The Circulation Migration of the Skilled and Economic Development

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Although there is much discussion of immigration's impact on the U.S. domestic economy, there is also renewed interest in immigration's effects on low-income, sending countries. However, in this latter discussion, there is an under-appreciation of two important features.

First, a significant proportion of the skill residing in low-income countries is produced in high-income countries. Four countries—United States, Great Britain, Australia, and Canada—provide over 525,000 student visas per year. In the U.S., over 250,000 student visas were issued in 2004, compared with 73,212 employment visas for permanent immigrants screened for skill. The United Nations Educational, Scientific and Cultural Organization (UNESCO) estimates that there are over 2.5 million foreign students in the world, and more than half are from low-income countries.

Second, many "permanent" skilled migrants—those entitled to stay for the rest of their lives in the receiving country—and those who migrate to acquire additional schooling (and get good jobs) return to their home country.

Little is known about the international net flow of high-skill human capital and its effects on developing countries. The immigration literature has three deficiencies in studying the determinants of who immigrates and who returns:

1. Existing frameworks and data are inadequate to appropriately describe measures of gaps in rewards to skill across countries.
2. Empirical analyses lump together immigrants selected via family reunification rules and those selected on the basis of skill and jobs. Decision rules

are likely to be quite different for the two groups. Indeed, permanent resident aliens in the U.S. are admitted mostly (over 90 percent) based on family criteria and subject to country ceilings. Standard economic models of self-selection may not be adequate to understand international flows of people, as they ignore networking and marriage markets.

3. No representative databases have tracked either foreign students or immigrants over time to enable estimates of return rates.

I will consider three questions. First, how inefficient is the global allocation of workers and how large are the gains from increased international migration? How do you measure these gains? We will see that standard GDP comparisons are not sufficient. Second, how would reallocating high-skill workers from low- to high-wage areas affect low-wage countries? Third, what is the relationship between the net international flow of skilled individuals and the development of low-income countries? Which countries benefit the most and least from skill migration?

I use simple analytics combined with new data on immigrants, foreign students, and out-migrants. Two main data sources are newly available:

- New Immigrant Survey (NIS): 4 percent sample of all U.S. adult (18+) permanent resident aliens who received their visas between April and November 2003 (number surveyed = 8,575).
- New Immigrant Survey–Pilot (NIS–P): smaller sample of all U.S. adult (18+) permanent resident aliens who received their visas in July and August of 1996 (number surveyed = 1,032).

Other sources I will draw on are an immigration survey of Australia, International Labor Organization (ILO) data on international wages, and databases on students in the U.S.

Two sets of mechanisms will be discussed for how international movements of the skilled affect sending countries:

- Direct short- and long-run effects on wages in sending countries: distinguishing between changes in prices of skill, skill composition effects, and skill upgrading incentives.
- Return migration: brain drain and brain gain issues and evidence. I will discuss the potentially large biases in recent World Bank estimates of the brain drain from low-income countries based on census data and look at determinants of foreign students' inflows and the return rates of foreign students and skilled "permanent" immigrants.

First, we will consider the principal source of the global migration/labor mis-

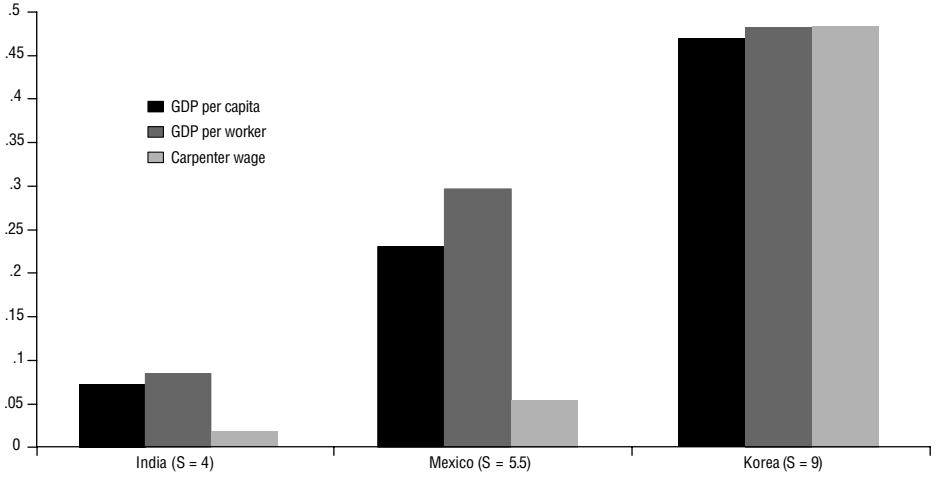
allocation problem: differing cross-country rewards for skills.

What are wage differences for comparable workers across countries? One example: A construction carpenter's monthly wage is $42 in India, $125 in Mexico, $1,113 in Korea, and $2,299 in the U.S. (ILO 1995 data). The problem: Carpenters in India may have much lower schooling than carpenters in the U.S. or even Korea. This does not capture correctly the gains from the migration of a person of a given skill. Per capita GDP gaps are used in most analyses of the determinants of migration (*Figure 1*). But cross-country variation in GDP is due to differences in the proportion of the population in the labor force and in skill levels, not just rewards to skills. Per-worker GDP also is not adequate. Workers vary substantially in skill across countries. So we can't know how the rewards to skills differ across countries from the databases that have been available.

Skill-Price Model and Identification of Cross-Country Skill Rewards

The simplest economic model, a one-skill model, illustrates the main direct effects of migration and is key to understanding the migration of skills across countries.

Figure 1
Ratio of Sending Country to U.S. "Wages" for Three Sending Countries in 1996, by Measure



NOTE: S = average years of schooling.

SOURCES: World Bank and Occupational Wages Around the World.

Worker i's wage W_{ij} in home country j is

$$W_{ij} = \omega_j x_i, \tag{1}$$

where x_i = the skill level of the worker (amount of skill units) and ω_j = the amount each unit of skill is valued in the economy in which the worker is located, referred to here as the skill price.

Variation in wages across workers *within* a country is due to variation in skill levels. Variation in the average wages of workers *across* countries is due to inter-country differences in (a) average skill levels x_i and (b) skill prices ω_j. Increasing incomes in a country thus entails increasing either (a) the price paid for skills or (b) skill levels.

Much attention has been given to raising skills in low-income countries (for example, greater access to education, improved school quality). But why skill prices—rewards to skills—differ across countries is really the key question of development economics, as difference in skill levels across countries is substantially smaller than differences in skill rewards. Some of the suspects are natural endowments (geography), population density, the level of technology, the amount of capital, the amount of aggregate skill, or, on a deeper level, the quality of institutions. The question today is how international migration affects skill levels, skill prices, and the determinants of skill prices.

The model has implications for the number and quality (skill composition) of immigrants from and to a country. The expected initial earnings that worker i in country j could earn in destination country u (ignoring for simplicity skill transferability) is given by:

$$pW_{iu} = p\omega_u x_i, \tag{2}$$

where ω_u = the destination-country skill price and p = the probability of obtaining a permanent destination-country job.

The economic gain from migrating from j to u, G_{ij}, for worker i is

$$G_{ij} = x_i[p\omega_u - \omega_j(1 + \pi_j)] - C_j, \tag{3}$$

where C_j = direct costs of migrating and $\pi_j W_{ij}$ = time costs of migrating.

Implications of the Skill-Price Migration Model

1. Higher-skill persons always have greater gains from out-migration, compared with lower-skill persons, for a given skill-price gap (selectivity). Thus, immigrants from high-skill-price countries will be more skilled on average than those from low-skill-price countries.
2. The higher the domestic skill price, the lower is the gain from out-migration. Thus, there will be fewer immigrants from high-skill-price countries.
3. Schooling acquired in the destination country may increase p and thus facilitate migration (and skill transferability, too).
4. The lower the domestic skill price, the more an increase in skill increases the gain from migrating. Thus, increasing access to schooling in low-skill-price countries can lead to higher rates of out-migration.

But how do we know what skill prices are around the world? And isn't using differences in per capita GDP good enough to gauge the gains from migrating (as used in almost all studies of the determinants of migration)? In fact, variations in the skill price and GDP per capita can have opposite effects on migration (*Figures 2 and 3*). For given direct migration costs, a rise in the skill price at home lowers the gain from migration. For a given skill price, higher per capita GDP may facilitate financing of the direct costs of migration.

And what about within-country inequality and its effects on emigration, as highlighted by George Borjas (1987)?

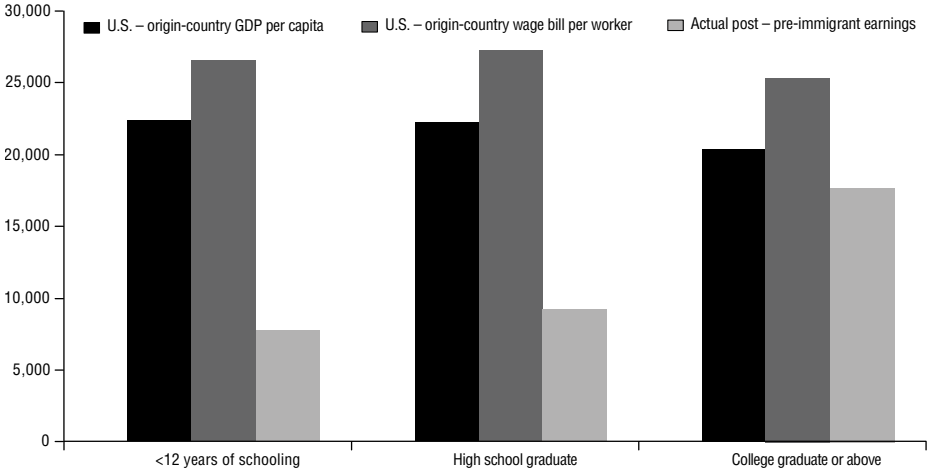
Estimating World Skill Prices

Estimating world skill prices requires comparable information on the earnings of workers of the same skill across all countries of the world. Three recently available sources of data are

1. New Immigrant Survey–Pilot (NIS–P), 1996 (Jasso et al. 2000): This data set provides the earnings of new U.S. immigrants in their last job in their home country.
   Advantages:
   - Information is obtained from a common questionnaire.
   - Information is obtained on workers' schooling, age, and work experience.

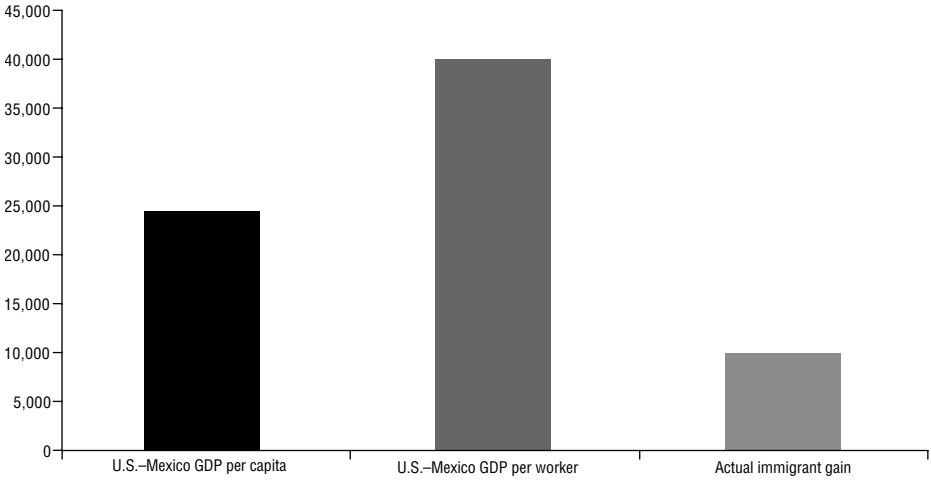
   Disadvantages:
   - This is a selective sample: The model implies immigrants are positively selected on unobservables.
   - The sample size is small: 332 workers for 54 countries.

Figure 2
Alternative Measures of the Net One-Year Benefit from the U.S. Immigration of One Person, by Schooling Level: All U.S. Employment and Spouse Immigrants, 1996



SOURCE: New Immigrant Survey–Pilot.

Figure 3
Alternative Measures of the Net One-Year Benefit from the U.S. Immigration of One Person: Adult *Mexican* Immigrants to the United States, 2003



SOURCE: New Immigrant Survey.

2. Occupational Wages Around the World (OWW) (Freeman and Oostendorp 2000): This data source provides monthly earnings (estimated) for workers by occupation, industry, and year.
   Advantages:
   - The sample size is large: 4,924 observations in a single year (1995).
   - It is meant to be nonselective.

   Disadvantages:
   - The information is not necessarily comparable across countries.
   - The number of countries represented is small in any one year: 67.
   - There is no information on the education, work experience, or age of workers (see carpenters example above).
3. New Immigrant Survey (NIS), 2003 baseline: Like the NIS pilot, this data set provides earnings of new U.S. immigrants in their last job in their home country.
   Advantages:
   - Information is obtained from a common questionnaire.
   - Information is obtained on workers' schooling, age, work experience, and occupation.
   - The sample size is over 2,200 workers for 130 countries.

   Disadvantages:
   - It is a selective sample: The model implies immigrants are positively selected on unobservables.

Table 1 shows some characteristics of these three data sets.

To estimate skill prices from microdata on wages "around the world," assume the number of skill units of a worker is a function of schooling, occupation, and an unobservable skill endowment. For example:

$$x_{ij} = \mu_{ij}\exp(\beta S_{ij} + \boldsymbol{I}_{ijk}\boldsymbol{\gamma}_k), \tag{4}$$

where S_{ij} = schooling, β = schooling "return," μ_{ij} = skill endowment (schooling missing in OWW), $\boldsymbol{I}_{ijk}$ = a vector of occupation dummies for worker i in country j, and $\boldsymbol{\gamma}_k$ = a vector of occupation coefficients.

Then the log of worker i's wage in country j, from equation (1), is

$$\mathrm{Ln}(W_{ij}) = \mathrm{Ln}\omega_j + \beta S_{ij} + \boldsymbol{I}_{ijk}\boldsymbol{\gamma}_k + \mathrm{Ln}\mu_{ij}. \tag{5}$$

The intercept in equation (5), which may differ across countries, provides the log of the skill price for each country represented in the data.

Table 1
Characteristics of Global Earnings Data Sets

Data set/variable	1996 NIS-P home-country workers	OWW, 1995	2003 NIS home-country workers
Mean annual earnings of respondents (U.S. $)	21,854[a] (77,608)	10,208[b] (13,289)	23,250[a] (54,596)
Mean age of respondents	34.6 (8.53)	–	33.5 (11.1)
Mean years of schooling of respondents	14.4 (4.5)	–	13.9 (3.7)
Number of industries	–	49	–
Number of occupations	–	161	363
Number of countries	54	67	130
Number of workers	332	4,924	2,823

[a] PPP-adjusted, full-time earnings
[b] Exchange-rate adjusted, country-specific calibration with lexicographic imputation.

NOTE: Standard deviations in parentheses.

What is the relationship between GDP and skill prices? Assume aggregate output Y in country j is produced according to Cobb–Douglas technology:

$$(6) \qquad Y_j = AL_j^{\alpha}K_j^{\gamma},$$

where K_j = country j's stock of nonlabor resources (for example, land, capital, minerals) and L_j = country j's aggregate stock of labor in skill, given by

$$(7) \qquad L_j = N_j\,[a(x_{ij})],$$

where N_j = the total number of workers in j and $a(\,)$ is an inverse function yielding the average skill units per worker in country j in terms of observables.

The skill price ω_j is the marginal product of an efficiency unit of labor, given by

$$(8) \qquad \omega_j = \alpha Y_j/N_j\,[a(x_{ij})].$$

Thus,

$$(9) \qquad \mathrm{Ln}(\omega_j) = \mathrm{Ln}\alpha + \mathrm{Ln}(Y_j/N_j) - \mathrm{Ln}[a(x_{ij})]$$

or, for the individual worker data on wages from the NIS–P, for example,

$$(10) \qquad \mathrm{Ln}(W_{ij}) = \mathrm{Ln}\alpha + \mathrm{Ln}(Y_j/N_j) - \mathrm{Ln}[a(x_{ij})] + \beta S_{ij} + \mathrm{Ln}\mu_{ij}.$$

Equations (9) and (10) imply that aggregate output *per worker* is positively, and average skill levels are negatively, correlated with skill prices across countries. Estimating equation (9) or (10) should yield a coefficient of 1.0 on the log of output per worker and a coefficient with a minus sign for the log of the aggregate skill measure (*Table 2*).

In Jasso and Rosenzweig (2005), we used the NIS-P data and cross-country information on per-worker GDP and average education levels, based on equation (10), to estimate country-specific rewards to skill (ω_j), controlling for the skills of the individual workers from the different countries represented in the NIS-P. Figure 4 displays the estimated earnings of high school versus college graduates for five countries based on the estimates using equation (5), with a common β ("return" to schooling) estimated to be 0.07. There are two features to note. One is the enormous difference in rewards to skills across the world. Second, compared with the differences in earnings across these countries, differences in earnings by schooling level are relatively minuscule.

How well does the variation across countries in (estimated) skill prices predict the number and skill composition of immigrants by country? In Jasso and Rosenzweig (2005), the NIS and the Longitudinal Survey of Australian Immigrants were used to compute:

- The number of skilled immigrants (employment-based principal applicants) by country of origin coming to the United States and Australia in the survey years of each data set.
- The average schooling level of these skill/employment immigrants by country of origin for U.S. and Australian immigrants.

In addition, we can ask how well does the cross-country variation in estimated skill prices predict the number of student visas issued per country. We use State Department information on F-1 student visas issued by country, averaged over 2003–04 (excludes Canada). To answer these questions we also look at the roles of the distance from the sending country to the receiving country, GDP per adult-equivalent, measures of school quality, the number of universities, and the number of ranked universities (*Tables 3 and 4*). Not surprisingly, for both Australia and the U.S., the higher the skill price in the home country, the fewer the immigrants from that country. What is surprising is that, given the skill price, GDP

Table 2
Estimates of the Determinants of the Country Log Skill Price

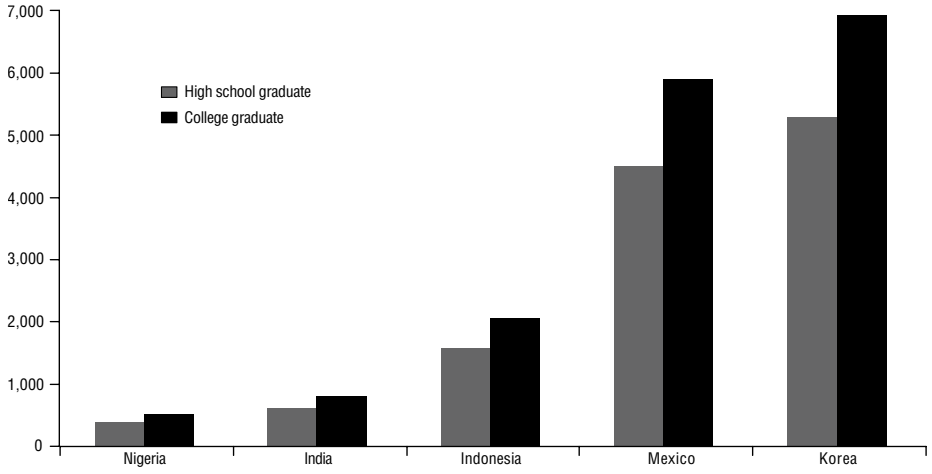
Sample	U.S. immigrant home wages (NIS-P)		OWW wages
Variable/estimation procedure	**GLS**	**GLS-SC**	**GLS**
Country characteristics:			
Log GDP per worker	1.41	1.35	1.10
	(5.01)	(5.21)	(10.4)
Log mean schooling	−1.77	−1.97	−.33
	(3.18)	(3.23)	(1.47)
Log teacher–pupil ratio, primary schools	−1.90	−2.17	−.509
	(3.68)	(3.80)	(1.83)
Log teacher–pupil ratio, secondary schools	1.44	1.36	.457
	(2.51)	(2.56)	(1.60)
Immigrant skill characteristics:			
Schooling	.0683	.0745	–
	(3.50)	(3.79)	
Age	.0428	.0436	–
	(4.32)	(4.50)	
λ	–	.800	–
		(1.46)	
Constant	−1.02	.713	−3.75
	(2.10)	(2.04)	(2.60)
Number of countries	54	54	57
Number of immigrants	332	332	–
R^2	.35	.36	.82

NOTES: GLS = generalized least squares; SC = selectivity-corrected. Absolute value of *t* statistics corrected for clustering at the country level in parentheses.

SOURCE: Rosenzweig (2006).

per adult-equivalent is positive. So, for a given skill price, if a country has higher income per capita, there is actually more out-migration. Why? One hypothesis would be that there are financial costs to migration and having more income for given rewards enables more people to take advantage of those gaps. Costs of migration are important, as distance is significantly negatively related to the number of migrants.

Figure 4
Estimated (Purchasing-Power-Adjusted 1996) Earnings of High School and College Graduates, Across Selected Countries Around the World



SOURCE: Author's calculations from Table 2.

Regarding student visas, the number of people who come from another country to study in the U.S. varies inversely with the rewards to skill in that country. Moreover, the larger the number and the higher the quality of universities in the home country, the more students come to the U.S. to study (*Table 5*). In Rosenzweig (2006), these results are shown to be supportive of the hypothesis that foreign students are attracted to the United States because of the rewards to obtaining jobs here and not primarily because of inadequate supplies of schooling opportunities at home.

What About Inequality and Immigration?

Using the "Roy model," Borjas has popularized the idea that inequality, and thus differences in the returns to schooling across countries, is an important determinant of immigration. However, the original Roy model assumes that wages are the same across countries! In the simple skill-price model outlined above, inequality has two sources: inequality in skills and the level of the return to schooling β. The higher β is, the greater the earnings difference between high- and low-schooled persons in the country. However, differences in returns to schooling (and inequality) across countries will only have second-order effects compared with differences in skill prices in determining the amount and selectivity of migration.

Table 3
Determinants of Employment-Visa Immigration Rates by Receiving Country: Sample Immigrants per Country Population ($x10^6$)

Variable/country	Australia	United States
Country skill price (NIS-P)	−20.9	−17.3
	(1.92)	(2.15)
GDP per adult-equivalent	3.03	.29
	(1.99)	(2.93)
Distance	−8.55	−1.22
	(1.38)	(1.50)
Population	−.0475	−.00178
	(1.43)	(.58)
Constant	75930	11659
	(1.41)	(2.26)
Number of countries	132	132
R^2	.11	.07

NOTE: Absolute values of robust *t* statistics in parentheses.

SOURCES: For immigrant characteristics: New Immigrant Survey and Longitudinal Survey of Immigrants to Australia 2, Wave 1 (Jasso and Rosenzweig 2005).

What is the effect of home-country relative "inequality" on the skill selectivity of immigration? In the one-skill model, higher inequality is due to higher "return" to schooling β. How does a rise in β in the sending country affect the differential gain of, say, high school and college graduates?

We can write the differential gain, high school and college graduates, as:

$$\text{Gain for college graduate} = e^{\beta USSC}(\omega_{US}) - e^{\beta MSC}(\omega_{M})$$

$$\text{Gain for high school graduate} = e^{\beta USSHS}(\omega_{US}) - e^{\beta MSHS}(\omega_{M}),$$

and compute the gains for $\beta = 0.07$ in the U.S. and Mexico. Then we can increase β to 0.10 in Mexico (more inequality) but keep average wages the same. The annual migration gain for high school graduates increases by $269 (0.9 percent). The annual migration gain for college graduates decreases by $329 (0.8 percent) (*Figure 5*).

Migration is trivially less selective compared with changes in the skill-price differential; inequality is second-order.

Table 4
Selectivity: Determinants of the Log Educational Attainment of Employment-Visa Immigrants in Australia and the United States (Combined)

Variable/specification	Parameter estimates
Log country skill price	.0266
	(2.45)
Log GDP per adult-equivalent	–.0169
	(1.71)
Log distance	.0172
	(4.51)
Log population ($x10^{-3}$)	21.2
	(5.06)
Receiving country is the United States	–.0250
	(1.99)
Constant	2.43
	(21.4)
Number of observations	148
R^2	.34

NOTE: Absolute values of robust *t* statistics in parentheses.

SOURCES: For immigrant characteristics: New Immigrant Survey and Longitudinal Survey of Immigrants to Australia 2, Wave 1 (Jasso and Rosenzweig 2005).

Direct Effects of Out-Migration on Wages in Sending Countries

Short-Run Effects

General-Equilibrium Effect. This is basically supply and demand: If aggregate skill quantity decreases, skill prices (wages) rise. This will increase sending-country wages. Computable world general-equilibrium models show this.

Compositional Effect. If out-migrants are higher (lower) than average in skill compared with the home-country population, then average skill decreases (increases) in the home country due to out-migration.

Skilled out-migration thus has an ambiguous effect on sending country wages: It raises the skill price but reduces average skill. Some analysts confuse these two effects. Borjas (2002), in discussing the effects of creating greater opportunities in the U.S. for skilled migrants, writes:

"Such a drain of human capital would further widen the income gap between the United States and the rest of the world, creating more incentives for migration to this country...."

Table 5
Determinants of the Demand for (Log)U.S. Student Visas, 2003–04

Country characteristic	NIS-P skill price		OWW skill price	
Log of country skill price	−.361	−.234	−.947	−.883
	(2.42)	(1.32)	(2.41)	(2.23)
Log of GDP per adult-equivalent	.682	.692	1.35	1.35
	(2.95)	(3.00)	(2.95)	(2.96)
Log of number of universities	.218	.768	.266	.435
	(1.90)	(2.28)	(2.26)	(1.60)
Log of number of universities x log of country skill price	–	−.0796	–	−.0328
		(1.86)		(.67)
Any ranked universities (top 200)	.467	.630	.312	.381
	(1.72)	(2.20)	(1.10)	(1.36)
Log of students per teacher, primary schools	−.377	−.418	−.240	−.246
	(1.17)	(1.31)	(.77)	(.79)
Log of students per teacher, secondary schools	.783	.770	.659	.628
	(2.09)	(2.03)	(1.86)	(1.75)
Log of population	.476	.492	.487	.491
	(3.57)	(3.60)	(3.47)	(3.44)
Log of distance to nearest U.S. city of entry (miles)	−.293	−.289	−.313	−.315
	(1.98)	(1.92)	(1.95)	(1.94)
Constant	−.801	−1.73	−4.04	−4.19
	(.30)	(.66)	(1.30)	(1.34)
Number of countries	124	124	124	124
R^2	.733	.741	.729	.730

NOTE: Absolute values of robust *t* ratios in parentheses.

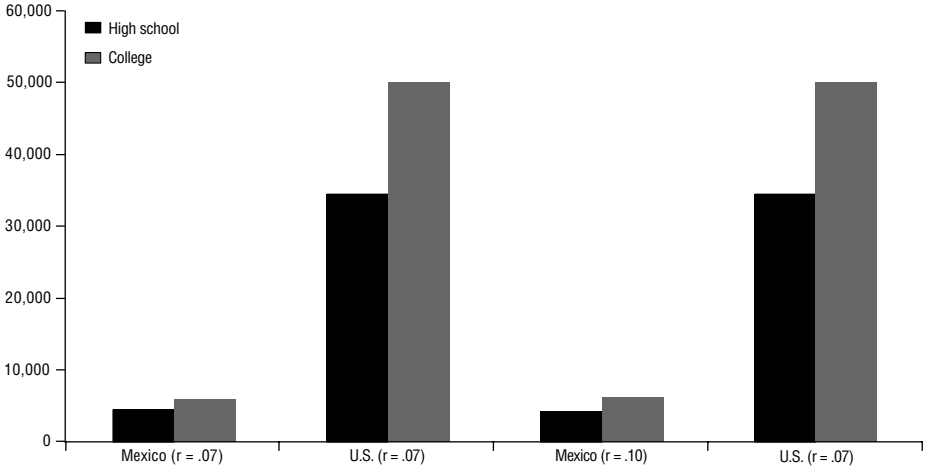
SOURCE: Rosenzweig (2006).

The skill price actually goes up in the sending country and the skill price gap, the incentive for migrating, narrows, so this is wrong.

Long-Run Effects

General-Equilibrium Effect. Changes in the skill price induced by the loss of skill raise the returns to skill investments—skills become scarcer and thus more valuable. Skills are not fixed but can respond to changes. Because the higher the out-migrants' skill level the greater the rise in the skill price, more

Figure 5
PPP-Adjusted 1996 Estimated Annual Earnings in Mexico and the United States, by Schooling Level and Schooling Return



NOTE: r = rate of return to schooling.
SOURCE: Rosenzweig (2006).

skilled out-migration will have a bigger effect on skill upgrading than less skilled out-migration. This long-run effect on incentives to invest in skills is ignored in the general-equilibrium models computing the consequences of migration. For evidence of responsiveness of school investments to change in returns in low-income countries, see the development economics literature.

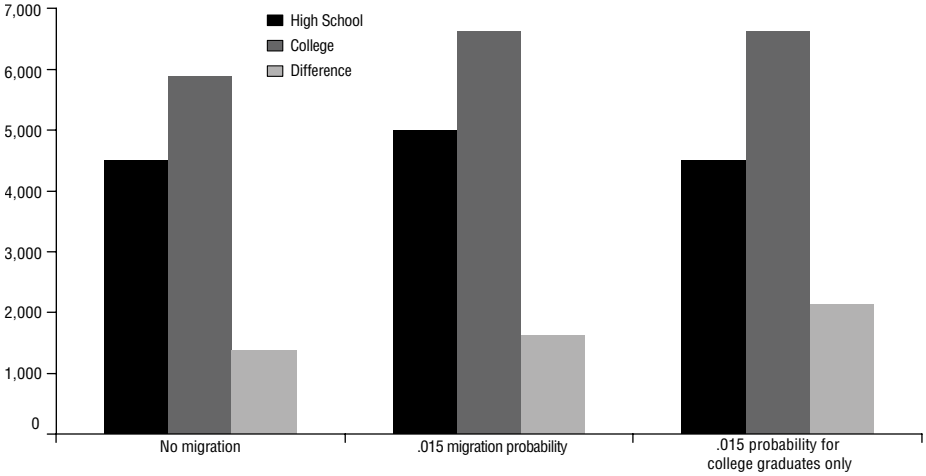
Migration Prospect Effect. Opening up the possibility of migration directly raises *expected* returns to skill investments. Assume that residents of a country face an exogenous probability p of being able to migrate to a higher skill-price country. Then residents respond to changes in the *expected* skill price:

$$(11) \qquad (1 - p)\omega_j + p\omega_k.$$

How large is the effect of increasing out-migration on the "return" to domestic schooling? Consider the case of Mexico, using NIS–P skill prices (*Figure 6*). The expected annual wage difference, college vs. high school in Mexico, given the skill price, and with no migration is

$$(12) \qquad E\,(W_{\mathrm{C}} - W_{\mathrm{HS}})_{\mathrm{M}} = e^{\beta \Delta S}(\omega_{\mathrm{M}}) = \$1{,}392,$$

Figure 6
Expected PPP-Adjusted 1996 Estimated Annual Earnings in Mexico, by Schooling Level and Migration Regime



SOURCE: Rosenzweig (2006).

where $\beta\Delta S$ = college – high school (four years).

The expected annual wage difference, college vs. high school, with an out-migration probability $p = .015$ is

$$(13) \qquad E\,(W_{\mathrm{C}} - W_{\mathrm{HS}})_{\mathrm{M}} = e^{\beta\Delta S}[(1-p)\omega_{\mathrm{M}} + p\omega_{\mathrm{US}}] = \$1{,}623.$$

The expected annual wage difference, with out-migration probability $p = .015$ for college-educated only (only the college-educated can migrate), is

$$(14) \qquad E\,(W_{\mathrm{C}} - W_{\mathrm{HS}})_{\mathrm{M}} = e^{\beta SC}[(1-p)\omega_{\mathrm{M}} + p\omega_{\mathrm{US}}] - e^{\beta SHS}(\omega_{\mathrm{M}}) = \$2{,}137.$$

The total annual gain in the college vs. high school wage differential (A – C) = \$745 from taking into account the prospect of migration is small.

The Return of Skilled Immigrants. Returning immigrants may bring back to the home country increased skills and knowledge that could only be picked up abroad but are transferable to the home environment. And compared with low-skill migrants who work temporarily in low-skill jobs for a short period, high-skill individuals working in dynamic sectors of the economy are more likely to

contribute, upon return, to the institutional development of the home country.

What are the magnitudes of return migration by skilled immigrants who have acquired significant skills in the receiving country and who were not required to return home? We have two ways to find this for U.S. immigrants:

1. Jasso and Rosenzweig (1982) combined Immigration and Naturalization Service administrative records at entry for the FY1971 cohort of legal permanent immigrants with their subsequent naturalization and address report records to estimate ten-year emigration rates: 30 percent, as high as 50 percent in some countries.
2. New Immigrant Survey: New 2003 ("permanent") immigrants were asked, "Do you intend to spend the rest of your life in the U.S.?"

The Training of Students in Developed Countries and Their Return. Many individuals come to developed countries for schooling. Borjas offers this "criticism" of the U.S. student visa program (Borjas 2002):

"The program is best viewed as yet another redistribution program, taking wealth away from native workers and taxpayers and redistributing it to universities *and foreigners* [italics mine]."

To the extent that schooling is publicly subsidized in receiving countries and foreign students do not remain in the receiving country, there is an important subsidy from receiving-country taxpayers going to immigrant-sending countries.

How Do We Measure Brain Drain?

Now turn to two final questions. First, how large is the brain drain and return migration? Second, what are the principal determinants of return migration by foreign students and by "permanent" immigrants? I present two alternative definitions (there are others).

The first is the proportion of highly educated persons born in a country living outside the country. Recent estimates of this definition of brain drain (BD) are based on census-type data, supported by the World Bank (Docquier and Marfouk 2006):

$$BD_i = \Sigma FB_{ij} / (S_i + \Sigma FB_{ij}), \tag{15}$$

where FB_{ij} = tertiary-educated persons age 25+ born in country i residing in destination country j and S_i = tertiary-educated persons residing in origin-country i. For example:

- 82 percent of tertiary-educated Jamaicans reside outside Jamaica.
- 43 percent of tertiary-educated Ghanaians reside outside Ghana.

The second definition is the number or proportion of highly educated persons who leave low-income countries for high-income countries, that is, the emigration only of *those educated in the sending countries* (domestic brain drain):

$$(16) \qquad DBD_i = (\Sigma FBH_{ij})/(S_i + \Sigma FBH_{ij} - \Sigma SFB_{ij}),$$

where FBH_{ij} = foreign-born residents educated in i living in j and SFB_{ij} = home-country residents in i educated in j.

Although the first construct can be useful, the notion of skill out-migration is better captured by the second. The World Bank (BD) estimate thus overstates the outflow rate of skilled persons for a country for two reasons:

- Many foreign born (*FB*) in destination countries received their schooling there, not in their home country. Thus the numerator is biased upward.
- Some "stayers" (*S*) also received their schooling in the destination country and then returned to the home country. These educated-abroad native residents should be subtracted from the denominator.

How off are these estimates? We need to know:

- Where permanent immigrants in receiving countries are schooled—at home or in the host country?
- Where stayers in sending countries are schooled—how many were formerly foreign students?

Where are the highly educated foreign-born schooled? Some emigrants left permanently as children and received all their higher schooling in the destination country. According to Bureau of Citizenship and Immigration Services data (FY2003), 20 percent of permanent resident aliens in the U.S. arrived before age 18. For Jamaica, 38 percent arrived before age 20; for the Gambia, only 10 percent arrived before age 20.

Thus, *BD* overstates the migration of the already skilled, and the bias in the estimates varies by country. Beine, Docquier, and Rapoport (2006) recomputed their country-specific brain drain estimates to take into account those foreign-born who arrived before age 22 (and could not possibly have completed their tertiary schooling at home). On average, their corrected estimates of the brain drain are 68 percent of the ones published initially, with some as low as 51 percent of those reported in the earlier work.

There is a caveat: Can the census data be used to correct the bias—remove those who arrived as children using information on date of arrival? For the U.S. (the major receiving country by far), date of entry is based on answers to the ambiguous question: "When did you first come to stay?" This contains a subjective element. They might answer when they received a permanent visa (not student visa) or when they first came at all (and some who have "permanent" visas, as we will see, never intend to stay).

The Beine, Docquier, and Rapoport (2006) estimates still do not take into account the training and experience received abroad by those residing in the home country. They neglect the reverse brain drain.

To examine foreign student return rates, we can construct a return rate for each country using the NIS data by dividing the number of permanent immigrants in 2003 (NIS) who had ever held a student visa (stayers) by the total stock of foreign students in 2003 (Student Exchange Visa Information System).

Estimates indicate about 6 percent of the stock convert to legal permanent resident status, consistent with about 80 percent of students not becoming permanent resident aliens in the United States and presumably returning home with their new skills (Rosenzweig 2007). We would like to know how skill prices in the home country affect the proportion who stay as legal permanent immigrants. In Rosenzweig (2007), I looked at the relationship between the return rate of students and skill prices and found that return rates of students were significantly higher to countries with higher skill prices.

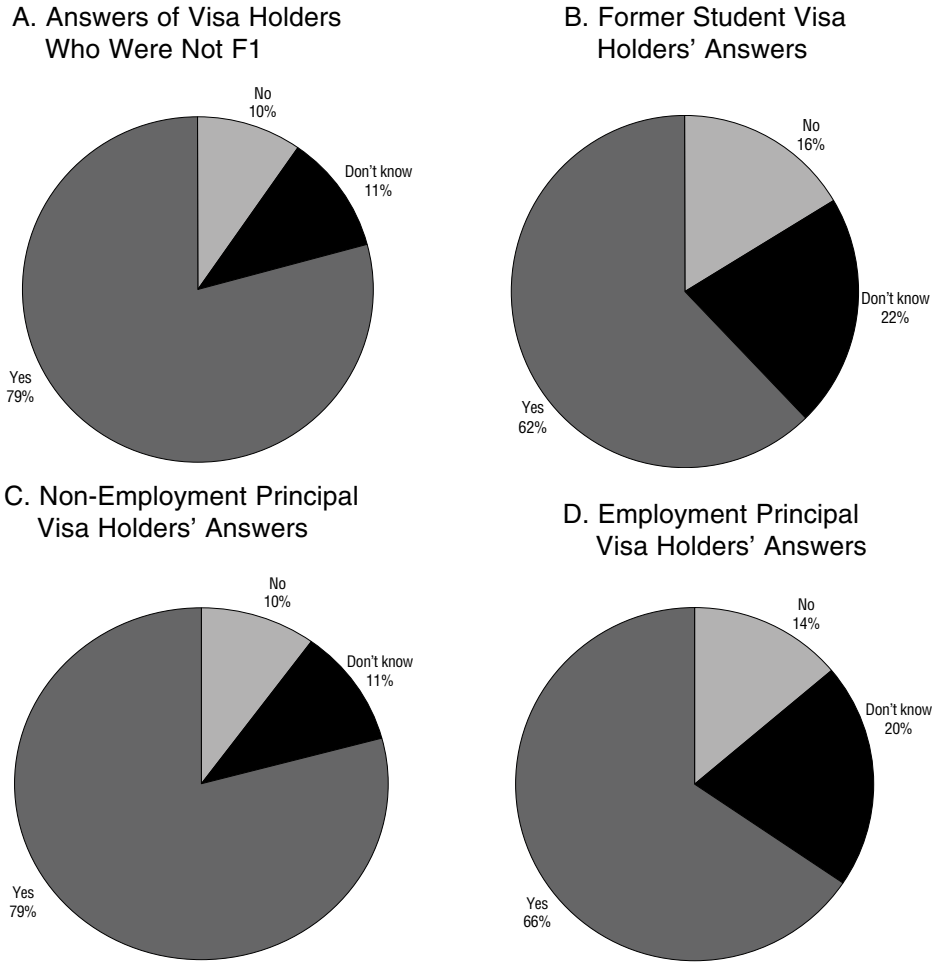
Without tracking immigrants over time, it is not possible to obtain an accurate measure of how many highly skilled permanent immigrants return to their origin countries. As noted, the first round of the NIS asked the new immigrants whether they intended to stay in the United States for the rest of their lives. Figure 7 displays the proportions of immigrants, by visa type, who answered no and don't know to this question. Among immigrants who never held a student visa (*Figure 7A*) or who had not obtained employment visas (*Figure 7C*), 21 percent did not say they intended to stay, and 10 percent of those indicated they would not stay.

However, among the highly skilled "permanent" immigrants who obtained their tertiary schooling in the United States (*Figure 7B*), 38 percent did not answer affirmatively—almost double the rate for those who did not receive their schooling in the U.S., with 16 percent saying no. Thus, the estimated return rates of students based on who immigrates among the students evidently understate the proportions who eventually return.

Among those who immigrated with an employment visa (*Figure 7D*), more than a third did not say they intended to stay in the United States for the rest of their lives, 50 percent more than immigrants outside this "skill" class. Thus it appears that more-skilled immigrants are more likely to return (or at least not stay).

How do skill prices in the home country affect the proportions of immigrants who say they will not stay, from the NIS question? Table 6 reports linear regression estimates of the effects of home-country skill price on the probabilities of not answering affirmatively to the "stay" question of the NIS, for the immigrants who had once held U.S. student visas and for all immigrants. Immigrants in both

Figure 7
"Do You Intend to Stay in the United States the Rest of Your Life?"



SOURCE: New Immigrant Survey.

groups from higher skill price countries were more likely to not intend to stay in the United States.

The estimates in Table 6 thus suggest that better-off countries on average attract back more immigrants. Moreover, the skill price effect is stronger for those immigrants with more education. Higher-skill immigrants are more likely to return to the better-off countries.

How large are these effects? Figure 8 displays the percentage increase in the probability of not staying associated with a doubling of the home-country skill price by the schooling level of the immigrant, based on the estimates in Table 6. These indicate that while a doubling of the skill price increases the probability of not staying by 5 percent for those with less than a high school education, among high school graduates the increase is 25 percent. And for college graduates the same doubling of the skill price leads to a 47 percent increase in those not intending to stay.

Another way of using the regression estimates is to compare the difference in the percentage of immigrants not intending to stay across college and high school graduates at different skill-price levels. Figure 9 shows these differences for three countries, based on their estimated skill prices. In the high-skill-price country, Great Britain, there is a 20 percentage point difference in the "return" of college versus high school graduates. This compares with a 7 percentage

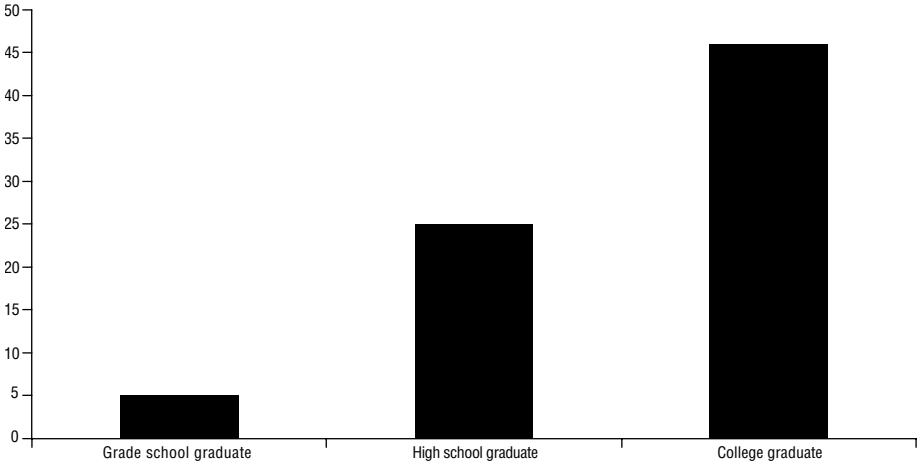
Table 6
Determinants and Selectivity of the Proportion of New "Permanent" Immigrants Intending to Leave, 2003

Country characteristics/immigrant type	Former U.S. student	All	
Log of country skill price (NIS estimate)	.0250 (3.26)	.0812 (2.39)	–.0355 (2.49)
Log of country skill price x years of schooling	–	–	.00509 (4.01)
Years of schooling	.0004 (.25)	.0015 (1.12)	.00854 (3.09)
Number of countries	59	121	121
Number of immigrants	212	3,879	3,879
R^2	.12	.03	.03

NOTE: Absolute values of robust *t* ratios in parentheses. Other variables included log of students per teacher, primary and secondary; age; age squared; gender; entry visa (employment principal, spouse of citizen); log of distance; any ranked universities; number of universities.

SOURCE: New Immigrant Survey.

Figure 8
Percentage Increase in the Proportion of "Permanent" Immigrants Intending to Return from Doubling the Home-Country Skill Price, by Schooling Level



SOURCE: New Immigrant Survey.

point difference for Korea. However, in a low-skill-price country like Mexico, high school graduates are more likely to return compared with college graduates.

Conclusions

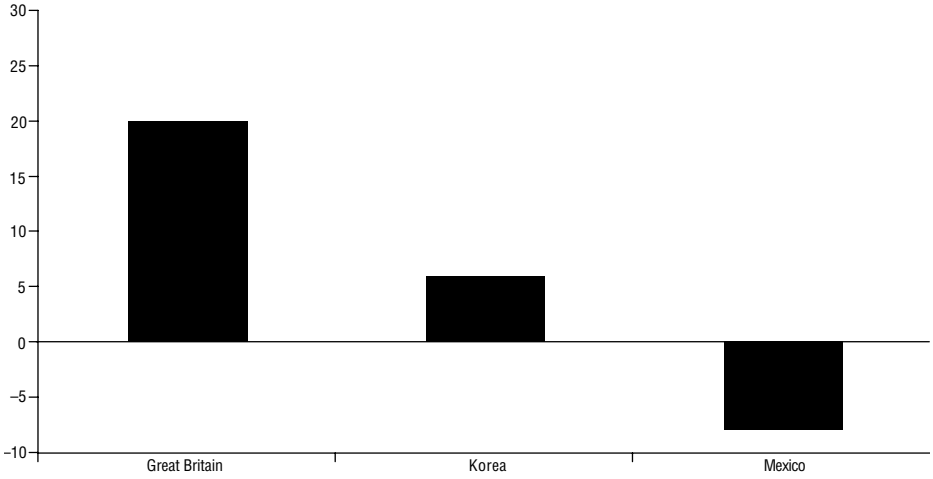
Some of the news about immigration's impact on sending countries is positive. In fact, the greatest impact of the international flow of skilled immigrants on low-income countries may lie in the return of individuals experiencing good institutions—working markets, high-quality educational organizations—in the destination country who then may have both the models and the means to effect institutional change in their home country. These will be returning students and skilled immigrants (for example, former President Ernesto Zedillo of Mexico).

In addition, the number of foreign-born skilled residing in developed countries substantially overstates the number of people educated in low-income countries who emigrated and especially overstates the net brain drain.

Further, a large number of people born in low-income countries receive their expensive, higher education in high-income countries, and the vast majority return to their home country despite the fact that the main motivation for acquiring education abroad appears to be wage improvements via migration.

Finally, a large fraction of "permanent" immigrants return to their home coun-

Figure 9
Percentage Difference in the Proportion of "Permanent" Immigrants Intending to Return Between High School and College Graduates, by Country (Skill Price)



SOURCE: New Immigrant Survey.

try. This rate is especially high among immigrants chosen on the basis of their skill.

On the negative side, the gaps between low-skill-price and high-skill-price countries, and thus the private gains from migration, are enormous, especially for the high-skilled.

And although high-skill out-migration is more prevalent in high-skill-price countries, both high- *and* low-skill immigrants leave low-skill-price countries in greater proportions.

Efforts to increase the number of domestic skilled persons through improving schools will be less effective in a low-skill-price country compared with a high-skill-price country because of out-migration.

Last, return migration rates of the schooled-abroad and immigrants are significantly lower and such returnees are significantly less skilled on average for low- than for high-skill-price countries.

The first-order issue is addressing why rewards to skills are low in low-income countries, for which high out-migration and low return-migration are important symptoms. The training of people in high-income, high-quality institutions may be the best assistance high-income countries provide.

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