cities and is, by construction, independent from city-specific shocks, we show that the positive correlations survive unscathed this attempt to reduce omitted variable bias. Given, however that such positive effect seems in contrast with existing estimates of the effect of foreign-born on wages of U.S. workers we also estimate skill-specific elasticities and the effects on wages of each skill-group of an increase in the total supply of foreign-born.

2.1 Average Effects: Wages, Value of Housing and Employment

Figures 1, 2 and 3 illustrate the correlation between the change in foreign-born workers (in percentage of the total initial employment) and the percentage increase of employment of US-born (figure 1), or the percentage increase of the average rent per room paid by US-born (figure 2) or the percentage increase of the average wage of US-born workers (figure 3) across the 86 largest metropolitan areas in the United States for the 1970-2000 period . The visual impression, confirmed by the regression lines, suggests a positive and strong correlation of the share of foreign-born with each of the three variables. Metropolitan areas where foreign-born workers came in larger numbers experienced faster employment growth for US born workers, they exhibited faster growth of average wages for US-born workers, as well as faster growth of property values (captured here by higher rents) for their homes. Without implying a direction of causality the described statistics show that an increase in foreign born is associated with all the characteristics of a booming metropolitan economy. If inflows of immigrants were to hurt local workers (as argued by the recent empirical literature), we should have observed the opposite correlations unless some other factors, correlated with the inflow of immigrants, more than compensate for their negative impacts. In the remaining of this section we analyze more formally these positive correlations in order to understand whether they are likely to be spurious or due to omitted variables.

2.1.1 Panel Estimates of the average effect: OLS

Using data from the Integrated Public Use Microdata Samples of the US census 1970, 80, 90 and 2000 for individuals in 86 metropolitan areas[3] we estimate the following three panel regressions:

$$\Delta n_{ct} = \alpha_c + \beta_t + \gamma_E \Delta f_{ct} + \varepsilon^E_{ct} \tag{1}$$

$$\Delta \ln \overline{w}_{ct} = \alpha_c + \beta_t + \gamma_w \Delta f_{ct} + \varepsilon^w_{ct} \tag{2}$$

$$\Delta \ln \overline{r}_{ct} = \alpha_c + \beta_t + \gamma_r \Delta f_{ct} + \varepsilon^r_{ct} \tag{3}$$

[3]details on data and on the constructoin of variables are erported in the Appendix A.

Each of the regressions (1)-(3) considers as independent variable the percentage increase of the total employment of city c in decade t due to immigration. This is defined as $\Delta f_{ct} = (F_{ct+10} - F_{ct})/(F_{ct} + N_{ct})$, where F_{ct} is the number of foreign-born workers in city c and year t, while N_{ct} is the number of US-born workers in city c and year t. If such increase, once we control for city fixed effects, α_c, and period fixed effects, β_t is exogenous to economic conditions of city c, then regression (1) estimates the effect of this increase on the increase of employment of US-born workers in city c and decade t, as percentage of total initial employment, namely, $\Delta n_{ct} = (N_{ct+10} - N_{ct})/(F_{ct} + N_{ct})$. The estimate of γ_E tells us what is the response of US-born workers to an increase of foreign-born workers in percentage of initial total employment. Similarly, the estimate of coefficient γ_w in regression (2) quantifies the percentage increase of the average real wage (in 2000 constant dollars) of US-born workers in city c and decade t ($\Delta \ln \overline{w}_{ct} = \ln \overline{w}_{ct} - \ln \overline{w}_{ct-10}$) in response to an increase of foreign-born, equal to 1% of total employment[4]. Finally coefficient γ_r in regression (3) quantifies the percentage increase of the real average house value (in 2000 constant dollars) of US-born workers in city c and decade t ($\Delta \ln \overline{r}_{ct} = \ln \overline{r}_{ct} - \ln \overline{r}_{c-10}$) in response to an increase of foreign-born workers, equal to 1% of total employment[5]. If the disturbance variables ε^E_{ct}, ε^w_{ct} and ε^r_{ct} are independent from the migration flows Δf_{ct} the OLS estimates of the parameters γ_E, γ_w, γ_r are consistent estimates of the parameters we are interested in. Table 1, Column 1 reports such estimates. Each of the coefficient is positive and very significant. The response of US-born employment to foreign-born employment is equal to 1.3, implying that cities that attract more foreign-born also attract more US-born in roughly the same amount. Rows two and three show the estimates of the elasticity of wage of US-born to immigration using hourly and yearly wages, respectively. The values are between 0.42-0.49 with a standard error around 0.15. finally the elasticity of house values to inflows of immigrants is also estimated to be positive and equal to 0.79 (when using rents) or 1.44 (when using value of houses). These estimates, especially the second, are not too precise but they are significantly positive and quite large. Taken together these coefficients mean that a city that receives an increase of foreign-born workers equal to 1% of its population experiences also an increase of 1% of the employment of US-born workers who, on top of that are paid 0.40% more than they received before and experience an increase in the value of their house between 1 and 1.6%. As the overall inflow of immigrants into the US economy between 1990 and 2000 was 6% of the initial total employment, these coefficients would produce an increase by 2-2.5% of the average wages of US born and by 6-9% of the average value of houses. Column 3

[4] In order to control for city composition, the value $\ln \overline{w}_{ct}$ is calculated as the city-specific intercept of a mincerian regression of log hourly (or yearly) wage of US born workers (in constant 2000 prices) on personal characteristics (years of schooling, experience dummies, gender dummy, race dummies, marital status dummy). The regressions are run separately for each census year. Details are reported in Appendix A.

[5] The value $\ln \overline{r}_{ct}$ is calculated as the average value of houses occupied by US born people (in constant 2000 prices) divided by the number of rooms in city c and year t. Alternatively The gross rental value per room is used as measure of housing value. Details are in the Appendix A

of Table 1 presents the estimates for the same coefficients using a larger sample of metropolitan areas (117) but only the period 1970-1990. The estimates are remarkably similar to those obtained in Column I.

2.1.2 Panel Estimates of the average effect: IV

Even controlling for city and time fixed effects the differences of immigration flows could be correlated with some unobservable city-specific shocks that may affect wages, employment and housing value of US born. In order to produce estimates that are less likely to suffer from omitted variable bias we instrument our independent variable using a measure of "imputed" immigrant flows that is likely to be exogenous to any city-specific shock between 1970 and 2000 (the period we consider). This variable, in fact is constructed independently from the actual flow of immigration in each city. This variable, that builds on a method first used by Card (2001) and then recently adapted by Saiz (2003) and Lewis (2004), considers the initial share (in year 1970) of foreign-born workers, by country of origin, in each metropolitan area. We are able to use 58 countries (or group of countries) of origin consistently recorded across the four censuses. We then impute to each national group in each metropolitan area, the overall immigration rate for the national group into the US overall. Aggregating across national groups in a city this procedure give us a "constructed" increase in the overall population of foreign-born for each decade[6]. The constructed values of immigration flows are good predictor for the actual ones if, as argued by Card (2001), new immigrants settle, at least for a period, where country fellows already live. In order to be more accurate we perform such imputation separately for each of four education groups (high school dropouts, high school graduates, college dropouts and college graduates). Importantly, as we use national immigration rates for each national group, we are not capturing in the constructed immigration flows, any city-specific factor that would affect actual immigration in a city during a decade. As a consequence the instrument should be orthogonal, by construction, to any city-specific shock to productivity, amenities and labor market conditions.

The instrument constructed in such a way is an excellent one. The partial R^2 of the first stage regression is 0.25 and the F-test for excluding the instrument is above 100. The estimates obtained using the IV estimator are reported in Column 2 of Table 1 (for the 1970-2000 sample of 86 metropolitan areas) and in Column 3 of Table 1, (for the 1970-1990 sample of 117 metropolitan areas). The impact of immigrants on employment of Us-born (γ_E) is still close to 1, however the standard error has increased and we cannot rule out that it is zero. No evidence of aggregate emigration of US-born workers exists, however, even using the IV estimates. Conversely the impact on wages and on the value of housing of US-born is still significantly positive and the estimates of the coefficients γ_w and γ_r are very close to the OLS ones. In particular, an increase in foreign-born workers by 1% increases average wage of US-born by 0.3-0.4%

[6]Details on the construction of the Instrument are in the Appendix A.

and the value of their houses between 1 and 1.5%. For a total immigration in a city equal to 6% of the initial employment (as it has been on average for the 1990-2000 period) these coefficients imply a positive impact of 1.8%-2.4% on average wages of US workers and of 6-9% on average value of their houses while the migratory reaction on US-born could be as small as 0% and as large 5% but not an out-migration. These results (which support those obtained in our previous study, Ottaviano and Peri 2004, that also included other controls in the estimates of the wage and rent regression 2 and 3) convince us that the positive correlations are a robust feature of the data and we have no good reason to believe they are spurious. Interpreting them and reconciling them with the findings of the literature is what we do in the remaining of the paper.

2.2 Relative Wages: the Elasticity of Labor Demand

The estimates of γ_w obtained in the previous section (Table 1, second and third row) are not elasticity of labor demand. In spite of being obtained by regressing changes in wages on changes in supply of immigrants, both the dependent variable and the independent one combine (average) different groups of skills. As a consequence the interpretation of the coefficient cannot be that of a straightforward labor demand elasticity to employment which (by the way) has to be negative. In the next section we discuss in detail what the coefficient γ_w captures and how it can be constructed using the elasticity of demand for each skill group and the changes in supply of each skill group. Here we want to clarify what parameter has been estimated by the empirical literature so far, and check that we can obtain estimates very similar to those existing in the literature, if we address the same estimation problem. Obviously, immigrants have very different (observable and unobservable) skills among themselves. In order to isolate the effect of immigrants on the employment and wages of the group of US-born worker with most comparable skills, the traditional labor literature has run the following two regressions:

$$\Delta n_{ckt} = \alpha_{ck} + \beta_{ct} + \gamma_{E_k} \Delta f_{ckt} + \varepsilon^E_{ckt} \tag{4}$$

$$\Delta \ln \overline{w}_{ckt} = \alpha_{ck} + \beta_{ct} + \gamma_{w_k} \Delta f_{ckt} + \varepsilon^w_{ckt} \tag{5}$$

These regressions are similar to (1) and (2), however the subscripts ckt indicate that each skill group k in a city c in period t is considered as a different observation. The parameter γ_{E_k} of the first regression captures the response of employment of US-born workers to the immigration of foreign-born in the same skill-group and city assuming that such response is equal across skill groups. The parameter γ_{w_k} captures the response of wage of US-born workers in skill group k and city c to an inflow of immigrants into that city and skill group assuming that such response is equal across skill groups. Notice that as the regressions controls for city by period fixed effects, β_{ct}, any positive average effect of foreign-born on wages or employment, of the kind detected by equation

(1) and (2) will not be captured in these equations. In particular the coefficients $\gamma_{E_k}, \gamma_{w_k}$ are identified by the variation across skill groups within a city and are (in absolute value) relative labor-demand elasticities. They measure the fact that, controlling for any aggregate city-effect of foreign-born, a relatively larger inflow of immigrants within a skill group implies that the wage of that group will decrease relatively to those of the other groups, as a direct effect of the increased supply. Let us emphasize three specific assumptions of this approach:

1) The definition of a skill group k vary across studies (they are defined by schooling, or schooling and experience, or by occupation), but within a group foreign-born and US-born workers are always assumed as perfect substitute and their supply is simply added to calculate total supply of the skill

2) If we think of equation (5) as derived from a CES production function that combines workers with different skills, then the parameter γ_{w_k} is equal to minus the inverse of the elasticity of substitution between skills. The coefficient captures the relative effect on wages due to an increase in the supply of one specific skill. However, just as the increase of one factor has a negative impact on the wage of its closest substitute, it has a positive impact on the wage of all other complementary factors. Such positive effects on other wages (and hence on the average wage), are absorbed into the common effect β_{ct}

3) If the definition of skills is fine enough (for instance 4 schooling group by eight experience groups, as chosen in Borjas 2003) then we may have enough observation across skill-groups and years so that the equation can be estimated for the country aggregate (rather than by city). In this case (preferred by Borjas) no employment equation need to be estimated (as US workers cannot move in or out of the US in response to immigration) and only equation (5) is estimated.

Table 2 presents a sample of some recent influential estimates of the parameters γ_{w_k} and γ_{E_k} (row 1 through 5) together with our estimates of the same coefficients (row 6 and 7). Let's first consider the values of γ_{E_k} , that captures the impact of immigrants on internal (inter-city) migration of US-born. The first three ranges of estimates (Row 1 is from Card and Di Nardo 1998 and Rows 2 and 3 are from Card 2001) vary between 0 and 0.3 with standard errors that make them insignificantly different from zero or only marginally significant but small. There are some previous estimates (notably Filer 1992 and Frey 1995) that report negative values for the parameter γ_{E_k} . The studies chosen here, however, seem to be based on more representative and more careful analysis. The estimates by Borjas, Freeman and Katz (1997) reported in row 4 are significantly positive (+0.77) or significantly negative (-0.75) depending on the method of estimation. In particular only controlling for the growth of US-born workers in the pervious decade they obtain a negative effect of immigrant flows on native employment. As growth rates of employment are very unstable across decades it seems inappropriate to use past values as "control" for a state-specific long-run trend. We try to produce the same estimates in the last two rows using decade change in immigration flows across MSA's and grouping immigrants in

four education groups[7]. We include MSA by decade fixed effects and obtain values of γ_{E_k} not significantly different from (and close to) zero, both using OLS (row 6) and IV (row 7) as estimation method. From this evidence we gather that, in general, no large reaction of US-born workers to immigration of workers with similar skills can be estimated. If this is correct, geographical variation of immigrants, as argued by Card, can be used to estimate their impact on wages of US-born. Column 2 shows the estimates of γ_{w_k} , the effect of immigrants on wages of US-born workers. Here all the estimates are negative, but those associated with Card are much smaller in absolute value (0.02-0.10) that those associated with Borjas (0.2-0.5). For this parameter, however, we have some other estimates of reference. As we argued above, as immigrants are assumed to be perfect substitute for US-born in the same skill group, the estimates of γ_{w_k} in absolute value should simply be the estimates of the inverse of the elasticity of substitution between skills. For similar definition of skill groups we could, then. compare these estimates to the estimates of the same elasticity estimated on US-born workers only. Therefore if the skill groups are four education groups[8] (as in Borjas 2003) the elasticity of substitution among them should be between 1.5 and 2 (as estimated among US natives by Katz and Murphy 1992 and Ciccone and Peri, forthcoming, as well as abroad by Angrist 1995,). The estimates of Borjas 2003 (0.75 inverse elasticity of substitution across education groups) is close to the available estimates of the elasticity of substitution between skills(1/0.75=1.33). To the contrary the very high elasticity estimates by Card (2001), (between 20 and 50) although the skill groups used are a mix of education and experience (six of them in total) do not seem in line with the estimates for US-born.

Our preferred estimates of the inverse elasticity using, four schooling groups is 0.45, obtained using instrumental variable estimation with the "imputed" immigrants by city and skill group calculated as described in section (2.1.2). This estimate is not far from Borjas (2003) and also not far from the estimates of the inverse elasticity of substitution between skills obtained using US-natives (0.5-0.66). Also, if we use four education by eight experience groups as definition of skills the elasticity of substitution obtained within an education group across experience groups is around 7 (inverse 0.14), somewhat larger but not far from the estimates (using inflow of foreign-born) obtained by Borjas (2003) and those (using US-born only) obtained by Card and Lemieux (2001).

2.3 Total Effects on each Skill Group

The estimated parameters in sections 2.1 and 2.2 are two ways of capturing different effect of increased supply of foreign-born on U.S.-born workers. The first approach that looks at the effect on the average wage of U.S. born captures an aggregate effect which certainly does not correspond to a "structural" parameter. The estimates of γ_w express simply the percentage change in average wages

[7] High school Dropouts, High School Graduates, College Dropouts and College Graduates.
[8] High School Dropouts, High School Graduates, College Dropouts and College Graduates.

of U.S. born workers in response to total migration disregarding any relative effect on wages. The estimates of γ_{wk}, to the other extreme, look simply at the relative effect of the inflow of immigrants, as they control for any common effect of immigration on wages of U.S. born and focus only on the relative variations of supplies and wages. The estimate of γ_{wk} expresses what is the percentage relative change in wages of U.S. born workers in a skill group as result of an increase of supply of foreign workers in the same group, keeping constant supplies in all other groups. Given that immigrants into the U.S. are present in all skill group this second parameter, by itself, does not tell us anything about the absolute (actual) variation of real wages of each skill group. Before developing a structural model (that would allow us to calculate aggregate and group-specific effects) we can learn from the data another elasticity which is informative and could guide our analysis of the gains from immigration. Let us call γ_{wk}^{total}, the elasticity of average wage of U.S. born workers in skill group k to an increase in the total supply of foreign workers (in percentage of total initial employment). Such effect should combine the (positive and negative) effects that increases in the supply of the own and other skill-groups have on the productivity of one skill group. Such elasticity (different for each group k) can be estimated empirically using the three separate regressions:

$$\Delta \ln \overline{w}_{ckt} = \alpha_c + \beta_{ct} + \gamma_{wk}^{total} \Delta f_{ct} + \varepsilon_{ct}, \text{ for } k = low,\ medium,\ high \qquad (6)$$

where $\overline{w}_{ckt}$ is wage of U.S. born in skill group k , for city $c$and period t while f_{ct} is the total number of foreign-born workers (relative to initial employment) in city c and period t. Table 3 reports the estimates for this parameter, using alternatively OLS and IV estimation. The Instruments used for the total increase of foreign-born workers are the same as used in Table 1. First notice that while the OLS estimate exhibit an overall effect of foreign-born that is positive for each group, this result changes drastically when using IV. The omitted unobservable "city-shocks" may drive up the wage of U.S.-born and attract foreign-born in one city and this would result in the positive correlation. To the contrary, the IV estimates, while not very precise, consistently exhibit a negative overall effect of foreign-born on low-skilled workers (first line) with an elasticity between -0.10 and -0.20. A mild positive effect on the wages of intermediate skills (high school graduates) in the range 0.15-0.20 and a positive, larger (and in one case significant) elasticity of the wage of college graduates to foreign-born supply, in the order of 0.40. These effects, if we trust our instrument, could be interpreted as the overall effect of an increase in foreign-born workers on the salary of each of the three skill groups. As the increase in foreign-born as percentage of initial employment was around 6% during the nineties the above values imply a decrease in the wage of low-skills by 0.6-1.2%, an increase in the wage of U.S. born high school graduates by 1-1.2% and an increase in the wage of college-educated U.S. workers by 2.4% as a consequence of immigrants and their skill distribution.

2.4 The facts to be explained: Elasticities and Structural Parameters

The empirical analysis presented above leaves us with some elasticity estimates which are not necessarily incompatible but need to be reconciled and explained. First, most of the literature (and our replication of it) does not find robust evidence that US-workers within a skill group move out of a city when immigrants of the same skill group move in. In general most of the estimates of γ_E and γ_{Ek} in the literature and in our analysis are weakly positive. There is, however, empirical evidence (and theoretical reasons, if we believe in imperfect substitutability across skills and negative elasticity of demand) that the wage of US born underwent a relative decrease when the flow of foreign immigrant in that skill group was relatively large. This negative (relative) *own-effect on wages* (γ_{wk}) is present for all skills. This parameter estimate is the closest to the estimate of a structural parameter of the model but does not say much about the effect of immigrants on a skill-group of U.S. born. In fact it does not consider the positive effect on U.S. wages coming from the increase in supply of different skill groups. In order to assess empirically the magnitude of actual wage change we need to estimate γ_{wk}^{total}, the overall impact on wages of U.S.-born workers of skill k of an increase in immigrants of all skills. This shows that only low skilled actually suffered from immigration, while intermediate and high skilled gained. Finally these effects by group have to be reconciled with the finding of a strong positive association between *average wages* of US- born and the flow of immigrants in a metropolitan area (γ_E). Moreover, in the aggregate we observe a strong and positive impact of inflow of foreign-born on value of housing (this effect was also found previously by Saiz 2004).

In the next section we present a very simple model of aggregate production (valid at the city level as well as the national level) in order to illustrate the channels and quantify the main effects of immigrants on wages of US-born workers. In that model we rely on some estimates of "structural" parameters and we calculate the effects that increase in supply of foreign born (given their skill composition) have on U.S.-born workers. We see that such simple model matches fairly well all the elasticities estimated above. Then we embed the simple production function into a general equilibrium model (with consumption and mobility of workers) and by simulating it we reproduce the effect of an inflows of immigrants on the average rents average migration of US-born as well as their average wages.

3 A Simple Explanation of the Gains from Migration

Consider total output in a city (or in the whole country) as described by the following classic aggregate production function

$$Y = A\widetilde{C}^{\alpha}K^{1-\alpha} \tag{7}$$

where Y is the aggregate income, A is total factor productivity, K is physical Capital and $\widetilde{C}$ is a Constant-Elasticity-of-Substitution aggregate of several, imperfectly substitutable, types of workers. The Elasticity of output to the labor aggregate is α and $\widetilde{C}$ is defined as:

$$\widetilde{C} = \left[\sum_{k=1}^{n}\left(\frac{C_k}{\tau_k}\right)^{\frac{\delta-1}{\delta}}\right]^{\frac{\delta}{\delta-1}} \tag{8}$$

C_k is an aggregate measure of worker of skill k and $\frac{1}{\tau_k}$ is the skill-specific productivity. We assume for simplicity that skills correspond to three educational groups: High School Dropouts (or low skills denoted with L) , High school Graduates (or intermediate skills denoted with M) and and College Graduates (or high skills denoted with S)[9] so that $k = L.M.S$. Within an educational group several other characteristics may differentiate workers (experience, occupation and so on) however, as we are interested in measuring the impact of foreign born on US born we assume that each aggregate C_k is a CES combination of US native workers and Foreign born workers in that education group. Foreign-born workers may have received part of their education abroad, they have language skills different from natives, receive an education at home that emphasizes different qualities than the Natives and so on. Therefore they seem to be differentiated enough to be potentially considered as imperfect substitutable with US born. In any case will be the empirical analysis to reveal wether their elasticity of substitution with US born in the same skill group is infinity or lower. Each C_k is defined as:

$$\frac{C_k}{\tau_k} = \left[\left(\frac{H_k}{\tau_{Hk}}\right)^{\frac{\sigma k-1}{\sigma k}} + \left(\frac{F_k}{\tau_{Fk}}\right)^{\frac{\sigma k-1}{\sigma k}}\right]^{\frac{\sigma k}{\sigma k-1}} \tag{9}$$

for $k = L, M, S$.

H_k is the number of Home-born worker with skill k, F_k is the number of foreign-born workers with skill k , $1/\tau_{Fk}$ is the efficiency of foreign workers relative to natives and σ_k is the elasticity of substitution between Home-born and Foreign-born within workers of skill k.

In the long run both at the national level an at the city level the stock of Capital is endogenously determined. If we assume perfect mobility of physical capital in the country and accumulation of capital following the Ramsey model in the aggregate, then in balanced growth path the real interest rate r as well as the capital-output ratio K/Y is constant and common across cities.

[9] We also did the calculations and simulations with four skill groups, separating high school graduates from college dropouts obtaining identical results

If we consider that physical capital adjusts (faster than labor does) in order to maintain such constant interest rate (i.e. towards the BGP) we can then solve K out of the production function and we get that in BGP output can be written as a linear function of the labor composite:

$$Y = \left(\frac{1-\alpha}{r}\right)^{\frac{1-\alpha}{\alpha}} A\widetilde{C} = \widehat{A}\widetilde{C} \tag{10}$$

where $\widehat{A} = \left(\frac{1-\alpha}{r}\right)^{\frac{1-\alpha}{\alpha}} A$ simply absorbs a constant into the TFP factor. Expression (10) shows that income per worker grows at the rate of exogenous technology, and that its level depends on the terms affecting the labor composite $\widetilde{L}$.Importantly in the long-run the elasticity of income to the labor composite $\widetilde{L}$ is one as capital is not a fixed factor and adjusts to the labor input to maintain a constant interest rate. Therefore when calculating the long-run elasticities of wages (income per worker) to supply of any kind of workers we will use the production function in (10)[10].

3.1 Labor-Demand Elasticities

Using the production function in (10) we calculate the long-run partial elasticity of wage of Home-born in group k_i ($i = 1...3$) to a shock in the supply of foreign-born F_{k_j}, ($j = 1...3$).These elasticities turn out to be functions of the parameters δ and σ_k and provide the long-run change in wage of each group and clarify which group gains and which one looses from the increase of specific groups of foreign-born. Then we can express, as a function of these elasticities, the elasticity of the average wage of US born (averaging across skill group) to the change in the supply of each group of foreign-born. Similarly we can calculate, as a function of δ and σ_k the elasticity of wage of a group to the combined changes in supply of foreign-born in all the groups.

Using the production function (10) and the definitions (8) and (9) of $\widetilde{C}$ and C_k respectively, we obtain the following two expressions for the wage of US-born workers within skill-group k, (w_{Hk}) and for the wage of foreign-born workers within skill group k, (w_{Fk}):

$$w_{Hk} = \widetilde{A}\left(\frac{1}{\tau_k}\right)^{\frac{\delta-1}{\delta}} \widetilde{L}^{\frac{1}{\delta}} L_k^{-\frac{1}{\delta}+\frac{1}{\sigma k}} H_k^{-\frac{1}{\sigma k}} \tag{11}$$

$$w_{Fk} = \widetilde{A}\left(\frac{1}{\tau_k}\right)^{\frac{\delta-1}{\delta}} \left(\frac{1}{\tau_{Fk}}\right)^{\frac{\sigma k-1}{\sigma k}} \widetilde{L}^{\frac{1}{\delta}} L_k^{-\frac{1}{\delta}+\frac{1}{\sigma k}} F_k^{-\frac{1}{\sigma k}} \tag{12}$$

[10] this is a crucial difference with Borjas (2003) who, in calcualting the long-run elasticities of wages to inflows of immigrants assumes, counterfactually, constant capital stock.

Taken in logs the above equation provides the empirical basis for obtaining the relevant elasticities. In particular if we compact in the term $B_k = \widetilde{A}\left(\frac{1}{\tau_k}\right)^{\frac{\delta-1}{\delta}}\left(\frac{1}{\tau_{Fk}}\right)^{\frac{\sigma k-1}{\sigma k}}$ all the terms capturing technology, which are independent of labor supply we can write:

$$\ln(w_{Hk}) = \ln B_k + \frac{1}{\delta}\ln(\widetilde{L}) - \left(\frac{1}{\delta} - \frac{1}{\sigma k}\right)\ln(L_k) - \frac{1}{\sigma k}\ln(H_k) \tag{13}$$

From this expression we can derive all the needed elasticities, and impute the impact of a change in supply of any group of foreign-born on any other group of home born and on their aggregates. Define the share of total wage bill going to foreign workers in skill group k, $\frac{w_{Fk}F_k}{\sum_j(w_{Fj}F_j+w_{Hj}H_j)}$, as s_{Fk} and the share of total labor supply represented by foreign workers in skill group k, $\frac{F_k}{\sum_j(F_j+H_j)}$, as $\varkappa_{Fk}$. Analogously $s_k = \frac{(w_{Fk}F_k+w_{Hk}H_k)}{\sum_j(w_{Fj}F_j+w_{Hj}H_j)}$ denotes the share of wages going to all workers of skill k and $\varkappa_k = \frac{(F_k+H_k)}{\sum_j(F_j+H_j)}$ is the share of labor supply represented by all workers in skill group k. The partial elasticity of wages of home-born to an increase in supply of foreign-born in the same skill group is:

$$\frac{\Delta w_{Hk}/w_{Hk}}{\Delta F_k/L_k} = \left(\frac{1}{\delta}s_{Fk} + \left(\frac{1}{\sigma_k} - \frac{1}{\delta}\right)\frac{s_{Fk}}{s_k}\right)\frac{\varkappa_k}{\varkappa_{Fk}} \tag{14}$$

we expressed, as customarily done in the empirical analysis (so that we can compare elasticities) the change in foreign-born ΔF_k as a percentage of the total initial supply of labor in skill group k, L_k, namely $\frac{\Delta F_k}{L_k} = (F_{kt+10} - F_{kt})/(F_t + H_t)$. The partial elasticity of wages of home born in skill group k to an increase in supply of foreign born in a different skill group, m, is:

$$\frac{\Delta w_{Hk}/w_{Hk}}{\Delta F_m/L_m} = \frac{1}{\delta}s_{Fki}\frac{\varkappa_m}{\varkappa_{Fm}} \tag{15}$$

The elasticity estimates, γ_{wk}, reported in section 2.2 and obtained using the standard method (such as in Borjas, 2003) where all the variation that is not skill subgroup-year specific is absorbed into fixed effect, can be expressed as follows:

$$\gamma_{wk} = \left|\frac{\Delta w_{Hk}/w_{Hk}}{\Delta F_k/L_k}\right|_{\widetilde{L}\text{,constant}} = \left(\frac{1}{\sigma_{ki}} - \frac{1}{\delta}\right)\left(\frac{s_{Fk}}{s_k}\right)\left(\frac{\varkappa_k}{\varkappa_{Fk}}\right) \tag{16}$$

Notice that only if foreign and native born within a skill group are prefect substitutes $\sigma_{ki} = \infty$ and they have the same efficiency, $\tau_{Hk} = \tau_{Fk}$, (which would imply that the wage share of Foreign-born in skill group k and its labor share are equal) then the expression (16) is equal to $-\frac{1}{\delta}$, the elasticity of substitution

between skills. If there is imperfect substitutability between foreign-born and home-born workers (as it is the case) and if the share of wage of foreign-born is smaller than their share of labor (which is true for low and medium skills) the value above is smaller in absolute value than $-\frac{1}{\delta}$.

While the "cross" elasticity of wages of home workers with respect to change in supply of foreign workers, expressed by (15) is always positive, the elasticity of home workers with respect to changes in the supply of foreign in the same skill group could be positive or negative depending on the magnitude of the parameter σ_{ki}. If $\sigma_{ki} > \delta$ the expression in (**??**) can be negative and for $\sigma_{ki} = \infty$ (foreign born are perfect substitute for US born) then the elasticity in (**??**) is certainly negative. A central role is therefore played by σ_{ki} the elasticity of substitution between foreign and US-born workers within each group. Luckily taking the logarithmic ratio of expression (11) and (12) we obtain the following expression:

$$\ln(w_{Hk}/w_{Fk}) = -\frac{1}{\sigma_k}\ln(H_k/F_k) - \frac{\sigma_k - 1}{\sigma_k}\ln\tau_{Fk} \tag{17}$$

Assuming that the relative supply H_k/F_k varies independently of τ_{Fk}, or at least that we can effectively find an instrument that affects the relative supply of foreign born and is independent of τ_{Fk} we can estimate consistently the parameter $\frac{1}{\sigma k}$.

3.2 The Impact of Immigration on wages

The expressions (14) and (15) provide all that is needed to evaluate the effect of an exogenous immigration shock (distributed across skill groups) on the average wage of US born workers. Such effect will depend on a combination of the elasticities, δ and σ_k and on the initial share of wages across groups (besides the magnitude to the supply shock itself).

We can define γ_{wk}^{total}, the elasticity of the wage of US-born workers in skill group k to the total increase in the supply of foreigners (combining all skill groups) as:

$$\gamma_{wk}^{total} = \frac{\Delta w_{Hk}/w_{Hk}}{\Delta f} = \frac{\left(\frac{1}{\sigma_{ki}} - \frac{1}{\delta}\right)\left(\frac{s_{Fk}}{s_k}\frac{1}{\varkappa_{Fk}}\right)\frac{\Delta F_k}{L} + \frac{1}{\delta}\sum_j \frac{s_{Fi}}{s_j}\frac{\Delta F_j}{L}}{\Delta f} \tag{18}$$

where $\Delta f = \frac{\Delta F}{L} = \sum_k \left(\frac{\Delta F_k}{L}\right)$.Finally, combining the above effects for all home-born workers, we can calculate the elasticity, γ_w (as estimated in section 2.1 above) of the average wage of home-born workers with respect to an increase in foreign-born of all skills which is equal to:

$$\gamma_w = \frac{\Delta \overline{w}_H / \overline{w}_H}{\Delta f} = \frac{\sum_k \left[\frac{1}{\delta} s_H + \left(\frac{1}{\sigma_k} - \frac{1}{\delta} \right) \frac{s_{Hk}}{s_k} \right] \left(\frac{s_{Fk}}{\varkappa_{Fk}} \right) \left(\frac{\Delta F_k}{L} \right)}{\Delta f} \tag{19}$$

In the next section we use our original estimates of the parameter σ_k, existing estimates of δ, data on supply and wages of U.S., and foreign-born workers, by skill, to substitute into formulas (16), (18) and (19) in order to calculate the impact of immigrants in the period 1990-2000 on the wages of U.S.-born workers.

3.3 Calculating the Effects of 1990-2000 migration on wages

3.3.1 Estimates of σ_k

In order to apply the formulas of the previous section (to calculate the effect of immigrants on the wage of U.S. born workers) we need to estimate some key parameters, namely the elasticities of substitution, σ_k, between U.S.-born and Foreign-born within each skill-group. The simplest way of doing it is by running a regression of relative wages on relative supplies controlling for skill and year effects (if we use national data) or skill, and city by year effects (if we use MSA data). Therefore we run the regression:

$$\ln(w_{Hkct}/w_{Fkct}) = D_k + D_{ct} - \frac{1}{\sigma_k} \ln(H_{kct}/F_{kct}) + \varepsilon_{kct} \tag{20}$$

The regression is clearly a generalization of (17) that is derived from our production function. We choose to implement these regression in several different ways. We first use country-level data (1970,80,90,2000) and a fine division of skills-groups (4 schooling groups and 8 experience groups, the same as in Borjas 2003) instrumenting the relative supply of foreign-born within each group and year, $\ln(H_{kt}/F_{kt})$ simply with $\ln(1/F_{kt})$.This amounts to assume that, after controlling for schooling by year, experience by year and experience by education effect the inflow of immigrants is exogenous to within skill relative productivity shocks in the US economy. We can perform such estimates either pooling all four schooling groups together, assuming equal elasticity σ_k within each schooling group, or for each schooling group separately allowing different σ_k across schooling groups.The above regression produces an estimate of $-\frac{1}{\sigma_k}$ and of its standard error. We use the delta-method to calculate σ_k and its standard error. The results of these estimation (each cell is a separate regression) are reported in the first column of Table 4. Alternatively we can use the variation across cities and years to identify such parameter. In the second column of table 4 we estimate σ_k using only four schooling groups (High school Dropouts, High School Graduates, College Dropouts and College Graduates) as skills but using the relative supply of Foreign and U.S. born across the 86 Metropolitan areas

in the four census years (1970-2000). Again we estimate the elasticities either allowing them to differ across schooling groups (hence having only 86 observation over 4 years) and including city and time fixed effects, or imposing that they are the same across the four groups and controlling for city by time fixed effects. The relative supply $\ln(H_{kct}/F_{kct})$ across cities is instrumented using the "imputed" number of foreign-born in each schooling group, calculated as described in section 2.1.2, and the initial supply of U.S. born (relative to year 1970).

First let us notice that the estimates of the elasticities are not very precise. They are often sensitive to the inclusion or exclusion of years and observations or to the exact definition of the wage variable. Few regularities emerge, however. First all estimates (and in particular those in Column 1 that are more precise) are well below infinity (i.e. the estimated parameter $-\frac{1}{\sigma_k}$ was significantly different from 0). This means that U.S. and foreign born are not perfect substitutes. Second in all cases the more educated workers appear more complementary to each other than the intermediate or low skilled ones. Third considering the most precise estimates in column 1 an elasticity of substitution around 7 seem appropriate within the low skill group while an elasticity around 4 seem appropriate within the high-skilled group. We will use values around these in the calculations of next section. Notice one important fact. If there is endogeneity bias driven by the fact that immigrant in a skill group are attracted by unobservable shocks that drive up their productivity in the US (or in a city) this would bias up our elasticity estimates (as it will bias down in absolute value the effect on wages due to increase in supply). Therefore if our instrument do not solve this problem fully our estimates of the elasticity should be considered as upper bounds for the real parameter values. Also referring to the existing estimates of substitutability across experience groups (Card and Lemieux 2001, Borjas 2003) which range between 3 and 4 we find our estimates very reasonable. Native and foreign-born should not be much easier to substitute in production than two U.S. born workers with 5 years of experience difference. While probably the future applied literature should try to tackle the estimation of the parameter σ_k carefully we consider our estimates as a useful starting point and we use them as reference point in our calculations and simulations.

3.3.2 Effects of Immigration and some Experiments

Table 5 presents the calculations of the effects of an increase in foreign-born workers (in each skill group expressed as a percentage of total 1990 employment) equal to the actual inflow occurred during the period 1990-2000 on the average wage of US-born . We use the formulas defined above to calculate the effects, We calculate the implied elasticity of average wage γ_w using (19), the elasticity of wages to total immigration for each skill group k, γ_{wk}^{total} (using 18) and the elasticity of labor demand within each skill group, γ_{wk} using (16). The first five rows of Table 5 present calculations using different values of the elasticities. The shock reproduces the inflow of foreign born during the nineties, as percentage of initial population, and considers only urban population as we

restrict our attention to cities in the empirical analysis. The shock has the following composition: $\Delta f_L = 1.4\%$, $\Delta f_M = 2.3\%$, $\Delta f_S = 2.3\%$ as the increase in foreign-born without an high school degree was equal to 1.4% of total US employment in 1990, the inflow of immigrants with high-school degree was equal to 2.3% of US employment in 1990 and the inflow of college graduates equal to 2.3% of employment in 1990. The overall increase in foreign-born worker equated 6% of the US employment in 1990, and the share of foreign-born in the US cities increased from 10.6% in 1990 to 16.6% in 2000. Specification 1 (first row) of Table 5 is reported as reference. We assume, counterfactually, that foreign-born and U.S. born workers within each skill group are perfect substitutes. Moreover we assume that the elasticity of substitution between schooling groups is 1.5 (consistently with most of the existing estimates, such as Katz and Murphy 1992, Angrist 1995 or Borjas 2003). Under this assumption there would only be a depressing effect of immigrants on wages of Americans in the same skill group. However American workers in the other skill groups would experience an increase in wage. We clearly see that the most important effects, in this case are relative changes of wages. Low skills experience a decrease in wage of 1.9 %(=0.06X0.36), intermediate skills experience an increase of their wage by 1.4% (=0.06X0.24) while high skills experience a decrease of their wage by 3.6%(=0.06X0.62). When we aggregate these effects, however, due to the fact that immigration was more abundant in this skill groups that are relatively scarce among U.S. born workers (low and high skills) and was scarce in group where U.S. born abound (intermediate skills) we observe a (very small) positive effect on average wage. Even in the case, in which contrarily to our estimates, we assume that foreign born do not supply any complementary unobservable skill, their overall effect on average U.S. wages is positive (however very small), due to the relative composition of their observable skills.

Consider now specification 2 in which we choose the values σ_L =8, σ_M =8 and σ_S =6 as elasticity of substitution between foreign and US-born workers in the Low, Medium and High skill groups, respectively. These values are well within the estimated range and probably closer to an upper bound for the elasticities, over-stating the degree of substitutability between US-born and foreign-born worker. Still, with such parameter values the overall implied impact of immigrants on average wage of US-born is a positive 0.9%. Also, plausibly, and not far from the previous existing (and ours) estimates the partial elasticity of labor demand is around -0.5 for each skill. Finally, and importantly, the overall effect of migration on low skill is a negative 0.17 for each percentage of foreign born workers moving in the country, while it is a positive 0.32 for wages of intermediate skills and close to zero for college graduates. The values presented fall somewhat short from reproducing the positive effect of foreign-born on average wages and the effect on the wages of college graduates. However, relative to the case of no complementarity, they do a much better job in reproducing (at least in part) the positive average effect, the negative effect on low-skill wages and the positive effect on intermediate skill wages, still matching perfectly the elasticity of demand for each skill. The three following specifications choose lower values of the elasticities, still in the plausible range given our estimates, with the result

of increasing the positive effect on average wages and strengthening the positive impact on wages of college-graduates, which are both features of the empirical correlations found above. In particular our preferred specification with elasticity of substitution equal to 6,6 and 4 produces an elasticity of average wages to total immigrants, γ_w, equal to 0.28 (vis-a-vis IV estimates between 0.35-0.4) an elasticity of demand within a skill group, γ_{wk} around 0.40 (vis-a-vis IV estimate of 0.45) and elasticity of Low, Intermediate and High skills to total migration equal to -0.02, 0.41 and 0.56 vis-a-vis IV estimates of those effects equal to -0.10, 0.15, 0.40. Broadly speaking the match is remarkably good and the value of the parameters is extremely plausible so that we consider specification 4 as the preferred one. Specification 3 and 5 come however close in their ability of matching the elasticities (each one mathcing better some elasticity than others). Therefore, with a very simple production function that only accounts for complementarity across workers' skills we are able to account for between 70 and 80% of the positive estimated average effect of immigrants on average wages of U.S. born workers. This seems remarkable.

At this point we could not resist the temptation to take our preferred parameter specification and run a few counterfactual experiments. Namely what would happen to the average wage of U.S. born if the skill distribution of skills of immigrants were to be shifted drastically either eliminating low skill immigrants, or (alternatively) eliminating high skilled immigrants or intermediate skills immigrants? Specification 6,7 and 8 perform such counter-factual experiment, keeping the total immigration constant but shifting immigrants into the closest skill group. Specification 6 shifts the inflow of 1.4% of low skills into an extra-inflow of intermediate skills which now increase by 3.7% of the initial total employment. Similarly specification 7 eliminates any college-graduate immigration and add 2.3% immigrant to the intermediate skills. The last specification distributes the 2.3% inflow of intermediate skilled immigrants equally into the other two groups (1.15% to high and 1.15% to low skills). The main thing we want to point out is that the elimination of either low or high skill immigrants result into a smaller gain for the average native worker. With no unskilled migration the 6% immigration causes an increase of average U.S. wages by 1.6% (rather then by 1.7%, in specification 4), while eliminating high-skills the effect is larger with only a positive 1.0% effect on average U.S. wages. The only beneficial shift would be to eliminate immigration of the intermediate skills group increasing high and low skilled immigrants. The intuition for this result is clear. First more benefit accrue to the average US economy the more different is the skill composition of immigrant to its own composition, this is achieved by making even scarcer among immigrants those skills that are abundant among American (i.e. the intermediate skills). Second there is a greater advantage from having high-skilled given their higher degree of complementarity with U.S. high skills, therefore having more of those immigrants is good. All in all while highly skilled immigrants are good for the U.S. , low skilled immigrants are not bad either, while the intermediate skills do not seem to have a positive impact on overall wages. Of course the impact on relative wages also follows (inversely) the relative scarcity of immigrant skills.

4 A General City Model

Consider a city with land area equal to T. There are W workers who, mirroring the assumptions in section 3 are differentiated both horizontally (between Home and Foreign born) and vertically in terms of skill level (Low, Medium, High). This gives rise to six categories denoted as described in the following matrix:

	Home	Foreign	Total
Low skill	H_L	F_L	L
Medium skill	H_M	F_M	M
High skill	H_S	F_S	S
Total	H	F	W

Each worker inelastically supplies one unit of labor to production of tradable good Y and one unit of labor to the production of a locally consumed "ethnic" non-tradable service X. 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 born in h with skill level k in production of good Y. Analogously, we call $1/\tau_{Xh}$ the efficiency units of a worker born in h in the production of service X ($1/\tau_{Xh}$ can be also interpreted as a quality parameter).

4.1 Preferences

Workers' preference are defined over three goods: the tradable good Y, the ethnic non-tradable service X, and housing:

$$U = Y^{\alpha} X^{\beta} T^{1-\alpha-\beta} \tag{21}$$

with

$$X = \left[\left(\frac{X_H}{\tau_{XH}} \right)^{\frac{\gamma-1}{\gamma}} + \left(\frac{X_F}{\tau_{XF}} \right)^{\frac{\gamma-1}{\gamma}} \right]^{\frac{\gamma}{\gamma-1}} \tag{22}$$

where Y is consumption of the tradable good, T is consumption of housing services, X_H and X_F are the quantities consumed of the local service produced, respectively by the home-born and by the foreign-born. $\gamma > 1$ is their elasticity of substitution. The idea that we capture with the introduction of this "backyard production" of the ethnic service, X, is that the variety of local services provided by Home and Foreign-born and available for consumption in a city may add to its amenities. What we have in mind is the fact that in a city with more foreign-born people there will be a variety of restaurants, specialty food shops and entertainment opportunities that enhance the utility of a family as long as they are not perfect substitute with the varieties provided by US born. This extra-channel introduced in this "city" model links foreign-born not only to productivity but to consumption amenities of US-born in a city. What we have in mind is that Chinese, Italian, Brazilian restaurants as well as Spanish Opera Singers and Russian dancers add to the diversity (and the value) of local consumption and are varieties of a service (restaurants, entertainments) exclusively provided by foreign-born.

4.2 Technology

On the supply side, all markets are perfectly competitive. The production of tradables is identical to the one defined in (10) which can be explicitly written, redefining the terms τ_k to incorporate the constant term $\widetilde{A}$ as:

$$Y = \left[\left(\frac{C_L}{\tau_L} \right)^{\frac{\delta-1}{\delta}} + \left(\frac{C_M}{\tau_M} \right)^{\frac{\delta-1}{\delta}} + \left(\frac{C_S}{\tau_S} \right)^{\frac{\delta-1}{\delta}} \right]^{\frac{\delta}{\delta-1}} \tag{23}$$

with

$$\frac{C_L}{\tau_L} = \left[\left(\frac{H_L}{\tau_{LH}} \right)^{\frac{\sigma_L-1}{\sigma_L}} + \left(\frac{F_L}{\tau_{LF}} \right)^{\frac{\sigma_L-1}{\sigma_L}} \right]^{\frac{\sigma_L}{\sigma L-1}}$$

$$\frac{C_M}{\tau_M} = \left[\left(\frac{H_M}{\tau_{MH}} \right)^{\frac{\sigma_M-1}{\sigma_M}} + \left(\frac{F_M}{\tau_{MF}} \right)^{\frac{\sigma_M-1}{\sigma_M}} \right]^{\frac{\sigma_M}{\sigma_M-1}}$$

$$\frac{C_S}{\tau_S} = \left[\left(\frac{H_S}{\tau_{SH}} \right)^{\frac{\sigma_S-1}{\sigma_S}} + \left(\frac{F_S}{\tau_{SF}} \right)^{\frac{\sigma_S-1}{\sigma_S}} \right]^{\frac{\sigma_S}{\sigma_S-1}}$$

The production of local service X_h requires one unit of labor of type h per unit of output. Hence, $X_H = H$ and $X_F = F$. Analogously, housing requires one unit of land per unit of output. Lot size is normalized to unity.

4.3 Equilibrium

The analytic description of equilibrium conditions as well as the explicit solution for some intermediate results of the model is provided in the Appendix. Here we describe the equilibrium conditions and the simulation exercise that we perform in order to evaluate the impact of an exogenous shock to the supply of foreign-born workers. The individuals maximize their utility and firms maximize profits. Moreover US-born individuals are free to move across cities in order to take advantage of better wages and lower prices, so that free mobility of people ensures that their utility is equated across cities. Similarly firms can move between cities, however the CRS property of the production function and perfect competition ensures that they will have zero profit in any location. We assume that the initial distribution of foreign-born workers in the city, F_L, F_M, F_S is exogenously given and we consider the city as a small-open economy in which US-born workers move in or out in order to equate the real wage in the city to the real wage perceived in the rest of the economy. For an initial distribution F_{L0}, F_{M0}, F_{S0} and a given level of utility, $\overline{V}_{LH}, \overline{V}_{MH}, \overline{V}_{SH}$ that can be reached by each US-born individual of skill group L, M, S in the rest of the country we can calculate the initial distribution of US-born workers H_{L0}, H_{M0}, H_{S0} in the city and evaluate their nominal wages, the price of local service and of housing and their real wage. We then introduce a shock to the exogenous supply of

foreign-born workers $\Delta F_L, \Delta F_M, \Delta F_S$ which represents a migratory inflow. We evaluate the impact effect of such shock on the wage, housing prices and local service price (short term impact). Then, letting US-born workers free to move in and out of the city in order to arbitrage away the differences in real wages that arose as a consequence of migration we calculate the new equilibrium once the free-mobility condition is satisfied. We can calculate the change in nominal wage of each group, as well as the change in average wage, rents and the change in employment of US-born. The mathematical details of the equilibrium are in the Appendix. Here we simply discuss the parametrization of the model, and we present some simulations of the shocks, providing intuition for effect of an inflow of immigrants on wages, rents and employment of US-born.

In the light of the positive effect of an inflow of Foreign-born workers on the productivity of US-born workers found in the previous section, let me discuss, intuitively, what will happen in this multi-city model when the local economy is hit by an inflow of foreign workers. As a consequence of the increased average productivity of US-born more workers would be attracted to the city. However the inflow of foreigners will also have an impact on housing values (increasing population density and therefore the cost of a house) and on the price of the local service (decreasing its price for US-born as more varieties of services are available). Therefore, the new equilibrium will be established as higher price of housing and increased inflow of US-born compensate for the increase in productivity (wage income) and lower price of the ethnic good. The new equilibrium exhibits higher rents and wages. Even in an open economy with perfectly mobile workers the effect on wages, therefore, is not dispersed, due to migration, but is, at least in part, capitalized into higher housing values. The equilibrium is guaranteed by the fact that higher wages are now offset by higher housing prices and the real wage (but only the real wage) returns to its initial level.

5 Simulation of the Model

We consider a small open city and its equilibrium before ($t = 0$) and after ($t = 1$) a migratory shock captured by the exogenous change of the supply of foreign-born workers in each of the three skill groups. Variables with a 0 subscript indicate pre-shock equilibrium, while those with a 1 subscript denote post-shock values. Our exercise is one of comparative statics as we consider what happens to the variables of interest, once the new equilibrium is reached. However, in order to understand the mechanisms that drive migration of workers (free-mobility condition) between the shock and the new equilibrium we also report the impact effect of the immigration of foreign-born, namely, what happens to wages and value of houses, before the migratory response of US citizen takes place .

5.1 Initial Conditions and Shock

The initial condition that we try to mirror in this simulation is that of the average US metropolitan area in 1990 and the shock that we produce mirrors the increase in foreign-born in each group of skills, that took place in the 1990-2000 period. We standardize the initial total employment of the representative metropolitan area to 1. The vector of initial supply of US-born workers, $(H_{L0}, H_{M0}H_{S0})$ is $(0.15, 0.59, 0.19)$ and the vector of the initial supply of Foreign-Born workers is: $(F_{L0}, F_{M0}F_{S0})$ is $(0.03, 0.026, 0.014)$. This implies that Foreign-born workers (as a whole) are equal to 7% of US employment, which corresponds to the aggregate figure for 1990. Also, their distribution was unequal across skill groups as they were over-represented among low-skilled (16% of high-school dropouts were foreign born), under-represented among medium-skills (only 4.5% of high school graduates were foreign-born) and about exactly represented among high-skills (7% of college graduates were foreign-born). The magnitude of the immigration shock during the nineties is certainly large, as the foreign-born population almost doubled in the US, going from 7% to 13% of the employment. Our experiment maintains the employment and distribution of US-born workers as in 1990 and increases Foreign-born workers by the amount experienced by the average US city during the 1990-2000 period. The shock is $(\Delta F_L, \Delta F_M, \Delta F_S)$ =$(0.015, 0.03, 0.015)$. The total increase in foreign employment was 6% of the initial US employment. Notice that the values used for the initial conditions and for the shock are the same as those used in the simple calculations in section 3.3.

5.2 Parameterization

We obtain some of the parameters' values from the literature or from simple calculations. Others, mainly the elasticity of substitution between US-born and foreign-born, as they have a particularly crucial role, were estimated, as described in section 3.3. We also provide several robustness checks for different values of the parameters. The parameters of the utility function have been obtained using the share of expenditures of families on housing services to obtain $(1-\alpha-\beta)$ and on local services X to obtain β.These data are from the Consumer Expenditure Survey, available at Bureau of Labor statistics (2005). The share of expenditure in housing services for the 1999-2002 period was somewhat larger than 0.20. We choose $1-\alpha-\beta = 0.20$ as base-value and we also test the effect of $1-\alpha-\beta = 0.25$. As for the share of expenditure on local service X we only include those clearly non-tradable "consumption services" that benefit from "ethnic diversity" in their supply. We include, therefore, the expenditures for food in restaurants, food in specialty shops, and entertainment. This share range between 0.15 and 0.20 of the expenditure of the average US family. We choose $\beta = 0.2$ as base- value and test the effect of $\beta = 0.15$. As for the substitutability between the non-tradable services provided by US-born and Foreign-born we were very conservative assuming a high elasticity (6-7). Considering that the median elasticity of substitution between goods within a five-digit SITC sector

is 4.7 as estimated by Weinstein and Broda (2004) our values are certainly on the high side[11]. Such choice of high elasticity limits the importance of diversity in making a location attractive, therefore bias against us the results.

In the production function of the traded good (23) we assume an elasticity between skill groups, δ, between 1.5 and 2, which is consistent with most of the existing estimates in the literature (Angrist,1995, Katz and Murphy,1992, and Ciccone and Peri, forthcoming). The relative efficiencies of the factors, $(1/\tau_L)$ are taken to match the national wage premia between factors given the relative supply of factors and the elasticity δ. Standardizing the efficiency of unskilled workers, $\tau_L = 1$, we can obtain the other values 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_i is the national average wage of skill k and E_k is the total supply of workers of skill k. The relative efficiency of foreign-born to US-born in any skill group as well as in the production of the local service has been set equal to 1. As the supply of US-born workers in a city is endogenously determined by the equilibrium and the free mobility conditions, but we still want to match their initial distribution we calibrate the levels of utility reached by workers in each skill group $(\overline{V_L}, \overline{V_M}, \overline{V_S})$ so that the initial distribution of US-born is equal to $(H_{L0}, H_{M0}H_{S0})$, defined in the previous section. This complete the parametrization of our model and in the following section we describe the results of the simulation.

5.3 Results

Table 6 summarizes the results of our simulations. Maintaining the common average shock that mimics the increase in foreign-born experienced during the nineties the seven columns correspond to simulations for different combinations of the parameters. While we are mainly interested in the long-run (equilibrium) effect in order to match our estimated effects across decades the first two rows (below the parameters values) in Table 6 report the short-run impact of immigrants on average wages and value of housing of US-born workers. The following three rows of Table 6 report the effect on the average variables for US-born individuals (the percentage change in average wage, the percentage change in the value of housing and the migration in or out) all calculated in the new equilibrium, after internal migration took place. The last three row of Table 6 report the implied elasticity of wages, rents and internal migration to inflow of foreign-born and are directly comparable with the coefficients $\gamma_w, \gamma_r, \gamma_L$ reported in table 1.

Simulation I uses the baseline values for the parameters, while simulation II makes college educated foreigners harder to substitute for US-educated ones. As we can see from the implied long-run elasticities these simulations produce effect on average wage of US born and on their average housing prices extremely close to the parameters estimated in table 1 using instrumental variables. The simulated long-run elasticity of average wages is between 0.35 and 0.46 which

[11] For instance a narrow SITC-5 digits category such as "cheese" has an elasticity of 4.5 among its varieties.

is exactly the range of the IV estimates of γ_w , while the simulated elasticity of housing value is between 1.5 and 1.9 which is a bit higher but still close to the range of the IV estimates of γ_w, 1.2-1.6. Finally the response of internal migration is rather small confirming the IV estimate of a response not significantly different from 0. The other simulations produce results only slightly different from those in column I and II. In fact the effect on average wages is very stable even if we increase somewhat the substitutability between US and foreign-born (column III) or that of the local services (column IV). Increasing the relevance of housing services in the expenditure of families (column V) reduces the impact of immigrants on value of housing, making the implied elasticity equal to the value estimated in Table 1 (1.6). Such modification, however, induces small out-migration of natives. This is due to the fact that as housing expenditures become a more important item a smaller increase in its price balance the positive effect of immigration on wages. Looking at the impact effect, in fact, the impact of foreign-born on wages of US born is smaller and their impact on house prices bigger the after the adjustment. What happens is that US-born worker emigrate in part because of the very large effect on housing prices, and in so doing increase the positive impact on wages and ease the increase in price of houses. Similar effect has the reduction of expenditure in the local service (Column VI). Finally reducing the elasticity of substitution across skills, as the shock affects high skill more than other groups, the attraction effect on the other two groups will increase and more internal migration will be observed. Consistently across estimates, though, the migration response is small (elasticity less than 0.2) while most of the adjustment takes place through increase in wage and in price of housing. This, ultimately, explains our findings of Table 1.

6 Conclusion

Increased movement of people across countries, commonly known as migrations, are a feature of the last decades just as increased movements of goods and capital. While in general economists are found among the staunchest supporters of freer trade and capital movements, they have been mostly arguing that migration hurts native workers, in particular those with low skills. While it is hard to deny that, in any reasonable model, the relative increase of low skill workers will cause a decrease in their relative wage, here we are first interested in determining the overall (average) effect of immigration, aggregating across groups of US-born workers. It turns out empirically and theoretically that immigration, as we have known it during the nineties, had a sizeable beneficial effect to US wages. For a flow of migrants that increases total employment by 10%, with a distribution among skills just as the one observed in the nineties, US-born workers have an average benefit of 3-4% of their wage. This happens because US-born and Foreign-born workers are not perfectly substitutable even when they have similar observable skills. German education emphasizes the study of classic languages (such as Latin) and Math, and German culture stresses virtues as timeliness and order. Spanish education and culture stresses values such as

creativity, imagination and study of foreign languages. Clearly workers born and raised in these environments are not identical to US-born and raised workers. Such "differences" which we may call the "diversity" of foreign-born, is the basis for the gains from immigration that accrue to US-born workers. Even a small amount of difference that translates in a high elasticity of substitution between US and foreign-born workers (in the order of 3 to 6) is enough to generate the average gains that we estimate from US metropolitan data. We believe that sharpening the understanding of complementarities and substitutabilities between Us and Foreign born in different sectors and skills is a crucial step to quantify the benefits of immigrants to the US economy. We hope that this work will open a line of research into the "gains" from immigration that may complement the existing lines of research.

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A Data and Definition of the Variables

A.1 Construction of average wage and average house values

The value of $\ln \overline{w}_{ct}$ used in Section 2.1 to calculate $\Delta \ln \overline{w}_{ct}$ is obtained separately for each census year as the MSA-specific intercept of the following mincerian regression on individual data, after having selected only US-born individuals of individuals born abroad but US citizens since birth:

$$\ln w_{ict} = \ln \overline{w}_{ct} + \alpha(School)_i + \beta(Experience)_i + \gamma(Sex)_i + \delta(Race)_i + \theta(Marital)_i + \varepsilon_{ict}$$

The variable $\ln \overline{w}_{ct}$ captures 84 (or in the 1970-1990 sample 117) MSA-specific dummies. The variable *School* represents four dummies corresponding to the following groups: High School Dropouts, High School Graduates, College Dropouts and College Graduates. This variable is constructed using the variable "highest grade attended" (HIGRADEG) for the 1970 and 1980 Census, and the categorical variable (defined as educ99 in the IPUMS files). Such variable has been converted into years of schooling using the correspondence developed in Park (1994). The variable *Experience* represents eight dummies for five-year groups of experiecen between 0 and 40 years.It is calcualted as potential experience, namely, Age-years of schooling -6. The variable *Sex* is a dummy equal to 1 when the worker is a woman and 0 otherwise. The variable *Race* stand for five dummiews corresponding to White, Black, Hispanic, Native and Asian. The variable *Marital* aidentifies three dummies corresponding to being single, being married or being divorced. The omitted dummies are such that the intercept captures the value for the reference group of High school graduates, 15-20 years of experience, white, male married. When we use hourly wage as measure of w_{ict} we obtain it by dividing the variable "wage and salary income" (previously converted in 2000 USA $ using the CPI deflator) by the variable weeks worked last year and then by "hours worked last week (in the 1970 and 1980 Census) or by "Hours usually worked per week" (in the 1990 and 2000 Census). We selected people who were in the labor force and worked at least one week during the census year and received non-zero salary.

The value of $\ln \overline{r}_{ct}$ used in Section 2.1 to calculate $\Delta \ln \overline{r}_{ct}$ is also obtained separately for each census year as the average by MSA of monthly gross rent (RENTGRS) converted in 2000 US $ using the CPI deflator, or of the Value of the house (VALUEH) also converted in 2000 US $. Each value has been divided by the number of rooms (ROOMS) in the house to standardize for the size of the house and obtain a value per room, comparable across cities. Only US-born head of households have been included in the sample.

A.2 Construction of the Instrument

We first defined 56 countries (or group of countries) of origin of foreign-born that could be tracked consistently from the Census 1970 to the Census 2000. They accounted together for more than 98% of all foreign-born. These countries are: Canada, Atlantic Islands, Mexico, Central America, Cuba

West Indies, SOUTH AMERICA, Denmark, Finland, Iceland, Norway, Sweden, England, Scotland, Wales, Ireland, Belgium, France, Luxembourg, Netherlands, Switerland, Albania, Greece, Italy, Portugal, Spain, Austria, Bulgaria, Czechoslovakia, Germany, Hungary, Poland, Romania, Yugoslavia, Estonia, Latvia, Lithuania,Russia, Rest of Europe, China, Japan, Korea, Philippines, Vietnam, India, Iran, Israel/Palestine, Jordan, Lebanon, Syria,Turkey, Rest of Asia, AFRICA, Australia and New Zealand, Pacific Islands, Abroad (unknown). From the Census 1970 we calcualted the population from each of these nations plus the group opf US born ($n = 1, ...56, 57$) in each of the 177 MSA ($c = 1, ...117$) and called it Pop_{nc1970}. Using the overall Census (1980-2000) we calculated the rowth rate of each nationasl group ($n = 1, ...56, 57$) for the whole US. Foreign-born groups grew because of migration, US-born because of demographics. For each decade $t = 1970, 1980, 1990$ we can define the growth rate of a national group in the whole USA during that decade as $g_{nt} = (Pop_{nt+10} - Pop_{nt})/Pop_{nt}$. Finally we apply these national growth rates for each decade to the initial populaation Pop_{nc1970} to obtain an imputed population which would correspond to the real population of that group only if in city c national group n has grown exactly as the overall community in the US. $\widehat{Pop}_{nct+10} = Pop_{nc1970}(1 + g_{nt})$ where the "hat" indicates that the value is imputed. Finally we can calculate using these inputed population the inputed shares of foreign born in each city in each census year (1980-2000).

B Equilibrium of the City Model

Let us define w_{kh} as the wage per worker born in h with skill level k, p_Y the price per unit of the tradable good Y, p_{Xh} the price per unit of local service X_h, and r the land rent. If we call $\overline{w}$ the vector of w_{kh}'s and $\overline{E}$ the associated vector of labor endowments, then aggregate income can be written as:

$$I = \overline{w}'\overline{E} + p_{XH}X_H + p_{XF}X_F + rT$$

Utility maximization, profit maximization, and land market clearing imply:

$$rT = (1 - \alpha - \beta)\, I$$

Utility maximization, profit maximization, and service-market clearing imply:

$$p_{XH}X_H + p_{XF}X_F = \beta I \tag{24}$$

Utility maximization, profit maximization, and tradable good-market clearing imply:

$$p_Y Y = \alpha I$$

These four conditions together give:

$$I = \frac{\overline{w}'\overline{E}}{\alpha} \tag{25}$$

$$p_Y Y = \overline{w}'\overline{E} \tag{26}$$

$$rT = \frac{1-\alpha-\beta}{\alpha}\overline{w}'\overline{E} \tag{27}$$

Profit maximization also requires:

$$p_Y = P_C \tag{28}$$

where:

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

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

for all $k \in \{L, M, S\}$ are the price indices associated with the quantity indices C and C_k/τ_k respectively.

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

$$P_k C_k = \phi_k \left(\frac{P_k}{P_C}\right)^{1-\delta} P_C C \tag{29}$$

$$w_{kh} k_h = \phi_{kh} \left(\frac{w_{kh}}{P_k}\right)^{1-\sigma_k} P_k C_k \tag{30}$$

for all $k = \{L, M, S\}$ and $h = \{H, F\}$. These expressions can be easily manipulated to produce:

$$\phi_k \left(\frac{P_k}{P_C}\right)^{1-\delta} = \frac{\phi_k^{\frac{1}{\delta}} C_k^{\frac{\delta-1}{\delta}}}{\phi_L^{\frac{1}{\delta}} C_L^{\frac{\delta-1}{\delta}} + \phi_M^{\frac{1}{\delta}} C_M^{\frac{\delta-1}{\delta}} + \phi_S^{\frac{1}{\delta}} C_S^{\frac{\delta-1}{\delta}}} = \phi_k^{\frac{1}{\delta}} \left(\frac{C_k}{C}\right)^{\frac{\delta-1}{\delta}} \tag{31}$$

$$\phi_{kh} \left(\frac{w_{kh}}{P_k}\right)^{1-\sigma_k} = \frac{\phi_{kh}^{\frac{1}{\sigma_k}} k_h^{\frac{\sigma_k-1}{\sigma_k}}}{\phi_{kH}^{\frac{1}{\sigma_k}} k_H^{\frac{\sigma_k-1}{\sigma_k}} + \phi_{kF}^{\frac{1}{\sigma_k}} k_F^{\frac{\sigma_k-1}{\sigma_k}}} = \phi_{kh}^{\frac{1}{\sigma_k}} \left(\frac{k_h}{C_k}\right)^{\frac{\sigma_k-1}{\sigma_k}} \tag{32}$$

Considering $P_C C = \overline{w}'\overline{E}$ together with (27) and (28) gives:

$$\overline{w}'\overline{E} = p_Y C \tag{33}$$

Finally, we need to characterize the equilibrium prices of the local service. To do this, we observe that we can exploit for the utility the same aggregation properties we used for the production of tradable good. Specifically:

$$p_{Xh} h = \frac{\phi_{Xh}^{\frac{1}{\gamma}} h^{\frac{\gamma-1}{\gamma}}}{\phi_{XH}^{\frac{1}{\gamma}} H^{\frac{\gamma-1}{\gamma}} + \phi_{XF}^{\frac{1}{\gamma}} F^{\frac{\gamma-1}{\gamma}}} \beta I \tag{34}$$

for $h = \{H, F\}$.

B.1 Labor Market

We can represent the equilibrium as the intersection of a labor demand and a labor supply as follows. Demand for labor of skill level k and ethnic group h can be derived by considering (30), (29), (31), (32), (33) together with $P_C C = \overline{w}'\overline{E}$. This gives:

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

where $A \equiv p_Y$ is a constant. Simplifying we get:

$$w_{kh} = A \cdot C^{-\left(\frac{\delta-1}{\delta} - \eta\right)} \cdot \phi_{kh}^{\frac{1}{\sigma_k}} (h_k)^{-\frac{1}{\sigma_k}} \cdot \phi_k^{\frac{1}{\delta}} (C_k)^{-\frac{\sigma_k - \delta}{\delta \sigma_k}} \tag{35}$$

At a free-mobility spatial equilbrium a worker must be indifferent about location irrespective of its ethnicity and skill level. This is the case if she achieves the same level of indirect utility $\overline{V}_{kh}$ is all cities. Given the utility function (21) this requires

$$w_{kh} = \overline{V}_{kh} p_y^{\alpha} P_X^{\beta} r^{1-\alpha-\beta} \tag{36}$$

where

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

is the exact price index associated with (22) such that $P_X X = \beta I$. Thus, by (25) and (27), we have

$$w_{kh} = \overline{V}_{kh} p_y^{\alpha} P_X^{\beta} r^{1-\alpha-\beta} = \overline{V}_{kh} p_y^{\alpha} \left(\frac{\beta}{X}\right)^{\beta} \left(\frac{1-\alpha-\beta}{T}\right)^{1-\alpha-\beta} \left(\frac{\overline{w}'\overline{E}}{\alpha}\right)^{1-\alpha}$$

which, by (33), can be rewritten as:

$$w_{kh} = B \cdot \frac{(C)^{1-\alpha}}{(X)^{\beta} (T)^{1-\alpha-\beta}} \tag{37}$$

where B is a positive constant. Given the definition of the composite C, (37) depicts the (inverse) supply of workers born in h with skill level k as a positive relationship between w_{kh} and k_h.

B.2 Wages and rents

Alternatively we can use a wage equation and a rent equation to illustrate the requilibrium

B.2.1 Free entry

By (28), profit maximization requires

$$p_Y = P_C$$

where P_C can be written as a function of w_{kh} and endowments. This is achieved by considering (30), (29), (31), and (32), which yields

$$P_C = w_{kh}\phi_{kh}^{-\frac{1}{\sigma_k}} \left(\frac{k_h}{C_k}\right)^{\frac{1}{\sigma_k}} \phi_k^{-\frac{1}{\delta}} \left(\frac{C_k}{C}\right)^{\frac{1}{\delta}}$$

Substituting this result into (28) then gives

$$w_{kh} = \phi_{kh}^{\frac{1}{\sigma_k}} (h_k)^{-\frac{1}{\sigma_k}} (C_k)^{-\frac{\sigma_k-\delta}{\delta\sigma_k}} \phi_k^{\frac{1}{\delta}} C^{-\frac{1}{\delta}} p_Y \tag{38}$$

This is the free-entry schedule expressing w_{kh} as independent of r. Any increase in h_k, C_k, and C shifts (38) downwards.

B.2.2 Free mobility

By (36), workers are indifferent about location if

$$w_{kh} = \overline{V}_{kh} p_y^{\alpha} P_X^{\beta} r^{1-\alpha-\beta}$$

To find the free mobility schedule, we need to write P_X as a function of endowments. By (24), (25) and (33), this is achieved as we have:

$$P_X X = \frac{\beta}{\alpha}\overline{w}'\overline{E} = \frac{\beta}{\alpha} p_Y C$$

Hence, by substitution into (36), we get:

$$w_{kh} = B' \left(\frac{C}{X}\right)^{\beta} r^{1-\alpha-\beta} \tag{39}$$

where

$$B' \equiv \overline{V}_{kh} p_y^{\alpha+\beta} \left(\frac{\beta}{\alpha}\right)^{\beta}$$

is a positive constant and

$$X = \left[\phi_{XH}^{\frac{1}{\gamma}} H^{\frac{\gamma-1}{\gamma}} + \phi_{FH}^{\frac{1}{\gamma}} F^{\frac{\gamma-1}{\gamma}}\right]^{\frac{\gamma}{\gamma-1}}$$

FM is the free-entry schedule expressing w_{kh} as an increasing function of r. Any increase C and any decrease in H or F shifts (38) downwards.

Figures and Tables

Figure 1
Response of Employment of US born (% of initial Employment) to changes in Employment of Foreign Born (% of initial Employment) 1970-2000

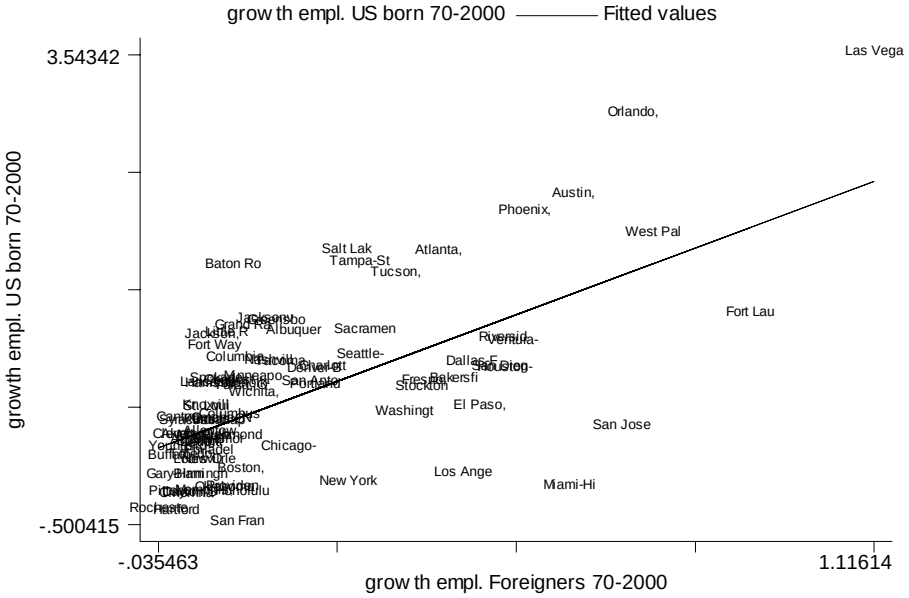

Figure 2
Response of Rent per room for US born (% of initial rent) to change in Foreign Born Employment (% of initial total employment) 1970-2000

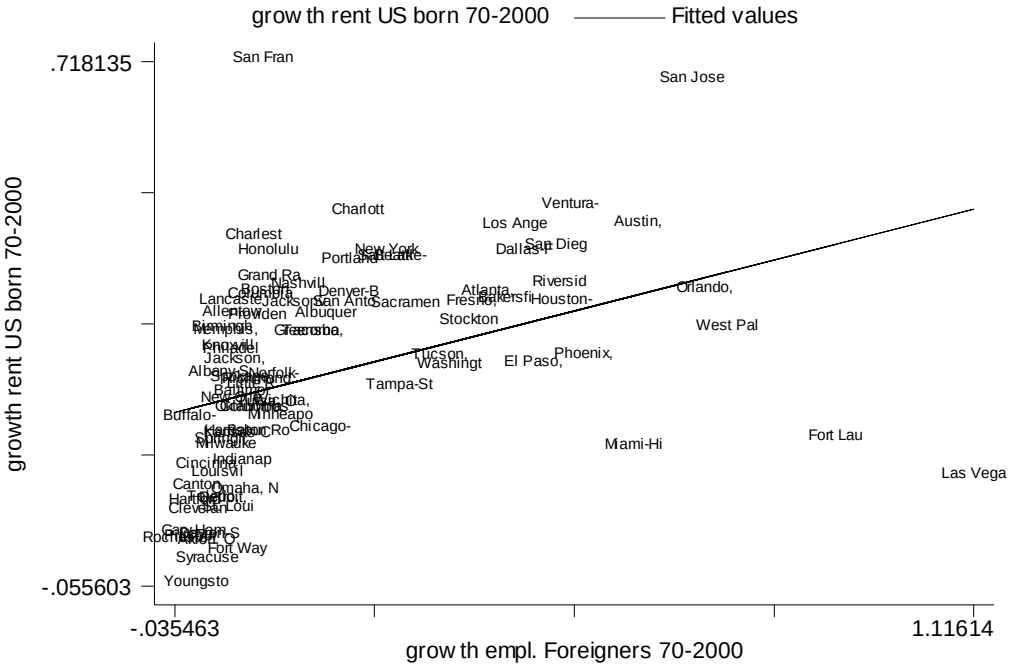

Figure 3
Response of Hourly Wages (% of initial level) to change in Foreign Born Employment (% of initial level) 1970-2000

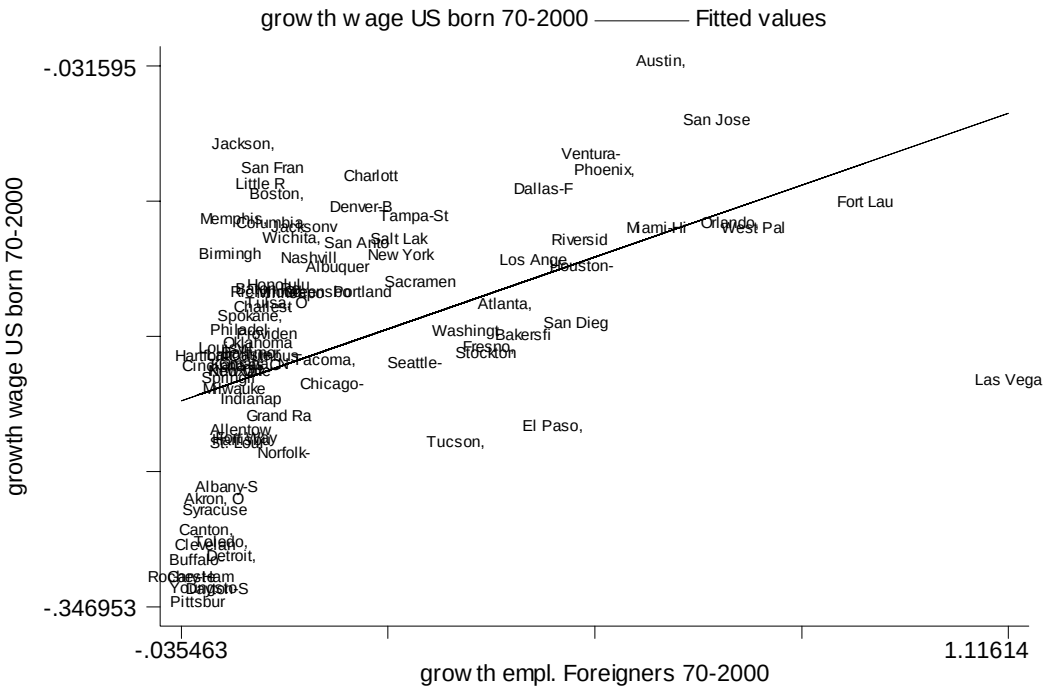

Table 1
Impact of the inflow of immigrants on the employment, average wage and value of housing of US born workers

Specification:	**I**	**II**	**III**	**IV**
Sample and Method of Estimation:	**1970-2000 Panel OLS 86 MSA**	**1970-2000 Panel IV 86 MSA**	**1970-1990 Panel OLS 117 MSA**	**1970-1990 Panel IV 117 MSA**
γ_E	1.30*	0.87	1.44*	1.30
	(0.52)	(0.80)	(0.43)	(0.74)
γ_w	0.42*	0.46*	0.39*	0.38*
(real hourly wages)	(0.15)	(0.21)	(0.08)	(0.19)
γ_w	0.49*	0.35*	0.48*	0.36
(real yearly wages)	(0.17)	(0.19)	(0.09)	(0.22)
γ_r	0.79*	1.25*	0.75*	1.11*
(real gross rents)	(0.37)	(0.40)	(0.19)	(0.30)
γ_r	1.44*	1.61*	1.50*	1.60*
(real value of the house)	(0.65)	(0.75)	(0.28)	(0.60)
City Dummies	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes
Observations	252	252	234	234

The parameter estimate in each cell are from a separate panel regression. The explanatory variables in each regression are city dummies, time dummies and the increase in foreign-born workers as a percentage of initial total employment, as defined by Δf_{ct} in the text. Units of observation: Metropolitan Statistical Areas (MSA) consistently defined across Census years.
Heteroskedasticity-robust standard errors are reported in parenthesis.
*=significant at 5% confidence level.
First Row, Estimates of γ_E **.** The dependent variable is Δn_{ct} , the change in US-born workers in city (MSA) c during decade t as percentage of the initial total employment. Specification I and II use a sample of 86 MSA's for the 1970-2000 period, specification III and IV use 117 MSA's for the 1970-1990 period. Estimates in specification II and IV use the "constructed" inflow of immigrants (from initial shares by nationality and average immigration rates into the US, described in the text) as Instrument for Δf.
Second and Third Row, Estimates of γ_w **.** The dependent variable is $\Delta \ln(w)_{ct}$, the percentage change in average real wage (hourly in the second and yearly in the third row) of US-born workers in city c for decade t. The average logarithmic wage for a city in a census year is calculated as the city-specific intercept of a mincerian regression of individual (log)wages on education dummies, experience dummies, gender, race and marital status dummies restricting the sample to US-born individuals and running the regression separately for each census year. Samples and methods of estimation for γ_w are identical to those described for the first row.
Fourth and Fifth Row, Estimates of γ_r **.** The dependent variable is $\Delta \ln(r)_{ct}$, the percentage change in average real monthly rent (fourth row) or house value (fifth row) divided by the number of rooms, for US-born individuals in city c for decade t. Samples and methods of estimation for γ_r are identical to those described for the first row.

Table 2
Estimates of the Elasticity of Labor Demand, using immigrant flows:
Our Values and Existing estimates

	Source and Method of the Estimate	γ_{Ek}: Response of Employment of US-born to Immigration in the same skill Group	γ_{wk}: Demand Elasticity within a skill group
1	Card and Di Nardo (1998) IV, 119 MSA's	0.24/0.28 (0.09/0.22)	n.a.
2	Card (2001) OLS, 119 MSA's	0.02/0.11 (0.03-0.06)	-0.02/-0.05* (0.005/0.01)
3	Card (2001) IV, MSA's	0.11/0.16* (0.03/0.04)	-0.04/-0.10* (0.02/0.04)
4	Borjas, Freeman and Katz OLS (1997) 48 States	0.77/-0.75* (0.31/0.28)	n.a.
5	Borjas, (2003), OLS, national	n.a.	-0.75* (0.64)
6	Ottaviano and Peri (2005) OLS, 86 MSA's	0.08 (0.13)	-0.02 (0.03)
7	Ottaviano and Peri (2005) IV, 86 MSA's	-0.08 (0.60)	-0.45* (0.25)

1.Estimates are taken from Table 2, Column (7) and (8) of Card and Di Nardo (1998). Observations are relative to three skill groups in 199 MSA for the 1980-1990 period. Instruments are the fraction of Mexican Immigrants in the city.

2 and 3. Estimates of γ_{Ek} are taken from Table 4, column 4 in Card (2001). Data include six occupational groups in 175 cities, period 1985-1990. Instruments are the constructed share of immigrants in each city. Estimates of γ_{wk} are taken from table 7, first column in Card (2001).

4. The estimate range reported is taken from Table 9 in Borjas, Freemand and Katz (1997) and considers the total employment in a state for the period 1960-1990.

5 . Estimate is taken from the estimate of Equation 17 in Borjas (2003)

6 and 7. Estimates are obtained from a sample of 86 MSA's for 1970-2000, and four education groups (HSD, HSG, COD, COG). We control for city by period fixed effect as well as education group by period fixed effect. The IV are the imputed changes in foreign-born workers by city and skill group obtained as described in the text. Robust standard errors are reported in parenthesis.

Table 3
Estimate of the elasticity of wage of each skill group to total change in foreign-born supply.

Specification:	**I**	**II**	**III**	**IV**
Sample and Method of Estimation:	**1970-2000 Panel OLS 86 MSA**	**1970-2000 Panel IV 86 MSA**	**1970-1990 Panel OLS 117 MSA**	**1970-1990 Panel IV 117 MSA**
γ_{wk}^{total} **(High school Dropouts)**	0.28* (0.09)	-0.10 (0.24)	0.38* (0.10)	-0.20 (0.17)
γ_{wk}^{total} **(High School Graduates)**	0.39* (0.07)	0.15 (0.19)	0.43* (0.10)	0.20 (0.15)
γ_{wk}^{total} **(College Graduates)**	0.33* (0.07)	0.40* (0.20)	0.45* (0.09)	0.40* (0.15*)
City Dummies	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes
Observations	252	252	234	234

We use as dependent variable $\Delta\ln(w)_{ct}$, the percentage change in average real wage (hourly) of US-born workers in city c for decade t. The average logarithmic wage for a city in a census year is calculated as the city-specific intercept of a mincerian regression of individual (log)wages on education dummies, experience dummies, gender, race and marital status dummies restricting the sample to US-born individuals and running the regression separately for each census year.

Table 4
Estimate of the elasticity of substitution between U.S. born and Foreign-Born

Sample and Method of Estimation:	**IV** **8 experience groups,** **4 schooling groups,** **National**	**IV** **4 schooling groups,** **MSA data**
σ_k **Imposing same elasticity for different skill groups**	7.7 (1.77)	14.5 (4.25)
Allowing different elasticity for each skill		
σ_{HSD}	7.10 (1.05)	20 (8)
σ_{HSG}	10.1 (3.02)	16 (8.3)
σ_{COD}	16.6 (11.1)	10 (7)
σ_{COG}	4.21 (0.66)	12.5 (11)
Experience X school effects	YES	NO
Year X school effects	YES	NO
Year X Experience Effects	YES	NO
City Dummies	NO	YES
Year Dummies	NO	YES
Instruments:	Total foreign immigrants in each skill group	Imputed foreign-immigrants in each city-skill group
Observations	512 in the pooled regression 128 in each of the skill-specific regression	1376 in the pooled regression 344 in each of the skill-specific regression

We estimate the parameters -($1/\sigma_k$) from the regression of relative wages (foreign-born/US born in the same skill-group) on relative supply (foreign-born/US born in that group). We then compute σ_k and its standard error using the delta-method.

Table 5
Calculated Impact of the inflows of immigrant 1990-2000 using the CES production

	Shocks, 1990-2000				**Parameter Values**		**Calculated Effects on Wages**			
Specification	Δf_L	Δf_M	Δf_S	Δf (sum)	δ	σ_L, σ_M, σ_H	Δlnw= % Increase in average wage of U.S. born workers	γ_w	γ_{wk} Low Medium High	γ_{wk}^{total} Low Medium High
1 Perfect Subst.	1.4%	2.3%	2.3%	6%	1.5	∞ ∞ ∞	0.07%	0.04	-0.60 -0.64 -0.65	-0.36 0.24 -0.62
2	1.4%	2.3%	2.3%	6%	1.5	8 8 6	0.9%	0.15	-0.49 -0.52 -0.49	-0.17 0.32 -0.03
3	1.4%	2.3%	2.3%	6%	1.5	6 6 4	1.2%	0.20	-0.45 -0.48 -0.41	-0.10 0.35 0.26
4	1.4%	2.3%	2.3%	6%	1.5	4 4 3	1.7%	0.28	-0.37 -0.40 -0.33	-0.02 0.41 0.56
5	1.4%	2.3%	2.3%	6%	1.5	8 8 2	1.6%	0.26	-0.49 -0.52 -0.26	-0.17 0.32 0.80
COUNTERFACTUAL SHOCKS										
6 no low skills	0%	3.7%	2.3%	6%	1.5	4 4 3	1.6%	0.27	-0.37 -0.40 -0.32	0.65 0.27 0.26
7 no high skills	1.4%	4.6%	0%	6%	1.5	4 4 3	1.0%	0.18	-0.37 -0.40 -0.32	-0.13 -0.01 0.52
7 no medium skills	2.5%	0%	3.4%	6%	1.5	4 4 3	1.9%	0.32	-0.37 -0.40 -0.32	-0.46 0.72 0.02

The Values of Δlnw, γ_w, γ_{wk} and γ_{wk}^{total} are obtained using the formulas derived in the text. The initial composition of US-born and Foreign-born in each of the skill group replicates the composition from year 1990, as obtained from the IPUMS Census data. In percentage of total employment 10%, 55% and 25% are, respectively, US-born workers in the Low skill (High School dropouts) , Medium skill (High school Graduates) and High skill (college graduates) group, while 3.5%, 4.4% and 2.7% are foreign -born in each of the three skill groups.

Table 6
Simulation of the long-run impact of immigration shock
From the City-Model

	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)
Immigration Shock : Δf=6%, Δf_L=1.5%, Δf_M=3%, Δf_S=1.5%.							
Parameter Values							
$1-\alpha-\beta$	**0.2**	0.2	0.2	0.2	**0.25**	0.2	0.2
β	**0.2**	0.2	0.2	0.2	0.2	**0.15**	0.2
γ	**6**	6	6	**7**	6	6	6
δ	**2**	2	2	2	2	2	**1.5**
σ_L	**6**	6	**7**	6	6	6	6
σ_M	**6**	6	**7**	6	6	6	6
σ_S	**3**	**4**	3	3	3	3	3
Short-Run (Impact) Effect							
Change of average Wage US born	2.6%	1.9%	2.5%	2.6%	2.6%	2.6%	2.9%
Change of average Value of Houses	9.8%	9.2%	9.5%	9.8%	9.8%	9.8%	10.3%
Long-Run Effects							
Change of average Wage US born	2.8%	2.1%	2.7%	2.8%	2.9%	2.9%	2.8%
Change of average Value of Houses	11.6%	9.0%	11.2%	11.3%	9.5%	9.8%	12.0%
Total Migration of US born	1.5%	-0.2%	1.4%	1.1%	-0.5%	-0.3%	1.7%
Implied Long-Run Elasticities							
γ_w	0.46	0.35	0.45	0.46	0.48	0.48	0.46
γ_r	1.9	1.5	1.8	1.8	1.6	1.6	2
γ_E	0.25	0.03	0.23	0.18	-0.08	-0.05	0.21

The Value of all other parameters as well as the initial conditions in the supply of US-born and Foreign-born workers of each skill group are constant across simulations and are reported in the section "Simulation of the Model" in the text.