THE ECONOMIC ANALYSIS OF IMMIGRATION

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1. Introduction

Why do some people move? And what happens when they do? The study of labor flows across labor markets—whether within or across countries—is a central ingredient in any discussion of labor market equilibrium. These labor flows help markets reach a more efficient allocation of resources. As a result, the questions posed above have been at the core of labor economics research for many decades.

At the end of the 20th Century, about 140 million persons—or roughly 2 percent of the world's population—reside in a country where they were not born.[1] Nearly 6 percent of the population in Austria, 17 percent in Canada, 11 percent in France, 17 percent in Switzerland, and 9 percent in the United States is foreign-born.[2] These sizable labor flows have altered economic opportunities for native workers in the host countries, and they have generated a great deal of debate over the economic impact of immigration and over the types of immigration policies that host countries should pursue.

This chapter surveys the economic analysis of immigration.[3] In particular, the study investigates the determinants of the immigration decision by workers in source countries and the impact of that decision on the labor market in the host country. There already exist a number of surveys that stress the implications of the empirical findings in the immigration literature, particularly in the U.S. context [Borjas (1994), Friedberg and Hunt (1995), LaLonde and Topel (1996)]. This survey also reviews the empirical evidence, but it differs by stressing the ideas and models that economists use to analyze immigration, and by delineating the implications of these models for empirical research and for our understanding of the labor market effects of immigration. A key lesson of economic theory is that the labor market impact of immigration hinges crucially on how the skills of immigrants compare to those of natives in the host country. And, in fact, much of the research effort in the immigration literature has been devoted to: (a) understanding the factors that determine the relative skills of the immigrant flow; (b) measuring the relative skills of immigrants in the host country; and (c) evaluating how relative skill differentials affect economic outcomes.

Because the survey focuses on the impact of immigration on the host country's labor market, the analysis ignores a number of important and equally interesting issues—both in terms

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[1] Martin (1998).

[2] United Nations (1989, p. 61).

[3] Although the discussion focuses on the economic analysis of international migration, many of the models and concepts can also be used to analyze migration behavior within a country. Greenwood (1975) surveys the extensive literature on internal migration decisions.

of their theoretical implications and of their empirical significance. Immigration, after all, affects economic opportunities not only in the host country, but in the source country as well. Few studies, however, investigate what happens to economic opportunities in a source country when a selected subsample of its population moves elsewhere. Immigration also has economic effects on the host country that extend far beyond the labor market. An important part of the modern debate over immigration policy, for instance, concerns the impact of immigrants on expenditures in the programs that make up the welfare state. Finally, the survey focuses on the economic impact of immigrants, and ignores the long-run impact of the children and grandchildren of immigrants on the host country.[4]

The survey is structured as follows. Section 2 examines how immigration affects labor market opportunities in the host country. Economic theory implies that immigrants will generally increase the national income that accrues to the native population in the host country, and that these gains are larger the greater the differences in productive endowments between immigrants and natives. Section 3 analyzes the factors that determine the skills of immigrants. The discussion summarizes the implications of the income-maximization hypothesis for the skill composition of the self-selected immigrant flow. Section 4 discusses the identification problems encountered by studies that attempt to estimate how the skills of immigrants compare to those of natives—both at the time of entry and over time as immigrants adapt to the host country's labor market. The discussion also examines the concept of economic assimilation and investigates the nature of the correlation between an immigrant's "pre-existing" skills and the skills that the immigrant acquires in the host country. Section 5 surveys the vast literature that attempts to measure the impact of immigration on the wage structure in the host country. For the most part this literature estimates "spatial correlations"—correlations between economic outcomes in an area (such as a metropolitan area or a state in the United States) and the immigrant supply shock in that area. The section presents a simple economic model to illustrate that these spatial correlations typically do not estimate any parameter of interest, and suggests how these spatial correlations can be adjusted to estimate the "true" wage effects of immigration as long as estimates of native responses to immigration are available. Finally, Section 6 offers some concluding remarks and discusses some research areas that require further exploration.

2. Immigration and the Host Country's Economy

This section uses a simple economic framework to describe how immigration affects the labor market in the host country, and to calculate the gains and losses that accrue to different groups in the population.[5] The analysis shows that natives in the host country benefit from immigration as long as immigrants and natives differ in their productive endowments; that the benefits are larger the greater the differences in endowments; and that the benefits are not evenly distributed over the native population—natives who have productive endowments that

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[4] There is increasing interest in analyzing how the skill composition of the immigrant flow affects the skill distribution of the children and grandchildren of immigrants. Borjas (1992) finds that skill differentials across the national origin groups in the immigrant generation tend to persist into the second and third generations, and attributes part of this persistence to "ethnic externalities."

[5] Borjas (1995b) and Johnson (1997) present more extensive discussions of this framework. Benhabib (1996) gives a political economy extension that examines how natives form voting coalitions to maximize the gains from immigration.

complement those of immigrants gain, while natives who have endowments that compete with those of immigrants lose.

2.1. A Model with Homogeneous Labor

Suppose the production technology in the host country can be summarized by a twice-differentiable and continuous linear homogeneous aggregate production function with two inputs, capital (K) and labor (L), so that output $Q = f(K, L)$. The work force contains N native and M immigrant workers, and all workers are perfect substitutes in production ($L = N + M$). Natives own the entire capital stock in the host country and, initially, the supply of capital is perfectly inelastic. Finally, the supplies of both natives and immigrants are also perfectly inelastic.[6]

In a competitive equilibrium, each factor price equals the respective value of marginal product. Let the price of the output be the numeraire. The rental rate of capital in the pre-immigration equilibrium is $r_0 = f_K(K, N)$ and the price of labor is $w_0 = f_L(K, N)$. Because the aggregate production function exhibits constant returns, the entire output is distributed to the owners of capital and to workers. In the pre-immigration regime, the national income accruing to natives, Q_N, is given by:

$$Q_N = r_0 K + w_0 L. \tag{1}$$

Figure 1 illustrates this initial equilibrium. Because the supply of capital is fixed, the area under the marginal product of labor curve (f_L) gives the economy's total output. The national income accruing to natives Q_N is given by the trapezoid ABN0.

The entry of M immigrants shifts the supply curve and lowers the market wage to w_1. The area in the trapezoid ACL0 now gives national income. Part of the increase in national income is distributed directly to immigrants (who get $w_1 M$ in labor earnings). The area in the triangle BCD gives the increase in national income that accrues to natives, or the "immigration surplus."

The area of BCD is given by $\frac{1}{2} \times (w_0 - w_1) \times M$. The immigration surplus, as a fraction of national income, equals:[7]

$$\frac{\Delta Q_N}{Q} = -\frac{1}{2}\alpha_L \varepsilon_{LL} m^2, \tag{2}$$

where α_L is labor's share of national income ($\alpha_L = wL/Q$); ε_{LL} is the elasticity of factor price for labor ($\varepsilon_{LL} = d \log w/d \log L$, holding marginal cost constant); and m is the fraction of the work force that is foreign born ($m = M/L$).

Equation (2) can be used to make "back-of-the-envelope" calculations of how much a host country gains from immigration. In the United States, the share of labor income is about 70 percent, and the fraction of immigrants in the work force is slightly less than 10 percent.

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6 The calculation of the gains from immigration would be more cumbersome if native labor supply was not inelastic because the analysis would have to value the change in utility experienced by native workers as they move between the market and non-market sectors.

7 The derivation in (2) uses the approximation that $(w_0 - w_1) \approx (\partial w/\partial L) \times M$.

Hamermesh's (1993, pp. 26-29) survey of the empirical evidence on labor demand suggests that the elasticity of factor price for labor may be around −.3. The U.S. immigration surplus, therefore, is on the order of .1 percent of GDP.

Equation (2) shows that the immigration surplus is proportional to ε_{LL}. The net gains from immigration to the host country, therefore, are intimately linked to the adverse impact that immigration has on the wage of competing native workers. If the increase in labor supply greatly reduces the wage, natives *as a whole* gain substantially from immigration. If the native wage does not respond to the admission of immigrants, the immigration surplus is zero.[8]

Immigration redistributes income from labor to capital. In terms of Figure 1, native workers lose the area in the rectangle w_0BDw_1, and this quantity plus the immigration surplus accrues to capitalists. Expressed as fractions of GDP, the net changes in the incomes of native workers and capitalists are approximately given by:[9]

$$(3) \qquad \left.\frac{\text{Change in Native Labor Earnings}}{Q}\right|_{dK=0} = \alpha_L\, \varepsilon_{LL}\, m(1-m),$$

$$(4) \qquad \left.\frac{\text{Change in Income of Capitalists}}{Q}\right|_{dK=0} = -\alpha_L\, \varepsilon_{LL}\, m\left(1-\frac{m}{2}\right).$$

Consider again the calculation for the United States. If the elasticity of factor price is −.3, native-born workers lose about 1.9 percent of GDP, while native-owned capital gains about 2.0 percent of GDP. The small immigration surplus can disguise a sizable income redistribution from workers to the users of immigrant labor.

The derivation of the immigration surplus in equation (2) assumed that the host country's capital stock is fixed. However, immigrants may themselves add to the capital stock of the host country, and the rise in the return to capital will encourage capital flows into the country until the rental rate is again equalized across markets.[10]

As an alternative polar assumption, suppose that the supply of capital is perfectly elastic at the world price ($dr = 0$). Differentiating the marginal productivity condition $r = f_K(K, L)$ implies that the immigration-induced change in the capital stock is:

$$(5) \qquad \left.\frac{dK}{dM}\right|_{dr=0} = -\frac{f_{KL}}{f_{KK}} > 0.$$

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[8] The gains from immigration and the adverse impact on the native wage are directly linked unless all immigrants have skills that complement those of native workers.

[9] Equation (3) uses the approximation that $(w_0 - w_1)N \approx (\partial w/\partial L) \times M \times N$. The gains accruing to capitalists are calculated by adding the absolute value of this expression to the immigration surplus.

[10] However, Feldstein and Horioka (1980) find evidence that capital is somewhat immobile across countries.

The derivative in (5) is positive because $f_{KL} > 0$ when the production function is linear homogeneous. For convenience, assume that the additional capital stock defined by (5) either originates abroad and is owned by foreigners, or is owned by the immigrants themselves.

The elasticity of complementarity for any input pair i and j is $c_{ij} = f_{ij}\, f / f_i\, f_j$.[11] The elasticity of factor price is proportional to the elasticity of complementarity, or $\varepsilon_{ij} = \alpha_j\, c_{ij}$, where α_j gives the share of income accruing to j. The immigration-induced wage change is given by:

(6)
$$\left.\frac{d\log w}{d\log M}\right|_{dr=0} = \left(\varepsilon_{LK} \left.\frac{d\log K}{d\log M}\right|_{dr=0} + \varepsilon_{LL}\, m \right)$$
$$= \frac{\alpha_L}{c_{KK}} (c_{KK}\, c_{LL} - c_{LK}^2)\, m.$$

The linear homogeneity of the production function implies that $(c_{KK}\, c_{LL} - c_{LK}^2) = 0$, so that the host country's wage is independent of immigration. Hence the immigration surplus when the supply curve of capital is perfectly elastic is:

(7)
$$\left.\frac{\Delta Q_N}{Q}\right|_{dr=0} = 0.$$

The immigration-induced capital flow reestablishes the pre-immigration capital/labor ratio in the host country. Immigration does not alter the price of labor or the returns to capital, and natives neither gain nor lose from immigration.

2.2. Heterogeneous Labor and Perfectly Elastic Capital

Suppose there are two types of workers in the host country's labor market, skilled (L_S) and unskilled (L_U). The linear homogeneous aggregate production function is given by:

(8)
$$Q = f(K, L_S, L_U) = f[K, bN + \beta M, (1- b)N + (1 - \beta)M],$$

where b and β denote the fraction of skilled workers among natives and immigrants, respectively.[12] The production function is continuous and twice differentiable, with $f_i > 0$ and $f_{ii} < 0$ ($i = K, L_S, L_U$). The price of each factor of production, r for capital and w_i (i=S, U) for labor, is determined by the respective marginal productivity condition. As we saw earlier, the economic impact of immigration depends crucially on what happens to the capital stock when

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[11] The elasticity of complementarity is the dual of the elasticity of substitution. Hamermesh (1993, Chapter 2) presents a detailed discussion of the properties of the elasticity of complementarity.

[12] A more general model would allow the host country to produce and consume more than one output. This generalization introduces additional sources of potential complementarity between immigrants and natives. The model, however, is much more complex. Trefler (1997) presents a discussion of these types of models in an open economy framework.

immigrants enter the country. Let's initially consider the case where the supply of capital is perfectly elastic, so that $dr = 0$. Let p_S and p_U be the shares of the work force that are skilled and unskilled, respectively. The condition that $r = f_K(K, L_S, L_U)$ is constant implies that the immigration-induced adjustment in the capital stock equals:

(9) $$\left.\frac{dK}{dM}\right|_{dr=0} = -\frac{[f_{KS}\,\beta + f_{KU}\,(1-\beta)]}{f_{KK}}.$$

We can determine the impact of immigration on the wages of skilled and unskilled workers by differentiating the respective marginal productivity conditions, and by imposing the restriction in equation (9). The wage effects of immigration are:[13]

(10) $$\left.\frac{d\log w_S}{d\log M}\right|_{dr=0} = \frac{\alpha_S}{c_{KK}}[c_{SS}c_{KK} - c_{SK}^2]\frac{(\beta - b)}{p_S\;p_U}(1-m)m,$$

(11) $$\left.\frac{d\log w_U}{d\log M}\right|_{dr=0} = \frac{-\alpha_U}{c_{KK}}[c_{UU}c_{KK} - c_{UK}^2]\frac{(\beta - b)}{p_S\;p_U}(1-m)m,$$

where α_i is the share of national income accruing to factor i.

One can always write a linear homogeneous production function with inputs (X_1, X_2, X_3) as $Q = X_3\, g(X_1/X_3, X_2/X_3)$. Suppose that the function g is strictly concave, so that the isoquants between any pair of inputs have the conventional convex shape. This assumption implies that $c_{11}c_{22} - c_{12}^2 > 0$. Equations (10) and (11) then indicate that the impact of immigration on the wage structure depends entirely on how the skill distribution of immigrants compares to that of natives. If the two skill distributions are equal ($\beta = b$), immigration has no impact on the wage structure of the host country. If immigrants are relatively unskilled ($\beta < b$), the unskilled wage declines and the skilled wage rises. If immigrants are relatively skilled ($\beta > b$), the skilled wage declines and the unskilled wage rises. In short, the impact of immigration on the wage structure depends on the *relative* skills of immigrants, not on their absolute skills.

The immigration surplus in this model is defined by:

(12) $$\Delta Q_N\Big|_{dr=0} = \left(bN\frac{\partial w_S}{\partial M} + (1-b)N\frac{\partial w_U}{\partial M}\right)M\,.$$

It is well known that when the derivatives in (12) are evaluated at the initial equilibrium, where $L_S = bN$ and $L_U = (1 - b)N$, the infinitesimal increase in national income accruing to natives is zero.[14] To calculate finite changes, evaluate the immigration surplus using an "average" rate for

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[13] The derivation of equations (10) and (11) is somewhat tedious and requires using the identities $(\varepsilon_{SS}\varepsilon_{KK} - \varepsilon_{SK}\varepsilon_{KS}) \equiv -(\varepsilon_{SU}\varepsilon_{KK} - \varepsilon_{SK}\varepsilon_{KU})$ and $(\varepsilon_{UU}\varepsilon_{KK} - \varepsilon_{UK}\varepsilon_{KU}) \equiv -(\varepsilon_{US}\varepsilon_{KK} - \varepsilon_{UK}\varepsilon_{KS})$. These identities follow from the fact that a weighted average of factor price elasticities equals zero.

[14] Bhagwati and Srinivasan (1983, p. 294).

$\partial w_S/\partial M$ and $\partial w_U/\partial M$, where the average is defined by $\frac{1}{2}\left(\frac{\partial w_S}{\partial M}\bigg|_{L_S=bN} + \frac{\partial w_S}{\partial M}\bigg|_{L_S=bN+\beta M}\right)$, and by $\frac{1}{2}\left(\frac{\partial w_U}{\partial M}\bigg|_{L_U=(1-b)N} + \frac{\partial w_S}{\partial M}\bigg|_{L_U=(1-b)N+(1-\beta)M}\right)$, respectively.[15] By using equations (10) and (11), it can be shown that the immigration surplus as a fraction of national income is given by:[16]

$$(13) \qquad \frac{\Delta Q_N}{Q}\bigg|_{dr=0} = \frac{-\alpha_S^2}{2c_{KK}}[c_{SS}c_{KK} - c_{SK}^2]\frac{(\beta-b)^2}{p_S^2\, p_U^2}(1-m)^2\, m^2.$$

The immigration surplus is zero if $\beta = b$, and positive if $\beta \neq b$. If immigrants had the same skill distribution as natives, the immigration-induced change in the capital stock implies that the wages of skilled and unskilled workers are unaffected by immigration. The gains arise only if immigrants differ from natives.

Let β^* be the value of β that maximizes the immigration surplus in the host country. By partially differentiating equation (13) with respect to β, we obtain:[17]

$$(14) \qquad \begin{array}{ll} \beta^* = 1, & \text{if } b < .5, \\ \beta^* = 0 \quad \text{or} \quad \beta^* = 1, & \text{if } b = .5, \\ \beta^* = 0, & \text{if } b > .5. \end{array}$$

Suppose that $b = .5$. There is no immigration surplus if half of the immigrant flow is also composed of skilled workers. The immigration surplus is maximized when the immigrant flow is either exclusively skilled or exclusively unskilled. Either policy choice generates an immigrant flow that is very different from the native work force.

Economic incentives for moving to a particular tail of the skill distribution arise when the native work force is relatively skilled or unskilled. Suppose the native work force is relatively unskilled ($b < .5$). Admitting skilled immigrants, who most complement native workers, maximizes the immigration surplus. If the native work force is relatively skilled, the host country should admit unskilled immigrants to maximize the gains.

2.3. Heterogeneous Labor and Inelastic Capital

The results in (14) are very sensitive to the assumption that the supply curve of capital is perfectly elastic. Suppose instead that the capital stock is perfectly inelastic and is owned by

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15 This approximation implies that the finite change in the immigration surplus is half the gain obtained when equation (12) is evaluated at the post-immigration level of labor supply.

16 The derivation of equation (13) uses the fact that $\alpha_S^2\,(c_{KK}c_{SS} - c_{SK}^2) = \alpha_U^2\,(c_{KK}c_{UU} - c_{UK}^2)$. This restriction follows from the identities defined in note 11.

17 The differentiation assumes that the immigrant supply shock is "small" and does not affect the values of p_S and p_U.

natives. By differentiating the marginal productivity conditions, it can be shown that the changes in the various factor prices are given by:

(15) $$\left.\frac{d\log r}{d\log M}\right|_{dK=0} = \varepsilon_{KS}\,\frac{(\beta - b)}{p_S\, p_U}(1-m)\,m - \varepsilon_{KK}\,\frac{1-\beta}{p_U}\,m,$$

(16) $$\left.\frac{d\log w_S}{d\log M}\right|_{dK=0} = \varepsilon_{SS}\,\frac{(\beta - b)}{p_S\, p_U}(1-m)\,m - \varepsilon_{SK}\,\frac{1-\beta}{p_U}\,m,$$

(17) $$\left.\frac{d\log w_U}{d\log M}\right|_{dK=0} = -\,\varepsilon_{UU}\,\frac{(\beta - b)}{p_S\, p_U}(1-m)\,m - \varepsilon_{UK}\,\frac{1-\beta}{p_U}\,m.$$

Immigration alters the distribution of income even when immigrants have the same skill distribution as natives. Suppose, in fact, that $\beta = b$. Equation (15) then shows that immigration increases the rental rate of capital (ε_{KK} is negative). Moreover, immigration reduces the *total* earnings of native workers:

(18) $$\text{Change in Labor Earnings}\Big|_{dK=0} = bN\,\frac{\P w_S}{\P M}\,M + (1-b)\,N\,\frac{\P w_U}{\P M}\,M\,,$$

$$= -\,Q_N\,[a_S\, e_{SK} + a_U\, e_{UK}]\,\frac{(1-b)^2}{p_U^2}\,(1-m)\,m < 0.$$

The sign of (18) follows from the fact that a weighted average of factor price elasticities equals zero ($\alpha_K\,\varepsilon_{KK} + \alpha_S\,\varepsilon_{SK} + \alpha_U\,\varepsilon_{UK} = 0$). Even though immigrants have the same skill distribution as natives, immigration reduces the capital/labor ratio and workers, as a group, lose.

The immigration surplus equals:

(19) $$\Delta Q_N\Big|_{dK=0} = \left(K\,\frac{\partial r}{\partial M} + bN\,\frac{\partial w_S}{\partial M} + (1-b)\,N\,\frac{\partial w_U}{\partial M}\right) M.$$

By using the wage effects defined in equations (15)-(17) and evaluating the various derivatives in (19) at the "average" point, we obtain:

(20) $$\left.\frac{\Delta Q_N}{Q}\right|_{dK=0} = -\frac{\alpha_S^2\, c_{SS}\,\beta^2\, m^2}{2\,p_S^2} - \frac{\alpha_U^2\, c_{UU}\,(1-\beta)^2\, m^2}{2\,p_U^2} - \frac{\alpha_S\,\alpha_U\, c_{SU}\,\beta\,(1-\beta)\,m^2}{p_S\, p_U}.$$

The quadratic form in (20) is positive.[18] Natives gain from immigration, therefore, even if the skill distribution of immigrants is the same as that of natives.

To illustrate the relationship between the immigration surplus and the skill distribution of immigrants, let V be the immigration surplus defined in (20) and consider the special case where $p_S = p_U = .5$. The first and second derivatives of the immigration surplus are proportional to:

$$\frac{\partial V}{\partial \beta} \propto -\alpha_S^2\, c_{SS}\, \beta + \alpha_U^2\, c_{UU}\,(1-\beta) - \alpha_S\, \alpha_U\, c_{SU}\,(1-2\beta), \tag{21}$$

$$\frac{\partial^2 V}{\partial \beta^2} \propto -\alpha_S^2\, c_{SS} - \alpha_U^2\, c_{UU} + 2\,\alpha_S\, \alpha_U\, c_{SU}. \tag{22}$$

Suppose now that $c_{SS} < c_{UU}$ (which implies that $\varepsilon_{SS} < \varepsilon_{UU}$ and the demand for skilled labor is less elastic than the demand for unskilled labor). This assumption tends to be supported by the empirical evidence (Hamermesh, 1993, Chapter 3). The first derivative is then positive at $\beta = 1$, and the second derivative is positive everywhere, so that (20) is convex.[19]

Evaluating the immigration surplus in equation (20) at $\beta = 0$ or $\beta = 1$, and using the convexity restrictions in (21) and (22), implies that the immigration surplus is maximized when the immigrant flow is exclusively skilled. The assumption that the wages of skilled workers are more responsive to a supply shift than the wages of unskilled workers "breaks the tie" between the choice of an exclusively skilled or an exclusively unskilled immigrant flow—and it breaks the tie in favor of skilled immigrants. A very negative elasticity of factor price for skilled workers suggests that skilled workers are highly complementary with other factors of production, particularly capital. The complementarity between native-owned capital and skills provides an economic rationale for admitting skilled workers.

This conclusion, of course, may change if the native work force is predominantly skilled. There then exist two sets of conflicting incentives. On the one hand, the immigration surplus is larger if the host country admits immigrants who most complement the skilled native workers, or unskilled immigrants. On the other hand, the immigration surplus is larger if the host country admits immigrants who most complement the native-owned capital, or skilled immigrants.

Finally, comparing equations (13) and (20) yields:

$$\left.\frac{\Delta Q_N}{Q}\right|_{dK=0} - \left.\frac{\Delta Q_N}{Q}\right|_{dr=0} = -\frac{1}{2c_{KK}}\left(\alpha_S\, c_{SK}\,\frac{\beta}{p_S} + \alpha_U\, c_{UK}\,\frac{1-\beta}{p_U}\right)^2 m^2 > 0, \tag{23}$$

so that the immigration surplus is larger if the capital stock in the host country is fixed.

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[18] Equation (20) is a quadratic form in the negative-definite matrix $\begin{bmatrix} c_{SS} & c_{SU} \\ c_{US} & c_{UU} \end{bmatrix}$.

[19] The first derivative evaluated at $\beta = 1$ is $(-\alpha_S^2\, c_{SS} + \alpha_S\, \alpha_U\, c_{SU})$. The inequality $(c_{SS}\, c_{UU} - c_{SU}^2) > 0$ implies that $(-c_{SS} - c_{UU} + 2c_{SU}) > 0$, and $(-c_{SS} + c_{SU}) > 0$. As a result, the first derivative evaluated at $\beta = 1$ is positive (since $\alpha_S > \alpha_U$). The same restrictions can be used to show that the second derivative is positive everywhere.

2.4. Simulating the Impact of Immigration

Borjas (1995a), Borjas, Freeman, and Katz (1997) and Johnson (1997) have used the family of models presented above to simulate the impact of immigration on the U.S. labor market.[20] The exercise requires information on the responsiveness of factor prices to increases in labor supply. Hamermesh's (1993) comprehensive survey of the labor demand literature reveals a great deal of uncertainty in the estimates of the relevant factor price elasticities. The simulation presented here uses the following range for the vector (ε_{SS}, ε_{UU}): (-.5, -.3), (-.9, -.6), and (-1.5, -.8). This range covers most of the elasticity estimates reported in the Hamermesh survey. The cross-elasticity ε_{SU} is set to .05 in all the simulations. Because the weighted average of factor price elasticities is zero, these assumptions determine all the other elasticities in the model. The assumption that the wage of skilled workers is more responsive to supply shifts is consistent with the evidence, and "builds in" capital-skill complementarity into the calculations. The exercise assumes that immigration increased the labor supply of the United States by 10 percent—roughly the fraction of the work force that is foreign-born.

The simulation requires that workers in the U.S. labor market be aggregated into two skill classes *and* that workers within each of the skill classes be perfect substitutes. Following Borjas, Freeman, and Katz (1997), the exercise uses two alternative aggregations. First, all workers who are high school dropouts are defined to be in the unskilled group, while high school graduates make up the skilled group. Using this aggregation scheme, data from the 1995 Current Population Survey (CPS) then indicate that p_S = .91, but that β = .68. If labor's share of income is .7, the CPS data on the relative earnings of high school dropouts implies that the share of income accruing to skilled workers is .661, and that accruing to unskilled workers is .039.

Alternatively, divide the work force into college equivalents and high school equivalents.[21] The CPS estimates of the parameters of the skill distribution are p_S = .43 and β = .33; and the share of income accruing to skilled workers equals .371, while that accruing to unskilled workers is .329. Note that this aggregation of skills (unlike the one that divides the work force into high school dropouts and high school graduates) implies that the skill distribution of the immigrant work force does not differ greatly from that of the native work force.

The first two columns of Table 1 report the results using the high school dropout-graduate skill classification. If capital is perfectly inelastic, all workers lose and capital gains substantially—the income of capitalists increases by between 2.4 and 11.8 percent. If capital is perfectly elastic, unskilled workers lose (their earnings fall by between 1.2 and 6.1 percent) and skilled workers gain slightly (their earnings increase by less than .2 percent). Overall, the national income accruing to native rises by .1 to .4 percent when capital is perfectly inelastic, and by .1 to .2 percent when capital is perfectly elastic.

The last two columns of the table report the results using the high school-college equivalent aggregation. All workers still lose when capital is perfectly inelastic, and skilled

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[20] The simulation reported here uses data drawn from Borjas, Freeman, and Katz (1997).

[21] The college equivalent group contains all workers who have at least a college degree, plus one-half of the workers with some college. The high school equivalent group includes workers with a high school diploma or less, plus one-half of the workers with some college. Katz and Murphy (1992) provide a detailed justification of this skill classification.

workers gain and unskilled workers lose when capital is perfectly elastic. However, the losses and gains are even smaller. Immigration increases the national income accruing to natives by only .1 to .3 percent when capital is inelastic and by .01 to .02 percent when capital is elastic.

The simulation suggests that the overall impact of immigration on the U.S. labor market is small—regardless of how workers are grouped into different skill categories, and of the assumptions made about the factor price elasticities and the supply elasticity of capital.

3. The Skills of Immigrants: Theory

As we have seen, the economic impact of immigration depends crucially on the differences in the skill distributions of immigrants and natives. A great deal of empirical research in economics focuses precisely on the question of how immigrant skills compare to those of native workers. Perhaps the central finding of this literature is that immigrants are not a randomly selected sample of the population of the source countries. As a result, an understanding of the skill differentials between immigrants and natives must begin with an analysis of the factors that motivate only some persons in the source country to migrate to a particular host country.

3.1. The Migration Decision

It is instructive to consider a two-country model.[22] Residents of the source country (country 0) consider migrating to the host country (country 1). The migration decision is assumed to be irreversible.[23] Residents of the source country face the earnings distribution:

(24) $$\log w_0 = \mu_0 + v_0,$$

where w_0 gives the wage in the source country; μ_0 gives the mean earnings in the source country; and the random variable v_0 measures deviations from mean earnings and is normally distributed with mean zero and variance σ_0^2. For convenience, equation (24) omits the subscript that indexes a particular individual.

If the *entire* population of the source country were to migrate to the host country, this population would face the earnings distribution:

(25) $$\log w_1 = \mu_1 + v_1,$$

where μ_1 gives the mean earnings in the host country *for this particular population*, and the random variable v_1 is normally distributed with mean zero and variance σ_1^2. The correlation coefficient between v_0 and v_1 equals ρ_{01}.

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[22] The discussion in this section is based on the presentation of Borjas (1987) and Borjas (1991).

[23] Borjas and Bratsberg (1996) generalize the model to allow for return migration by immigrants. In their model, return migration may be part of an optimal location plan over the life cycle or be induced by worse-than-expected outcomes in the host country. Regardless of the motivation, Borjas and Bratsberg show that return migration does not alter the key insights of the model, and, in fact, tends to intensify the type of selection that characterize the immigrant flow.

In general, the population mean μ_1 will not equal the mean earnings of native workers in the host country. The average worker in the source country might be more or less skilled than the average worker in the host country. It is convenient to initially assume that the average person in both countries is equally skilled (or, equivalently, that any differences in average skills have been controlled for), so that μ_1 also gives the mean earnings of natives in the host country. This assumption helps isolate the impact of the selection process on the skill composition of the immigrant flow and provides a simple way for comparing the skills of immigrants and natives in the host country.

Equations (24) and (25) completely describe the earnings opportunities available to persons born in the source country. The insight that migration decisions are motivated mainly by wage differentials can be attributed to Sir John Hicks. In *The Theory of Wages*, Hicks (1932, p. 76) argued that "differences in net economic advantages, chiefly differences in wages, are the main causes of migration". Practically all modern studies of migration decisions use this conjecture as a point of departure. Assume that the migration decision is determined by a comparison of earnings opportunities across countries, net of migration costs.[24] Define the index function:

$$(26) \qquad I = \log\left(\frac{w_1}{w_0 + C}\right) \approx (\mu_1 - \mu_0 - \pi) + (v_1 - v_0),$$

where C gives the level of migration costs, and π gives a "time-equivalent" measure of these costs ($\pi = C/w_0$). A person emigrates if $I > 0$, and remains in the source country otherwise.

Migration is costly, and these costs probably vary among persons—but the sign of the correlation between costs (whether in dollars on in time-equivalent terms) and wages is ambiguous. Migration costs involve direct costs (e.g., the transportation of persons and household goods), forgone earnings (e.g., the opportunity cost of a post-migration unemployment spell), and psychic costs (e.g., the disutility associated with leaving behind family ties and social networks). The distribution of the random variable π in the source country's population is:

$$(27) \qquad \pi = \mu_\pi + v_\pi,$$

where μ_π is the mean level of migration costs in the population, and v_π is a normally distributed random variable with mean zero and variance σ_π^2. The correlation coefficients between v_π and (v_0, v_1) are given by $(\rho_{\pi 0}, \rho_{\pi 1})$. The probability that a person migrates to the host country can be written as:

$$(28) \qquad P(z) = \Pr[v > -(\mu_1 - \mu_0 - \mu_\pi)] = 1 - \Phi(z),$$

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[24] The wage distributions in equations (24) and (25) could be reinterpreted as giving the distributions of the present value of the earnings stream in each country. This reformulation places the model within the human capital framework proposed by Sjaastad (1962).

where $v = v_1 - v_0 - v_\pi$, $z = -(\mu_1 - \mu_0 - \mu_\pi)/\sigma_v$, and Φ is the standard normal distribution function.

Equation (28) summarizes the economic content of the Hicksian theory of migration. In particular:

$$\text{(29)} \qquad \frac{\partial P}{\partial \mu_0} < 0, \ \frac{\partial P}{\partial \mu_1} > 0, \ \text{and} \ \frac{\partial P}{\partial \mu_\pi} < 0.$$

The emigration rate falls when the mean income in the source country rises, when the mean income in the host country falls, and when time-equivalent migration costs rise. Most studies in the literature on the internal migration of persons within a particular country focus on testing these theoretical predictions (Greenwood, 1975). The empirical evidence in these studies is generally supportive of the theory.

3.2. The Self-Selection of Immigrants

Although it is of important to determine the size and direction of migration flows, it is equally important to determine *which* persons find it most worthwhile to migrate to the host country. This question lies at the heart of the Roy model (Roy, 1951; Heckman and Honoré, 1990). Consider the conditional means $E(\log w_0 \mid \mu_0, I > 0)$ and $E(\log w_1 \mid \mu_1, I > 0)$. These conditional means give the average earnings in both the source and host countries for persons who migrate. Note that the conditional means hold μ_0 and μ_1 constant. The calculation effectively assumes that the migration flow is sufficiently small so that there are no feedback effects on the performance of immigrants (or natives) in the host country or on the performance of the "stayers" in the source country. A general equilibrium model would account for the fact that the mean of the income distributions depends on the size and composition of the immigrant flow. Because the random variables v_0, v_1, and v_π are jointly normally distributed, these conditional means are given by:

$$\text{(30)} \qquad E(\log w_0 \mid \mu_0,\ I > 0) = \mu_0 + \left[\frac{\sigma_0 \sigma_1}{\sigma_v}\left(\rho_{01} - \frac{\sigma_0}{\sigma_1}\right) - \rho_{\pi 0}\frac{\sigma_\pi}{\sigma_1}\right]\lambda,$$

$$\text{(31)} \qquad E(\log w_1 \mid \mu_1,\ I > 0) = \mu_1 + \left[\frac{\sigma_0 \sigma_1}{\sigma_v}\left(\frac{\sigma_1}{\sigma_0} - \rho_{01}\right) - \rho_{\pi 1}\frac{\sigma_\pi}{\sigma_0}\right]\lambda,$$

where $\lambda = \phi(z)/(1 - \Phi(z))$, and ϕ is the density of the standard normal. The variable λ is inversely related to the emigration rate [Heckman (1979, p. 156)], and will be positive as long as some persons find it profitable to remain in the country of origin ($P(z) < 1$). It is easier to initially interpret the results in equations (30) and (31) by assuming that $\sigma_\pi = 0$, so that time-equivalent migration costs are constant. Let $Q_0 = E(v_0 \mid \mu_0, I > 0)$ and $Q_1 = E(v_1 \mid \mu_1, I > 0)$. The Roy model identifies three cases that summarize the skill differentials between immigrants and natives:

$$
(32)\qquad
\begin{aligned}
&Q_0 > 0 \text{ and } Q_1 > 0, && \text{if} && \rho_{01} > \frac{\sigma_0}{\sigma_1} \text{ and } \frac{\sigma_1}{\sigma_0} > 1,\\
&Q_0 < 0 \text{ and } Q_1 < 0, && \text{if} && \rho_{01} > \frac{\sigma_1}{\sigma_0} \text{ and } \frac{\sigma_0}{\sigma_1} > 1,\\
&Q_0 < 0 \text{ and } Q_1 > 0, && \text{if} && \rho_{01} < \min\left(\frac{\sigma_1}{\sigma_0}, \frac{\sigma_0}{\sigma_1}\right).
\end{aligned}
$$

Positive selection occurs when immigrants have above-average earnings in both the source and host countries ($Q_0 > 0$ and $Q_1 > 0$), and negative selection when immigrants have below-average earnings in both countries ($Q_0 < 0$ and $Q_1 < 0$). Equation (32) shows that either type of selection requires that skills be positively correlated across countries. The variances σ_0 and σ_1 measure the "price" of skills: the greater the rewards to skills, the larger the inequality in wages.[25] Immigrants are then positively selected when the source country—*relative to the host country*—"taxes" highly skilled workers and "insures" less skilled workers from poor labor market outcomes, and immigrants are negatively selected when the host country taxes highly skilled workers and subsidizes less skilled workers.

There exists the possibility that the host country draws persons who have below-average earnings in the source country but do well in the host country ($Q_0 < 0$ and $Q_1 > 0$). This sorting occurs when the correlation coefficient ρ_{01} is small or negative. Borjas (1987) argues that this correlation may be negative when a source country experiences a Communist takeover. In its initial stages, this political system often redistributes incomes by confiscating the assets of relatively successful persons. Immigrants from such systems will be in the lower tail of the post-revolution income distribution, but will perform well in the host country's market economy.

Equation (32) shows that neither differences in mean incomes across countries nor the level of migration costs determines the type of selection that characterizes the immigrant flow. Mean incomes and migration costs affect the size of the flow (and the extent to which the skills of the average immigrant differ from the mean skills of the population), but they do not determine if the immigrants are drawn mainly from the upper or lower tail of the skill distribution.

The analysis has assumed that μ_1 gives the mean income in the host country both for the average person in the source country's population as well as for the average native in the host country. The selection rules in (32) then contain all the implications of economic theory for the qualitative differences in skill distributions between immigrants and natives. Immigrants will be more skilled than natives if there is positive selection or a refugee sorting, and will be less skilled if there is negative selection. I return below to the comparison of skill distributions between immigrants and natives when mean skills differ across countries.

The discussion also assumed that migration costs are constant in the population. Equations (30) and (31) indicate that variable migration costs do not alter any of the selection rules if: (a) time-equivalent migration costs are uncorrelated with skills ($\rho_{\pi 0} = \rho_{\pi 1} = 0$); or (b) the ratio of variances σ_π/σ_j ($j = 0, 1$) is "small." Otherwise, variable migration costs can change the

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[25] This interpretation of the variances follows from the definition of the log wage distribution in the host country in terms of what the population of the source country would earn if the entire population migrated there. This definition effectively holds constant the distribution of skills.

nature of selection. Suppose that π is negatively correlated with earnings, perhaps because less skilled persons find it more difficult to find jobs in the host country. This negative correlation increases the likelihood that the bracketed term in equations (30) and (31) is positive, and the immigrant flow is more likely to be positively selected. Conversely, the likelihood of negative selection increases if π and earnings are positively correlated.

The theoretical analysis generates a reduced form model that describes the determinants of the relative skill composition of the immigrant flow. To simplify, suppose that time-equivalent migration costs are constant. The reduced-form equation is then given by:

$$(33) \qquad Q_1 = g(\mu_0, \mu_1, \pi, \sigma_0, \sigma_1, \rho).$$

Equation (33) summarizes the relationship between the relative skills of immigrants and the characteristics of both the source and host countries. Borjas (1987) analyzes the restrictions imposed by the income-maximization hypothesis on the function g in (33). The qualitative effects of the independent variables cannot typically be signed and can be decomposed in terms of composition effects and scale effects. A change in a variable θ might create incentives for a different type of person to migrate (a composition effect) and for a different number of persons to migrate (the scale effect).

The two effects can be isolated by estimating the two-equation structural model:

$$(34) \qquad P = P(\mu_0, \mu_1, \pi, \sigma_0, \sigma_1, \rho)$$
$$(35) \qquad Q_1 = h(\sigma_0, \sigma_1, \rho)\, \lambda.$$

Equation (34) describes the determinants of the probability of migration, and (35) describes the determinants of the relative skills of immigrants. Recall that λ is a transformation of the probability of migration. By holding λ constant, the function h in (35) nets out the scale effect and isolates the impact of source and host country characteristics on the selection of the immigrant flow.

The income-maximization hypothesis imposes the following restrictions on h, the λ-constant "immigrant quality" function:

1. An increase in σ_0 decreases the average skills of immigrant.
2. An increase in σ_1 increases the average skills of immigrants.[26]
3. An increase in ρ_{01} increases the average skills of immigrants if there is positive selection and decreases the average skills if there is negative selection.

The Roy model generates predictions about how immigrants compare to the population of the *source* countries. This contrast is not relevant if we wish to determine the impact of immigration on the host country—that impact depends on the skill differential between immigrants and natives in the host country. The discussion introduced the immigrant-native comparison by assuming that the average person in the source country has the same skills as the

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[26] An increase in σ_1 stretches the income distribution in the host country and leads to a different mean wage level in the pool of migrants even when the pool is restricted to include the same persons—so that it is not a mean-preserving shift. A simple solution to this technical detail is to define immigrant quality in terms of standardized units (or Q_1/σ_1). The prediction in the text can then be easily derived.

average person in the host country. Different countries, however, have different skill distributions.

The skill differential between immigrants and natives in the host country, therefore, will depend both on the selection rules and on the average skill differential between the source and host countries. Suppose we interpret the mean income in the source country, μ_0, as a measure of the average skills in that country. The mean earnings of immigrants in the host country are then given by:

$$E(\log w_1 \mid \mu_0, I > 0) = \mu_1(\mu_0) + E(v_1 \mid \mu_0, I > 0). \tag{36}$$

Equation (36) shows that the mean income of immigrants in the host country depends on the extent to which the average skills in the source country affect earnings in the host country (i.e., $d\mu_1/d\mu_0$). If this derivative were equal to one, skills are perfectly transferable across countries, and, abstracting from selection issues, workers who originate in high-income countries would have higher earnings in the host country.

Some of the implications of the Roy model have been tested empirically by estimating the correlation between the earnings of immigrants in the United States and measures of the rate of return to skills in the source country. There exists a great deal of dispersion in skills and economic performance among immigrant groups in the United States. In 1990, immigrants originating in Mexico or Portugal had about 8 years of schooling, while those originating in Austria, India, Japan, and the United Kingdom had about 15 years. Immigrants from El Salvador or Mexico earn 40 percent less than natives, while immigrants from Australia or South Africa earn 30 to 40 percent more than natives.[27]

The empirical studies have typically estimated the reduced-form earnings equation in (33). The evidence provides some support for the hypothesis that immigrants originating in countries with higher rates of return to skills have lower earnings in the United States. Borjas (1987, 1991) reports that measures of income inequality in the source country, which are a very rough proxy for the rate of return to skills, tend to be negatively correlated with the earnings of immigrant men, while Cobb-Clark (1993) reports a similar finding for immigrant women.[28] Barrett (1993) shows that immigrants who enter the United States using a family reunification visa have lower earnings when they originate in countries where the income distribution has a large variance. Bratsberg (1995) documents that the foreign students who remain in the United States after completing their education earn relatively high U.S. wages if the source country offers a low rate of return to skills, but earn low wages if the source country offers a high rate of return to skills. Finally, Taylor's (1987) case study of migration in a rural Mexican village

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[27] These statistics are reported in Borjas (1994, p. 1686).

[28] Migration decisions are typically made in a family context. Mincer's (1978) family migration model assumes that the family's objective is to maximize family income. Some persons in the household may then take actions that are not "privately" optimal (i.e., they would not have taken those actions if they wished to maximize their own individual income). The family context of immigration gives rise to "tied movers" (persons who moved, even though it was privately optimal to stay), and "tied stayers" (persons who stayed, even though it was privately optimal to move). The presence of tied movers in the immigrant flow tends to attenuate the type of selection that characterizes the immigrant population in the host country (Borjas and Bronars, 1991). The study of the economic performance of immigrant women requires a careful delineation of how the family migration decision alters the skill composition of immigrants. Such a study, however, has not yet been conducted for the United States.

concludes that Mexicans who migrated illegally to the United States are less skilled, on average, than the typical person residing in the village. This type of selection is consistent with the fact that Mexico has a higher rate of return to skills than the United States.[29]

3.3. Selection in Observed Characteristics

It is instructive to differentiate between skills that are observed and skills that are not. For simplicity, let's assume that a worker obtains *s* years of schooling *prior* to the migration decision, and that this educational attainment can be observed and valued properly by employers in both countries. The earnings functions are given by:

$$\log w_0 = \mu_0 + \delta_0 s + \varepsilon_0, \quad (37)$$

$$\log w_1 = \mu_1 + \delta_1 s + \varepsilon_1, \quad (38)$$

where δ_j gives the rate of return to schooling in country *j*, and ε_j is a random variable measuring deviations in earnings due to unobserved characteristics.[30] The random variables ε_0 and ε_1 are jointly normally distributed with mean zero, variances σ_0^2 and σ_1^2, and correlation coefficient ρ_{01}. The variance σ_j^2 now measures the price of unobserved skills in country *j*.

Suppose the distribution of educational attainment in the source country's population is:

$$s = \mu_s + \varepsilon_s, \quad (39)$$

where ε_s is normally distributed with mean zero and variance σ_s^2. In general, the random variable ε_s is correlated with ε_0 and ε_1. For analytical convenience, suppose that ε_s is uncorrelated with the difference $(\varepsilon_1 - \varepsilon_0)$.

Assume that time-equivalent migration costs are constant. The migration rate for the population of the source country is:

$$P(z^*) = \Pr[\tau > -[(\mu_1 - \mu_0) + (\delta_1 - \delta_0)\mu_s - \pi] = 1 - \Phi(z^*), \quad (40)$$

where $\tau = (\varepsilon_1 - \varepsilon_0) + (\delta_1 - \delta_0)\varepsilon_s$, and $z^* = -[(\mu_1 - \mu_0) + (\delta_1 - \delta_0)\mu_s - \pi] / \sigma_\tau$.

It is easy to show that the selection in unobserved skills follows the selection rules derived earlier in equation (32). The mean schooling of persons who choose to migrate is:

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[29] Some empirical studies also report a strong positive correlation between the earnings of immigrants in the United States and the level of economic development in the source country, as measured by per-capita GDP (Jasso and Rosenzweig, 1986). As suggested by equation (36), this correlation might measure the portability of human capital across countries, with capital acquired in more developed countries being more easily transferable to the U.S. labor market.

[30] The rate of return offered by the host country to schooling acquired in the source country might have little relation to the rate of return that the host country offers to schooling acquired in the host country. In the United States, for example, the empirical evidence suggests that schooling acquired in the pre-migration period has a lower value than schooling acquired in the United States [Borjas (1995a) and Funkhouser and Trejo (1995)].

(41) $$E(s \mid \mu_s, I > 0) = \mu_s + \frac{\sigma_s^2}{\sigma_\tau}(\delta_1 - \delta_0)\lambda.$$

The mean schooling of immigrants is less than or greater than the mean schooling in the source country depending on which country has a higher rate of return. Highly educated workers end up in the country that values them the most.

Differentiating the conditional mean in (41) yields:

(42) $$\frac{\partial E(s|\mu_s, I>0)}{\partial \mu_s} = 1 - \frac{(\delta_1-\delta_0)^2 \sigma_s^2}{\sigma_\tau^2}\frac{\partial \lambda}{\partial z^*}.$$

The definition of the variance σ_τ^2 implies that $(\delta_1 - \delta_0)^2 \sigma_s^2 < \sigma_\tau^2$. It can be shown that $0 < \partial\lambda/\partial z^* < 1$ [Heckman (1979, p. 157)] . Therefore:

(43) $$0 < \frac{\partial E(s|I>0)}{\partial \mu_s} < 1.$$

A one-year increase in the mean education of the source country increases the mean education of persons who actually migrate to the host country, but by less than one year.[31] The inequality in (43) implies that the variance in mean education across immigrant groups who originate in different countries but live in the same host country is smaller than the variance in mean education across the different source countries. As a result of immigrant self-selection, relatively similar persons tend to migrate to the host country. The selection process thus serves as a pre-arrival "melting pot" that makes the immigrant population in the host country more homogeneous than the population of the various countries of origin.

Superficially, it seems as if the selection rule for observable skills implicit in equation (41) has little to do with the selection rules for unobserved skills in (32). However, the fundamentals that drive immigrant selection are exactly the same. The sorting in observed characteristics is guided by the prices δ_0 and δ_1. The selection in unobserved characteristics is also guided by their prices, the variances σ_0^2 and σ_1^2.[32]

4. The Skills of Immigrants: Empirics

Much of the empirical research in the immigration literature analyzes the differences in the skill distributions of immigrants and natives. Beginning with the work of Chiswick (1978)

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[31] Suppose, for example, that $(\delta_1 - \delta_0) > 0$. An increase in μ_s makes it worthwhile for more persons to migrate and dilutes the mean education of the immigrant sample. Hence the increase in the conditional expectation of schooling is smaller than the increase in the population mean.

[32] Borjas, Bronars, and Trejo (1992) generalize the Roy model to show that the skill sorting of workers among *n* potential regions is also guided by the regional distribution of the returns to skills. The *n*-country model is difficult to solve (and estimate) unless one makes a number of simplifying assumptions about the joint distribution of skills. Dahl (1997) provides a good discussion of the challenges encountered in estimating polychotomous choice models in the context of internal migration decisions.

and Carliner (1980), these studies attempt to measure both the skill differential at the time of entry and how this differential changes over time as immigrants adapt to the host country's labor market. A key result of this literature is that there exists a positive correlation between the earnings of immigrants and the number of years that have elapsed since immigration.[33] As will be seen below, there has been a great deal of debate over the interpretation of this correlation.

4.1. The Identification Problem

The empirical analysis of the relative economic performance of immigrants was initially based on the cross-section regression model:

$$\log w_\ell = X_\ell \beta_0 + \beta_1 I_\ell + \beta_2 y_\ell + \varepsilon_\ell, \quad (44)$$

where w_ℓ is the wage rate of person ℓ in the host country; X_ℓ is a vector of socioeconomic characteristics (often including age and education); I_ℓ is a dummy variable set to unity if person ℓ is foreign-born; and y_ℓ gives the number of years that the immigrant has resided in the United States and is set to zero if ℓ is a native.[34] Because the vector X controls for age, the coefficient β_2 measures the differential value that the host country's labor market attaches to time spent in the host country versus time spent in the source country.

Beginning with Chiswick (1978), cross-section studies of immigrant earnings have typically found that β_1 is negative and β_2 is positive. Chiswick's analysis of the 1970 U.S. Census data indicates that immigrants earn about 17 percent less than "comparable" natives at the time of entry, and this gap narrows by slightly over 1 percentage point per year.[35] As a result, immigrant earnings overtake those of their native counterparts after about 15 years in the United States. The steeper age earnings profiles of immigrants was interpreted as saying that immigrants accumulated human capital—relative to natives—as the "Americanization" process took hold, closing the wage gap between the two groups. The overtaking phenomenon was then explained in terms of a selection argument: immigrants are "more able and more highly motivated" than natives [Chiswick (1978, p. 900)], or immigrants "choose to work longer and harder than nonmigrants" [Carliner (1980, p. 89)]. As we have seen, these assumptions about the selection process are not necessarily implied by income-maximizing behavior on the part of immigrants.

Borjas (1985) suggested an alternative interpretation of the cross-section evidence. Instead of interpreting the positive β_2 as a measure of assimilation, he argued that the cross-

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[33] Although most of the empirical evidence focuses on the U.S. experience, the literature also suggests that this correlation is observed in Canada [Baker and Benjamin (1994); Bloom and Gunderson (1991)], Australia [Beggs and Chapman (1991)], and Germany [Dustmann (1993); Pischke (1993)].

[34] The models actually used in empirical studies typically include higher-order polynomials in age and years-since-migration. These nonlinearities, however, do not affect the key identification issue.

[35] Chiswick's (1978) study uses log annual earnings as the dependent variable and includes education, potential experience (and its squared), the log of weeks worked, and some regional characteristics in the vector X.

section data might be revealing a decline in relative skills across successive immigrant cohorts.[36] In the United States, the postwar era witnessed major changes in immigration policy and in the size and national origin mix of the immigrant flow. If these changes generated a less-skilled immigrant flow, the cross-section correlation indicating that more recent immigrants earn less may say little about the process of wage convergence, but may instead reflect innate differences in ability or skills across cohorts.[37]

The identification of aging and cohort effects raises difficult methodological problems in many demographic contexts. Identification requires the availability of longitudinal data where a particular worker is tracked over time, or, equivalently, the availability of a number of randomly drawn cross-sections so that specific cohorts can be tracked across survey years. Suppose that a total of Ω cross-section surveys are available, with cross-section τ ($\tau = 1, \ldots, \Omega$) being obtained in calendar year T_τ. Pool the data for immigrants and natives across the cross-sections, and consider the regression model:

(45) Immigrant Equation: $$\log w_{\ell\tau} = X_{\ell\tau}\phi_{i\tau} + \delta_i A_{\ell\tau} + \alpha\, y_{\ell\tau} + \beta C_{\ell\tau} + \sum_{\tau=1}^{\Omega} \gamma_{i\tau}\, \pi_{\ell\tau} + \varepsilon_{\ell\tau},$$

(46) Native Equation: $$\log w_{\ell\tau} = X_{\ell\tau}\phi_{n\tau} + \delta_n A_{\ell\tau} + \sum_{\tau=1}^{\Omega} \gamma_{n\tau}\, \pi_{\ell\tau} + \varepsilon_{\ell\tau},$$

where $w_{\ell\tau}$ gives the wage of person ℓ in cross-section τ; X gives a vector of socioeconomic characteristics; A gives the worker's age at the time the cross-section survey is observed; $C_{\ell\tau}$ gives the calendar year in which the immigrant arrived in the host country; $y_{\ell\tau}$ gives the number of years that the immigrant has resided in the host country ($y_{\ell\tau} = T_\tau - C_{\ell\tau}$); and $\pi_{\ell\tau}$ is a dummy variable indicating if person ℓ was drawn from cross-section τ.[38]

Because the worker's age is a regressor, the coefficient α measures the differential value of a year spent in the host country versus a year spent in the source country. Define:

(47) $$\alpha^* = \left.\frac{\partial \log w_\ell}{\partial t}\right|_{\text{Immigrant}} - \left.\frac{\partial \log w_\ell}{\partial t}\right|_{\text{Native}} = (\delta_i + \alpha) - \delta_n,$$

where the derivatives account for the fact that both age and the number of years-since-migration change over time. The parameter α^* measures the rate of wage convergence between

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[36] Douglas (1919) presents a related discussion of cohort effects in the context of early 20$^{\text{th}}$ Century immigration.

[37] Endogenous return migration can also generate skill differentials among immigrant cohorts. Suppose, for example, that return migrants have relatively lower wages. Earlier cohorts will then have higher average wages than more recent cohorts.

[38] A more general model would allow for nonlinearities in the age, years-since-migration, and year-of-arrival variables, variation in the coefficient vector (ϕ, δ) over time, as well as differences in the coefficient α across immigrant cohorts. For the most part, these generalizations do not affect the discussion of identification issues.

immigrants and natives (an aging effect); the coefficient β indicates how the earnings of immigrants are changing across cohorts, and measures the cohort effect, and the vectors γ_i and γ_n give the impact of aggregate economic conditions on immigrant and natives wages, respectively, and measure period effects.

The identification problem arises from the identity:

$$y_{\ell\tau} \equiv \sum_{\tau=1}^{\Omega} \pi_\tau (T_\tau - C_{\ell\tau}). \tag{48}$$

Equation (48) introduces perfect collinearity among the variables $y_{\ell\tau}$, $C_{\ell\tau}$ and $\pi_{\ell\tau}$ in the immigrant earnings function. As a result, the key parameters of interest—α, β, and the vector γ_i—are not identified. Some type of restriction must be imposed if we wish to separately identify the aging effect, the cohort effect, and the period effects. Borjas (1985) proposed the restriction that the period effects are the same for immigrants and natives:

$$\gamma_{i\tau} = \gamma_{n\tau}, \qquad \forall\tau. \tag{49}$$

Put differently, trends in aggregate economic conditions change immigrant and native wages by the same percentage amount. A useful way of thinking about this restriction is that the period effects for immigrants are calculated from *outside* the immigrant wage determination system.[39]

Friedberg (1992) argued that the generic model in (45) and (46) ignores an important aspect of immigrant wage determination: the role of age-at-arrival in the host country. The U.S. data suggest a strong negative correlation between age-at-arrival and entry earnings. The identification problem, however, does not disappear when the entry wage of immigrants depends on age-at-migration. Rather, it becomes more severe. Consider the following generalization of equation (45):

$$\log w_{\ell\tau} = X_{\ell\tau}\phi_{i\tau} + \delta_i A_{\ell\tau} + \alpha\, y_{\ell\tau} + \beta\, C_{\ell\tau} + \theta\, M_{\ell\tau} + \sum_{\tau=1}^{\Omega} \gamma_{i\tau}\, \pi_{\ell\tau} + \varepsilon_{\ell\tau}, \tag{50}$$

where $M_{\ell\tau}$ gives the immigrant's age at migration. As before, the parameter vector (α, β, γ_i) in (50) cannot be identified because the identity in equation (48) still holds. The inclusion of the age-at-migration variable, however, introduces yet another identity: $M_{\ell\tau} \equiv A_{\ell\tau} - y_{\ell\tau}$. Moreover, the perfect collinearity introduced by this identity remains even after the period effects are assumed to be the same for immigrants and natives. As a result, an additional restriction must be imposed on the data. One possible restriction is that the coefficient of the age variable is the same for immigrants and natives. The estimation of the system in (46) and (50) then requires that:

$$\delta_i = \delta_n \quad \text{and} \quad \gamma_{i\tau} = \gamma_{n\tau}, \qquad \forall\tau. \tag{51}$$

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[39] Equation (49) is less restrictive than it seems. After all, it does not define *which* native group experienced the same period effects as the immigrant population.

The assumption that the age coefficient is the same in both the immigrant and native samples is very restrictive, and contradicts the notion of specific human capital. After all, it is very unlikely that a year of pre-migration "experience" for immigrants has the same value in the host country's labor market as a year of experience for the native population. Nevertheless, *some* restriction must be imposed if age-at-migration is to have an independent effect on the wage determination process. An alternative approach might model the age-at-migration effect as a step function: persons who migrate as children face different opportunities in the host country than those who migrate as adults. This specification would break the perfect collinearity between age, age-at-migration, and years-since-migration.

Overall, the lesson is clear: estimates of aging and cohort effects are conditional on the imposed restrictions. Different restrictions lead to different estimates of the underlying parameters of interest.

4.2. Economic Assimilation

Even after the analysis has allowed for the possibility of cohort effects, there seems to be a great deal of confusion in the empirical literature about whether immigrants in the United States experience a substantial degree of "economic assimilation."[40] Part of the confusion can be traced directly to a conceptual disagreement over the definition of assimilation.

The *Oxford English Dictionary* defines assimilation as "the action of making or becoming like," while *Webster's Collegiate Dictionary* defines it as "the process whereby individuals or groups of differing ethnic heritage are absorbed into the dominant culture of a society." Any sensible definition of economic assimilation, therefore, must define a base group that the immigrants are assimilating to. Beginning with Chiswick's (1978) study of the "Americanization" of the foreign-born in the United States, many studies implicitly or explicitly use a definition that equates the concept of economic assimilation with the rate of wage convergence between immigrants and natives in the host country. This definition of economic assimilation is given by α^* in equation (47).

LaLonde and Topel (1992, p. 75) propose a very different definition of the process: "assimilation occurs if, between two observationally equivalent [foreign-born] persons, the one with greater time in the United States typically earns more" [LaLonde and Topel (1992), p. 75]. In terms of the econometric model in equations (45) and (46), the LaLonde-Topel definition is simply the parameter α, the coefficient of years-since-migration in the immigrant earnings function.

The two alternative definitions of economic assimilation, α^* and α, stress different concepts and address different questions. The parameter α defines assimilation by comparing the economic value (in terms of the host country's labor market) of a year spent in the host country *relative* to a year spent in the source country. Hence the base group in the LaLonde-Topel definition of economic assimilation is *the immigrant himself*. Immigrants assimilate in the sense that they are picking up skills in the host country's labor market that they would not be picking up if they remained in the source country.

A positive α, however, provides no information whatsoever about the trend in the economic performance of immigrants in the host country—relative to that of natives. Suppose, for example, that the coefficient of the age variable in the immigrant earnings function is smaller

[40] The confusion is also present in the empirical studies of the Canadian experience. See, for example, Bloom and Gunderson (1991, 1995) and Baker and Benjamin (1994).

than the respective coefficient in the native earnings function ($\delta_i < \delta_n$).[41] It is then numerically possible to estimate a very positive α, conclude that there is economic assimilation in the LaLonde-Topel sense, and observe that immigrant earnings keep falling further behind those of natives over time ($\alpha^* < 0$).

The ambiguities introduced by the choice of a base group pervade studies of immigrant economic performance. For example, the discussion of identification issues ignored the question of exactly which variables should enter the standardizing vector *X* in the earnings functions (see equations 45 and 46). The choice of standardizing variables is not discussed seriously in most empirical studies in labor economics, where the inclusion criteria seems to be determined by the list of variables available in the survey data under analysis. But this issue plays a significant role in the study of immigrant wage determination. The disagreement in the empirical literature over the relative economic status of immigrants in the United States arises not only because different studies use different definitions of economic assimilation, but also because different studies use different standardizing variables. As a result, the base group differs haphazardly from study to study.

For example, many studies include a worker's educational attainment (measured as of the time of the survey) in the vector *X*, so that the cohort and aging effects are measured relative to native workers who have the same schooling. This standardization introduces two distinct problems. First, part of the adaptation process experienced by immigrants might include the acquisition of additional schooling. By controlling for schooling observed at the time of the survey, the analysis hides the fact that there might be a great deal of wage convergence between immigrants and natives. Second, the inclusion of schooling in the earnings functions introduces the possibility of "over-controlling"—of addressing such narrow questions that the empirical evidence has little economic or policy significance. It might be interesting to know that the wage of an immigrant high school dropout converges to that of a native high school dropout, but it is probably more important to determine how the skills of the immigrant high school dropout compare to those of the typical native worker. After all, economic theory teaches us that the economic impact of immigration depends on how immigrants compare to natives, and *not* on how immigrants compare to statistically similar natives.

4.3. Empirical Evidence for the United States

A large literature summarizes the trends in the skills and wages of immigrants in the United States.[42] Almost all of these studies combine data from various U.S. Census cross-sections to identify the aging and cohort effects. The essence of the empirical evidence reported in this literature can be obtained by estimating the following regression model in the sample of working men in each Census cross-section:[43]

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[41] This is not an idle speculation. Most empirical studies for the United States do, in fact, show that the age coefficient in the immigrant regression is much smaller than the respective coefficient in the native regression; see Borjas (1995a), LaLonde and Topel (1992), and Funkhouser and Trejo (1995). Baker and Benjamin (1994) also find the same difference in the age coefficients in the Canadian context.

[42] See, for example, Borjas (1985, 1995a), Chiswick (1978, 1986), Duleep and Regets (1997), Funkhouser and Trejo (1995), LaLonde and Topel (1992), National Research Council [1997, Chapter 5), and Yuengert (1994).

[43] The empirical analysis reported below uses the sample of men aged 25-64 who are employed in the civilian sector, are not self-employed, and do not live in group quarters.

$$\text{(52)} \qquad \log w_{\ell\tau} = X_{\ell\tau}\, \beta_\tau + \delta_\tau\, I_{\ell\tau} + \varepsilon_{\ell\tau},$$

where $w_{\ell\tau}$ is the wage of person ℓ in the cross-section observed at time τ (τ = 1960, 1970, 1980, 1990); X is a vector of socioeconomic characteristics; and $I_{\ell\tau}$ is a dummy variable set to unity if person ℓ is an immigrant and zero otherwise. The coefficient δ_τ gives the log wage differential between immigrants and natives at time τ. The analysis uses two alternative specifications of the vector X. In the first, this vector contains only an intercept. In the second, X includes the worker's educational attainment, a fourth-order polynomial in the worker's age, and variables indicating the Census region of residence.[44]

The first row of Table 2 summarizes the trend in the relative wage of immigrant men. The sign and magnitude of the unadjusted wage differential between immigrant and native men changed substantially between 1960 and 1990. In 1960, immigrants earned about 4 percent more than natives did; by 1990, immigrants earned 16.3 percent less. About half of the decline in the relative wage of immigrants can be explained by changes in observable socioeconomic characteristics, particularly educational attainment.

The second row of the table documents the trend in the relative wage of "new" immigrants (these immigrants have been in the United States for less than five years as of the time of the Census).[45] The latest cohort of immigrants earned 13.9 percent less than natives in 1960 and 38.0 percent less in 1990. A substantial fraction of the decline in the relative wage of new immigrants can also be explained by changes in observable socioeconomic characteristics.

As indicated earlier, the *interpretation* of these trends requires that restrictions be imposed on the period effects. If changes in aggregate economic conditions did not affect the relative wage of immigrants (as implied by equation 49), the cohort effects in Table 2 then indicate that the relative skills of immigrants declined across successive immigrant cohorts.[46] This interpretation, therefore, uses a difference-in-differences estimator to identify the trend in relative immigrant skills.[47]

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[44] The vector of educational attainment indicates if the worker has less than 9 years of schooling; 9 to 11 years; 12 years; 13 to 15 years; and 16 or more years. The Census region of residence dummies indicate if the worker lives in the Northeast region, the North Central region, the South region, or the West region.

[45] The year-of-migration question in the 1960 Census differs from that in the post-1960 Censuses. In 1960, persons reported where they lived five years ago. The new immigrant cohort in 1960 is composed of persons who are either naturalized citizens or non-citizens, and were residing abroad in 1955. Since 1970, persons are asked when they came to the United States to stay, and the new immigrant cohorts in these Censuses are composed of persons who are either naturalized citizens or non-citizens, and who came to the United States "to stay" in the last five years. Finally, the 1955-60 cohort can be defined uniquely only in the 1960 and 1970 Censuses.

[46] The implicit link between wages and skills, of course, presupposes that the data are being interpreted through the lens of a human capital model of wage determination.

[47] However, the U.S. wage structure changed markedly in the 1980s (Murphy and Welch, 1992; Katz and Murphy, 1992), with a substantial decline in the relative wage of less-skilled workers. As a result, the assumption that the period effects are the same for immigrants and natives is probably invalid. Borjas (1995a) presents some evidence suggesting that the changes in the U.S. wage structure were not sufficiently large to account for the cohort effects reported in Table 2.

The remaining rows of Table 2 show how the relative wage of a particular immigrant cohort changes over time. These statistics are obtained by estimating the regression model in (52) on a pooled sample that includes natives in a particular age group and immigrants who arrived at a particular point in time and are in the same age group. For example, the third row of the table report the results from regressions that includes natives aged 25-34 as of 1960 and immigrants who were also 25-34 as of 1960 and arrived between 1955 and 1960. This sample is then "tracked" across Censuses. The wage of these immigrants not only caught up with, but also overtook, the wage of similarly aged natives; an initial 9.4 percent wage disadvantage in 1960 became a 6.2 percent wage advantage by 1970. The post-1965 immigrants, however, generally start with a larger wage disadvantage and have a smaller rate of relative wage growth.

Although much of the empirical literature focuses on the secular trend in the mean of the relative wage of immigrants, it is useful to describe the evolution of the income distributions of immigrants and natives (Butcher and DiNardo, 1996). A simple representation of these trends can be obtained by using each Census cross-section to estimate the following regression in the sample of *native* workers:

$$\log w_{\ell\tau} = X_{\ell\tau}\,\beta_\tau + \varepsilon_{\ell\tau}. \tag{53}$$

The residuals from each regression are used to divide the native wage distribution into deciles, with $\upsilon_{k\tau}$ giving the benchmark for the k^{th} decile in Census year τ (with $\upsilon_{0\tau} = -\infty$, and $\upsilon_{10,\tau} = +\infty$). By construction, 10 percent of the native sample lies in each decile. As before, the analysis uses two alternative specifications of X. The first includes only an intercept; the second includes educational attainment, age, and region of residence.

To calculate how many immigrants place in each decile of the native wage distribution, we can use the equations estimated in (53) to predict the residuals for the immigrant sample in each cross-section. Let $\tilde{\upsilon}_{\ell\tau}$ be the residual for immigrant ℓ in year τ and define:

$$d_{k\tau} = \Pr[\upsilon_{k-1,\tau} < \tilde{\upsilon}_{\ell\tau} < \upsilon_{k\tau}]. \tag{54}$$

The statistic $d_{k\tau}$ gives the fraction of the immigrant sample that lies in the k^{th} decile of the native wage distribution in year τ.

The top panel of Table 3 reports the calculations for the immigrant sample, while the bottom panel reports the distributions for the sample of newly arrived immigrants (where the calculation in equation (54) uses only the sample of immigrants who have been in the United States less than 5 years).[48] The 1960-90 period witnessed a substantial change in the *relative* wage distribution of immigrants. In 1960, 17.4 percent of all immigrants and 28.5 percent of new immigrants fell in the bottom two deciles of the native wage distribution. By 1990, 32.9 percent of all immigrants and 48.9 percent of new immigrants fell in the bottom two deciles. Put differently, the decline in the average relative wage of successive immigrant cohorts can be

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[48] This methodology can also be used to describe how the wage distribution of a particular immigrant cohort evolves over time and to compare this evolution to that experienced by native workers. This type of analysis would allow the calculation of rates of "distributional convergence." The results (not shown) suggest that the 1955-60 cohort experienced substantial distributional convergence, but that this type of convergence is rarer for the post-1965 cohorts.

attributed to the increasing likelihood that new immigrants fall into the very bottom of the native wage distribution.[49]

Finally, it is instructive to estimate the regression model presented in the previous section in equations (45) and (46) to illustrate the importance of choosing a definition of economic assimilation. The regression results reported in Table 4 are drawn from Borjas (1995a), pool data from the 1970, 1980, and 1990 Censuses, and include third-order polynomials in age and years-since-migration.[50] The bottom rows of the table use the two alternative definitions of economic assimilation (α^* and α) to calculate the extent of economic assimilation experienced either during the first 10 or first 20 years in the United States.

The regression results reported in column (1) show that the wage of immigrants—*relative to natives*—increases by 6.0 percentage points during the first 10 years in the United States and by 9.9 points during the first 20 years. The LaLonde-Topel definition of assimilation, however, suggests that the wage of immigrants rises by 7.6 percentage points in the first 10 years and by 14.9 points in the first 20 years. The regression in column (2) includes educational attainment as a regressor and the rate of economic assimilation increases. In other words, immigrants experience greater economic assimilation relative to workers who have the same schooling. In view of the huge variation in the rates of "economic assimilation" estimated from the *same* regression model, it is not too surprising that the empirical literature disagrees over how much economic progress immigrants experience in the United States.

4.4. Convergence and Conditional Convergence

The confusion over the measurement of economic assimilation has motivated some researchers to estimate more directly the correlation between the skills of immigrants at the time of entry and the post-migration rate of human capital acquisition [Duleep and Regets (1996, 1997), Borjas (1997)]. A simple two-period model of the human capital accumulation process provides a way of thinking about this correlation.[51] Let K give the number of efficiency units that an immigrant has acquired in the source country. Because human capital may be partly specific, a fraction δ of these efficiency units evaporate when the worker emigrates. The number of effective efficiency units that the immigrant can rent out in the host country is $E = (1 - \delta) K$.

An immigrant lives for two periods in the host country. During the investment period, the immigrant devotes a fraction q of his human capital to the production of additional human capital, and this investment increases the number of available efficiency units in the payoff period by $g \times 100$ percent. If the market-determined rental rate for an efficiency unit in the host country is one dollar, the present value of the post-migration income stream is:

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[49] The results presented in Table 3 are consistent with the evidence presented by Borjas, Freeman, and Katz (1997, Table 15) and Card (1997, Table 2). Butcher and DiNardo (1996) use a kernel density estimator and find that the differences between the wage distributions of immigrants and natives have not changed much in the past three decades. The Butcher-DiNardo analysis, however, controls for differences in educational attainment among the various groups.

[50] The regression models estimated in Table 4 also allow the coefficients for the linear term in age and years of schooling to vary over time; see Borjas (1995a) for additional details. The age and schooling coefficients reported in the table are those referring to the 1990 Census.

[51] See Borjas (1997) for a detailed discussion of this framework. A more general theory would model jointly both the human capital investment decision and the decision to emigrate the source country.

(55) $$V = (1 - \delta)\, K\, (1 - q) + \rho\, [(1 - \delta)\, K\, (1 + g)],$$

where ρ is the discounting factor.[52]

The human capital production function is given by:

(56) $$gE = (qE)^{\alpha}\, E^{\beta},$$

where $\alpha < 1$. Immigrants with higher levels of human capital at the time of entry may be more efficient at acquiring additional human capital. This complementarity between "pre-existing" skills and the skills acquired in the post-migration period suggests that β is positive. However, because the costs of human capital investments are mostly forgone earnings, higher initial skills may make it very expensive to acquire additional skills. This "substitutability" would suggest that β is negative.

Ben-Porath's (1967) neutrality assumption states that these two effects exactly offset each other and β is zero, so that the marginal cost curve of producing human capital is independent of the worker's initial stock. Hence the *dollar* age-earnings profiles of workers who differ only in their initial stock of human capital are parallel to each other. Most empirical studies of earnings determination analyze the characteristics of *log* age-earnings profiles. Hence it is analytically convenient to define a different type of neutrality. Rewrite the human capital production function as:

(57) $$g = q^{\alpha}\, E^{\alpha+\beta-1}.$$

Equation (57) relates the rate of human capital accumulation (g) to the fraction of efficiency units used for investment purposes (q). Define "relative neutrality" as the case where the rate of human capital accumulation is independent of the initial level of effective capital, so $\alpha + \beta = 1$. If $\alpha + \beta > 1$, the rate of human capital accumulation is positively related to initial skills, and we have "relative complementarity." If $\alpha + \beta < 1$, the rate of human capital accumulation is negatively related to initial skills, and we have "relative substitutability."

Immigrants choose the rate of human capital accumulation that maximizes the post-migration present value of earnings. The optimal level of investment is:

(58) $$q = (\alpha\rho)^{\frac{1}{1-\alpha}}\, E^{\frac{\alpha+\beta-1}{1-\alpha}}.$$

If there is relative complementarity, highly skilled workers invest more; if there is relative substitutability, the more skilled invest less.

Let Δ be the percentage wage growth experienced by an immigrant in the host country:

(59) $$\Delta = \frac{(1-\delta)\, K\, (1+g) - (1-\delta)\, K\, (1-q)}{E} = g + q.$$

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[52] The parameter ρ depends on the immigrant's discount rate and on the probability that the immigrant will stay in the host country (and collect the returns on the investments that are partly specific to the host country).

The relationship between initial skills and wage growth is:

(60) $$\frac{d\Delta}{dE} = (\alpha + \beta - 1)\frac{(1+\alpha\rho)\, q}{\alpha\rho(1-\alpha)E} \; .$$

The log wage at the time of entry is:

(61) $$\log w_0 = \log E + \log(1 - q),$$

and the relationship between the entry wage and initial skills is:

(62) $$\frac{d\log w_0}{dE} = \frac{1}{E}\left[1 - \frac{q}{1-q}\cdot\frac{\alpha+\beta-1}{1-\alpha}\right].$$

The positive sign of the first term inside the brackets of (62) suggests that higher initial skills increase entry wages simply because those skills are valued by the host country's employers. Skills at the time of entry, however, also affect the investment rate. Define κ^* as:

(63) $$\kappa^* = \frac{(1-q)\,(1-\alpha)}{q} > 0.$$

By definition, the log entry wage is independent of the initial endowment of human capital when $\alpha + \beta - 1 = \kappa^*$. The inspection of equations (60) and (62) reveal four cases that summarize the potential relationship between the log entry wage and the rate of wage growth:

1. Relative substitution between pre- and post-migration human capital ($\alpha + \beta - 1 < 0$). Skilled immigrants invest less, earn more at the time of entry, and experience less wage growth. There is a negative correlation between log entry wages and the rate of wage growth.

2. Relative neutrality in the human capital production function ($\alpha + \beta - 1 = 0$). Skilled immigrants devote the same fraction of time to human capital investments as less skilled immigrants, but earn more. There is zero correlation between log entry wages and wage growth.

3. Weak relative complementarity in human capital ($0 < \alpha + \beta - 1 < \kappa^*$). Skilled immigrants invest more, and equation (62) indicates that these immigrants also have higher entry wages. There is a positive correlation between log entry wages and wage growth.

4. Strong relative complementarity in human capital ($0 < \kappa^* < \alpha + \beta - 1$). The rate of human capital investment is so high for skilled workers that they actually earn less initially. There is a negative correlation between log entry wages and wage growth.[53]

These cases summarize the implications of human capital theory for the *unconditional* correlation between entry wages and the rate of wage growth. It is also of interest to determine the sign of the *conditional* correlation between log entry wages and the rate of wage growth.

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[53] A fifth case, where $\alpha + \beta - 1 = \kappa^*$, is also possible. In this case, skilled immigrants invest more but entry wages are independent of the level of effective human capital.

This conditional correlation holds initial skills constant. Differences in discounting factors (ρ) generate differences in entry wages and wage growth among immigrants. It is easy to show that:

(64) $$\left.\frac{d\log w_0}{d\rho}\right|_E = \frac{-1}{1-q}\cdot\frac{dq}{d\rho} < 0,$$

(65) $$\left.\frac{d\Delta}{d\rho}\right|_E = \frac{dq}{d\rho}\left(1+\frac{1}{\rho}\right) > 0,$$

since $dq/d\rho > 0$. Equations (64) and (65) indicate a negative correlation between the log entry wage of immigrants and the rate of wage growth, holding initial skills constant. In other words, the theory predicts "conditional convergence."[54]

One can calculate the correlation between the rate of wage growth and the log entry wages in the host country by tracking specific immigrant cohorts over time. Consider the cohort of immigrants who migrated from country j at time t, when they were k years old. Their log wage at the time of entry is given by $w_{jk}(t)$. The rate of wage growth of this immigrant cohort over the (t, t') time interval is:

(66) $$\Delta w_{jk}(t, t') = [w_{jk}(t') - w_{jk}(t)].$$

Consider the regression model:

(67) $$\Delta w_{jk}(t, t') = \theta\, w_{jk}(t) + \xi_{kt} + \nu_{jk},$$

where ξ_{kt} gives a year-of-arrival/age-at-migration fixed effect.[55]

The empirical analysis uses the 1970, 1980, and 1990 U.S. Censuses and is restricted to immigrant men who arrived either in 1965-69 or in 1975-79. A cohort is defined in terms of country of birth (85 national origin groups) and age at arrival (25-34, 35-44, and 45-54 years old), and is tracked across the Censuses for a 10-year period. The first column of Table 5 reports the estimated θ. There is a *positive*, though insignificant, unconditional correlation between the rate of wage growth and the log entry wage of immigrant cohorts. The point estimate suggests that the earnings of different immigrant groups diverge somewhat over time—the cohorts that have the highest log wage at the time of entry experience a slightly faster rate of wage growth. In other words, there seems to be some weak relative complementarity between the skills that immigrants bring into the United States and the skills that they acquire in the post-migration period. This result, of course, resembles Mincer's (1974) finding of complementarity between investments in school and investments in on-the-job training.

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[54] This concept plays an important role in the economic growth literature [Barro (1991), Barro and Sala-i-Martin, (1992)]. In this literature, per-capita income across countries converges if the initial level of the human capital stock is held constant across countries, but does not converge if initial human capital varies across countries.

[55] The inclusion of the fixed effect ξ_{kt} in (67) implies that the numerical value of the coefficient θ is unchanged if the dependent variable were redefined to be the rate of wage growth of the immigrant cohort relative to that experienced by natives in the same age group, and the independent variable were the log entry wage of the immigrant cohort minus the log wage of natives in that age group.

To evaluate the presence of conditional convergence, consider the regression model:

(68) $$\Delta w_{jk}(t, t') = \theta^{*} w_{jk}(t) + \phi\, s_{jk}(t) + \xi_{kt} + \omega_{jk},$$

where $s_{jk}(t)$ gives the average years of schooling of the immigrant cohort that originated from country j at age k—measured as of the time of entry t. The second column of Table 5 shows that θ^{*}, a measure of conditional convergence, is negative and significant. The same sign reversal occurs if the regression adds country-of-origin fixed effects (see column 3), so that there is a great deal of convergence among immigrant groups from a particular country of origin. These country-of-origin fixed effects, of course, can also be interpreted as measures of the cohort's human capital stock at the time of entry.

Duleep and Regets (1997) have estimated these types of convergence regressions but use a different definition of an immigrant cohort. In particular, the immigrant cohort is defined not only in terms of country-of-origin, age-at-migration, and year-of-arrival (i.e., a cell in j, k, t), but also in terms of educational attainment. In particular, let $w_{jks}(t)$ be the log wage of an immigrant cohort originating in country j, migrating at age k, with s years of schooling, and arriving in calendar year t. Similarly, let $\Delta w_{jks}(t, t')$ be the rate of wage growth experienced by this cohort over the time interval (t, t'). For expositional convenience, suppose that all immigrant cohorts arrive in the same calendar year t. Consider the regression model:

(69) $$\Delta w_{jks} = \lambda\, w_{jks} + \xi_k + \omega_{jks},$$

where ω_{jks} is an i.i.d. error term. Duleep and Regets (1997) document that λ is strongly negative in U.S. data, and interpret this finding as implying that the decline in quality across successive immigrant cohorts is not as strong as suggested by the trend in entry wages. A negative λ suggests that more recent cohorts will experience faster wage growth in the future, and the present value of the age-earnings profile might not differ much across cohorts.

This alternative framework raises the interesting question of whether the coefficient λ estimates the unconditional rate of convergence (θ) or the conditional rate of convergence (θ^{*}). To see the relationship among these parameters, rewrite the wage level and wage growth for the (j, k, s) cohort as:

(70) $$w_{jks} = w_{jk} + \varphi_s + e_{jks},$$
(71) $$\Delta w_{jks} = \Delta w_{jk} + \chi_s + \varepsilon_{jks},$$

where φ_s and χ_s are fixed effects giving the "returns to schooling" for wage levels and wage growth, respectively; and e_{jks} and ε_{jks} are i.i.d. random variables that are uncorrelated with the other right-hand-side variables in (70) and (71). The convergence regression in (69) can be rewritten as:

(72) $$\Delta w_{jk} = \lambda\, w_{jk} + (\lambda\varphi_s - \chi_s) + \xi_k + \omega',$$

where $\omega' = \omega_{jks} + \lambda e_{jks} - \varepsilon_{jks}$, and an observation is a (j, k, s) cell. Let $p_{jk}(s)$ be the fraction of the population that has s years of schooling in a (j, k) cell, and aggregate across schooling groups within a (j, k) cell.[56] This aggregation yields:

$$(73) \qquad \Delta w_{jk} = \lambda\, w_{jk} + \sum_s (\lambda \varphi_s - \chi_s)\, p_{jk}(s) + \xi_k + \bar{\omega}\,.$$

Equation (73) shows that the convergence regression that uses schooling groups to define the cohort is equivalent to a regression that aggregates across schooling groups but includes variables that indicate the educational attainment of the cohort. As a result, the coefficient λ estimates the extent of conditional convergence across immigrant cohorts. It is not surprising, therefore, that Duleep and Regets (1997) find a great deal of wage convergence across immigrant cohorts since they are implicitly holding initial skills constant. It is worth stressing, however, that a finding of conditional convergence does *not* suggest that immigrant cohorts with lower entry wages experience faster wage growth in the host country. As Table 5 shows, the choice of a base group is crucial. Overall, immigrant cohorts that start out with higher wages, if anything, tend to have slightly faster wage growth.

5. Immigration and the Wage Structure

The literature attempting to measure how immigrants affect the employment opportunities of native workers in a host country has grown rapidly in the past decade. However, a number of difficult conceptual and econometric problems plague this literature. As a result, much of the accumulated empirical evidence probably has little to say about a central question in the economics of immigration.

5.1. Spatial Correlations

Economic theory suggests that immigration into a *closed* labor market affects the wage structure in that market by raising the wage of complementary workers and lowering the wage of substitutes. Almost all of the empirical studies in this literature define the labor market along a geographic dimension—such as metropolitan areas or states in the United States. If immigrant flows penetrate geographic labor markets in the host country randomly *and* if natives do not respond to these supply shocks, the "spatial correlation" between labor market outcomes in a locality and the extent of immigrant penetration would identify the impact of immigration. Beginning with the early work of Grossman (1982) and Borjas (1983), the typical study regresses a measure of native economic outcomes in the locality (or the change in that outcome) on the relative quantity of immigrants in that locality (or the change in the relative number).[57] The regression coefficient is then interpreted as the "impact" of immigration on the native wage structure.

There are two well-known problems with this approach. First, immigrants may not be randomly distributed across labor markets. The 1990 U.S. Census indicates that immigrants

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[56] The aggregation uses $p_{jk}(s)$ as weights.

[57] More recent studies include Altonji and Card (1991), Card (1997), Jaeger (1996), LaLonde and Topel (1991), and Schoeni (1997). De New and Zimmermann (1994) and Pischke and Velling (1997) provide similar studies of the German labor market.

cluster in a very small number of places: 73.8 percent of immigrants aged 18-64 reside in 6 states (California, New York, Texas, Florida, Illinois, and New Jersey), but only 35.5 percent of natives live in those states. Similarly, 35.4 percent of immigrants live in four metropolitan areas (Los Angeles, New York, Chicago, and Miami), but only 12.9 percent of natives live in those localities. If the areas where immigrants cluster (e.g., California) have done well over some time periods, this would produce a spurious correlation between immigration and area outcomes either in the cross-section or in the time-series. A positive spatial correlation would simply indicate that immigrants choose to reside in areas that are doing relatively well, rather than measure the extent of complementarity between immigrant and native workers.

The second problem with the spatial correlation approach is that natives may respond to the entry of immigrants in a local labor market by moving their labor or capital to other localities until native wages and returns to capital are again equalized across areas. A large immigrant flow arriving in Los Angeles might well result in, say, fewer workers from Mississippi or Michigan moving to California, and a reallocation of capital from those states to California. A comparison of the wage of native workers between California and other states might show little or no difference because the effects of immigration are diffused throughout the national economy, and not because immigration had no economic effects.

In view of these potential problems it is not too surprising that the empirical literature has produced a confusing array of results. The generic regression model used in the spatial correlation literature is of the form:[58]

$$\Delta y_{js}(t, t') = \beta_t \, \Delta m_{js}(t, t') + X_{js}(t)\, \alpha_t + u_{js}(t, t'), \qquad (74)$$

where $\Delta y_{js}(t, t')$ is the change in a measure of employment opportunities experienced by natives who live in region j and belong to skill group s between years t and t'; $\Delta m_{js}(t, t')$ is a measure of the immigrant supply shock in that region for that skill group over the (t, t') time interval; X is a vector of standardizing variables; and $u_{js}(t, t')$ is the stochastic error.

Table 6 summarizes the estimated β's from recent studies by Borjas, Freeman, and Katz (1997) and Schoeni (1997). The Borjas-Freeman-Katz study uses states as the geographic unit, covers the 1960-70, 1970-80, and 1980-90 periods, and defines the immigrant supply shock $\Delta m_{js}(t, t')$ as the change in the number of immigrants between t and t' relative to the number of natives in cell (j, s) at time t. Borjas, Freeman, and Katz pool across education groups and estimate equation (74) by including fixed effects indicating the native group's educational attainment and state of residence. The Schoeni study uses metropolitan areas as the geographic unit, covers the 1970-80 and 1980-90 time periods, and defines the immigrant supply shock as the change in the fraction of the total population that is foreign-born. Schoeni estimates equation (74) separately by education group, and includes the native group's mean education and age, as well as a measure of the size of the labor market, in the vector X. In both studies, the immigrant supply shock is related to wage and employment changes.

The most striking feature of Table 6 is that each study finds huge differences across coefficients, making it extremely difficult to generalize about the effect of immigration on labor market outcomes. Both studies report that the sign of the coefficient β_t changes erratically over

[58] The early studies estimated equation (74) in level form, while more recent studies tend to use first-difference measures of labor market outcomes.

time. In the Borjas-Freeman-Katz analysis, there is a negative correlation between immigration and employment in the 1960s, but the coefficient becomes positive (and numerically larger) in the 1970s, and turns negative and modest in the 1980s. Similarly, Schoeni finds that a three-point increase in the immigrant share of the population (from, say, 7 to 10 percent) reduced the earnings of men who are high school graduates by 1 percent in the 1970s, but the same supply shock would have increased the wage of this group by .8 percent had it occurred between 1980 and 1990. Note also that there is a lot of dispersion in the coefficients (within a given time period) when one compares the results for men and women, or if one looks at wage outcomes or employment outcomes.

As noted above, the supply shock to a particular labor market is likely to be endogenous because immigrants choose where to live depending on economic conditions in the locality (this point is discussed in more detail in the next section). Altonji and Card (1991, p. 222) instrument the immigrant supply shock with a second-order polynomial in the fraction of the work force that is foreign-born at the beginning of the period. In the Altonji-Card study (which covers the 1970-80 period), the OLS estimate of β_t for white men with less than a high school education is -.36 (with a standard error of .41), but the IV estimate is –1.10 (.64). The Altonji-Card IV estimate of equation (74), therefore, seems to suggest that immigrants have a substantial adverse effect on the wages of natives.

The Schoeni study uses the Altonji-Card IV procedure, and also finds that IV leads to very different estimates. As Table 6 shows, however, the IV procedure does not reduce the confusion created by the excessive time variation in the estimated β's. If anything, the IV procedure increases it. In the 1970s, the OLS spatial correlation is usually negative and the IV procedure tends to make β even more negative. In the 1980s, the OLS spatial correlation is usually positive and the IV procedure tends to make β even more positive.

The ambiguous empirical evidence raises a number of important questions—most of which have yet to be seriously addressed by the literature. For instance, why is the sign of the spatial correlation in the United States so dependent on the time period under analysis? Borjas, Freeman, and Katz suggest that the instability in the spatial correlation over time can probably be traced back to major changes in the U.S. regional wage structure—changes that are not well understood and that probably have little, if anything, to do with immigration. Figure 2 illustrates the nature of the structural change by showing the relationship by state between (education-adjusted) wage growth in the 1980s and wage growth in the 1970s for men.[59] The figure illustrates a strong *negative* correlation in wage growth by state across the two decades.[60] In other words, the high wage growth states of the 1970s became low wage growth states in the 1980s.

However, Figure 3 shows that *the same states* continued to receive large numbers of immigrants. The reversal of wage growth among states thus implies a reversal in the sign of the

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[59] The data underlying the figure adjusts for interstate differences in the educational attainment of natives by aggregating across different education cells using a fixed weight of the native education distribution; see Borjas, Freeman, and Katz (1997) for more details. The data points illustrated in both panels of Figure 2 are weighted by the size of the adult-age population in the state in 1980.

[60] Borjas-Freeman-Katz show that this negative correlation does not exist between the 1960s and the 1970s. The correlation in those two decades is nearly zero. Shoeni (1997, unpublished tabulations) also finds a strong negative correlation in wage growth by metropolitan area between the 1970s and the 1980s.

correlation between changes in wages and in immigration. An observer will almost certainly draw different inferences about the impact of immigration by analyzing spatial correlations estimated in different time periods. Unless the analyst can net out the impact of these structural shifts (and that would require an understanding of why the shifts occurred in the first place), it is almost hopeless to isolate the impact of immigration on the U.S. wage structure from regression-based spatial correlations.

A different approach to estimating spatial correlations appears in Card's (1990) influential case study of the Mariel immigrant flow. On April 20, 1980, Fidel Castro declared that Cuban nationals wishing to move to the United States could leave freely from the port of Mariel. By September 1980, about 125,000 Cubans had chosen to undertake the journey. Almost overnight, the Mariel "natural experiment" increased Miami's labor force by 7 percent. Card's (1990) analysis of the CPS data indicates that labor market trends in Miami between 1980 and 1985—in terms of wage levels and unemployment rates—were similar to those experienced by such cities as Los Angeles, Houston and Atlanta, cities that did not experience the Mariel supply shock.[61]

Although superficially different, all spatial correlation studies—whether they use the regression model in (74) or focus on a single unexpected supply shock—rely on difference-in-differences estimates of how immigration changes native outcomes in cities that received immigrants versus in cities that did not.[62] One could easily argue that this literature has failed to increase our understanding of how labor markets respond to immigration. If we take the empirical evidence summarized in Table 6 at face value, the implications are disturbing: either we need different economic models to understand how supply shocks affect labor markets in different time periods (and we would then be left wondering which model we should use to predict the impact of the next immigrant wave), or the regression coefficients are simply not measuring what we think they should be measuring.

5.2. A Model of Wage Determination and Internal Migration

As noted earlier, natives might respond to immigration by "voting with their feet," either through capital or labor flows. What structural parameters, if any, do the spatial correlations between native wages and immigrant supply shocks then measure? And, in particular, is there a way of recovering the "true" wage effect of immigration from spatial correlations?

This section shows formally what these spatial correlations identify in a simple framework that jointly models the wage determination process in a local labor market and the internal migration decision of native workers. The model presented here borrows liberally from a framework developed by Borjas, Freeman, and Katz (1997, unpublished appendix).[63]

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[61] Related studies include Hunt's (1992) analysis of the movement of 900,000 persons of European origin between Algeria and France in 1962, and Carrington and de Lima's (1994) study of the 600,000 refugees who entered Portugal after the country lost the African colonies of Mozambique and Angola in the mid-1970s. Neither study finds a substantial impact of immigration on the affected local labor markets.

[62] The key distinction between the two approaches concerns the extent to which the immigrant flow is unexpected (and natives have had little opportunity to plan in advance for the supply shock).

[63] The model can be viewed as an application of the Blanchard and Katz (1992) framework that analyzes how local labor markets respond to demand shocks. The model can also be adapted to incorporate capital flows.

Suppose that the labor demand function in geographic area j (j = 1, …, J) at time t can be written as:

$$w_{jt} = X_{jt} \, L_{jt}^{\eta}, \tag{75}$$

where w_{jt} is the wage in region j at time t; X_{jt} is a demand shifter; L_{jt} gives the total number of workers (both immigrants, M_{jt}, and natives, N_{jt}); and η is the factor price elasticity ($\eta < 0$). It is useful to interpret equation (75) as the marginal productivity condition for a group of workers with a particular skill level. For convenience, I omit the subscript indicating the skill class, and I assume that all workers within a particular skill class are perfect substitutes.

Suppose that $N_{j,-1}$ native workers reside in region j in the pre-immigration regime (t = -1), and that the national labor market is in equilibrium prior to the entry of immigrants. The wage, therefore, is initially constant across all J regions. We can then write the marginal productivity condition in the pre-immigration regime as:

$$w_{j,-1} = X_{j,-1} \, N_{j,-1}^{\eta} = w_{-1}, \qquad \forall j. \tag{76}$$

We will assume that this economy is affected only by supply shocks, so that the demand shifter X_{jt} remains constant across all time periods (i.e., $X_{jt} = X_{j,-1}$, $\forall j$).[64]

It is instructive to begin with a very simple version of the supply shock, a one-time supply increase. In particular, M_{j0} immigrants enter region j at time 0. This supply shock will generally induce a response by native workers, but this response occurs *with a lag*. For simplicity, assume that immigrants do not migrate internally within the United States—they enter region j, and remain there.[65] Natives do respond, and region j experiences a net migration of ΔN_{j1} natives in period 1, ΔN_{j2} natives in period 2, and so on. The variable N_{jt} then gives the number of native workers present in region j at time t, and M_{jt} gives the number of immigrants who entered (and remained) in region j. The wage in region j at time t is given by:

$$\log w_{jt} = \log X_{jt} + \eta \log(N_{j,-1} + M_{j0} + \Delta N_{j1} + \ . \ . \ . + \Delta N_{jt}), \tag{77}$$

which can be rewritten as:

$$\log w_{jt} \approx \log w_{-1} + \eta(m_{j0} + v_{j1} + \ldots + v_{jt}), \qquad \text{for } t \geq 0, \tag{78}$$

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[64] This assumption implies that the entry of immigrants will necessarily lower the average wage in the economy. The model can be extended to allow for capital flows from abroad. These capital flows would bring the rental rate of capital back to the world price and re-equilibrate the economy at the pre-migration wage. This extension, however, complicates the notation substantially without altering the key insights.

[65] Some of the "movers" will be immigrants taking advantage of better opportunities in other regions. The empirical evidence in Bartel (1989), however, suggests that immigrants in the United States are not very mobile once they enter the main gateway areas. The possibility that some of the movers might be immigrants does not affect the nature of the results reported below.

where $m_{j0} = M_{j0} / N_{j0}$, the relative number of immigrants entering region j; and $v_{jt} = \Delta N_{jt} / N_{j0}$, the net migration rate of natives in region j at time t (relative to the initial population in the region).[66]

The lagged native supply response is described by the function:

$$v_{jt} = \sigma (\log w_{j,t-1} - \log \bar{w}), \tag{79}$$

where $\log \bar{w}$ is the equilibrium wage that the national economy will attain once the one-time immigrant supply shock works itself through the system, and σ is the supply elasticity ($\sigma > 0$).[67] The equilibrium wage that will be eventually attained in the national economy is defined by:

$$\log \bar{w} = \log w_{-1} + \eta m, \tag{80}$$

where $m = M / N$; M gives the total number of immigrants in the economy; and N gives the (fixed) total number of natives.

The relationship between the region-specific supply shock m_{j0} and the national supply shock, m, is easy to derive. In particular, suppose region j has (in the pre-immigration regime) a fraction r_j of the native population and receives a fraction ρ_j of the immigrants. The region-specific supply shock is then given by:

$$m_{j0} = \frac{M_{j0}}{N_{j0}} = \frac{\rho_j\ M}{r_j\ N} = k_j\ m, \tag{81}$$

where $k_j = \rho_j / r_j$, a measure of the penetration of immigrants into region j *relative* to the region's pre-immigration size. Immigration is "neutrally" distributed across the host country if $k_j = 1\ \forall\ j$. The long-run equilibrium wage $\log \bar{w}$ defined in equation (80) would be attained immediately in all regions if the immigrant supply shock were neutrally distributed over the country.

There are a number of substantive assumptions implicit in the supply function given by equation (79) that are worth noting. First, the native supply response is lagged. Immigrants arrive in period 0. The demand function in equation (78) implies that the wage response to immigration is immediate, so that wages fall in the affected regions. Natives, however, do not respond to this change in the regional wage structure until period 1. Secondly, the model has not imposed any restrictions on the value of the parameter σ. If σ is sufficiently "small," the

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66 The lag in native migration decisions implies that $N_{j0} = N_{j,-1}$.

67 The supply function is typically written in terms of wage differentials among regions. Consider a two-region framework with equally sized regions. The alternative specification of the supply function is:

$$v_2 = \gamma (\log w_2 - \log w_1),$$

where γ would be the conventionally defined supply elasticity. Because the regions are equally sized, the equilibrium wage $\log \bar{w} = .5 (\log w_2 + \log w_1)$. Substituting this definition into the supply function yields:

$$v_2 = 2\gamma (\log w_2 - \log \bar{w}),$$

so that the elasticity σ defined in (79) is twice the conventionally defined supply elasticity.

migration response of natives may not be completed within one period. Some individuals may respond immediately, but other individuals will take somewhat longer.[68] Finally, note that the migration decision is made by comparing the current wage in region *j* to the wage that region *j* will eventually attain. In this model, therefore, there is perfect information about the eventual outcome that results from the immigrant supply shock. Unlike the typical cobweb model, persons are not making decisions based on erroneous information. The lags arise simply because it is difficult to change locations immediately.

The model is now closed and can be solved recursively. The native net migration rate in region *j* at time *t* is given by:[69]

$$v_{jt} = -\eta\sigma(1+\eta\sigma)^{t-1}(1-k_j)m, \tag{82}$$

where the restriction $0 < (1 + \eta\sigma) < 1$ is assumed to hold throughout the analysis. Equation (82) shows that region *j* does not experience any net migration of natives if $k_j = 1$, since the "right" share of immigrants entered that region in the first place. Regions that received a relatively large number of immigrants ($k_j > 1$) experience native out-migration in the post-immigration period (recall $\eta < 0$), while regions that received relatively few immigrants experience native in-migration. Native net migration is largest immediately after the immigrant supply shock, and declines exponentially thereafter.

The wage in region *j* at time *t* depends on the total net migration of natives up to that time. This total migration is given by:

$$V_{jt} = -\sum_{\tau=1}^{t}\eta\sigma(1+\eta\sigma)^{\tau-1}(1-k_j)m = (1-k_j)[1-(1+\eta\sigma)^t]m. \tag{83}$$

Equation (78) then implies that the wage in region *j* at time *t* equals:

$$\log w_{jt} = \log w_{-1} + \eta\left\{k_j + (1-k_j)[1-(1+\eta\sigma)^t]\right\}m. \tag{84}$$

Equations (83) and (84) provide the foundations for a two-equation model that jointly analyzes the native response to immigration and the immigrant impact on the wage structure. To evaluate if the data can identify the relevant parameters, consider a slightly different form of the model:

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[68] In a sense, the migration behavior underlying equation (79) is analogous to the firm's behavior in the presence of adjustment costs (Hamermesh, 1993). One can justify this staggered response in a number of ways. The labor market is in continual flux, with persons entering and leaving the market, and some of the migration responses may occur concurrently with these transitions. Workers may also face constraints that prevent them from taking immediate advantage of regional wage differentials. Some families, for example, might have children enrolled in school or might lack the capital required to fund the migration.

[69] Equation (82) is derived as follows. First, use the demand function in (78) to calculate the wage observed in region *j* at time 0 after the immigrant supply shock. This wage can then be used to calculate the net migration flow experienced by region *j* in period 1 using the supply function in (79), and to calculate the period-1 wage in the region. Equation (82) follows from this procedure by carrying the process forward to period *t*.

(85) $$V_{jt} = [1-(1+\eta\sigma)^t]m - [1-(1+\eta\sigma)^t]m_j ,$$

(86) $$\log w_{jt} - \log w_{-1} = \eta[1-(1+\eta\sigma)^t]m + \eta(1+\eta\sigma)^t m_j .$$

Note that both equations (85) and (86) are of the "before-and-after" type. In effect, equation (85) presents a first-difference model of the total migration of natives (where there was zero migration in the pre-immigration regime), while equation (86) presents a model of the wage change in region j before and after the immigrant supply shock. Both regressions contain two explanatory variables: the national immigrant supply shock (m), and the regional supply shock (m_j). The model has been derived for a single skill class, so that the national immigrant supply shock is a constant across all observations and its coefficient is subsumed into the intercept. One can imagine having a number of different skill classes and "stacking" the data across skill groups (assuming that there are no cross-effects that must be taken into account). The national immigrant supply variable would then be a constant within a skill class. It is likely, however, that there are skill-specific fixed effects both in net migration rates and in wage changes. These fixed effects imply that the coefficient of the national supply shock cannot be separately estimated. Therefore, all the estimable information about how regional wages evolve and how natives respond to immigration is contained in the coefficient of the supply shock variable m_j.

Suppose we observe data as of time t (i.e., t years after the immigrant supply shock). Let δ_t be the coefficient from the native net migration regression, and β_t be the coefficient from the wage change regression. These coefficients are defined by:

(87) $$\delta_t = -[1-(1+\eta\sigma)^t],$$

(88) $$\beta_t = \eta(1+\eta\sigma)^t .$$

These coefficients yield a number of interesting implications. As t grows large, the coefficient in the migration regression converges to –1 and the coefficient in the wage change regression converges to zero. Put differently, the longer the time elapsed between the one-time immigrant supply shock and the measurement of native migration decisions and wage changes, the more likely that natives have completely internalized the supply shock, and the less likely that the data will uncover *any* wage effect on local labor markets. Second, note that the wage regression will not estimate the factor price elasticity η except at time 0—*immediately* after the immigrant supply shock. Over time, the wage effect is contaminated by native migration, and the contamination grows larger the longer one waits to measure the effect. In fact, reasonable assumptions for the factor price and supply elasticities suggest that the wage regression will yield useless estimates of the wage effect even if the data is observed only 10 years after the one-time supply shock. For example, suppose that $\eta = -.3$, and that $\sigma = .5$. After 10 years, the wage change regression would yield a coefficient of –.06. Finally, and most important, the two-equation model allows us to identify the factor price elasticity if we do not wait "too long" after the immigrant supply shock. The definitions of the coefficients δ_t and β_t imply that:

(89) $$\eta = \frac{\beta_t}{1+\delta_t}.$$

The factor price elasticity can be estimated from the spatial correlation between wage growth and immigration by "blowing up" the coefficient from the wage change regression. Suppose, for example, that the migration coefficient is –.5, so that 5 natives leave the region for every 10 "excess" immigrants that enter. The true factor price elasticity η is then estimated by doubling the spatial correlation between wages and immigration. Note, however, that because δ approaches –1 as t grows large, the formula given by equation (89) is not useful if the data are observed some time after the immigrant supply shock took place.[70]

The model suggests that the problem with the spatial correlations reported in the literature may not be so much the endogeneity problem caused by immigrants choosing to move to "good" areas, but the fact that all of the currently available empirical models suffer from omitted-variable bias. The correct specification of the wage change regression is one in which the wage change in the region (for a particular skill group) is regressed on the *net* supply shock induced by immigration. The correct generic regression is of the form:

$$\text{(90)} \qquad \Delta w_j = \eta(m_j + V_j) + \text{other variables} + e_j,$$

where m_j measures the immigrant supply shock; V_j measures the (total) net migration rate of natives; and e_j is the stochastic error. The typical regression in the literature is of the form:

$$\text{(91)} \qquad \Delta w_j = \beta\, m_j + \text{other variables} + (e_j + \eta V_j).$$

As discussed above, it is not uncommon to estimate equation (91) using instrumental variables, where the instrument is the fraction of region j's population that is foreign-born at the beginning of the period. The joint model of wage determination and internal migration, however, clearly indicates that this instrument is invalid because it *must be* correlated with the disturbance term in

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[70] Although the model presented here focuses on the response of native workers to immigration, the framework can be extended to take into account the response of capital flows. These capital flows would include both the response of native-owned capital "residing" in other regions, as well as the response of international capital to the lower wages now available in the host country. It is instructive to sketch a model that incorporates these capital flows, and to compare the key results to those of the internal migration model. Let F_{jt} be the capital flow in year t induced by the immigrant supply shock in year 0, and suppose that the supply response of capital is given by:

$$F_{jt} = \alpha_1 (\log w_{jt} - \log \bar{w}_t) + \alpha_2 (\log w_{jt} - \log w_{-1}),$$

where $\bar{w}_t$ gives the average wage observed in the host country at time t. The first term of this equation summarizes the incentives for capital flows to occur within the host country, while the second term summarizes the incentives for international capital flows (assuming that the world economy was in equilibrium at wage w_{-1} prior to the immigrant supply shock.). Note that both supply elasticities α_1 and α_2 are negative. The specification of the capital supply response implies that internal and international capital flows continue until the wage in all regions of the host country re-equilibrate at the world wage w_{-1}. The variable F_{jt} enters additively into the earnings function in (78). To simplify, suppose that there are only capital responses to immigration (and no native internal migration). After some tedious algebra, it can be shown that the equation giving the change in the log wage between time t and –1 (the before-and-after comparison) depends on both m, the national supply shock, and on m_j, the regional supply shock. The coefficient of the regional supply shock (the only coefficient that can be identified by the data) is then given by $\eta (1 + \alpha_1 + \alpha_2)^t$. As with the native migration model, therefore, the factor price elasticity is identifiable only in the initial year, and the spatial correlation converges to zero (assuming that $-1 < \alpha_1 + \alpha_2 < 0$). This approach can be extended to incorporate both native internal migration and capital flows into the model. The simple form of the "blowing up" property reported in equation (89) does not hold in this more general model because the true factor price elasticity cannot be identified from estimates of the spatial correlations (β) and the native migration response (δ). The identification of η now also requires information on the elasticities of the capital supply equation.

(91). After all, the native net migration response depends on the number of immigrants in the local labor market at the beginning of the period. As a result, the IV methodology commonly used in the literature does not identify any parameter of interest. A valid IV procedure would require constructing an instrument that is correlated with the immigrant supply shock, but is uncorrelated with the native migration response. Such an instrument, it is fair to say, will be hard to find.[71]

The model also suggests that the factor price elasticity *is* directly identifiable from a before-and-after wage change regression if the regression is estimated immediately after the immigrant supply shock takes place. Card's (1990) study of the Mariel flow carries out precisely this type of exercise, yet fails to find any measurable response to immigration in the Miami labor market in the year after the supply shock took place. Card also reports evidence that population flows into the Miami area slowed down as a result of the Mariel shock, but it seems unlikely that native migration decisions completely internalized the impact of the supply shock within a year. It is possible that capital flows from other cities to Miami "take up the slack," but there does not exist any evidence indicating that this, in fact, happened. Card's evidence (although imprecisely estimated), therefore, cannot be easily dismissed and the findings of the Card study remain a major puzzle.

5.3. A Model with a Permanent Supply Shock

The model presented in the previous section assumed that immigration is a one-time supply shock, and the model's parameters were estimated by comparing outcomes in the pre- and post-immigration periods. Some host countries, particularly the United States, have been receiving a continuous (and large) flow of immigrants for more than 30 years. As a result, it is useful to determine what, if anything, can be learned from spatial correlations when immigrants add to the labor supply of the host country in every period, and the parameters of the model are estimated while the immigrant supply shock continues to take place.

The framework presented in the previous section can be easily generalized to the case of a permanent influx if we assume that each region of the country receives the *same* immigrant supply shock every year. This assumption is not grossly contradicted by the data for the United States because the same regions have been the recipients of immigrants for several decades. At time t, therefore, native workers respond to the supply shock that occurred in the preceding period, as well as to the supply shocks that occurred in all earlier periods. The main adjustment that has to be made to the earlier model concerns the specification of the native supply function. In particular, suppose that the native migration response at time t is:

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[71] The generic model in equation (90) can be used to illustrate that the "blowing-up" result is a general property of this type of framework. In addition to the wage change equation in (90), there exists an equation relating the native response to the initial supply shock:

$$V_j = \delta m_j + \text{other variables} + v_j.$$

Substituting this equation into (90) yields the reduced-form regression:

$$\Delta w_j = \eta(1 + \delta)\, m_j + \text{other variables} + \omega_j.$$

The coefficient of m_j in this reduced-form equation equals β, the spatial correlation typically reported in the literature. It then follows that $\eta = \beta/(1 + \delta)$.

(92) $$v_{jt} = \sigma\,(\log w_{j,t\text{-}1} - \log \bar{w}_{t\text{-}1}),$$

where $\log \bar{w}_{t\text{-}1}$ is the equilibrium wage that will be observed throughout the national economy once all the immigrant supply shocks that have occurred up to time t-1 work themselves through the system. As before, the native response is forward-looking in the sense that natives take into account the consequences of the *total* immigrant supply shock that has already taken place. It might seem preferable to model the supply function so that natives take into account the expected impact of future immigration. However, the total supply shock up to time t-1 is a "sufficient statistic" because we have assumed that the region receives the same number of immigrants in every period.

The national equilibrium wage that will be eventually attained as a result of the immigrant supply shocks up to period t-1 is:

(93) $$\log \bar{w}_{t\text{-}1} = \log w_{\text{-}1} + \eta(m_{j0} + \ldots + m_{j,t\text{-}1}) = \log w_{\text{-}1} + \eta\, t\, m_j.$$

Consider the native supply response to the immigrants who entered the country in period 0. Equation (83) in the previous section showed that the net migration rate of natives in period t induced by the period-0 immigrant flow equals $(1 - k_j)\,[1 - (1 + \eta\sigma)^t]\, m$. Consider now the native response to the supply shock in year 1. Equation (83) then implies that the net migration rate of natives induced by the period-1 migration flow equals $(1 - k_j)\,[1 - (1 + \eta\sigma)^{t\text{-}1}]\, m$. The total net migration of natives in period t attributable to a supply shock of $k_j m$ in region j between periods 0 and t-1 is then given by:

(94) $$V_{jt} = \sum_{\tau=0}^{t-1} (1-k_j)[1-(1+\eta\sigma)^{\tau}]m = (1-k_j)\left[t + \frac{1+\eta\sigma}{\eta\sigma}[1-(1+\eta\sigma)^t]\right]m,$$

and the wage observed in region j at time t equals:

(95) $$\log w_{jt} = \log w_{-1} + \eta\left\{(t+1)k_j + (1-k_j)\left[t + \frac{1+\eta\sigma}{\eta\sigma}[1-(1+\eta\sigma)^t]\right]\right\}m.$$

We can now derive the two first-difference regression models that compare native net migration rates and wages before-and-after the beginning of the immigrant supply shock. These regression models are given by:

(96) $$\begin{aligned} V_{jt} = &\left[\frac{t}{t+1} + \frac{(1+\eta\sigma)}{\eta\sigma}\frac{[1-(1+\eta\sigma)^t]}{(t+1)}\right](t+1)m \\ &-\left[\frac{t}{t+1} + \frac{(1+\eta\sigma)}{\eta\sigma}\frac{[1-(1+\eta\sigma)^t]}{(t+1)}\right](t+1)m_j, \end{aligned}$$

$$\log w_{jt} - \log w_{-1} = \eta\left[\frac{t}{t+1} + \frac{(1+\eta\sigma)}{\eta\sigma}\frac{[1-(1+\eta\sigma)^t]}{(t+1)}\right](t+1)\,m + \eta\left[\frac{1}{t+1} - \frac{(1+\eta\sigma)}{\eta\sigma}\frac{[1-(1+\eta\sigma)^t]}{(t+1)}\right](t+1)\,m_j, \tag{97}$$

where the independent variables have been defined to measure the total (as of time t) immigrant supply shock either at the national level, $(t+1)m$, or at the regional level, $(t+1)m_j$. As before, we can estimate these models either within a single skill group, or by "stacking" across skill groups. If the latter model also includes skill fixed effects, the regression models can only identify the coefficient of $(t+1)m_j$. If we let δ_t be the coefficient of the regional supply shock in the internal migration regression, and β_t be the coefficient in the wage change regression, we can estimate:

$$\delta_t = -\left[\frac{t}{t+1} + \frac{(1+\eta\sigma)}{\eta\sigma}\frac{[1-(1+\eta\sigma)^t]}{(t+1)}\right], \tag{98}$$

$$\beta_t = \eta\left[\frac{1}{t+1} - \frac{(1+\eta\sigma)}{\eta\sigma}\frac{[1-(1+\eta\sigma)^t]}{(t+1)}\right]. \tag{99}$$

Equations (98) and (99) indicate that the permanent supply shock model yields insights similar to those obtained in the one-time model. In particular, the wage change regression will estimate the factor price elasticity η only at the very beginning of the immigrant supply shock (when $t = 0$). As t grows larger, the coefficient in the migration regression converges to –1, while that of the wage change regression converges to zero. Finally, the manipulation of equations (98) and (99) reveals that $\eta = \beta_t/(1 + \delta_t)$, so that we can still recover the true factor price elasticity from the spatial correlation by blowing up the estimated wage effect—as long as we do not wait too long into the immigration period.

Few empirical studies actually conduct the "before-and-after" regression analysis suggested by equations (98) and (99). The historical data are usually hard to obtain, particularly if the immigrant supply shock has been in motion for some decades. Instead, most empirical studies attempt to estimate the parameters of interest by first-differencing the data, so that all the observations come from the post-migration period. The first-difference models are given by:

$$V_{jt} - V_{j,t-1} = [1-(1+\eta\sigma)^t]m - [1-(1+\eta\sigma)^t]m_j, \tag{100}$$

$$\log w_{jt} - \log w_{j,t-1} = \eta\left[1-(1+\eta\sigma)^t\right]m + \eta(1+\eta\sigma)^t m_j, \tag{101}$$

where the independent variables are defined to be the per-period immigrant supply shock.

As before, let $\delta_t = -[1 - (1 + \eta\sigma)^{t-1}]$, the coefficient of m_j in the first-difference native migration equation; and $\beta_t = \eta(1 + \eta\sigma)^t$, the respective coefficient in the first-difference wage equation.[72] Both of these coefficients are negative so that first-difference regressions should have the "right" sign even when all of the data are observed while the immigrant supply shock is

[72] Interestingly, these coefficients are similar to those obtained in the before-and-after regression in the one-period supply shock model [see equations (87) and (88)].

under way. Neither of these coefficients, however, estimates a parameter of interest. Moreover, δ_t approaches minus one and β_t approaches zero as $t \to \infty$. As a result, some local labor markets could be the recipients of very large and permanent supply shocks, but spatial correlations will not reveal the impact of these flows on the wage structure if the first-difference regression is estimated some time after the immigrant supply shock began. Finally, the definitions of δ_t and β_t indicate that the factor price elasticity is estimated by blowing up the coefficient from the wage regression, so that $\eta = \beta_t/(1 + \delta_t)$.

5.4. Immigration and Native Internal Migration

The empirical studies that measure spatial correlations typically ignore the fact that identification of the labor market effects of immigration requires the joint analysis of labor market outcomes and the native response to the immigrant supply shock. The few studies that specifically attempt to determine if native migration decisions are correlated with immigration have yielded a confusing set of results. Filer (1992) finds that metropolitan areas where immigrants cluster had lower rates of native in-migration and higher rates of native out-migration in the 1970s, and Frey (1995) and Frey and Liaw (1996) find a strong negative correlation between immigration and the net migration rates of natives in the 1990 Census. In contrast, White and Liang (1993) and Wright, Ellis and Reibel (1997) report a positive correlation between the in-migration rates of natives to particular cities and immigration flows in the 1980s.

Recent work by Borjas, Freeman, and Katz (1997) and Card (1997) provide the first attempts to jointly analyze labor market outcomes and native migration decisions. In view of the disagreement in earlier research, it should not be too surprising that these two studies reach very different conclusions. Card reports a slight positive correlation between the 1985-90 rate of growth in native population and the immigrant supply shock by metropolitan area, while Borjas, Freeman, and Katz (1997) report a strong negative correlation between native net migration in 1970-90 and immigration by states. The two studies provide a stark example of how different conceptual approaches to the question can lead to very different answers.

Perhaps the clearest evidence of a *potential* relation between immigration and native migration decisions in the United States is summarized in Table 7.[73] Divide the country into three "regions": California, the other five states that receive large numbers of immigrants (New York, Texas, Florida, New Jersey, and Illinois), and the remainder of the country. Table 7 reports the proportion of the total population, of natives, and of immigrants living in these areas from 1950 to 1990. The modern-era immigrant supply shock in the United States began around 1970 and has continued since. It seems natural to contrast pre-1970 changes in the residential location of the native population with post-1970 changes to assess the effects of immigration on native location decisions.

The data reveal that the share of natives who lived in the major immigrant receiving state, California, was rising rapidly prior to 1970. Since 1970, however, the share of natives living in California has barely changed. However, California's share of the *total* population kept rising from 10.2 percent in 1970 to 12.4 percent in 1990. Put differently, an extrapolation of the demographic trends that existed before 1970—*before the immigrant supply shock*—would have

[73] This section is based on the discussion by Borjas, Freeman, and Katz (1997).

predicted the state's 1990 share of the total population quite well.[74] This result resembles Card's (1991, p. 255) conclusion about the long-run impact of the Mariel flow on Miami's population. Card estimates that Miami's population grew at an annual rate of 2.5 percent in the 1970s, as compared to a growth rate of 3.9 percent for the rest of Florida. After the Mariel low, Miami's annual growth rate slowed to 1.4 percent, as compared to 3.4 percent in the rest of Florida. As a result, the actual population of Dade county in 1986 was roughly the same as the pre-Mariel projection made by the University of Florida.

The finding that the rate of total population growth in areas affected by immigrant supply shocks seems to be independent of immigration may have profound implications for the interpretation of spatial correlations between native economic outcomes and immigration. In particular, the immigrants who chose a particular area as their destination "displaced" the native net migration that would have occurred, and this native feedback effect diffused the economic impact of immigration from that area to the rest of the country.

To determine the formal relationship between native migration and immigration, define:

(102) $$\Delta n_j(t,t') = \frac{N_j(t') - N_j(t)}{L_j(t)} \div (t'-t),$$

(103) $$\Delta m_j(t,t') = \frac{M_j(t') - M_j(t)}{L_j(t)} \div (t'-t),$$

where $N_j(t)$ gives the number of natives living in area j at time t; $M_j(t)$ gives the number of immigrants; and $L_j(t) = N_j(t) + M_j(t)$. The variable $\Delta n_j(t, t')$ gives the (annualized) rate of native population growth in area j between years t and t' relative to the initial population of the area; and $\Delta m_j(t, t')$ gives the annualized contribution of immigrants to population in the area, again relative to the initial population in the area. Card (1997) and Borjas, Freeman, and Katz (1997) suggest the regression model:

(104) $$\Delta n_j(t, t') = a + \delta^* \Delta m_j(t, t') + e_j .$$

The coefficient δ^* measures the impact of an additional immigrant arriving in region j in the time interval (t, t') on the change in the number of natives living in that region. The coefficient δ^*, therefore, is the empirical counterpart of the parameter δ in the model presented in the previous sections.

Table 8 reports the estimates of equation (104) using U.S. states as the geographic unit. The table summarizes the substantive content of the evidence reported in the Borjas-Freeman-Katz (from which Table 8 is drawn) as well as, to some extent, in the Card study. The first column reports that the coefficient δ^* is positive and significant over the 1970-90 period. This positive correlation between immigration and native net migration is also reported in the Card study, which uses a different empirical specification: the period under analysis is 1985-90, the

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[74] Borjas, Freeman, and Katz (1997, Figure 4) show that the data point for California (and, in fact, for all the other major immigrant-receiving states) lies close to the regression line linking the 1970-90 population growth rate to the 1950-70 rate.

geographic region is the metropolitan area, and the analysis distinguishes among skill groups. Despite the differences between the two studies, the conclusion is similar—the same areas tend to attract both immigrants and natives.

The positive correlation seems to imply that natives do not respond to immigration or that perhaps natives even respond by moving *to* areas penetrated by immigrants. Borjas, Freeman, and Katz argue that the regression specification in (104) misses an important part of the story. In particular, it compares native population growth among states with different levels of immigration between 1970 and 1990, rather than native population growth in a state *before and after* the immigrant supply shock. In other words, the regression model implicitly assumes that each state would have had the same rate of native population growth in the absence of immigration. But if each state had its own growth path prior to immigration and that growth path *would have continued* absent immigration, the regression might give a misleading inference about immigration's effects. Borjas, Freeman, and Katz thus propose the "double-difference" model:

$$\Delta n_j(t, t') - \Delta n_j(t_0, t_1) = \alpha + \tilde{\delta}\ [\Delta m_j(t, t') - \Delta m_j(t_0, t_1)] + v_j, \tag{105}$$

where the time interval (t_0, t_1) occurs in the period prior to the immigrant supply shock, and the coefficient $\tilde{\delta}$ measures the impact of an increase in the number of immigrants on the number of natives—relative to the "pre-existing conditions" in the state.

The second column of Table 8 reports the coefficient from the double-difference model using the state's population growth from 1960 to 1970 to measure the pre-existing trend. The estimated $\tilde{\delta}$ is not significantly different from –1, suggesting considerable displacement. Finally, the third column of the table re-estimates the double-difference model using the state's growth rate between 1950 and 1970 to control for pre-existing conditions. This regression yields an even more negative coefficient. Because the estimated $\tilde{\delta}$ is near (or below) –1, the model presented in the previous sections implies that it is impossible to blow up the spatial correlations and calculate the "true" factor price elasticity.

Table 8 shows that whether one finds a negative or a positive impact of immigration on native net migration depends on the counterfactual posed by a particular regression model. The single-difference regression model in equation (104) ignores valuable information provided by the state's demographic trends prior to the immigrant supply shock *and* assumes that all states lie on the same growth path in the post-migration period. The double-difference regression model in equation (105) accounts for the pre-existing trends *and* assumes that the trends would have continued in the absence of immigration. The specification of a clear counterfactual is crucial in measuring and understanding the link between immigration, native migration decisions, and the impact of immigrants on the wage structure.

Although the data suggest that the total population growth in a state is independent of immigration, the migration response of natives would completely diffuse the effect of immigration only if the native flows of particular skill groups counterbalanced the immigrant influx and left unchanged the relative factor proportions *within* a state. The evidence on this issue, however, is inconclusive. Borjas, Freeman, and Katz (1997, Table 10), for instance, report that factor proportions were converging across states even before the immigrant supply shock began *circa* 1970. As a result, the sign of the correlation between native migration flows in particular skill groups and the corresponding immigrant supply shock depends not only on whether the counterfactual specifies a before-and-after comparison, but also on whether the model controls for the pre-immigration convergence trends.

Finally, all of the empirical studies in the literature fail to take into account the possibility that the response to immigration includes the movement of capital flows to regions affected by immigrant supply shocks. As a result, the joint analysis of native migration decisions and labor market outcomes may not solve the problems with the spatial correlation approach.

5.5. The Factor Proportions Approach

Because the native response to immigration implies that spatial correlations may not estimate the impact of immigration on the labor market, Borjas, Freeman, and Katz (1992) proposed an alternative methodology. The "factor proportions approach" compares a nation's actual supplies of workers in particular skill groups to those it would had had in the absence of immigration, and then uses outside information on the elasticity of substitution among skill groups to compute the relative wage consequences of the supply shock.[75]

Suppose the aggregate technology in the host country can be described by a linear homogeneous CES production function with two inputs, skilled labor (L_s) and unskilled labor (L_u):

$$Q_t = A_t\,[\alpha\, L_s^{\rho} + (1-\alpha)\, L_u^{\rho}]^{1/\rho}\,. \qquad (106)$$

The elasticity of substitution between skilled and unskilled workers is given by $\sigma = 1/(1 - \rho)$. Suppose further that relative wages are determined by the intersection of an inelastic relative labor supply function with the downward-sloping relative labor demand function derived from the CES. Relative wages in year t are then given by:

$$\log(w_{st} / w_{ut}) = D_t - \frac{1}{\sigma}\log(L_{st} / L_{ut})\,, \qquad (107)$$

where D_t is a relative demand shifter.

The aggregate supply of skill group j at time t is composed of native workers (N_{jt}) and immigrant workers (M_{jt}):

$$L_{jt} = N_{jt} + M_{jt} = N_{jt}\,(1 + m_{jt}), \qquad (108)$$

where $m_{jt} = M_{jt}/N_{jt}$. Equation (107) can be rewritten as::

$$\log(w_{st} / w_{ut}) = D_t - \frac{1}{\sigma}\log(N_{st} / N_{ut}) - \frac{1}{\sigma}\big[\log(1+m_{st}) - \log(1+m_{ut})\big]. \qquad (109)$$

An immigrant supply shock in the (t, t') time interval changes the relative number of immigrants by $\Delta \log(1 + m_{jt})$ for skill group j. The predicted impact of the immigrant supply shock on the relative wage of skilled and unskilled workers equals:

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[75] Related applications of the factor proportions approach include Freeman (1977), Johnson (1970), and Welch (1969, 1979).

$$(110) \qquad \Delta \log(w_{st} / w_{ut}) = -\frac{1}{\sigma}\left[\Delta \log(1 + m_{st}) - \Delta \log(1 + m_{ut})\right].$$

The calculation implied by (110) requires: (a) the aggregation of heterogeneous workers into two skill groups; (b) the assumption that natives and immigrants within each skill group are perfect substitutes; (c) information on the change in the relative number of immigrants for each skill group; and (d) an estimate of the relative wage elasticity ($-1/\sigma$).

The factor proportions literature often assumes that workers with the same educational attainment are perfect substitutes.[76] Table 9 summarizes the results from the most recent application of this approach by Borjas, Freeman, and Katz (1997), using two alternative classifications of skill groups. In the first, workers who are high school dropouts are defined to be "unskilled," and all other workers are defined to be "skilled." In the second, the skill groups are defined in terms of high school equivalents versus college equivalents. To isolate the labor market effects of post-1979 immigration, the simulation normalizes the data so that all persons present in the United States as of 1979 are considered "natives." The immigrant supply shock that occurred between 1980 and 1995 increased relative supplies by 20.7 percentage points for high school dropouts, and by 4.1 percentage points for workers with at least a high school education. The change in the log gap defined by the bracketed term in (110) is .149. Borjas, Freeman, and Katz (1992) estimate the relative wage elasticity for these two groups to be –.322. Equation (110) then implies that the immigration-induced change in the relative supply of high school dropouts reduced their relative wage by 4.8 percentage points, or about 44 percent of the total decline in the relative wage of high school dropouts between 1980 and 1995.

Table 9 also shows, however, that immigration has a much smaller impact if we use an alternative skill aggregation. The post-1979 immigrants increased the relative supply of high-school equivalents by only 1.3 percentage points. Katz and Murphy (1992) estimate that the relative wage elasticity for these two groups is –.709. The immigrant supply shock then lowered the college/high school wage differential by about .9 percentage points, about 5 percent of the actual decline in this wage gap.

In an important sense, the factor proportions approach is unsatisfactory. It departs from the tradition of decades of research in labor economics that attempts to estimate the impact of a particular shock on the labor market by directly observing how this shock affects some workers and not others. The factor proportions approach does not *estimate* the impact of immigration on the wage structure; rather, it *simulates* the impact. For a given elasticity of substitution, the factor proportions approach mechanically predicts the relative wage consequences of a supply shock. It is not surprising that the approach has been criticized for relying on theoretical models to calculate the effect of immigration on native outcomes [Card (1997, p. 2), DiNardo (1997, p. 75)].

On the one hand, the criticism is valid. The factor proportions approach certainly relies on a theoretical framework. If the model of the labor market underlying the calculations or the estimate of the relative wage elasticity is incorrect, the estimated impact of immigration is also incorrect. On the other hand, a great deal of empirical research shows that relative supplies *do* affect relative prices.[77] Moreover, the spatial correlations estimated over the past fifteen years have failed to

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[76] Jaeger (1996) presents evidence that immigrant and native workers within broadly defined education groups may be near-perfect substitutes.

[77] See, for example, Katz and Murphy (1992) and Murphy and Welch (1992).

reveal with any degree of precision the impact that immigration has on the wage structure. Finally, although the factor proportions approach relies on theory, so must any applied economic analysis that wishes to do more than simply calculate correlations. In the end, *any* interpretation of economic data—and particularly any use of these data to predict the outcomes of shifts in immigration policy—requires a "story". The factor proportions approach tells a very specific story of the economy and relies on that story to estimate the impact of immigration on the wage structure.

6. Conclusion

Our understanding of the labor market effects of immigration grew significantly in the past two decades. In view of the potential policy implications of this research and the emotional questions that immigration raises in many countries, it is inevitable that these advances have been marked by heated and sometimes contentious debate over a number of conceptual and methodological issues. Nevertheless, we now have a better grasp on a number of central questions: Which types of persons choose to emigrate? What is the relative importance of aging and cohort effects in determining how the skills of immigrant compare to those of natives in the host country? Which segments of the population in the host country benefit or lose from immigration, and how large are these gains and losses?

It is worth noting that our increased understanding of these issues resulted from both theoretical and empirical developments. The *joint* application of economic theory and econometric methods to analyze the many questions raised by immigration has been a distinctive feature of recent research in this field, and is mainly responsible for the research advances.

It should not be surprising that in a subject as far-reaching as immigration, there remain many outstanding questions. For example, the economic literature has not devoted sufficient attention to the public finance implications of immigration for the host country. Although many "accounting exercises" in the United States purport to compare the taxes paid by immigrants to the expenditures incurred by governments in the receiving areas, these exercises tend to be purely mechanical and use few insights from the public finance literature. In fact, the link between immigration and the welfare state in many host countries not only raises questions about the tax burden that immigrants might impose on natives, but also about whether the welfare state alters the incentives to migrate and stay in a host country in the first place.

The immigration literature has also downplayed the link between immigration and foreign trade. Economic models suggest that immigration and trade alter national output in the host country by increasing the country's supply of relatively scarce factors of production. As a result, the economic incentives that motivate particular types of workers to migrate to a host country motivate those same workers to produce goods that can be exported to that host country. In the presence of free trade, much of the labor market impact of immigration on the host country would have been observed even in the absence of immigration. A key distinction between immigration and trade, however, is that natives can escape some of the competition from abroad by working in the non-traded sector. Immigrants, however, can move between the traded and non-traded sectors, and natives cannot escape competition from immigrant workers.

The immigration literature has not exploited the fact that different host countries pursue very different immigration policies (and that each country's policy can vary significantly over time). These international differences in immigration policy can be used to evaluate how particular policy parameters influence the labor market impact of immigration on the host country, and may greatly increase our understanding of how immigration alters economic opportunities.

Perhaps the most important topic that has yet to be addressed by the immigration literature concerns the economic impact of immigration on the source country. A relatively large fraction of the population of some source countries has moved elsewhere. Moreover, this emigrant population is not randomly selected, but is composed of workers who have particular sets of skills and attributes. What is the impact of this selective migration on the economic opportunities of those who remain behind? And what is the nature and impact of the economic links that exist between the immigrants in the host country and the remaining population in the source country?

The resurgence of large-scale migration across international boundaries ensures that research in the economics of immigration will continue. The impact of the sizable immigrant flows that have *already* entered many host countries will likely reverberate throughout the host country's economic markets (and social structures) for many decades to come. As a result, it is unlikely that our interest in the issues raised by the economics of immigration will diminish in the future.

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FIGURE 1

THE IMMIGRATION SURPLUS IN A MODEL WITH HOMOGENEOUS LABOR AND FIXED CAPITAL

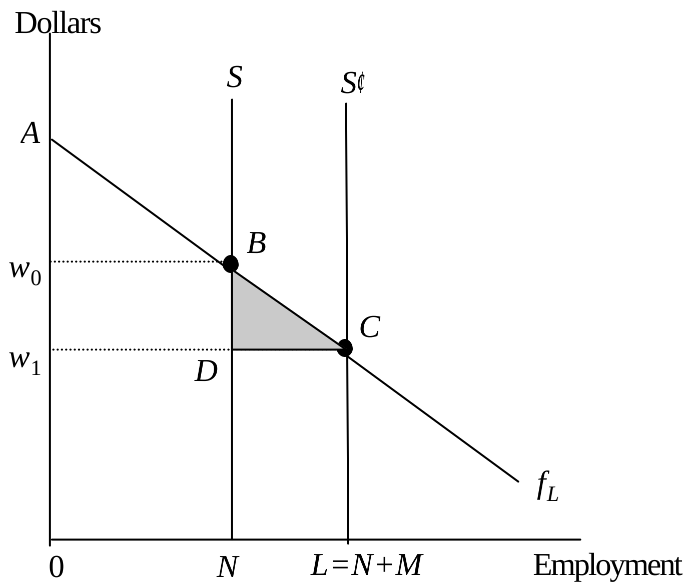

Figure 2. Wage Growth by State, 1980-90 and 1970-80

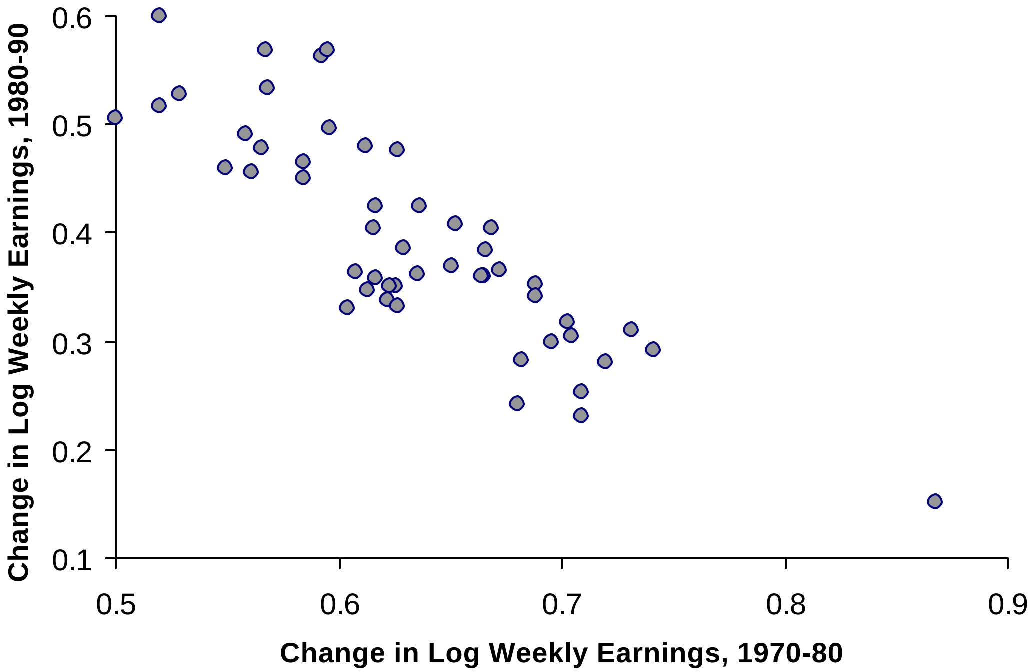

Figure 3. Immigrant Supply Shocks by State, 1980-90 and 1970-80

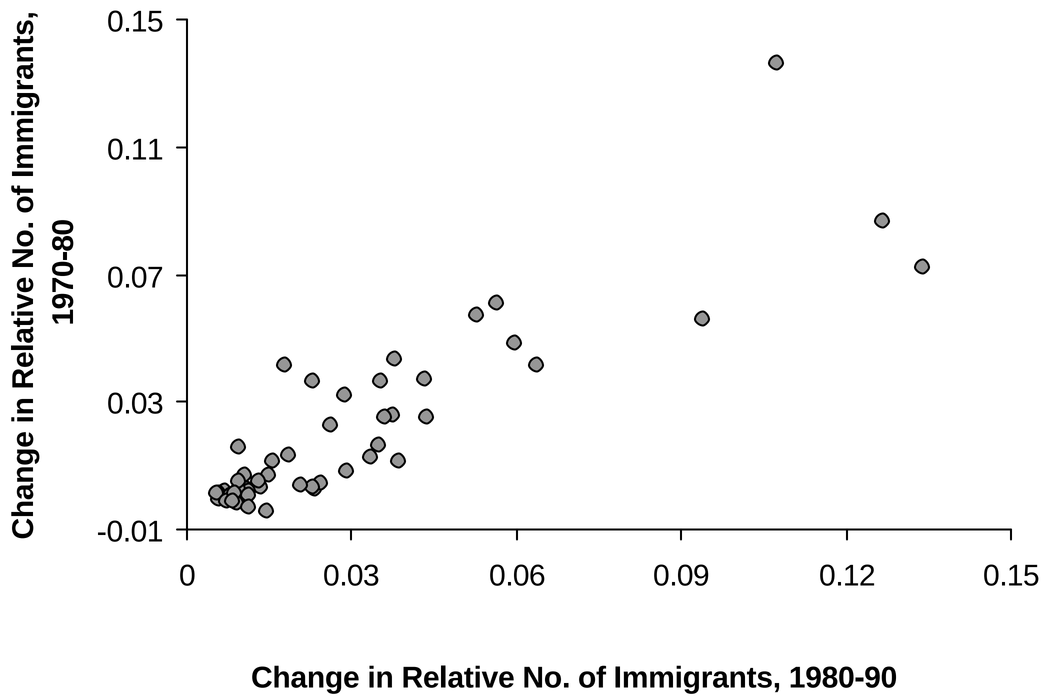

TABLE 1. SIMULATION OF ECONOMIC COSTS AND BENEFITS FROM IMMIGRATION FOR THE UNITED STATES

	Definition of skill groups			
	High school dropouts and high school graduates		High school equivalents and college equivalents	
	Capital fixed	Price of capital fixed	Capital fixed	Price of capital fixed
Assume: $(\varepsilon_{SS}, \varepsilon_{UU}) = (-.3, -.5)$				
Percent change in earnings of capital	2.44	---	3.71	---
Percent change in earnings of skilled workers	-.91	.20	-1.51	.36
Percent change in earnings of unskilled workers	-.28	-1.21	-1.34	-.37
Percent change in GDP accruing to natives	.12	.08	.11	.01
Dollar gain to natives in billions, assuming $8 trillion GDP	9.76	6.65	8.94	.91
Assume: $(\varepsilon_{SS}, \varepsilon_{UU}) = (-.6, -.9)$				
Percent change in earnings of capital	6.43	---	7.55	---
Percent change in earnings of skilled workers	-2.29	.46	-2.94	.65
Percent change in earnings of unskilled workers	-3.72	-4.27	-2.89	-.69
Percent change in GDP accruing to natives	.27	.14	.22	.02
Dollar gain to natives in billions, assuming $8 trillion GDP	24.15	10.81	17.88	1.28
Assume: $(\varepsilon_{SS}, \varepsilon_{UU}) = (-.8, -1.5)$				
Percent change in earnings of capital	11.83	---	11.70	---
Percent change in earnings of skilled workers	-4.36	.61	-5.08	.92
Percent change in earnings of unskilled workers	-6.01	-6.12	-3.92	-.98
Percent change in GDP accruing to natives	.43	.17	.33	.02
Dollar gain to natives in billions, assuming $8 trillion GDP	32.43	13.33	26.80	1.62

Notes: Adapted from Borjas, Freeman, and Katz (1997, Table 19). All simulations assume that $\varepsilon_{SU} = .05$; that labor's share of income is .7; and that the immigrant supply shock increases labor supply in the United States by 10 percent. The values for the other parameters are as follows. High school dropout-graduate skill grouping: $p_S = .91$, $\beta = .68$, $\alpha_S = .661$; $\alpha_U = .039$. High school-college equivalent: $p_S = .43$, $\beta = .33$, $\alpha_S = .371$, $\alpha_U = .329$.

TABLE 2

RELATIVE WAGE OF IMMIGRANT MEN IN THE UNITED STATES, 1960-90

	Unadjusted relative wage				Adjusted relative wage			
Group	1960	1970	1980	1990	1960	1970	1980	1990
All immigrants	.041	-.001	-.097	-.163	.013	-.017	-.071	-.100
	(.005)	(.005)	(.004)	(.003)	(.004)	(.004)	(.003)	(.003)
Newly arrived	-.139	-.188	-.328	-.380	-.162	-.198	-.241	-.269
Immigrants	(.014)	(.011)	(.008)	(.007)	(.013)	(.010)	(.008)	(.006)
1955-60 arrivals								
25-34 in 1960	-.094	.062	---	---	-.128	.049	---	---
	(.019)	(.019)			(.018)	(.018)		
35-44 in 1960	-.140	-.010	---	---	-.181	-.012	---	---
	(.025)	(.027)			(.023)	(.025)		
45-54 in 1960	-.172	-.056	---	---	-.218	-.097	---	---
	(.036)	(.039)			(.033)	(.036)		
1965-70 arrivals								
15-24 in 1970	---	---	-.047	-.067	---	---	.023	.032
			(.015)	(.016)			(.015)	(.015)
25-34 in 1970	---	-.139	-.061	-.022	---	-.173	-.046	-.014
		(.014)	(.015)	(.016)		(.014)	(.014)	(.015)
35-44 in 1970	---	-.170	-.159	-.087	---	-.190	-.121	-.052
		(.019)	(.021)	(.026)		(.017)	(.020)	(.024)
45-54 in 1970	---	-.248	-.247	---	---	-.220	-.194	---
		(.029)	(.034)			(.026)	(.032)	
1975-80 arrivals								
25-34 in 1980	---	---	-.244	-.164	---	---	-.200	-.087
			(.010)	(.011)			(.010)	(.011)
35-44 in 1980	---	---	-.295	-.271	---	---	-.285	-.213
			(.016)	(.019)			(.016)	(.017)
45-54 in 1980	---	---	-.353	-.302	---	---	-.337	-.277
			(.026)	(.033)			(.016)	(.031)

Notes: Standard errors are reported in parentheses. The adjusted relative wage is obtained from a regression that includes a fourth-order polynomial in age, a vector of dummy variables indicating the worker's educational attainment, and a vector of dummy variables indicating the region of residence. The statistics are calculated in the sample of men aged 25-64 (unless otherwise indicated), who work in the civilian sector, who are not self-employed, and who do not reside in group quarters.

TABLE 3

IMMIGRANT PLACEMENT IN THE U.S. NATIVE WAGE DISTRIBUTION, BY DECILE

Decile of Native Distribution	Unadjusted Distribution				Adjusted Distribution			
	1960	1970	1980	1990	1960	1970	1980	1990
All Immigrants								
1	7.7	11.2	15.4	18.3	9.9	12.1	14.3	15.1
2	9.7	10.3	13.1	14.6	9.9	10.6	12.8	13.4
3	12.3	10.4	11.3	10.6	9.9	9.9	11.2	11.4
4	9.2	10.0	9.6	9.5	9.7	9.4	9.6	9.7
5	10.8	9.2	8.7	8.9	9.4	8.6	8.9	8.9
6	9.6	10.5	8.4	7.5	9.9	9.7	8.3	8.2
7	9.7	8.0	7.2	6.5	10.5	9.5	8.2	7.9
8	9.7	9.5	7.6	7.0	9.9	9.4	8.1	7.8
9	10.6	10.0	8.1	8.1	10.0	10.0	8.2	7.9
10	10.9	11.0	10.5	8.9	10.8	10.7	10.4	9.7
Newly Arrived Immigrants								
1	14.6	19.8	26.9	30.0	18.5	22.3	23.5	24.5
2	13.9	15.8	18.1	18.9	12.6	14.5	17.1	17.5
3	15.6	11.6	13.1	10.8	12.7	11.0	12.2	12.2
4	8.9	9.3	8.7	8.4	8.8	8.9	9.1	9.1
5	8.7	7.3	6.7	6.9	8.5	7.2	7.4	7.1
6	7.3	7.5	5.5	4.7	8.1	7.9	5.7	5.9
7	7.2	5.6	4.3	4.0	7.3	6.9	5.3	5.4
8	7.8	6.9	4.3	4.2	8.0	6.2	5.1	5.1
9	7.1	7.7	4.2	5.0	6.9	6.7	5.2	4.9
10	8.8	8.6	8.2	7.0	8.6	8.4	9.2	8.4

Notes: The adjusted distributions are obtained from a regression that includes a fourth-order polynomial in age, a vector of dummy variables indicating the worker's educational attainment, and a vector of dummy variables indicating the region of residence. The statistics are calculated in the sample of men aged 25-64 who work in the civilian sector, who are not self-employed, and who do not reside in group quarters.

TABLE 4

LOG WAGE REGRESSIONS ESTIMATING AGING AND COHORT EFFECTS IN THE UNITED STATES

	Model			
	(1)		2	
Variable	Native	Immigrant	Native	Immigrant
Intercept	-0.624	-0.971	-1.222	-1.057
	(0.057)	(0.062)	(0.054)	(0.059)
Age at time of survey	0.118	0.129	0.094	0.088
	(0.004)	(0.005)	(0.004)	(0.004)
Age squared	-0.002	-0.002	-0.002	-0.002
	(0.000)	(0.000)	(0.000)	(0.000)
Age cubed $\times 10^{-4}$	0.104	0.145	0.074	0.086
	(0.008)	(0.008)	(0.007)	(0.008)
Educational attainment at time of survey	---	---	0.060	0.047
			(0.000)	(0.000)
Years since migration at time of survey	---	0.011	---	0.019
		(0.001)		(0.001)
Years since migration squared	---	0.000	---	0.000
		(0.000)		(0.000)
Years since migration cubed $\times 10^{-4}$	---	0.004	---	0.032
		(0.004)		(0.004)
Cohort effects: relative to 1985-89 arrivals				
Arrived in 1980-85	---	0.000	---	0.004
		(0.005)		(0.005)
Arrived in 1975-79	---	0.061	---	0.059
		(0.005)		(0.005)
Arrived in 1970-74	---	0.097	---	0.095
		(0.007)		(0.007)
Arrived in 1965-69	---	0.153	---	0.113
		(0.008)		(0.008)
Arrived in 1960-64	---	0.202	---	0.137
		(0.010)		(0.010)
Arrived in 1950-59	---	0.235	---	0.160
		(0.012)		(0.012)
Arrived prior to 1950	---	0.235	---	0.146
		(0.016)		(0.017)
Period effects: relative to 1990 observation				
Observation drawn from 1970 Census	0.007	0.007	0.025	0.025
	(0.008)	(0.008)	(0.011)	(0.011)
Observation drawn from 1980 Census	0.048	0.048	-0.001	-0.001
	(0.006)	(0.006)	(0.008)	(0.008)
Estimated assimilation over first 10 years				
Using α*	.060		.076	
Using α	.099		.149	
Estimated assimilation over first 20 years				
Using α*	.076		.100	
Using α	.175		.235	

Notes: Adapted from Borjas (1995a, Table 5). Standard errors are reported in parentheses. The regressions are estimated in the sample of men aged 25-64 (unless otherwis e indicated), who work in the civilian sector, who are not self-employed, and who do not reside in group quarters, and use the 1970, 1980, and 1990 Census cross-sections. Model (2) also includes a dummy variable indicating if the worker lives in a metropolitan area.

TABLE 5

CONVERGENCE REGRESSIONS IN THE UNITED STATES

	Dependent variable: rate of wage growth in first 10 years in the United States			
Independent variable	(1)	(2)	(3)	(4)
Log wage at time of entry	.049	-.428	-.711	-.824
	(.121)	(.074)	(.067)	(.065)
Average years of schooling at time of entry	---	.050	---	.045
		(.006)		(.007)
Fixed effects for country of origin	No	No	Yes	Yes
R^2	.301	.648	.820	.840

Notes: Standard errors reported in parentheses. The regressions are estimated in the sample of men aged 25-64, who work in the civilian sector, who are not self-employed, and who do not reside in group quarters. The unit of observation is an immigrant cohort, defined in terms of country of origin, age-at-arrival, and calendar year-of-arrival. The cohorts included in the regression arrived either between 1965-70 or between 1975-80. All regressions also include a vector of fixed effects indexing a particular age-at-arrival/calendar-year-of-arrival group. The regressions have 414 observations. See Borjas (1997) for details.

TABLE 6

SUMMARY OF RESULTS FROM SPATIAL CORRELATIONS APPROACH

	Men			Women		
Dependent Variable/Group:	1960-70	1970-80	1980-90	1960-70	1970-80	1980-90
State data, OLS:						
Log weekly earnings	0.59	0.07	-0.10	0.20	0.37	-0.02
	(0.11)	(0.08)	(0.06)	(0.21)	(0.14)	(0.04)
Employment probability	-0.06	0.08	-0.03	0.19	0.11	0.01
	(0.03)	(0.05)	(0.01)	(0.05)	(0.09)	(0.01)
Metropolitan area data, OLS:						
Years of schooling < 12						
Log weekly earnings	---	-0.09	0.69	---	-0.77	0.73
	---	(0.29)	(0.32)	---	(0.40)	(0.26)
Labor force participation rate	---	-0.02	-0.21	---	0.13	-0.42
	---	(0.10)	(0.10)	---	(0.15)	(0.10)
Years of schooling = 12						
Log weekly earnings	---	-0.32	0.27	---	0.13	0.86
	---	(0.23)	(0.28)	---	(0.25)	(0.23)
Labor force participation rate	---	0.01	-0.12	---	0.27	-0.21
	---	(0.08)	(0.06)	---	(0.11)	(0.07)
Years of schooling > 12						
Log weekly earnings	---	0.03	0.45	---	0.04	0.83
	---	(0.25)	(0.15)	---	(0.29)	(0.17)
Labor force participation rate	---	-0.08	-0.05	---	0.30	-0.22
	---	(0.07)	(0.04)	---	(0.14)	(0.07)
Metropolitan area data, IV:						
Years of schooling < 12						
Log weekly earnings	---	-1.05	1.12	---	-2.72	1.20
	---	(0.42)	(0.36)	---	(0.63)	(0.31)
Labor force participation rate	---	-0.37	-0.23	---	-0.27	-0.43
	---	(0.16)	(0.11)	---	(0.21)	(0.12)
Years of schooling = 12						
Log weekly earnings	---	-0.96	1.01	---	-0.55	1.20
	---	(0.31)	(0.35)	---	(0.35)	(0.27)
Labor force participation rate	---	0.08	-0.20	---	0.50	-0.25
	---	(0.09)	(0.07)	---	(0.15)	(0.08)
Years of schooling > 12						
Log weekly earnings	---	-0.76	0.72	---	-0.39	1.05
	---	(0.29)	(0.18)	---	(0.38)	(0.20)
Labor force participation rate	---	-0.11	0.00	---	0.17	-0.26
	---	(0.11)	(0.10)	---	(0.17)	(0.08)

Notes: Standard errors are reported in parentheses. The regression coefficients from the state data are drawn from Borjas, Freeman, and Katz (1997, Table 7), and the regression coefficients from the metropolitan area data are drawn from Schoeni (1997, Tables 1, 2, 3). The IV procedure instruments the immigrant supply shock with a second-order polynomial in the fraction of the work force that is foreign-born at the beginning of the period.

TABLE 7

REGIONAL DISTRIBUTION OF ADULT-AGE U.S. POPULATION, 1950-90

	Percent of Total U.S. Population Living in:		
	California	Other Immigrant States	Rest of Country
1950	7.2	26.9	65.9
1960	8.9	27.3	63.7
1970	10.2	27.1	62.7
1980	10.9	26.7	62.4
1990	12.4	27.0	60.7
	Percent of Native U.S. Population Living in:		
	California	Other Immigrant States	Rest of Country
1950	6.9	25.4	67.7
1960	8.6	26.2	65.2
1970	9.6	26.2	64.2
1980	9.7	25.6	64.8
1990	10.0	25.5	64.4
	Percent of Foreign-Born U.S. Population Living in:		
	California	Other Immigrant States	Rest of Country
1950	10.4	44.4	45.2
1960	14.6	44.9	40.6
1970	20.1	43.8	36.0
1980	27.2	41.9	30.9
1990	33.8	40.0	26.1

Source: Borjas, Freeman, and Katz (1997, Table 8). The calculations use the 1950-90 U.S. Censuses. The adult-age population contains all persons aged 18-64 who are not living in group quarters.

TABLE 8

REGRESSION COEFFICIENTS ESTIMATING THE RESPONSE OF CHANGE IN NATIVE POPULATION TO IMMIGRANT SUPPLY SHOCKS IN THE UNITED STATES, BY STATE

First-Difference Regression, 1970-90	Double-Difference Regressions: 1970-90 relative to 1960-70	Double-Difference Regressions: 1970-90 relative to 1950-70
.777	-.756	-1.673
(.311)	(.278)	(.285)

Source: Borjas, Freeman, and Katz (1997, Table 8). Standard errors reported in parentheses. The regressions have 51 observations (one for each state plus the District of Columbia), except for the regression in the last column, which omits Alaska and Hawaii and has 49 observations.

TABLE 9

THE IMPACT OF IMMIGRATION ON THE UNITED STATES
USING THE FACTOR PROPORTIONS APPROACH

	Definition of Skill Groups	
	High school dropouts and high school graduates	High school equivalents and college equivalents
Relative number of post-1979 unskilled immigrants in 1995 ($m_{ut} = M_{ut}/N_{ut}$)	.207	.056
Relative number of post-1979 skilled immigrants in 1995 ($m_{st} = M_{st}/N_{st}$)	.041	.043
Log change in relative supplies $= \log(1 + m_{st}) - \log(1 + m_{ut})$	-.149	-.013
Estimate of relative wage elasticity	-.322	-.709
Change in log relative wage attributable to post-1979 immigration	.048	.009
Actual change in log relative wage between 1980-95	.109	.191

Source: Borjas, Freeman, and Katz (1997, Tables 14, 18).