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The Economic Progress of Immigrants

George J. Borjas

1.1 Introduction

The economic impact of immigration depends both on how immigrants perform in the United States when they first enter the country, as well as on their long-run economic prospects. Beginning with Chiswick's (1978) pioneering work, this dual concern has guided much of the empirical research in the economics of immigration.[1] The literature has typically found that immigrants earn less than natives at the time of entry (with the entry wage disadvantage being larger for more recent cohorts), and that the wage gap between immigrants and natives narrows over time as immigrants assimilate into U.S. society. Many studies conclude that the rate of wage convergence between immigrants and natives is not very large, so that the most recent immigrant waves will probably suffer from a substantial wage disadvantage for much of their working lives.

The literature also stresses that there are sizable differences in economic performance among national origin groups (Borjas 1987; LaLonde and Topel 1992; and Funkhouser and Trejo 1995). For the most part, these studies have examined the impact of national origin on the wage *level* of immigrants in the United States, and the data suggest that immigrants who originate in developed countries earn more than immigrants who originate in poorer countries. The sizable wage differentials among na-

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1. Borjas (1994) presents a detailed survey of the literature.

tional origin groups combined with the changing national origin mix of the immigrant population in the United States has been *the* crucial factor in generating the trends in cohort "quality" that have been the subject of intense interest, both in academic studies and in the policy debate.

It turns out that there are also sizable differences in the rate of wage growth experienced by the different national origin groups in the United States (Borjas 1995; Duleep and Regets 1997a, 1997b; Schoeni, McCarthy, and Vernez 1996; and Yuengert 1994). Therefore, it is important to determine if the rate of wage convergence exhibits cohort effects: Do the most recent immigrant cohorts experience either faster or slower wage growth than earlier cohorts? The existing evidence, however, does not settle this issue conclusively. Duleep and Regets (1997b) argue that more recent waves, who have lower entry wages, will experience faster wage growth in the future, while Borjas (1995) and Schoeni, McCarthy, and Vernez (1996) do not find any evidence of cohort effects in the rate of wage growth.

This paper presents a theoretical and empirical study of the rate of economic progress experienced by immigrants. The study uses a human capital framework to motivate and guide the analysis. There seems to be some confusion about whether human capital theory implies wage convergence among the various immigrant groups, in the sense that immigrants who have high wages at the time of entry should experience slower subsequent wage growth. I show that a reasonable set of assumptions can easily generate investment behavior in the immigrant population that leads to wage divergence among groups, with the most skilled groups earning more at the time of entry and experiencing faster wage growth.

The empirical analysis uses the 1970, 1980, and 1990 Public Use Microdata Samples (PUMS) of the decennial census. The empirical analysis of wage convergence in the immigrant population has much in common with the literature that estimates cross-country regressions to determine if there is convergence in per capita income across countries (Barro 1991, 1997; Mankiw, Romer, and Weil 1992; Quah 1993). These studies typically find that the "raw" correlation between the growth rate in per capita GDP and the initial level of per capita GDP is positive, but weak. There is, however, a strong negative correlation between growth rates and initial levels of per capita income when the regression controls for measures of the country's human capital endowment. The data, therefore, reveal *conditional convergence* in per capita income, in the sense that countries that start out with the same human capital endowments will tend to have the same per capita income levels in the long run.

The differentiation between convergence and conditional convergence is extremely useful for understanding the economic progress of immigrants. As in the cross-country studies in the economic growth literature, the raw data reveal a positive correlation between the log entry wage of immigrants and the subsequent rate of wage growth. Furthermore, the same source country characteristics that lead to high entry wages tend to lead to faster wage growth. This positive correlation between entry wages and wage growth, however, turns negative when one compares immigrant groups who start out with similar human capital endowments. The empirical evidence, therefore, indicates that even though immigrant groups with the same level of human capital will have similar earnings over the long haul, the sizable wage differentials observed among the various immigrant groups at the time of entry may well diverge over time.

1.2 Conceptual Framework

What is the relationship between entry wage levels and the rate of economic progress experienced by immigrants? This question is of more than passing interest because the entry wages of immigrant cohorts (relative to natives) have fallen dramatically in recent decades. Borjas (1995) reports that the immigrants who entered the United States between 1965 and 1969 earned about 18 percent less than natives in 1970, while the immigrants who entered between 1985 and 1989 earned 38 percent less than natives in 1990.[2]

If the lower entry wages of more recent cohorts were compensated by a sufficiently higher rate of future wage growth, the present value of the (relative) earnings profiles of immigrants might not be as different as the differences in entry wage levels would suggest. In fact, the direction of the "quality" differential between immigrants and natives could be the opposite of that implied by the trend in entry wages. However, if more recent cohorts have a lower rate of wage growth than earlier cohorts, the long-run implications of the decline in entry wages are amplified. It is important, therefore, to isolate the factors that determine the rate of wage growth of immigrant cohorts, and to determine the trends in the rate of economic progress across successive cohorts.

Beginning with Chiswick (1978), practically all studies of the economic progress of immigrants use the human capital model as a point of departure.[3] The typical discussion argues that immigrants have a relative wage disadvantage at the time of entry because immigrants lack the U.S.-specific skills that are rewarded in the labor market. Moreover, the costs of acquiring human capital in the post migration period (such as becoming proficient in English) are mainly incurred as forgone earnings, so that these initial human capital investments further depress entry wages for immigrants. Over time, as the immigrants reduce their human capital acquisitions and collect the returns on earlier investments, they experience faster wage growth than natives.

This generic restatement of the human capital model seems to suggest

2. These statistics actually refer to log point differentials. The convention of approximating log point differentials by percentage differences will be used throughout most of the paper.

3. Ben-Porath (1967) gives the classic presentation of the life-cycle human capital accumulation model.

that one should expect a negative correlation between entry wages and subsequent wage growth: Faster wage growth results only if immigrants are willing to give up some earnings at the time of entry. This inference, however, is incorrect because it does not account for the dispersion in the human capital stock that exists in the immigrant population at the time of entry.[4] This heterogeneity could easily lead to a *positive* correlation between entry wages and wage growth. A simple two-period model of the human capital accumulation process captures the basic idea.

Let K measure the number of efficiency units that an immigrant has acquired in the source country. Because human capital is not perfectly transferable across countries, a fraction δ of these efficiency units evaporate when the immigrant enters the United States. The number of effective efficiency units that the immigrant can rent out in the U.S. labor market is then given by $E = (1 - \delta)K$. Without loss of generality, suppose that the market-determined rental rate for an efficiency unit is one dollar.

An immigrant lives for two periods after arriving in the United States—the investment period and the payoff period. During the investment period, the immigrant devotes a fraction s of his efficiency units (or of his productive time) to the production of additional human capital. This allocation of effort might be worthwhile because it increases the number of efficiency units available in the payoff period by $g \times 100$ percent. The present value of the immigrant's income stream in the United States equals

$$V = (1 - \delta)K(1 - s) + \rho[(1 - \delta)K(1 + g)], \tag{1}$$

where ρ is the discounting factor. It is instructive to think of ρ not only as a function of the immigrant's discount rate but also as measuring the probability that the immigrant will stay in the United States (and hence collect the returns on the part of the investments that are U.S.-specific). The parameter ρ, therefore, is smaller when the immigrant has either a high discount rate or a high probability of out-migration.

The human capital production function is:

$$gE = (sE)^{\alpha}E^{\beta}, \tag{2}$$

where $\alpha < 1$ because of diminishing marginal productivity to human capital investments. Beginning with Ben-Porath (1967), the value of the parameter β has been a matter of debate in the human capital literature. Highly skilled immigrants may be more adept at acquiring additional human capital. This complementarity between pre-existing human capital and the skills acquired in the postmigration period would suggest that β is positive. Because the costs of human capital investments are mostly forgone earnings, however, it may be that highly skilled workers find it

4. Many studies in the human capital literature attempt to estimate the correlation between initial earnings and wage growth. See, e.g., Hause (1980), Kearl (1988), and Neumark and Taubman (1995).

very expensive to augment their human capital stock. This "substitutability" would then suggest that β is negative.

The Ben-Porath specification of the human capital production function assumes "neutrality," so that the two effects cancel each other and β is zero.[5] Holding ρ constant, the neutrality assumption states that all workers invest the same *dollar* amount in human capital, regardless of their initial endowment. All workers then get the same *dollar* increase in earnings in the payoff period. As a result, the *dollar* age-earnings profiles of different workers are parallel to each other. The neutrality assumption also implies that the *log* age-earnings profiles of different workers must converge because the payoff from human capital investment is relatively smaller for more-skilled workers.[6]

Most of the empirical work in the human capital literature focuses on the life-cycle trends in log earnings, and analyzes the determinants of the rate of growth of earnings (rather than of the absolute change in earnings). It is, therefore, analytically convenient to define a different type of neutrality in the production function. In particular, rewrite equation (2) as:

$$g = s^{\alpha} E^{\alpha+\beta-1}. \tag{3}$$

Equation (3) relates the percentage increase in the human capital stock to the fraction of efficiency units that are used for investment purposes during the investment period. Define *relative neutrality* to occur when the relative increase in the human capital stock (g) depends only on the fraction of time devoted to investment (s), and not on the initial level of effective capital. Relative neutrality then occurs when $\alpha + \beta = 1$. If $\alpha + \beta > 1$, the relative returns from the investment (for a given time input) depend positively on the initial level of effective capital, and there is *relative complementarity.* Conversely, if $\alpha + \beta < 1$, the relative returns from the investment are negatively related to the level of initial capital, and there is *relative substitutability.* Not surprisingly, the sign of $(\alpha + \beta - 1)$ plays a crucial role in determining the relationship between the log entry wage of immigrants and the subsequent rate of wage growth.

Before proceeding to an analysis of the model, it is worth noting that relative neutrality implies human capital complementarity in the Ben-Porath sense. After all, if the log age-earnings profiles are parallel across different workers, more-skilled workers must be investing more in human capital. An empirical finding of relative neutrality or relative complementarity, therefore, would necessarily imply "Ben-Porath complementarity" in the production of human capital.

Workers choose the rate of human capital investment (s) that maximizes

5. In later work, Ben-Porath (1970) rejected some of the implications of the neutrality assumption. Rosen (1976) presents a model of human capital accumulation that does not rely on the neutrality assumption.

6. Mincer (1974, ch. 4) provides a detailed discussion of the implications of human capital theory for the convergence of dollar and log age-earnings profiles.

the present value of earnings. The first-order condition to the maximization problem implies that:

$$s = (\alpha\rho)^{1/(1-\alpha)} E^{(\alpha+\beta-1)/(1-\alpha)}. \tag{4}$$

Equation (4) shows that the rate of human capital investment is positively related to the discounting factor, and that the relationship between the rate of human capital investment and initial human capital depends on the sign of $\alpha + \beta - 1$. Suppose that all workers have the same discounting factor ρ. Relative neutrality then implies that all persons allocate the same fraction of time to the production of human capital. Highly skilled workers invest more if there is relative complementarity ($\alpha + \beta > 1$) and invest less if there is relative substitutability ($\alpha + \beta < 1$).

Of course, we seldom have data on the fraction of time that workers allocate to human capital investments. However, we do observe the earnings histories of workers. Let Δ be the *relative* wage growth experienced by an immigrant over his postmigration life cycle:

$$\Delta = \frac{(1-\delta)K(1+g) - (1-\delta)K(1-s)}{E} = g + s. \tag{5}$$

It is easy to show that

$$\left.\frac{d\Delta}{d\rho}\right|_E = \frac{ds}{d\rho}\left(1 + \frac{1}{\rho}\right) > 0. \tag{6}$$

Holding constant the immigrant's initial endowment of human capital, the theory implies that immigrants with a higher ρ (and hence lower discount rates or probabilities of out-migration) experience faster wage growth. The relationship between the rate of wage growth and the initial level of effective human capital, however, is more complicated:

$$\left.\frac{d\Delta}{dE}\right|_\rho = (\alpha + \beta - 1)\frac{(1+\alpha\rho)s}{\alpha\rho(1-\alpha)E}. \tag{7}$$

The correlation between the rate of wage growth and initial human capital depends on the sign of $\alpha + \beta - 1$. If there is relative complementarity in the human capital production function, relative wage growth will be higher for immigrants who have higher levels of effective human capital. In contrast, if there is relative substitutability—and higher levels of effective human capital make it costly to acquire additional human capital—the most-skilled immigrants experience less relative wage growth.

The model can be used to determine the correlation between log entry wages and the rate of wage growth. The log entry wage of the immigrant is

$$\log w_0 = \log E + \log(1 - s). \tag{8}$$

It is instructive to begin the discussion of the relationship between log w_0 and Δ by considering the simpler case where the only exogenous variation in the immigrant population is in the discounting factor ρ. One can show that

$$(9) \qquad \left.\frac{d \log w_0}{d\rho}\right|_E = \frac{-1}{1-s} \cdot \frac{ds}{d\rho} < 0.$$

A higher discounting factor, therefore, reduces the log entry wage while raising the relative rate of wage growth. Equations (6) and (9) replicate the conceptual experiment where initial earnings vary among workers who have the same initial human capital. This experiment is the basis for many of the discussions of the human capital model. Human capital investment steepens the age-earnings profile by reducing entry wages, raising future wages, and effectively generating a negative correlation between the log entry wage and the rate of wage growth.

However, this negative correlation can potentially break down when the entry wage is lower because the effective level of human capital is itself lower. In particular,

$$(10) \qquad \left.\frac{d \log w_0}{dE}\right|_\rho = \frac{1}{E}\left[1 - \frac{s}{1-s} \cdot \frac{\alpha + \beta - 1}{1-\alpha}\right].$$

The positive sign of the first term inside the brackets of equation (10) indicates that the larger level of effective human capital raises entry wages simply because the additional skills are valued by American employers. At the same time, the larger human capital endowment alters the rate of human capital investment. Define κ^* as

$$(11) \qquad \kappa^* = \frac{(1-s)(1-\alpha)}{s} > 0.$$

By definition, the log entry wage is independent of the initial endowment of human capital when $\alpha + \beta - 1 = \kappa^*$. Figure 1.1 illustrates the four cases that summarize the potential relationship between log entry wages and the rate of wage growth of immigrants:

1. *Relative substitution between pre- and postmigration human capital ($\alpha + \beta < 1$).* Immigrants endowed with a substantial level of effective human capital find it expensive to augment their stock in the United States. There is then a negative correlation between log entry wages and the rate of wage growth. Skilled immigrants invest less, earn more at the time of entry, and have a smaller rate of wage growth.

2. *Relative neutrality in the human capital production function ($\alpha + \beta = 1$).* All workers have the same rate of investment (s). The correlation between the log entry wage and the rate of wage growth is zero.

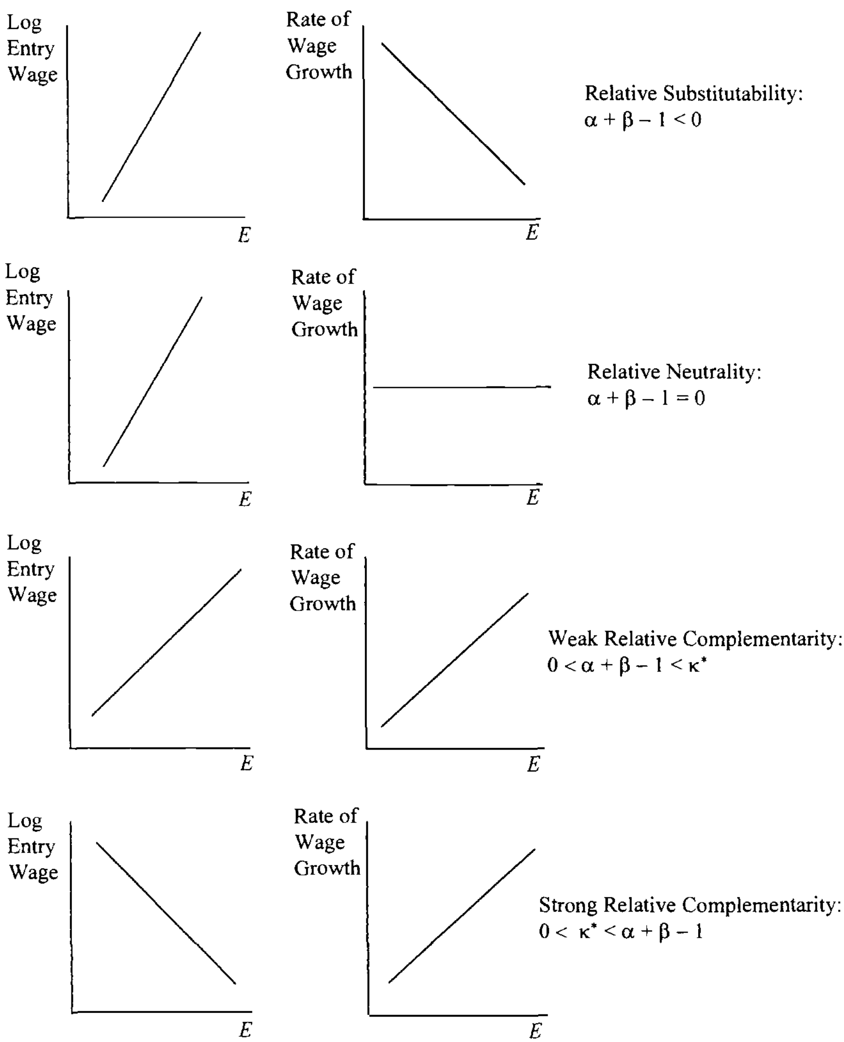

Fig. 1.1 Theoretical relationship between entry wages, wage growth, and effective human capital

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

4. *Strong relative complementarity in human capital* ($0 < \kappa^* < \alpha + \beta - 1$). Skilled immigrants invest so much in human capital that they actually earn less at the time of entry, but experience faster wage growth. There

is again a negative correlation between the log entry wage and the rate of wage growth.[7]

The potential relationships between the log entry wage and the rate of wage growth are illustrated in figure 1.1. These cases can be used to construct simple empirical tests that might distinguish among the various possibilities and provide valuable information about the human capital production function faced by immigrants. For example, suppose that there is weak relative complementarity in the production function. The variables that increase the immigrant's effective human capital at the time of entry would then have the same qualitative effect on the log entry wage and on the rate of wage growth. In contrast, if there were relative substitution, then variables that increase effective human capital would have a positive impact on the log entry wage but a negative impact on the rate of wage growth. The empirical analysis presented below suggests that the data is best summarized by a "weak" positive correlation between log entry wages and the rate of wage growth. Put differently, immigrants with high levels of effective human capital experience both higher entry wages and faster economic progress in the United States. This finding suggests that the immigrant human capital production function exhibits weak relative complementarity.[8]

1.3 Data and Basic Trends

The study uses data drawn from the 1970, 1980, and 1990 PUMS. A person is classified as an immigrant if he or she was born in a foreign country; all other workers are classified as natives.[9] I drew a 1 percent random sample from the native population in each of the census years. The immigrant extract comprises a 2 percent random sample in 1970 and a 5 percent random sample in both 1980 and 1990.[10] In each census year,

7. Note that cases 1 and 4 both imply a negative correlation between the log entry wage and the rate of wage growth, but for different reasons. In the case of relative substitutability, the skilled workers earn more at the time of entry and have slower wage growth, while in the case of strong relative complementarity, the skilled workers earn less at the time of entry and have faster wage growth. It is also possible that $\alpha + \beta - 1 = \kappa^*$. In this case, skilled immigrants invest more, but the log entry wage is independent of the level of effective human capital.

8. Although the theoretical framework provides a useful way for thinking about how heterogeneity in the immigrant population generates differences in the short-run and long-run economic performance of immigrant cohorts, the model ignored the link between the migration decision and postmigration human capital investments. A more general analysis would explore how the characteristics of the human capital production function might alter the process that selects the immigrant flow.

9. This definition implies that persons born abroad of American parents and persons born in a U.S. possession are classified as natives.

10. Unlike the earlier census data sets, the 1990 PUMS does not comprise a random sample. All calculations in the 1990 data use the sampling weights.

the study is restricted to men aged 25–64 who work in the civilian sector, are not self-employed, and do not reside in group quarters.

Consider the cohort of immigrants who migrated from country i, in calendar year j, when they were k years old. To calculate the wage for each of the cohorts in the analysis, consider the following individual-level regression model:

$$(12) \qquad \log w_{ijk}(t) = X_{ijk}(t)\beta(t) + v_{ijk}(t) + \varepsilon_{ijk}(t),$$

where $w_{ijk}(t)$ is the hourly wage of cohort (i, j, k) in calendar year t; X is a vector of socioeconomic characteristics (discussed below); $v_{ijk}(t)$ is a fixed effect giving the "adjusted" wage of a person who belongs to the cohort; and $\varepsilon_{ijk}(t)$ is the stochastic error, assumed to be independent from all other variables in the model. The regression model in equation (12) is estimated separately in each census year. To simplify the notation, I denote the adjusted wage of the comparable group of native workers by $v_{n0k}(t)$.[11] Consider initially the model where the standardizing vector X does not contain any variables. The vector of fixed effects in the immigrant population then gives the average log wage in each country-of-origin/year-of-migration/age-at-arrival cell, while the fixed effect in the native population gives the average log wage of natives in a particular age group. For example, $v_{ijk}(t)$ may give the average 1970 log wage for Mexican immigrants who arrived between 1965 and 1969 and who were 25–34 years old as of 1970. The respective fixed effect $v_{n0k}(t)$ in the native population then gives the average 1970 log wage for natives who were 25–34 years old as of 1970.

Suppose we estimate the cross-section regression model in two different calendar years, say t and t'. We can use the estimated fixed effects to calculate the rate of wage growth of immigrants over the calendar-time interval (t, t') as

$$(13) \qquad \Delta v_{ijk}(t,t') = [v_{ijk}(t') - v_{ijk}(t)].$$

We can also estimate the rate of wage growth of immigrants relative to that of comparable natives as

$$(14) \qquad \Delta\tilde{v}_{ijk}(t,t') = [v_{ijk}(t') - v_{ijk}(t)] - [v_{n0k}(t') - v_{n0k}(t)].$$

If the vector X does not contain any standardizing variables, equation (13) defines the mean rate of wage growth for cohort (i, j, k), and equation (14) defines the cohort's rate of wage growth relative to that observed in a comparably aged group of natives.

I restrict the study to the immigrant cohorts who arrived between 1960

11. I obtained the adjusted native wage by simply adding the sample of native workers to the regression in equation (12) and including a vector of dummy variables indicating if the person in a particular age group (k) is native born.

and 1979. The census data define four year-of-migration cohorts within this period: immigrants who arrived in 1960–64, 1965–69, 1970–74, and 1975–79. The immigrant cohorts will also be defined in terms of four age groups, where the age of the immigrant is observed at the time the census is taken: immigrants who are 25–34, 35–44, 45–54, and 55–64 years old.

It is useful to begin by summarizing the broad trends in the rate of wage growth in the immigrant population over the 1970–90 period. The first three columns of table 1.1 report the wage of immigrants—*relative to that of comparably aged natives*—for each of the year-of-migration/age-at-arrival cohorts (aggregated over all national origin groups). Consider the immigrants who arrived in the United States between 1965 and 1969 and were 25–34 years old at the time of the 1970 census enumeration. These immigrants earned 13 percent less than natives who were 25–34 years old in 1970. By 1980, the wage gap between the two groups (who were 10 years older) had narrowed to 6 percent, and by 1990 (when the two groups were 20 years older) to 3 percent. The last two columns of the table report the rate of wage convergence implied by these wage data ($\Delta\tilde{v}_{ijk}(t, t')$). This particular cohort experienced a rate of wage convergence of 7 percentage points in the first 10 years after arrival, and of another 4 percentage points in the second 10 years.[12]

The remaining rows of the table reveal roughly the same rate of relative economic progress for many of the cohorts: about 10 percentage points over a 20-year period, with most of the wage convergence taking place in the first 10 years after arrival. Consider, for example, the experience of the group of young men who migrated in the late 1970s. Their relative wage increased by 7 percentage points between 1980 and 1990—the same rate of relative wage growth experienced by the young men who entered between 1965 and 1969 during *their* first 10 years in the country. The data in table 1.1, therefore, do not provide strong evidence for the hypothesis that, on aggregate, there are cohort effects in the rate of wage convergence.[13]

12. A potential problem with interpreting the relative wage growth of immigrants as a measure of economic progress is that there were historic changes in the U.S. wage structure during the 1980s, and these changes did not affect all skill groups equally (Murphy and Welch 1992; Katz and Murphy 1992). To control for the changes in the wage structure, LaLonde and Topel (1992) and Borjas (1995) propose "deflating" immigrant wages by measures of the wage change experienced within particular skill groups in the native population. I replicated the analysis presented in this paper using "real" wages that had been deflated by the wage growth experienced by particular age-education groups in the native population. None of the results are affected by this adjustment of the data.

13. The intercensal "tracking" reported in table 1.1 may lead to a biased picture of immigrant economic progress if there is substantial nonrandom out-migration in the immigrant population (Borjas and Bratsberg 1996). Because the sample composition of "stayers" (i.e., persons who remain in the United States) is likely to change over time, the rates of wage convergence reported in the table might reflect both the economic progress of immigrants and the selection bias created by out-migration. Unfortunately, the United States does not collect systematic data on the number or skill composition of the immigrants (and natives) who leave the country.

Table 1.1 Relative Wages and Wage Growth for Immigrant Cohorts

Year of Migration/ Age at Arrival	Relative Wage			Rate of Wage Convergence	
	1970	1980	1990	1970–80	1980–90
1960–64 Arrivals					
15–24 in 1970	—	.0105	.0409	—	.0304
		(.0089)	(.0099)		(.0133)
25–34 in 1970	.0310	−.0026	−.0019	−.0336	.0007
	(.0117)	(.0081)	(.0090)	(.0142)	(.0121)
35–44 in 1970	−.0620	−.0693	.0114	−.0073	.0807
	(.0143)	(.0101)	(.0126)	(.0175)	(.0161)
45–54 in 1970	−.1179	−.1140	—	.0039	—
	(.0201)	(.0152)		(.0252)	
1965–69 Arrivals					
15–24 in 1970	—	−.0475	−.0713	—	−.0238
		(.0069)	(.0078)		(.0104)
25–34 in 1970	−.1276	−.0613	−.0255	.0663	.0358
	(.0100)	(.0072)	(.0082)	(.0123)	(.0109)
35–44 in 1970	−.1737	−.1660	−.0919	.0077	.0741
	(.0137)	(.0098)	(.0125)	(.0168)	(.0159)
45–54 in 1970	−.2544	−.2365	—	.0179	—
	(.0200)	(.0153)		(.0252)	
1970–74 Arrivals					
25–34 in 1980	—	−.1212	−.1250	—	−.0038
		(.0054)	(.0060)		(.0081)
35–44 in 1980	—	−.1950	−.1786	—	.0164
		(.0074)	(.0084)		(.0112)
45–54 in 1980	—	−.3008	−.2315	—	.0693
		(.0112)	(.0143)		(.0182)
1975–79 Arrivals					
25–34 in 1980	—	−.2400	−.1688	—	.0712
		(.0051)	(.0058)		(.0077)
35–44 in 1980	—	−.2859	−.2763	—	.0096
		(.0080)	(.0092)		(.0122)
45–54 in 1980	—	−.3545	−.3052	—	.0493
		(.0118)	(.0115)		(.0165)

Note: Standard errors are reported in parentheses.

As noted earlier, one can think of the data reported in table 1.1 as being calculated from the model in equations (12)–(14) where there are no standardizing variables in the vector X. It is of interest to determine the sensitivity of the rate of wage growth in the immigrant population (relative to that of natives) to differences in human capital across the groups, particularly educational attainment. I estimated the regression model in equation (12) including a vector of dummy variables indicating the worker's educational attainment. The dummy variables indicate if the worker has less than 9 years of schooling; 9–11 years; 12 years; 13–15 years; or 16 years or more.

The fixed effects v_{ijk} were then computed at the mean level of educational attainment for the entire immigrant sample.

Table 1.2 reports the education-adjusted log wage levels and rate of wage growth (relative to natives). Not surprisingly, the wage gap between immigrants and natives falls when we control for differences in educational attainment between the two groups. For example, the entry wage of the immigrants who migrated in 1970–74 and were 35–44 years old in 1980 is 20 percent lower than that of natives in the same age group, but it is

Table 1.2 **Relative Wages and Wage Growth for Immigrant Cohorts, Adjusted for Education**

Year of Migration/ Age at Arrival	Relative Wage			Rate of Wage Convergence	
	1970	1980	1990	1970–80	1980–90
1960–64 Arrivals					
15–24 in 1970	—	.0373	.0830	—	.0457
		(.0087)	(.0093)		(.0127)
25–34 in 1970	.0627	.0373	.0507	−.0254	.0134
	(.0113)	(.0078)	(.0084)	(.0137)	(.0115)
35–44 in 1970	−.0298	−.0386	.0535	−.0088	.0921
	(.0133)	(.0096)	(.0118)	(.0164)	(.0152)
45–54 in 1970	−.1201	−.1068	—	.0133	—
	(.0186)	(.0145)		(.0236)	
1965–69 Arrivals					
15–24 in 1970	—	.0323	.0570	—	.0247
		(.0071)	(.0076)		(.0104)
25–34 in 1970	−.1241	−.0329	.0200	.0912	.0529
	(.0098)	(.0070)	(.0077)	(.0120)	(.0104)
35–44 in 1970	−.1663	−.1152	−.0148	.0511	.1004
	(.0128)	(.0094)	(.0117)	(.0159)	(.0150)
45–54 in 1970	−.1997	−.1752	—	.0245	—
	(.0185)	(.0147)		(.0236)	
1970–74 Arrivals					
25–34 in 1980	—	−.0394	.0258	—	.0652
		(.0056)	(.0061)		(.0083)
35–44 in 1980	—	−.1512	−.0890	—	.0622
		(.0073)	(.0080)		(.0108)
45–54 in 1980	—	−.2234	−.1201	—	.1033
		(.0108)	(.0136)		(.0174)
1975–79 Arrivals					
25–34 in 1980	—	−.1868	−.0654	—	.1214
		(.0052)	(.0057)		(.0077)
35–44 in 1980	—	−.2637	−.1863	—	.0774
		(.0078)	(.0087)		(.0117)
45–54 in 1980	—	−.3231	−.2449	—	.0782
		(.0112)	(.0145)		(.0183)

Note: Standard errors are reported in parentheses.

Table 1.3 Rate of Wage Convergence, by Country of Origin

	Arrived in 1965–69; Was 25–34 Years Old at Arrival:		Arrived in 1975–79; Was 25–34 Years Old at Arrival:
Country of Origin	1970–80	1980–90	1980–90
Canada	.029	.238	.174
China	.146	.047	.151
Colombia	−.052	.084	.152
Cuba	.035	−.007	.101
Dominican Republic	.020	.028	.075
Egypt	.438	.301	.402
Germany	.168	.032	−.051
Greece	.022	.079	.110
Hungary	.008	.044	.226
India	.298	.134	.419
Ireland	.022	−.009	.368
Italy	−.053	.138	.157
Jamaica	.048	.036	.130
Korea	.403	.203	.221
Mexico	.147	−.122	−.062
Philippines	.319	.035	.229
Portugal	.073	.153	.099
United Kingdom	.150	.068	.238

only 15 percent lower than that of natives who have the same age and educational attainment. The data also suggests that there is faster wage convergence between immigrants and natives if we adjust for differences in educational attainment. The relative rate of wage growth for the immigrants who arrived in the late 1960s and were 25–34 years old in 1970 was 7 percentage points in the first 10 years, and an additional 4 percentage points in the second 10 years. The education-adjusted rate of wage growth was 9 percentage points in the first 10 years, and another 5 percentage points in the second 10 years.

Not surprisingly, there exist significant differences in economic progress across the various national origin groups. Table 1.3 illustrates this variation by reporting the unadjusted and education-adjusted rates of wage growth for selected national origin groups (relative to natives). Some of the groups exhibit very high rates of wage growth, while other groups do not exhibit *any* economic improvement. Consider, for example, the British immigrants who entered the United States in the late 1960s and were 25–34 years old in 1970. Their relative wage rose by 15 percentage points in the first 10 years after arrival, and by an additional 7 percentage points in the second 10 years. In contrast, the relative wage of the comparable group of immigrants from the Dominican Republic rose by only 2 percentage points in the first 10 years, and by another 3 percentage points in the second 10 years.

1.4 Wage Convergence

The raw data reveal substantial dispersion in the rate of wage convergence experienced by immigrants originating in different countries, arriving at different times and at different ages. The remainder of the empirical analysis attempts to understand the source of these differences.

The dependent variable in this section is $v_{ijk}(t, t')$, the rate of wage growth experienced by a particular immigrant cohort (from country i, arriving in year j, and at age k) over the intercensal 10-year period. The "cross-country" analysis is initially restricted to a sample that contains 85 countries (listed in the appendix), four age groups, and four year-of-migration cohorts. The analysis "stacks" the data. The 85 countries used in the study are chosen because immigrants born in these countries can be matched across two successive censuses, and these countries have sufficiently large numbers of observations in the 1970, 1980, and 1990 censuses to allow reliable estimation of the first-stage regressions in equation (12). The issue of cell size will be discussed in more detail below. About 92 percent of the immigrants who entered the United States between 1960 and 1979 originate in one of these 85 countries.[14]

I now use these data to examine some of the questions raised by the theory.[15] First, what is the correlation between the rate of wage growth and the log entry wage? Consider the convergence regression model:

$$\Delta v_{ijk}(t,t') = \theta v_{ijk}(t) + \delta_{jk} + \eta_{ijk}, \tag{15}$$

where δ_{jk} is a fixed effect indicating if the immigrant cohort arrived in calendar year j at age k; and η is a stochastic error.

A number of technical details about the regression model in equation (15) are worth noting. First, the dependent variable may contain a great deal of sampling error. To account for the heteroscedasticity induced by this sampling error, I weigh all regressions by the factor $(n_t^{-1} + n_{t'}^{-1})^{-1}$, where n_t is the sample size of the cell in census year t. Note that the same

14. About 60 percent of the immigrants omitted from the sample did not report a country of origin.

15. The grouped data can also be used to test whether there are cohort effects in the rate of wage growth. Consider a regression model that relates the rate of wage growth of immigrants relative to that of comparably aged natives, $\Delta\tilde{v}_{ijk}(t, t')$, to a vector of variables indicating the time of migration, holding constant the age at migration. This regression reveals that during the first 10 years after migration, the immigrants who migrated in the early 1960s experience the same relative wage growth as those who migrated in the early 1970s; and that the immigrants who migrated in the late 1960s experience the same relative wage growth as those who migrated in the late 1970s. The p-values for these tests are between .4 and .5.

country appears a number of times in the sample and the stochastic error η might contain a country-specific component. The tables, therefore, report White-corrected standard errors that adjust for this sampling frame.

Second, the fixed effect δ_{jk} control for common factors that affect the rate of wage growth of immigrants who arrived at the same time and at the same age. The inclusion of these fixed effects effectively implies that the regression coefficient θ would be numerically identical if the dependent variable had been defined in terms of the rate of wage growth of immigrants relative to that of comparably aged natives, or $\Delta\tilde{v}_{ijk}(t, t')$. The reason is that the native rate of wage growth is constant within a particular age group. The regression results reported below, therefore, can be interpreted as analyzing the determinants of the rate of wage convergence between immigrants and natives.

Finally, to ensure that the convergence regressions use the log entry wage as the independent variable, the analysis is restricted to the rate of wage growth observed during an immigrant cohort's first 10 years in the United States. As a result, the cohorts that arrived in the 1960s contribute only one observation to the sample, giving the wage growth between 1970 and 1980; and the cohorts that arrived in the 1970s also contribute one observation to the sample, giving the wage growth observed between 1980 and 1990. Of course, the wage at time t (the beginning of the decade) is a much better approximation of the entry wage for the immigrants who arrived in the last half of the preceding decade. Consider, for example, the cohort that arrived between 1965 and 1970. Equation (15) then relates the rate of wage growth over the period 1970–80 to the 1970 log wage. The 1970 wage, however, is not as good an approximation of the entry wage for the immigrants who arrived in the first half of the 1960s. I will show below that this rough approximation does not impart a serious bias on the analysis.

Row 1 of table 1.4 reports the relevant coefficients from the convergence regressions. The simplest specification (reported in the first column) reveals a *positive,* though insignificant, correlation between the unadjusted rate of wage growth and the log entry wage of immigrant cohorts. This weak correlation is consistent with the raw data summarized in table 1.1: More recent cohorts, who have much lower entry wages, experience roughly the same rate of wage growth as earlier cohorts. Therefore, there is little reason to expect that the earnings of immigrants who belong to different national origin groups and arrive at different times will converge as they assimilate in the United States. If we take the positive point estimate of θ at face value, the data, in fact, suggest that there might be some divergence over time: The immigrants with the highest entry wages are also the ones who experience the most rapid wage growth. In the context of the model, there seems to be some weak relative complementarity between the skills that immigrants bring into the United States and the skills

Table 1.4 Estimates of Wage Convergence

	Regression			
	(1)	(2)	(3)	(4)
1. Unadjusted rate of wage growth ($N = 819$)				
Log entry wage	.1199	−.3893	−.6569	−.8336
	(.1213)	(.0697)	(.0619)	(.0520)
Initial educational attainment	—	.0473	—	.0510
		(.0062)		(.0059)
R^2	.350	.651	.781	.816
2. Education-adjusted rate of wage growth ($N = 819$)				
Log entry wage	−.2623	−.3733	−.8062	−.8341
	(.0911)	(.0537)	(.0550)	(.0411)
Initial educational attainment	—	.0261	—	.0309
		(.0033)		(.0046)
R^2	.421	.653	.805	.824
3. Unadjusted rate of wage growth: Cohorts with large numbers of observations ($N = 409$)				
Log entry wage	.1981	−.3191	−.5774	−.8297
	(.1164)	(.0752)	(.0786)	(.0760)
Initial educational attainment	—	.0446	—	.0597
		(.0064)		(.0079)
R^2	.443	.730	.844	.883
4. Unadjusted rate of wage growth: Cohorts in United States for 5 years or less ($N = 414$)				
Log entry wage	.0493	−.4280	−.7107	−.8239
	(.1207)	(.0736)	(.0673)	(.0647)
Initial educational attainment	—	.0502	—	.0450
		(.0064)		(.0074)
R^2	.301	.648	.820	.840
Includes year-of-migration/ age-at-migration fixed effects	Yes	Yes	Yes	Yes
Includes country-of-origin fixed effects	No	No	Yes	Yes

Note: Dependent variable is rate of wage growth observed in first 10 years in United States. Standard errors are reported in parentheses. The regressions are weighted by $(n_0^{-1} + n_1^{-1})^{-1}$, where n_0 is the number of observations used in calculating the wage at the beginning of the decade, and n_1 is the number of observations used in calculating the wage at the end of the decade.

that they acquire in the postmigration period. This result resembles Mincer's (1974) finding of complementarity between investments in school and investments in on-the-job training.

As the remaining coefficients reported in row 1 of table 1.4 show, however, a simple change in the specification of the regression turns the weak positive coefficient into a significant negative one. Consider the regression model that estimates the rate of *conditional* convergence:

$$(16) \qquad \Delta v_{ijk}(t,t') = \theta^* v_{ijk}(t) + \phi H_{ijk}(t) + \xi_{jk} + \eta_{ijk},$$

where $H_{ijk}(t)$ gives the effective human capital of cohort (i, j, k) at time t. The parameter θ^* estimates the rate of conditional convergence, the rate at which the earnings of different immigrant cohorts converge *if* we hold the initial human capital endowment of the cohorts constant.

Although the census data do not offer precise measures of the cohort's effective human capital at the time of entry, we have information on the average educational attainment of the cohort at time t. Table 1.4 reveals that the coefficient θ^* is strongly negative when the regression adds the cohort's educational attainment, and becomes even more negative if the regression includes country-of-origin fixed effects (which can also be interpreted as determining effective human capital). Holding initial human capital constant, therefore, there is convergence among the various immigrant groups. Moreover, the rate of convergence is economically significant. The regression coefficient of −.39 suggests that wage differences among the various immigrant groups (holding initial skills constant) narrow by 32.2 percent within the first decade. If this rate of convergence remained constant over the immigrant's working life, over two-thirds of the initial wage differential would vanish within 30 years. This finding, of course, mirrors the well-known conditional convergence result in the economic growth literature (Barro 1997).

The conditional convergence result is also related to the recent work of Duleep and Regets (1997a, 1997b), who use an alternative way of controlling for education in the analysis. Duleep and Regets define the immigrant cohort not only in terms of country of origin, year of arrival, and age at migration (i.e., a cell in i, j, k) but also in terms of educational attainment (s). In particular, let $v_{ijks}(t)$ be the log wage of an immigrant cohort originating in country i, arriving in calendar year j, migrating at age k, and with s years of schooling. Similarly, let $\Delta v_{ijks}(t, t')$ be the rate of wage growth experienced by this cohort over the time interval (t, t'). To simplify the exposition, suppose that all immigrant cohorts arrive in the same calendar year j and that the wage growth is observed over the same time interval (t, t'). Consider the regression model:

$$(17) \qquad \Delta v_{iks} = \lambda v_{iks} + \xi_k + \omega_{iks},$$

where ω_{iks} is an independent identically distributed (i.i.d.) error term. Duleep and Regets (1997b) show that λ is strongly negative, and they interpret this finding as implying that the decline in skills across successive immigrant cohorts is not as strong as suggested by the trend in entry wages. A negative λ seems to suggest that more recent cohorts will experience faster wage growth in the future and that the present value of the age-earnings profile might not differ much across cohorts.

The key question, however, is whether the coefficient λ estimates the unconditional rate of convergence (θ) or the conditional rate of convergence (θ^*). To see the relationship among the various parameters, rewrite the log entry wage and the rate of wage growth for the (i, k, s) cohort as

$$v_{iks} = v_{ik} + \varphi_s + e_{iks}, \tag{18}$$

$$\Delta v_{iks} = \Delta v_{ik} = \chi_s + \varepsilon_{iks}, \tag{19}$$

where φ_s and χ_s are fixed effects giving the returns to schooling for the log entry wage and the rate of wage growth, respectively; and e_{iks} and ε_{iks} are i.i.d. random variables that are uncorrelated with the other right-hand-side variables in equations (18) and (19). The convergence regression in equation (17) can be rewritten as

$$\Delta v_{ik} = \lambda v_{ik} + (\lambda\varphi_s - \chi_s) + \xi_k + \omega', \tag{20}$$

where $\omega = \omega_{iks} + \lambda e_{iks} - \varepsilon_{iks}$, and an observation is an (i, k, s) cell. Let $p_{ik}(s)$ be the fraction of the population that has s years of schooling in the immigrant cohort that migrated from country i at age k, and aggregate across schooling groups within this cohort.[16] This aggregation yields

$$\Delta v_{ik} = \lambda v_{ik} + \sum_s (\lambda\varphi_s - \chi_s) p_{ik}(s) + \xi_k + \bar{\omega}. \tag{21}$$

Equation (21) 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, θ^*. It is not surprising, therefore, that Duleep and Regets (1997b) find a great deal of wage convergence across immigrant cohorts since they are implicitly holding constant the human capital endowment at the time of entry.

Row 2 of table 1.4 shows a related way of controlling for educational attainment. The regressions in this panel use earnings data that are adjusted for education in the first stage. In particular, the individual-level regressions in equation (12) include educational attainment as an independent variable. As a result, the log entry wage (v_{ijk}) and the rate of wage growth (Δv_{ijk}) are measured for the worker with the "average" level of schooling. This approach to controlling for differences in education attainment across the groups, therefore, is roughly similar to the Duleep-Regets approach. Not surprisingly, the regression coefficients reported in row 2 of table 1.4 show that the correlation between the rate of wage growth and the log entry

16. The aggregation uses $p_{jk}(s)$ as weights.

wage is strongly negative, regardless of the variables that are included in the regression.

Although interesting, it is important not to over interpret the practical significance of the finding of conditional convergence. Conditional convergence does *not* suggest that immigrant cohorts with lower entry wages experience faster wage growth in the United States. There is, in fact, *no* convergence among the various national origin groups that make up the immigrant population. The *observed* wage gap among the various immigrant cohorts will not narrow over time, but might even increase.

The lesson is clear: The choice of a base group is crucial in any discussion of immigrant economic progress or assimilation. Immigrants who start out with similar endowments of human capital tend to end up with roughly similar wages. But immigrants originating in different countries, in fact, have very different human capital endowments and will tend to end up in very different places in the income distribution.

There are a number of technical problems with the convergence regressions reported in table 1.4 that deserve some discussion. First, many of the cells in the analysis contain relatively few observations. The dependent variable in each cell is constructed from wages reported in two different censuses. Because the 1980 and 1990 immigrant extracts form a 5 percent random sample of the population (and because the immigrant population has grown rapidly over time), the sample size used in the construction of wage levels for the various cells is reasonable for most national origin groups. In particular, 19 observations were used to calculate the 1980 wage for the average cohort, and 24 observations were used to calculate the 1990 wage. The smaller size of the 1970 immigrant extract, however, implies that only 11 observations were used to calculate the 1970 wage for the average cohort.[17]

As noted earlier, all the regressions are weighted by the factor $(n_t^{-1} + n_{t'}^{-1})^{-1}$. I reestimated the regression models using only the cells that are likely to have the least sampling error. In particular, I restricted the analysis to the 50 percent of the cells that have the largest value of the weights. As shown in table 1.4, there is even stronger evidence of a positive correla-

17. These averages hide a lot of dispersion in sample size among cells. In calculating the 1980 wage for the 1980–1990 wage growth measure, 25 percent of the cells have 9 or fewer observations, 50 percent have more than 24 observations, and 25 percent have more than 72 observations. In calculating the 1990 wage for the 1980–1990 wage growth measure, 25 percent of the cells have 7 or fewer observations, 50 percent have more than 19 observations, and 25 percent have more than 55 observations. In calculating the 1970 wage for the 1970–1980 wage growth measure, 25 percent of the cells have 5 or fewer observations, 50 percent have more than 11 observations, and 25 percent have more than 30 observations. In calculating the 1980 wage for the 1970–1980 wage growth measure, 25 percent of the cells have 9 or fewer observations, 50 percent have more than 24 observations and 25 percent have more than 71 observations.

tion between entry wage levels and the unadjusted wage growth in this restricted sample. And as before, the positive convergence coefficient turns negative when the regressions control for either educational attainment or country of origin.[18]

A second potential problem is that the log entry wage measures different things for different cohorts. As noted above, the wage observed at the beginning of the decade (time t) is roughly the entry wage for those immigrants who arrived during the 1965–69 or 1975–79 periods. This wage, however, is not the entry wage for immigrants who arrived in either the first half of the 1960s or the first half of the 1970s. Row 4 of table 1.4 shows that the results do not change when the regressions are restricted to the immigrant cohorts that migrated in the last half of a particular decade. The correlation between the log entry wage and the rate of wage growth is positive when no controls are included in the regression, and turns negative when human capital controls are added.

Finally, there is probably measurement error in the log entry wage. Any measurement error in this wage will impart a negative bias on its coefficient (toward -1). The spurious negative correlation arises because the log entry wage appears on both sides of the equation, but with different signs. One can assess the sensitivity of the results to measurement error by using instrumental variables to eliminate the spurious correlation.

The construction of the census data suggests two alternative instruments for the log entry wage. The regressions reported in row 1 of table 1.4 use the rate of wage growth observed for the immigrant cohorts that arrived in 1960–64, 1965–69, 1970–74, or 1975–79. To eliminate the measurement error, we can use the log entry wage of the *preceding* immigrant cohort as an instrument for the entry wage of a particular cohort. Consider, for example, the Mexican immigrants who were 25–34 years old in 1980 and who entered the United States between 1975 and 1979. The proposed instrument would be the wage of Mexican immigrants who were 25–34 in 1980 but who entered the country between 1970 and 1974.[19] The

18. To assess the sensitivity of the results to sample size and outlying observations, I estimated a set of unweighted convergence regressions in the sample of immigrant cohorts where I used at least 30 observations to calculate the mean wage of the cohort. The basic convergence coefficient is $-.065$ with a standard error of .05, so that there is essentially no relationship between the rate of wage growth and the log entry wage. The basic conditional convergence coefficient is $-.313$, with a standard error of .06. These regressions have 270 observations. The unweighted results, therefore, are roughly similar to those reported in the text. I also estimated the regressions after omitting the immigrant cohorts that originated in Mexico. The unconditional convergence coefficient in the subsample of cohorts where I used more than 30 observations to calculate the mean wage of the cohort in each census year and where the Mexican cohorts are omitted is $-.097$, with a standard error of .05. The respective conditional convergence coefficient is $-.305$, with a standard error of .06. These regressions have 258 observations.

19. The R^2 for the first-stage regression is .68.

Table 1.5 Estimates of Wage Convergence, Using Instrumental Variables

	OLS		IV	
	(1)	(2)	(3)	(4)
1. Cohorts who migrated between 1965 and 1980[a]				
Log entry wage	.1686	−.3535	.3371	.0146
	(.1091)	(.0786)	(.0918)	(.0862)
Initial educational attainment	—	.0442	—	.0261
		(.0066)		(.0055)
2. Cohorts who migrated between 1960 and 1969[b]				
Log wage in 1980	.1523	−.1284	.2525	.2018
	(.0959)	(.0970)	(.0884)	(.1296)
Educational attainment in 1980	—	.0248	—	.0045
		(.0100)		(.0094)

Note: Standard errors are reported in parentheses. All regressions include a vector of fixed effects indicating the cohort's year of migration/age at arrival. The regressions are weighted by $(n_0^{-1} + n_1^{-1})^{-1}$, where n_0 is the number of observations used in calculating the wage at the beginning of the decade, and n_1 is the number of observations used in calculating the wage at the end of the decade.

[a]Dependent variable is rate of wage growth during first 10 years; instrument is log entry wage for preceding cohort. $N = 402$.

[b]Dependent variable is rate of wage growth between 1980 and 1990; instrument is log entry wage of cohort in 1970. $N = 235$.

construction of this instrument, of course, implies that the immigrants who arrived between 1960 and 1964 do not contribute any observations to the regression (since no preceding cohort is observed for this group).

Row 1 of table 1.5 reports both the ordinary least squares (OLS) and instrumental variables (IV) convergence coefficients in this subsample of the data. The OLS coefficients resemble those reported earlier: There is a positive correlation between the log entry wage and the rate of wage growth in the raw data, and this correlation turns negative once the regression controls for educational attainment. The IV procedure leads to a much stronger positive correlation between the log entry wage and the subsequent rate of wage growth when the regression does not control for initial educational attainment, and it greatly weakens the negative correlation (in fact, it is essentially zero) when the education control is added. The IV estimation, therefore, raises questions about the robustness of the finding of conditional convergence.

These doubts are reinforced when we use an alternative instrument. We have three measures of the wage for the immigrants who arrived between 1960 and 1970. For these immigrants, we can observe their wage in 1970, 1980, and 1990. We can use this subsample of immigrants to estimate a convergence coefficient by regressing the 1980–90 rate of wage growth on the 1980 log wage. The data, however, also allow us to instrument the 1980 wage by the group's 1970 wage.[20] The resulting OLS and IV estimates are reported in row 2 of table 1.5. The IV results show that the correlation between wage levels and wage growth remains positive even after we control for educational attainment.

In sum, there is a positive (although weak) correlation between the log entry wage and the subsequent rate of wage growth across immigrant cohorts. If anything, immigrants who earn high wages at the time of entry experience faster wage growth in the future. This correlation, however, turns negative when the analysis adjusts for differences in initial endowments of human capital, either by including measures of educational attainment or country-of-origin fixed effects. The results, therefore, seem to suggest that there exists conditional convergence in the immigrant population, in the sense that the wages of immigrant groups that have the same initial level of human capital converge over time. However, this finding is not robust to simple attempts to control for the bias introduced by measurement error.

1.5 Immigrant Economic Progress and Source Country Characteristics

As we have seen, there are huge differences in log entry wages across national origin groups. Many studies have found that the initial economic performance of immigrants in the United States is strongly correlated with source country characteristics. For example, Borjas (1987) reports that immigrant wages depend positively on the per capita GDP of the source country and negatively on measures of income inequality. Similarly, Jasso and Rosenzweig (1986) report a positive correlation between immigrant wages and a variable indicating if the country of origin receives a Voice of America broadcast (presumably because these broadcasts provide information about the United States).

Suppose we interpret some of the source country characteristics as rough measures of the effective human capital of immigrant cohorts. The human capital model presented earlier then predicts that the qualitative effects of the source country characteristics on the log entry wage and on the rate of wage growth depend on the extent of relative complementarity or substitutability in the production function. The convergence regressions suggest that the production function exhibits weak relative complementarity between pre-existing human capital and postmigration investments. We would then expect that the source country variables have the *same* qualitative impact on the log entry wage and on the rate of wage growth. To

20. The R^2 for the first-stage regression is .73.

examine this theoretical implication, I constructed a data set summarizing various economic characteristics for 75 source countries.[21] The source country characteristics are as follows:

1. *Per capita GDP in the source country.* I used the Penn World Tables (version 5.6) to obtain a measure of per capita GDP in 1960, 1965, 1970, and 1975.[22] These dates were chosen to correspond with the time at which each of the four year-of-migration cohorts left the source country. Immigrants from richer countries tend to earn more in the United States—even after controlling for educational attainment and other observable measures of a worker's skills. Presumably, this correlation arises because the skills acquired in industrialized economies are more easily transferable to the United States. If increases in per capita GDP raise the effective human capital that immigrants bring to the United States *and* if there is weak relative complementarity in the human capital production function, the theory predicts that immigrants originating in richer countries should also have higher rates of wage growth.

2. *The Gini coefficient of the source country's income distribution.* Borjas (1987) has argued that immigrants originating in countries that offer a high rate of return to skills are more likely to be negatively selected, will have a smaller effective human capital stock at the time of migration, and will earn less in the United States. A higher rate of return to skills implies a more disperse distribution of income. The Gini coefficient of the source country's income distribution should then have a negative impact on the rate of wage growth. Deininger and Squire (1996) have constructed various measures of income inequality, including the Gini coefficient, for most countries since 1960. I used these data to obtain measures of the Gini coefficients in four years: 1960, 1965, 1970, and 1975.[23]

3. *A measure of "openness" of the source country's economy.* The openness index is defined as the ratio of exports plus imports to GDP (in percentage terms). I used the Penn World Tables to get this index for the calendar years 1960, 1965, 1970, and 1975. Immigrants originating in countries with open economies are more likely to have some contact with for-

21. The 75 countries included in the data below contain about 89 percent of all immigrants enumerated in the census who arrived between 1960 and 1979. A list of the 75 countries in the data is presented in the appendix.

22. The variable used is the real GDP per capita (Laspeyres index) in 1985 international prices.

23. The Gini coefficients are not available for all countries in all the years required. For some countries, for example, there are only two data points over the 1960–1980 period, once in the 1960s and once in the 1970s. In such cases, I used the data point for the 1960s and applied it to both 1960 and 1965, and the data point for the 1970s and applied it to both 1970 and 1975. I did not use any type of linear interpolation in the study, but simply approximated the dates available in the data to the dates required for my analysis. I also reestimated the regressions in the subsample of countries where such approximations were not required and obtained very similar results.

eign industries and economic institutions *prior* to migration, are more likely to have the types of skills that other countries value, and would be expected to have a higher level of effective capital when they enter the United States. Weak relative complementarity in the production function implies that the openness index should be positively correlated with both the log entry wage and the rate of wage growth of immigrant cohorts.

4. *A Herfindahl index measuring how immigrant cohorts cluster geographically once they enter the United States.* It has long been suspected (without much evidence) that residential clustering affects economic opportunities. Define the Herfindahl index for the group of immigrants who arrived from country i in year j as

$$H_{ij} = \sum_r E^2_{ijr}, \tag{22}$$

where E_{ijr} gives the fraction of immigrants from the (i, j) cell who live in state r. The Herfindahl index takes on a maximum value of one if all immigrants live in a single state, and it becomes smaller the more randomly the immigrants are distributed over the United States. I use data on states, rather than on metropolitan areas, to calculate the clustering index. The Herfindahl index is sensitive to the number of geographic units, and the number of metropolitan areas identified by the census has grown significantly over time (particularly between 1970 and 1980). The state-based calculation, therefore, makes the Herfindahl index comparable over time. The measures of the Herfindahl index for the immigrant cohorts that arrived in either 1960–64 or 1965–69 are obtained from the 1970 census, while the measures of the index for the cohorts that arrived in 1970–74 or 1975–79 are obtained from the 1980 census.

5. *The distance from the country of origin to the United States (in thousands of miles).*[24] Borjas and Bratsberg (1996) have shown that the return migration rate of immigrants in the United States is negatively correlated with distance from the source country. This empirical finding suggests that immigrants who originate in far-away countries are more likely to view their migration to the United States as permanent, and have greater incentives to invest in U.S.-specific capital. In terms of the theoretical framework, longer distances decrease the probability of out-migration and increase the discounting factor ρ. Distance from the source country, therefore, should have a positive effect on the rate of wage growth.[25]

6. *Political conditions in the country of origin.* Barro and Lee (1994) used the Banks (1986) Cross-National Time-Series Data File to calculate the number of revolutions (per year) that occurred in the various countries in

24. These data are obtained from Fitzpatrick and Madlin (1986).

25. Borjas (1987) shows that distance from the source country (which presumably affects migration costs) can also have a direct effect on effective human capital because it influences the selection of the immigrant flow.

Table 1.6 Log Wage Level and Source Country Characteristics

	Regression			
Variable	(1)	(2)	(3)	(4)
Log per capita GDP	.0862	.1361	.1285	.0531
	(.0299)	(.0222)	(.0928)	(.0707)
Openness index	.0013	−.0001	−.0010	−.0004
	(.0006)	(.0006)	(.0008)	(.0006)
Gini coefficient	−.0047	−.0012	−.0070	−.0019
	(.0015)	(.0015)	(.0057)	(.0040)
Herfindahl index	−.8331	−.3133	−.0639	.1580
	(.1552)	(.1514)	(.1497)	(.1465)
Distance (in 1,000s of miles)	.0163	.0018	—	—
	(.0103)	(.0081)		
Revolutions per year	.0108	−.0105	.0201	−.0062
	(.0493)	(.0391)	(.0555)	(.0318)
Initial educational attainment	—	.0495	—	.0675
		(.0092)		(.0091)
R^2	.770	.845	.879	.906
Includes country-of-origin fixed effects	No	No	Yes	Yes

Note: Sample comprises immigrant cohorts who have been in United States 10 or fewer years. Standard errors are reported in parentheses. All regressions include a vector of dummy variables indicating the cohort's age at arrival and year of migration. The regressions have 966 observations. The regressions are weighted by the number of observations used in calculating the mean log wage.

the periods 1960–64, 1965–69, 1970–74, and 1975–79. Political instability in the country of origin would likely have an impact on the return migration rate, and should again affect the discounting factor. A higher degree of political instability, therefore, would presumably lead to higher rates of wage growth in the United States.

It is useful to begin by documenting that the source country characteristics have effects on the log entry wage that are consistent with those reported in the existing literature. The log entry wage is defined by the fixed effect $v_{ijk}(t)$ calculated in equation (12); it is obtained from the 1970 census for the cohorts that arrived in the 1960s, and from the 1980 census for the cohorts that arrived in the 1970s. The main specification of the log wage regressions is reported in the first column of table 1.6.[26] In general, the results are consistent with the evidence reported in existing studies. Immigrants who originate in richer countries earn more, and immigrants who originate in countries with high levels of income inequality earn less. The regression also reveals that immigrants originating in open economies earn more, and that the immigrant groups who exhibit substantial geo-

26. The regressions are weighted by the cell size.

graphic clustering earn less. The remaining columns of table 1.6 show that the inclusion of educational attainment or of country-of-origin fixed effects weaken many of the coefficients.

The first column of table 1.7 reports the main regression showing the relationship between the rate of wage growth and the source country characteristics. With one important exception, variables that presumably increase the cohort's effective human capital tend to have a positive impact on the rate of wage growth, suggesting weak relative complementarity in the human capital production function. Consider, for example, the index of openness in the source country. Immigrants originating in open economies both earn more and experience faster wage growth. Moreover, the effect is numerically important: A change in the index from 31 to 80, which are the 1975 openness indices for Spain and Jamaica respectively, implies a 7 percentage point increase in the rate of wage growth.

The regressions also indicate that immigrants originating in countries with higher Gini coefficients experience slower wage growth. And again, the effect is numerically important. In 1975, the Gini coefficient for Czechoslovakia was 21, while for Mexico it was 58. This difference in the Gini coefficient implies a 14 percentage point differential in the rate of wage growth.

Table 1.7 also shows that the distance between the source country and the United States, a measure of the difficulty of return migration, has a significant positive effect on the rate of wage growth. Immigrants who originate in a country that is 5,500 miles away will, on average, experience about 6 percentage points greater wage growth than immigrants who come from a country that is 500 miles away. The regression, however, shows that the political instability variable does not play a significant role in determining the rate of wage growth.

The regression also suggests that immigrant clustering reduces the rate of wage growth. The estimated coefficient of the Herfindahl index suggests that a reduction in this index from .25 to .04 (or roughly from the average Herfindahl index in the immigrant population to that found among natives) would increase the rate of wage growth by about 3 percentage points. Of course, the regressions do not tell us *why* this correlation arises. The clustering of immigrants, for instance, may have a direct impact on their economic opportunities simply because the increase in labor supply reduces wages (particularly if immigrants are immobile). Residential segregation, however, may also change the immigrant's effective human capital by reducing the incentives to invest in English language proficiency, or by "tying" the immigrants to specific regions of the country. It would be of great interest to determine the channels through which immigrant clustering slows down the rate of economic progress.

The one anomaly in the regression is the impact of per capita GDP in the source country. This variable has a strong positive effect on the log

Table 1.7 **Rate of Wage Growth and Source Country Characteristics**

Variable	Regression (1)	(2)	(3)	(4)	(5)	(6)
Log per capita GDP	−.0571	−.0238	−.0428	−.0220	−.0507	−.0445
	(.0147)	(.0886)	(.0155)	(.0878)	(.0235)	(.0234)
Openness index	.0015	.0014	.0011	.0014	.0011	.0010
	(.0003)	(.0014)	(.0003)	(.0014)	(.0005)	(.0005)
Gini coefficient	−.0039	−.0148	−.0031	−.0149	−.0058	−.0043
	(.0009)	(.0077)	(.0007)	(.0078)	(.0017)	(.0014)
Herfindahl index	−.1603	−.4217	−.0343	−.4260	.1166	.2006
	(.0740)	(.1424)	(.0859)	(.1511)	(.1577)	(.1569)
Distance (in 1,000s of miles)	.0110	—	.0077	—	.0186	.0126
	(.0044)		(.0038)		(.0081)	(.0072)
Revolutions per year	.0031	−.0032	−.0066	−.0023	−.0432	−.0482
	(.0229)	(.0362)	(.0211)	(.0360)	(.0375)	(.0369)
Initial educational attainment	—	—	.0119	−.0016	—	.0221
			(.0034)	(.0070)		(.0107)
English proficiency at entry	—	—	—	—	.0915	−.0503
					(.0596)	(.0926)
R^2	.601	.682	.613	.682	.586	.604
Includes year-of-migration/ age-at-arrival fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Includes country-of-origin fixed effects	No	Yes	No	Yes	No	No

Note: Dependent variable is rate of wage growth observed in first 10 years in United States. Standard errors are reported in parentheses. The regressions in columns (1) (4) have 749 observations. The regressions in columns (5) and (6) use only the cohort that arrived between 1975 and 1979, and have 219 observations. The regressions are weighted by $(n_0^{-1} + n_1^{-1})^{-1}$, where n_0 is the number of observations used in calculating the wage at the beginning of the decade, and n_1 is the number of observations used in calculating the wage at the end of the decade.

entry wage, but a strong negative effect on the rate of wage growth. The negative correlation reported in the first column of table 1.7, however, turns out to be very sensitive to model specification. Consider, for example, the regressions reported in columns (3) and (4), which add a vector of country-of-origin fixed effects to the specification. Most of the source country variables have the same impact as in the simpler regression, so that a decrease in income inequality *within* the country raises the rate of wage growth of immigrants in the United States. The coefficient of per capita GDP, however, becomes insignificant.

Finally, it is worth noting that the source country characteristics—which, at best, are rough measures of the effective human capital stock of a particular cohort of immigrants—explain about 60 percent of the dispersion in wage growth among the various cohorts. In other words, source country characteristics matter a great deal in determining the rate of wage growth of immigrants in the United States.

The regression specifications reported in columns (3) and (4) of table 1.7 include the average educational attainment of the immigrants at the time of entry. Column (3) implies that a one-year increase in educational attainment increases the rate of wage growth by 1.2 percentage points. Note, however, that the independent impact of educational attainment disappears when the regression includes a vector of country-of-origin fixed effects.

It would be of interest to include measures of English language proficiency in the wage growth regressions. Presumably, persons who know the language would have an easier time adapting in the United States (although this effect could be attenuated by residential segregation). The 1970 U.S. census, however, does not contain any information on English language proficiency, so we cannot observe the initial language skills of the immigrants who arrived in the 1960s. I used the 1980 census to calculate the probability that immigrants who arrived between 1975 and 1979 spoke English well or very well. This statistic was calculated for each cohort by country of origin and age at arrival. The last two columns of table 1.7 report the regression results obtained when one includes this variable in the model (and when the regression is estimated in the subsample of immigrants who migrated in 1975–79). English language proficiency at the time of entry has an independent positive impact on the rate of wage growth, but it does not change the impact of most of the other variables in the model. The last column in the table shows that the impact of English language proficiency becomes insignificant if we control for the educational attainment of the cohort.

In sum, the empirical evidence shows that source country characteristics matter in determining both the entry wage and the subsequent rate of wage growth. Moreover, the same underlying factors that tend to generate higher wages also tend to generate faster wage growth. In effect, the empirical results confirm that there is a positive correlation between the economic performance of immigrants at the time of entry and the rate of economic progress in the United States, so that the human capital production function for immigrants exhibits weak relative complementarity.

1.6 Investments in Education

The previous section documented that the rate of wage growth experienced by immigrants cohorts responded to source country characteristics that proxy for either the effective rate of human capital or the discounting factor. This section shows more directly that source country characteristics do indeed alter the rate of human capital accumulation by examining the determinants of investments in educational attainment in the postmigration period.

I computed the change in educational attainment experienced by each of the immigrant cohorts (by country of origin, year of arrival, and age at migration) during their first 10 years in the United States. I then estimated regressions, identical to those presented in earlier sections, that describe both the extent of convergence in educational attainment across immigrant cohorts and the link between investments in schooling and source country characteristics. The estimated regressions are reported in table 1.8.[27]

The first two columns of the table report the simple convergence regressions by relating the change in educational attainment during the first 10 years to the educational attainment at the time of entry. As with the analysis of wage convergence, the raw correlation is positive, but weak. If the regression also includes a vector of country-of-origin fixed effects, however, these correlations become negative and significant. Not surprisingly, immigrants who originate in the same country of origin (but arrive at different times and at different ages) tend to converge to the same educational attainment. Nevertheless, the main implication of the evidence is that immigrants who have the highest level of effective human capital at the time of entry are also the ones who make the largest postmigration investments, and hence experience the fastest rate of economic progress. Once again, the empirical evidence suggests some complementarity between pre-existing human capital and the rate of human capital accumulation in the United States.

The remaining columns of the table report regressions of the change in educational attainment on the source country characteristics. For the most

27. Not surprisingly, there is a strong positive link between $v_{ijk}(t, t')$, the wage change experienced by a particular cohort during the time interval (t, t'), and the cohort's change in educational attainment. The coefficient from a regression of the wage change on the change in educational attainment in the sample of cohorts used in table 1.8 is .070 (with a standard error of .018), and the R^2 is .402.

Table 1.8 **Determinants of Postmigration Investments in Education**

	Regression					
Variable	(1)	(2)	(3)	(4)	(5)	(6)
Initial educational attainment	.0209	−.3701	—	−.3773	—	−.0647
	(.0281)	(.0527)		(.0529)		(.0283)
Log per capita GDP	—	—	.7687	1.1772	−.0205	−.0984
			(.3302)	(.5498)	(.0650)	(.0770)
Openness index	—	—	−.0012	−.0045	.0056	.0076
			(.0055)	(.0056)	(.0020)	(.0026)
Gini coefficient	—	—	−.0233	−.0449	−.0154	−.0197
			(.0233)	(.0216)	(.0037)	(.0051)
Herfindahl index	—	—	−.1184	−1.1063	.1464	−.5384
			(.9397)	(.9948)	(.3916)	(.4616)
Distance (in 1,000s of miles)	—	—	—	—	.0022	.0199
					(.0243)	(.0253)
Revolutions per year	—	—	−.1113	.1065	−.0134	.0394
			(.1567)	(.1506)	(.1199)	(.1465)
R^2	.200	.504	.395	.520	.285	.306
Includes year-of-migration/ age-at-arrival fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Includes country-of-origin fixed effects	No	Yes	Yes	Yes	No	No

Note: Dependent variable is change in educational attainment of immigrant cohort in first 10 years after arrival. Standard errors are reported in parentheses. All regressions include a vector of dummy variables indicating the cohort's age at arrival and year of migration. The regressions in the first two columns have 819 observations, and the regressions in the remaining columns have 749 observations. The regressions are weighted by $(n_0^{-1} + n_1^{-1})^{-1}$, where n_0 is the number of observations used in calculating the education level at the beginning of the decade, and n_1 is the number of observations used in calculating the education level at the end of the decade.

part, the regressions confirm the results reported in the previous section. The source country characteristics tend to affect investments in education in the same way that they affect the rate of wage growth. Immigrants who originate in countries where the income distribution has a large Gini coefficient (and presumably there is a large rate of return to skills) acquire less schooling in the postmigration period; immigrants who originate in open economies acquire more schooling; and immigrants who originate in richer countries acquire less schooling (but this anomalous correlation is not significant).

1.7 Summary

This paper presented a theoretical and empirical study of the determinants of economic progress in the immigrant population. The theoretical framework used the human capital model to derive the relationship between the human capital endowment of immigrants at the time they enter the United States, the entry wage of the immigrant cohort, and the subsequent rate of wage growth. The theory showed that the correlation between initial (log) wages and the rate of wage growth could be positive if there existed some complementarity in the production function for human capital, so that highly skilled immigrants would find it easier to acquire additional human capital in the United States. The potential existence of relative complementarity has practical significance: The sizable skill differentials that are observed among immigrant groups at the time of entry could well widen over time.

The empirical analysis used the 1970, 1980, and 1990 Public Use Microdata Samples of the U.S. census. These data permit the tracking of specific cohorts of immigrants over a 20-year time frame. The immigrant cohorts were defined in terms of national origin, year of migration, and age at arrival. The study generated a number of findings:

1. There is a weak positive correlation between the log entry wage and the rate of wage growth, suggesting some complementarity between the human capital acquired abroad and the human capital that immigrants acquire in the United States. This positive correlation, however, probably turns negative if we compare immigrants who have similar human capital endowments when they enter the United States.

2. There is no evidence that more recent immigrant cohorts, who have lower entry wages, experience faster wage growth.

3. Because of the relative weak complementarity in the human capital production function, the same source country characteristics that improve the economic status of immigrants at the time of entry also lead to larger human capital acquisition in the postmigration period and faster wage growth.

The long-run economic performance of immigrants in the United States plays an important role in any assessment of the economic impact of immigration. The empirical evidence presented in this paper suggests that immigrants who enter the United States with a sizable human capital endowment are also the immigrants who find it easier to adapt and acquire additional skills in their new surroundings. As a result, the process of economic assimilation does not "even out" the playing field in the immigrant population. Instead, the assimilation process may actually increase income inequality among national origin groups in the immigrant population.

Appendix

Countries Used in the Analysis

Note: The countries marked with an asterisk are not included in the analysis that relates the rate of wage growth to source country characteristics.

Africa
Cape Verde*
Egypt
Ethiopia*
Ghana
Kenya
Liberia
Morocco
Nigeria
Sierra Leone
South Africa

Americas
Argentina
Barbados
Bolivia
Brazil
Canada
Chile
Colombia
Costa Rica
Cuba
Dominican Republic
Ecuador
El Salvador
Guatemala
Guyana
Haiti
Honduras
Jamaica
Mexico
Nicaragua
Panama
Peru
Trinidad
Uruguay*
Venezuela

Asia
Afghanistan*
Bangladesh
Cambodia*
China
Hong Kong
India
Indonesia
Iran
Iraq
Israel
Japan
Jordan
Korea
Laos*
Lebanon*
Malaysia
Myanmar
Pakistan
Philippines
Saudi Arabia*
Sri Lanka
Syria*
Taiwan
Thailand
Turkey
Vietnam*

Europe
Austria
Belgium
Czech
Denmark
Finland

France	Poland	USSR
Germany	Portugal	Yugoslavia
Greece	Romania	
Hungary	Spain	*Other*
Ireland	Sweden	Australia
Italy	Switzerland	Fiji
Netherlands	United Kingdom	New Zealand
Norway		

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