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A Gain with a Drain? Evidence from Rural Mexico on the New Economics of the Brain Drain

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Working Paper No. 05-005

August 2005

Giannini Foundation for Agricultural Economics

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Invited paper, 14th World Congress of the International Economic Association, Marrakech, Morocco, August 29 – September 2, 2005. We are indebted to Walter Hyll, Ewa Kepinska, Maja Micevska, and Aaron Smith for helpful advice and enlightening comments.

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Abstract

Evidence is presented in support of the “brain gain” view that the likelihood of migrating to a destination wherein the returns to human capital (schooling) are high creates incentives to acquire human capital in migrant-sending areas. In Mexico, even though internal migrants are more educated than those who stay behind, the average level of schooling in the migrant-sending villages increases with internal migration. This finding is consistent with the hypothesis that the dynamic investment effects reverse the static, depletion effects of migration on schooling. Households’ access to high-skill internal migration networks significantly increases the likelihood that children will attend school beyond the compulsory level. Access to low-skill internal networks has the opposite effect. By contrast with internal migration, migration from rural Mexico to the U.S. does not select positively on schooling, nor does it significantly influence human capital formation, even though remittances from Mexican migrants in the U.S. far outweigh remittances from internal migrants.

Keywords: Migration; Brain drain; Human capital formation; Brain gain; Rural Mexico

JEL Classification: D01; D13; F22; I29; J24; J61; O15

1. Introduction

Recent theoretical work provides conditions under which a positive probability of migration from a country stimulates human capital formation in that country *and* improves the welfare of migrants and non-migrants alike (Stark et al., 1997 and 1998; Stark and Wang, 2002). This "brain gain" hypothesis contrasts with the received "brain-drain" argument, which stipulates that the migration of skilled workers depletes the human capital stock and lowers welfare in the sending country (Usher, 1977; Blomqvist, 1986). The "brain gain" view is that a positive probability of migrating to destinations where the returns to human capital are higher than at home creates incentives to invest more in human capital formation in migrant-sending areas. There are two variants of the brain-gain hypothesis. The weak variant is that the dynamic investment effects cancel out the static depletion effects of migration on average schooling at migrant origins. The strong variant posits that the investment effect overwhelms the depletion effect, resulting in higher average schooling with than without migration.

Whether or not the increase in human capital is welfare enhancing depends, *inter alia*, upon the human capital externalities in the migrant-sending areas, as well as on the dynamic consequences, say in terms of embracing newer technologies, that higher levels of human capital tend to facilitate. If there are positive education spillovers, as modeled by Stark and Wang (2002) then, in the absence of any prospect of migration, the optimal level of human capital that individuals choose to form falls short of the socially optimal level of human capital. The probability of migration can be used as a policy tool to nudge the level of human capital investment towards the socially optimal level of investment.

A helpful step towards assessing the validity of the brain gain hypothesis is to examine empirically the relationship between migration probabilities and education in migrant-sending areas. Using data from 50 developing countries, Beine, Docquier and Rapoport (2001) find evidence that the migration of highly-educated individuals from developing countries has a significant positive impact on aggregate human capital formation in those countries. While providing some support for the brain gain hypothesis, the value of the Beine et al. study is limited by it being based on aggregate cross-sectional data, which requires working with considerably restrictive assumptions, as well as by its use of migration instruments to address migration endogeneity. To date, no study has tested the brain gain hypothesis either at the micro level or using a dynamic econometric model.

We propose to fill this empirical lacuna by developing and estimating a dynamic model using retrospective data gathered from households in rural Mexico. In section 2, we briefly lay out the conceptual framework that underlies the brain gain hypothesis. Section 3 sketches the econometric approach. Section 4 describes the data. Our findings are presented in section 5. Concluding remarks are offered in Section 6.

Our approach yields cautious but interesting support for the brain gain hypothesis. Specifically, we find that in rural Mexico, even though internal migrants are more educated than those who stay behind, average village schooling increases with internal migration. This finding is consistent with the hypothesis that the dynamic investment effects counteract and even reverse the static, depletion effects of migration on schooling. Households' access to high-skill internal migration networks significantly increases the probability that children will attend school beyond the compulsory level. Access to low-skill internal networks has the opposite effect. In contrast with internal migration, migration from rural Mexico to the U.S. does not select positively on schooling, and it does not significantly influence human capital formation, even though remittances from Mexican migrants in the U.S. far outweigh remittances from internal migrants.

2. A rudimentary theoretical model

Following Stark and Wang (2002), suppose that there are *N* identical workers in an economy denoted by *H*, and that labor is the only production input. Each worker produces output equal to:

$$f(\theta) = \alpha \ln(\theta + 1) + \eta \ln(\bar{\theta} + 1) \qquad \text{for } \theta > 0, \tag{1}$$

where θ is the worker's human capital; $\bar{\theta}$ is the economy-wide average level of human capital; and α and η are positive constants denoting, respectively, the private and the social returns to human capital (η represents the positive externalities accruing from the average level of human capital in *H*). Since labor is the only production input, the gross earnings per worker are also given by (1). The cost of forming human capital is given by the function $C(\theta) = k\theta$, where $0 < k < \alpha$ is a constant. In the absence of migration, it is easy to show[1] that a worker's chosen (individually optimal) level of human capital, θ^*, is:

$$\theta^* = \frac{\alpha}{k} - 1 > 0. \tag{2}$$

Given the assumption of identical workers, θ^* is also the average level of human capital in *H*.

[1] Differentiating $\alpha \ln(\theta + 1) + \eta \ln(\bar{\theta} + 1) - k\theta$ with respect to θ and setting the result equal to zero yields (2); the second-order condition for a maximum holds.

Now suppose that individuals have the opportunity to migrate to another, technologically-superior economy, *D*, where their output is:

$$\hat{f}(\theta) = \beta \ln(\theta + 1) + \gamma, \tag{3}$$

where $\beta > \alpha + \eta$, and $\gamma \geq 0$ represents variables besides the worker's own human capital that enhance productivity in *D*. Workers in *H* have an exogenous probability, $p > 0$, of migrating to *D* and obtaining gross earnings $\hat{f}(\theta)$ from employment there. With the complementary probability, *1-p*, the workers remain in *H* with whatever level of human capital they have chosen to form. Given the migration probability, the individually-optimal level of human capital becomes:

$$\tilde{\theta}^* = \frac{p(\beta - \alpha) + \alpha}{k} - 1 > \theta^*. \tag{4}$$

Thus, the individual worker's optimal level of human capital is higher when the worker faces a strictly positive probability of migration. Assuming identical workers, the average level of human capital of those remaining in *H* is also equal to $\tilde{\theta}^*$ and thus, is higher with migration. Stark and Wang show that with a finely-tuned migration policy, the government in *H* could set *p* at a level p^* so as to induce workers to form the socially-optimal level of human capital *and* thereby raise the welfare of all workers, both of the migrants and of those remaining in *H*. Even without the ability to finely-tune migration policy, the home country's government, as long as it does not choose $p > p^*$, could raise the human capital and the welfare of the migrants *and* of those remaining in *H* by choosing a strictly positive level of *p*. The human capital formation response of workers in the home country to incentives conferred by the probability of migration is a fundamental presumption of the brain gain model.

The objective of the present paper is to test this presumption econometrically using household data from rural Mexico. Specifically, we propose to test the hypothesis that, other things being equal, the average level of human capital is higher in villages from where there is a strictly positive but small probability of migrating to a destination in which the economic returns to schooling are higher than at origin. The "gain" in human capital by those workers who end up as non-migrants exceeds the "drain" of human capital from migration.

3. The empirical model

We use a unique new micro data set from rural Mexico to test the hypothesis that the opportunity to migrate to destinations where the returns to human capital are higher than at origin stimulates investment in human capital, thereby raising schooling levels in migrant-source areas. The focus of our study is on migrant-sending communities that are smaller than countries viz., villages. The econometric approach is designed to differentiate between the "selectivity hypothesis" and the "brain gain hypothesis." Under the selectivity hypothesis, migration is positively selective with respect to productive attributes such as educational level and hence, villages with a better educated workforce tend to generate more migration than villages with a poorly educated workforce. In contrast, the brain gain hypothesis suggests a reverse causality: it is not that education prompts migration, it is that migration prompts the acquisition of education at origin. This aspect of the brain-gain hypothesis is tested for two types of migration, relatively low skill and international, and relatively high skill and internal.

We need to take into account that typically, workers are not identical and that migration probabilities are not exogenous. Stark and Wang also study the case of a heterogeneous workforce and show that even when migration is pursued only by the more highly-skilled workers, the insights obtained from the case of the homogeneous workforce carry through to that of the heterogeneous workforce; the results are still a raised level of human capital at origin and improved welfare throughout. Note that the probability of successful migration is likely to depend on existing migration networks and on educational level in ways that vary across migrant destinations (Munshi, 2003; Taylor, 1986). This dependency may reinforce the incentive to acquire human capital and hence strengthen the positive effect of the probability of migration on investment in schooling in migrant-sending areas. In addition, migration probabilities are likely to influence human capital investment with a lag: a "credible" or expected probability of migration tomorrow will induce human capital formation today, while a rewarding experience of migration yesterday that is attributable to human capital will lead to the acquisition of human capital today.

Let $P_{m,t}$ denote the probability at time t of migration to destination m by members of the community of origin to an economy in which the returns from schooling are higher than at origin, let $\theta_{s,t}$ and $\theta_{m,t}$ denote the average levels of schooling of stayers and of migrants at time t, respectively, such that $\theta_{m,t} > \theta_{s,t}$, and let Δ_t be the change in the average level of human capital of stayers as a result of new schooling investment at time t. The average human capital stock in the community of origin at the end of period t, $\theta_{s,t}$, is given by:

$$\theta_{s,t} = \theta_{s,t-1} - P_{m,t}\theta_{m,t} + (1 - P_{m,t})\Delta_t . \qquad (5)$$

At time t, $\theta_{s,t-1}$ is given. According to the brain-gain hypothesis, both migration and investment in human capital are influenced positively by (past) migration to destinations where the returns to schooling are higher than at origin. A good proxy for past migration is the lagged share of villagers who are migrants at such destinations, ($P_{m,t-1}$). Thus,

$$P_{m,t} = P_{m,t}(P_{m,t-1}, \theta_{s,t-1}),$$
$$\Delta_t = \Delta_t(P_{m,t-1}, \theta_{s,t-1}).$$

Substituting and taking the derivative with respect to the lagged migration probability, we obtain:

$$\frac{\partial \theta_{s,t}}{\partial P_{m,t-1}} = -\frac{\partial P_{m,t}}{\partial P_{m,t-1}}(\theta_{m,t} + \Delta_t) + \frac{\partial \Delta_t}{\partial P_{m,t-1}}(1 - P_{m,t}). \quad (6)$$

The first term on the right-hand-side of equation (6) is the static depletion effect, as new migrants take with them their average human capital plus their share of the new human capital investment in the present period. The second term is the dynamic investment effect, which raises the average human capital of those who stay behind. The brain-gain hypothesis implies a dynamic positive relationship, while the brain-drain hypothesis implies a static negative relationship. If there is no investment effect, equation (6) collapses to the static brain drain:

$$\frac{\partial \theta_{s,t}}{\partial P_{m,t-1}} = -\frac{\partial P_{m,t}}{\partial P_{m,t-1}}\theta_{m,t} < 0. \quad (7)$$

The dynamic investment effect exactly offsets or dominates the static depletion effect if:

$$\frac{\partial \Delta_t}{\partial P_{m,t-1}}(1 - P_{m,t}) \geq \frac{\partial P_{m,t}}{\partial P_{m,t-1}}(\theta_{m,t} + \Delta_t).$$

In this case,

$$\frac{\partial \theta_{s,t}}{\partial P_{m,t-1}} \geq 0. \quad (8)$$

Otherwise, the reverse holds, and there is a brain drain.

For a given village i, the average level of human capital of stayers at time t can be represented in reduced form as:

$$\theta_{s,t,i} = f(P_{m,t-1,i}, \theta_{s,t-1,i}). \tag{9}$$

Villagers may migrate to alternative destinations. In our model, there are two such destinations: international, with a probability given by $P\_I_{t,i}$, and national, with a probability given by $P\_N_{t,i}$. Education is likely to influence migration to the two destinations differently. In the brain-drain literature, it is typically assumed that international migration selects positively on education. However, this is not necessarily the case of migration, usually of an unauthorized status, by rural Mexicans to low-skill labor markets in the United States. For example, Mexico-born persons represented an estimated 77 percent of the U.S. farm workforce in 1997-98 (up from 57 percent in 1990). Most of these workers were unauthorized (U.S. Department of Labor, 2000 and 1991). Immigration policies may compound existing asymmetries in the rewards to schooling across borders by discouraging the employment of unauthorized migrants in "good" jobs (Taylor, 1992).

To test the brain-gain hypothesis, we estimate a dynamic, 3-equation model of the following form:

$$\begin{aligned}
\theta_{s,t,i} &= \alpha_{0,i} + \alpha_1 P_I_{t-1,i} + \alpha_2 P_N_{t-1,i} + \alpha_3 \theta_{s,t-1,i} + \alpha_4 t + \varepsilon_{1,t,i} \\
P_I_{t,i} &= \beta_{0,i} + \beta_1 P_I_{t-1,i} + \beta_2 P_N_{t-1,i} + \beta_3 \theta_{s,t-1,i} + \beta_4 t + \varepsilon_{2,t,i} \\
P_N_{t,i} &= \gamma_{0,i} + \gamma_1 P_I_{t-1,i} + \gamma_2 P_N_{t-1,i} + \gamma_3 \theta_{s,t-1,i} + \gamma_4 t + \varepsilon_{3,t,i},
\end{aligned} \tag{10}$$

where $\theta_{s,t,i}$ is the mean years of schooling of adults in the community of origin, and $P\_I_{t,i}$ and $P\_N_{t,i}$ are the percentages of individuals from village i that are international and national migrants in year t, respectively. The regressors include the lagged dependent variables and a time trend, *t*. The parameters $\alpha_{0,i}, \beta_{0,i}$ and $\gamma_{0,i}$ are regional fixed effects. The $\varepsilon_{j,t,i}$, $j = 1,2,3$ are stochastic errors assumed to be approximately normally distributed. The time trend captures changes in average human capital at migrant origins over time, independent of migration. The fixed effects permit the intercept to vary across regions. Effects of other variables that may have promoted human capital investment, including other location or time-varying variables, are picked up by the fixed effects or trend coefficients. The coefficients $\alpha_3, \beta_1, \gamma_2$ represent the dynamic adjustments to exogenous shocks that divert the respective dependent variables from their trends. Stability of the dynamics requires that each of the three coefficients will be less than one.

Controlling for the underlying dynamics, the brain-drain hypothesis implies that $\alpha_j < 0,\ j = 1,2$. Assuming that schooling levels are higher for migrants than for stayers, a non-negative dynamic relationship between migration and average village schooling refutes the brain-drain hypothesis and supports the hypothesis that migration creates dynamic incentives to invest in human capital that are sufficient to at least cancel out the negative static effect of migration on the average village human capital stock. If the dynamic investment effect more than compensates for the static human capital loss, the average village schooling level could even be higher with than without migration.

4. Data

The data to estimate the model were generated through a nationwide rural household survey - The Mexico National Rural Household Survey (Encuesta Nacional a Hogares Rurales de Mexico, or ENHRUM) - carried out jointly by the University of California, Davis, and El Colegio de Mexico, Mexico City. The ENHRUM survey provides retrospective data on migration by individuals from a nationally representative sample of rural households. The survey, which was carried out in January and February of 2003, reports on a sample of 22 households in each of 80 villages. INEGI (*Instituto Nacional de Estadística, Geografía e Información*), Mexico's National Census Office, designed the sampling frame to provide a statistically reliable characterization of Mexico's population living in rural areas, defined by the Mexican government as communities with fewer than 2,500 inhabitants. For reasons of cost and tractability, individuals in hamlets or dispersed populations of fewer than 500 inhabitants were not included in the survey. The resulting sample is representative of more than 80 percent of the population that the Mexican National Census Office considers to be rural.

The ENHRUM survey assembled complete migration histories from 1980 through 2002 in 65 of the 80 villages.[2] From these 1,430 households, histories were constructed for (a) the household head, (b) the spouse of the household head, (c) all the individuals who lived in the household for three months or more in 2002, and (d) a random sample of sons and daughters of either the head or his/her spouse who lived outside the household for longer than three months in 2002. This information makes it possible to calculate the population shares of domestic and international migrants in each surveyed community and in each year from 1980 through 2002. The survey provides the most reliable longitudinal data to date on domestic and international migration from rural Mexican communities.

[2] In 15 of the 80 villages, the migration recall module of the survey was not applied to the children of household heads who were no longer living in the household. Those villages are not included in the empirical analysis that follows.

Information on education (years of completed schooling and number of repeated years) was collected for all family members. This information was used to reconstruct average village schooling levels for each year from 1980 through 2002. Human capital in the source area at time *t* was calculated as the average level of schooling of all non-migrants. In total there are (65 x 22 =) 1,430 village-year observations on migration and average education.[3]

Since the three equations in (10) share the same right-hand-side variables, there is no efficiency gain from estimating the equations as a system. The lagged education and migration variables are correlated with $\alpha_{0,i}, \beta_{0,i}$ and $\gamma_{0,i}$ because average schooling and migration from village *i* are correlated with the village fixed effect in all periods. Thus we treat $\alpha_{0,i}, \beta_{0,i}$ and $\gamma_{0,i}$ as fixed effects and estimate each equation in the model using the GMM estimator of Arellano and Bond (1991). This estimator is free from the bias that arises upon estimation of dynamic panel models by Least Squares Dummy Variable estimators.

5. Findings

Figure 1 illustrates trends in national and international migration from rural Mexico between 1980 and 2002. Figure 2 presents trends in average schooling for each type of migration and for stayers. The schedules in these figures were estimated using retrospective data on migration and on schooling gathered in the national survey. Migration to both internal and international destinations increased sharply during this period, as did the average schooling of

[3] One year per village is lost due to the use of lagged education and lagged migration variables in the regression analysis.

migrants and non-migrants. Of particular interest are the average schooling levels of non-migrants. The upward trend in this variable is consistent with a brain gain model. Alternatively, the trend could be attributable to Mexico's rural education policies and other variables exogenous to migration, which may have promoted human capital investments in rural areas independently of the inducement effect of migration. Because of this consideration, an increasing trend in average village schooling can also then be consistent with a brain drain model. Econometric techniques are required to separate out the influences and to test for an independent effect of migration on average village schooling.

Table 1 presents descriptive statistics for the variables in the model. Average completed schooling of stayers is only 5.4 years for the full 22-year period and 6.6 years in 2002, with little variation (the standard deviations are only 1.8 and 1.5 years, respectively). The average shares of international and internal migrants in total village populations are 7.9 percent and 11.6 percent, respectively, with considerable variation (standard deviations above 10.0 in both cases).

Migration and Schooling: A Dynamic Perspective

The results of the econometric estimation of the dynamic model are reported in Table 2. Arellano and Bond's m_2 test rejects the null hypothesis of no serial correlation in the international migration equation with a single lag. When a second lag is included, its coefficient is significant and the m_2 test no longer rejects the null of serial correlation. Adding the second lag does not substantially affect any of the parameter estimates in the other two equations.

There is no evidence that international migration selects positively on schooling. The effect of schooling on international migration is negative and statistically insignificant. This reflects low returns to schooling for (mostly undocumented) village migrants in U.S. labor markets. We should not then expect international migration to result in a significant brain drain in the population represented in our data. Nevertheless, a rewarding international migration by villagers with little human capital could negatively affect the incentives to invest in human capital by raising the opportunity cost of going to school. Alternatively, through remittances, it could contribute to human capital formation by providing rural households with financial resources to invest in schooling.

Internal migration, by contrast, selects positively and significantly on schooling. Other things being equal, a 1-year increase in the average schooling of village adults is associated with an increase in migration to internal destinations of 1.54 percentage points in the following period (see the top line of the third data column in Table 2). Given that, on average, 15 percent of villagers were internal migrants in 2002 (see Table 1) this represents a 10 percent increase in internal migration. In a static model, one would expect internal migration to deplete human capital in rural areas. However, in a dynamic model, and as already elucidated, high returns to schooling from internal migration may create incentives for human capital investment in villages - dampening, and perhaps reversing, the static brain drain effect.

International migration does not have a significant effect on next-period average schooling of non-migrants. This finding is not surprising since international migration does not select on schooling. In contrast, internal migration has a small but statistically significant *positive* effect on average schooling of non-migrants. This finding suggests that dynamic incentive effects of internal migration on human capital formation more than offset the static brain-drain effect.

A positive association between internal migration and schooling of non-migrants is unlikely to result from a contribution by internal migrants to their households' ability to finance schooling. Remittances from internal migrants in the sample averaged US$83 in 2002. By contrast, as shown in Table 3, total per-pupil expenditures averaged US$171 for grades 1 through 6 (primary), US$307 for grades 7 through 9 (lower secondary), and US$821 for grades 10 through 12 (upper secondary, or high school). The higher schooling costs for secondary education are attributable primarily to transportation and to meals away from home. Due to the presence of an elementary school in all villages in the sample, transportation costs are minimal for primary students. The absence of high schools in most villages results in both transportation and meal costs being highest for grades 10 through 12. (Only 11 percent of villages in the sample had a high school; 69 percent had a lower secondary school.) Since the opportunity costs of attending school can be expected to increase as children grow older and become more productive on the farm or in family businesses, the overall cost of attending grades 10 through 12 is yet higher, and the discrepancy between this cost and the cost of attending lower grades is larger.

The remaining results in Table 2 indicate that the schooling and internal migration equations are stable (the estimated coefficients on each of the lagged-dependent variables are significantly less than 1.0). Nevertheless, there is strong persistence in both migration equations and in the education equation. The trend variable is significant and positive for international migration, negative for internal migration, and insignificant for non-migrants' schooling. There are no cross effects of lagged migration between the two migration equations.

Migration and Schooling Enrollment: A Household Perspective

The findings from the dynamic model suggest a positive investment effect of internal migration on schooling that is sufficiently large to reverse the negative depletion effect on village human capital stocks. The brain gain hypothesis implies that, other things being equal, children in households with a positive probability of high-skill remunerating migration will have a higher probability of being enrolled in school than children in households where the probability of remunerating high-skill migration is low.

In this section, we use individual-level, cross-section data to test how the number of high-skill family migrants at internal destinations affects the likelihood of school enrollment back in the *households* at origin. The ENHRUM gathered detailed information on migration and schooling of individuals and on household characteristics in 2002. These data make it possible to estimate the impact of household migration networks, by skill level, on each child's enrollment status in 2002, controlling for other household characteristics.[4]

[4] Retrospective data on household characteristics are not available.

A network can be construed as a set of individuals linked together by a web of social interactions. In the economic sphere, the network serves as a conduit of personal exchanges that pass on job-related information. This transmission shapes and expands the employment opportunities of members of the network and improves their labor-market outcomes.

Migrant networks can affect the evaluation by a potential migrant (by a potential migrant's parent) of the returns to staying in school in at least two ways: access and information. Migrants holding high-skill jobs may facilitate access to, and placement in, such jobs by highly educated new arrivals, in a way that migrants holding low-skill jobs may not. Because of this access effect, we predict that children in households with high-skill migrant networks will be more likely to enroll in school than children in households without high-skill migrant networks. In addition, migrant networks convey information about the earnings of relatively educated workers employed in high-skill jobs in migrant destinations. High-skill networks are likely to convey this information more accurately and more effectively than low-skill networks. A low variance associated with the information signal from high-skill networks, in and by itself, would tend to reinforce the positive access and placement effect.

A child j who was enrolled in 2001 will enroll in 2002, that is, $E_j = 1$, if the expected benefits from enrollment exceed those of leaving school, subject to the household's budget. The enrollment decision depends on village, household and child characteristics that influence these benefits, and on household endowments that determine the household's budget. We denote these characteristics and endowments by the vector Z_j. Our hypotheses center on how the location (domestic versus foreign) and skill level of household migration networks, NET_j, affect the enrollment decision.

The enrollment model is estimated as a probit whose indicator function is:

$$E_j = \delta_0 + \delta_1 NET_j + \delta_2 Z_j + u_j \quad (11)$$

where δ_0, δ_1 and δ_2 are vectors of parameters to be estimated, and u_j is a normally distributed stochastic error term. Household income is endogenous. As proxies for income we use household income-producing assets in 2001. These include the number of adults and children in the household, schooling level of the household head (an indicator of the household's human capital and of parental attitudes towards children's schooling), a household wealth index (excluding productive capital), and the value of household landholdings (an indicator of productive capital). Individual characteristics include dummy variables for gender and for the child's grade-point average in 2001. Dummy variables were also included to control for the availability (supply) of secondary (grades 7-9) and high schools (grades 10-12) in the village. All villages in our sample had at least one elementary school. Household receipts of transfer payments under Mexico's PROGRESA[5] program were also included, inasmuch as access to these payments is linked to the enrollment of children in school.

The migration-skill variables measure the number of family members with low (grades 0-9) and high (10 or greater) school completion levels at internal and international migrant

[5] The Programa Nacional de Educación, Salud, y Alimentación (PROGRESA) targets cash transfers to the poorest communities and households in Mexico and conditions the transfers on school attendance between the third year of primary school and the third year of secondary school (grades 3 through 9), as well as on children's inscription in health clinics. This conditionality effectively transforms the cash transfers into human capital subsidies up to the lower secondary school level.

destinations.[6] Migration and schooling decisions could be jointly determined. To avoid possible endogeneity bias, we constructed the network variables using retrospective data for 1990, 13 years prior to the year of the survey.

School attendance in Mexico is compulsory through grade 9.[7] Probit results using a sample of all children between the ages of 6 (potential first graders) and 17 (potential 12th graders), and controlling for the grade level at $t-1$, revealed no significant relationship between any of the migration variables and the likelihood of enrollment. Figure 3 summarizes the probability of 2002 enrollment by grade level of children enrolled in 2001. It reveals that the probability of enrollment is high and nearly flat up through grade 6, decreases between the 6th and 7th grades, and decreases again, albeit more sharply, between the 9th and 10th grades. The trends depicted in Figure 3 mirror those presented in de Janvry and Sadoulet (2004), who draw on a large government-generated PROGRESA data set.

When we restrict our sample to include only children who were in the 9th grade in 2001 (Table 4), we find that high-skill internal migrant networks significantly *increase* the likelihood of high-school enrollment in 2002, while low-skill internal networks have the *opposite effect*, with both effects significant at the .05 level. Neither type of international migrant network significantly influences enrollment probabilities. Parent (household head) levels of school completion also have a significant positive influence on the probability of enrollment in high

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[6] For example, if a household had 1 family member with low schooling and 3 family members with high schooling at an internal migrant destination in 1990, then the low- and high-skill internal migrant variables would take on the values of 1 and 3, respectively. Family members include: the household head; the spouse of the household head; all individuals living in the household for at least three months in 2002; and all children of either the head or his/her spouse who lived outside the household for longer than three months in 2002.

[7] As in other contexts and settings, laws are not necessarily enforced.

school.[8] Government (PROGRESA) transfers have no significant effect, which is not surprising inasmuch as their receipt is not conditioned on school enrollment beyond ninth grade.

It might be argued that part of the positive effect of networks on school enrollment is due to a positive income effect of remittances that loosens the financial constraints on investments in schooling. If this were the case, one would expect the largest network effect to be associated with the largest remittance-generating migrant destination. Table 5 compares average annual remittances from high-education migrants and low-education migrants at internal and international destinations. Remittances from high-education internal migrants are 25 percent higher than remittances from low-education internal migrants. However, remittances from low-education and high-education international migrants are 1,500 percent higher than remittances from high-education internal migrants. In short, international migration is vastly superior to internal migration in terms of generating income that could be used to finance school expenditures.

Strictly speaking, it is high-skill migrant networks which confer high-skill jobs, not high-skill migrant networks as such that should be presumed to create the said incentives. Suppose though, that belonging to a high-skill migrant network did *not* increase the likelihood of school enrollment. We would then suspect that such a network did not convert skill endowments into skilled jobs. Conversely, if we were to find that belonging to a high-skill network did entail an increased likelihood of school enrollment, we would suspect that the network was effectively a skilled-jobs network. Otherwise, the network association would have indicated that skill

[8] We repeated this procedure considering only children who were in the 6th grade in 2001, but we found none of the network variables to be significant.

acquisition was useless. Put differently, it would not be logical to expect that the effect of a high-skill network on *skill acquisition* was positive when the network connection leads to jobs that are independent of skill. Furthermore, if a systematic relationship between skill acquisition and skill network affiliation is governed by an unobserved familial trait, such as a taste or proclivity for skill, we would not expect the relationship to be present in one context (say internal migrant networks) yet absent in another (say international migrant networks).

Even though internal migration is relatively inefficient as a generator of remittance income for rural households, past migration by skilled family members to internal destinations, where the returns to schooling are high, appears to send an enticing signal that has the effect of increasing rural households' demand for schooling above and beyond the compulsory level. The picture that emerges is that it is not the amount of remittances that determines schooling investments. A dollar remitted from a poorly educated family migrant in the U.S. does not convey the same appeal as a "dollar" remitted by a skilled family migrant in Mexico. One dollar of remittances turns out not to be equal to another dollar of remittances.

Our findings echo those of Kochar (2004), who reports that in India (1983-1994), the urban rate of return to schooling affects the incidence of rural schooling, especially among those rural households that are most likely to seek urban employment. Kochar found that for rural households who were more likely to engage in rural-to-urban migration that is, landless households as opposed to land-owning households, the urban rate of return to schooling had a significant positive effect on the probability of completing a rural middle school, an effect that was larger than the corresponding effect for land-owning households. Our analysis links the educational levels in the wake of migration to the human capital content of family migration networks.

6. Conclusion

Our econometric analysis of data from rural Mexico leads us to reject the brain-drain hypothesis, both for international migration and for internal migration. Relatively highly educated villagers are selected into internal migration. However, controlling for the underlying dynamics of human capital formation in rural areas, the effect of (lagged) internal migration propensities on average schooling of non-migrants is positive. The returns to -- and the continued possibility of -- internal migration appear to create dynamic incentives for investment in schooling which, in turn, reverses the static, human-capital depleting effect of internal migration. International migration that does not select on schooling has no significant positive effect on the average education of non-migrants.

Our probit analysis suggests that, *controlling for other household and village characteristics*, the presence of high-skill family migration networks at internal destinations significantly increases the likelihood that a child will be enrolled beyond the compulsory (9th grade) level. By contrast, low-skill internal networks decrease the likelihood of high-school enrollment. International networks have no significant effect on school enrollment. That international migration does not have a significant positive effect on schooling is not, however, inconsistent with the brain-gain hypothesis put forward by Stark and Wang. The brain-gain model *assumes* that the prospective returns to schooling are high in a foreign developed country compared to the sending developing country. Yet among the rural Mexican population, migration to the U.S. does not significantly select on schooling since the returns to schooling for unauthorized migrants are low.

Rural Mexico, with its almost uniformly poorly educated population, presents a particularly challenging setting in which to test the Stark and Wang brain gain model. Both our static estimations and dynamic estimations lend support to the brain-gain hypothesis in the case of internal migration. Internal migrants are significantly better educated than non-migrants (7.5 versus 5.5 years of completed schooling in 2002, a 36% disparity), and the effect of schooling on internal migration is positive and statistically significant. In a static world, given the large magnitude of migration to internal destinations, such migration would clearly have depleted rural human capital stocks. The fact that it *increases* the schooling of non-migrants is consistent with the existence of a dynamic and positive incentive effect of gainful internal migration on rural human capital formation. The finding that, controlling for remittance inflows, high-skill internal migration networks increase the probability of enrollment in post-compulsory (high-school) education provides further evidence of the inducement effect of the probability of migration on investment in schooling in rural Mexico.

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Figure 1. Trends in National and International Migration from Rural Mexico, 1980-2002

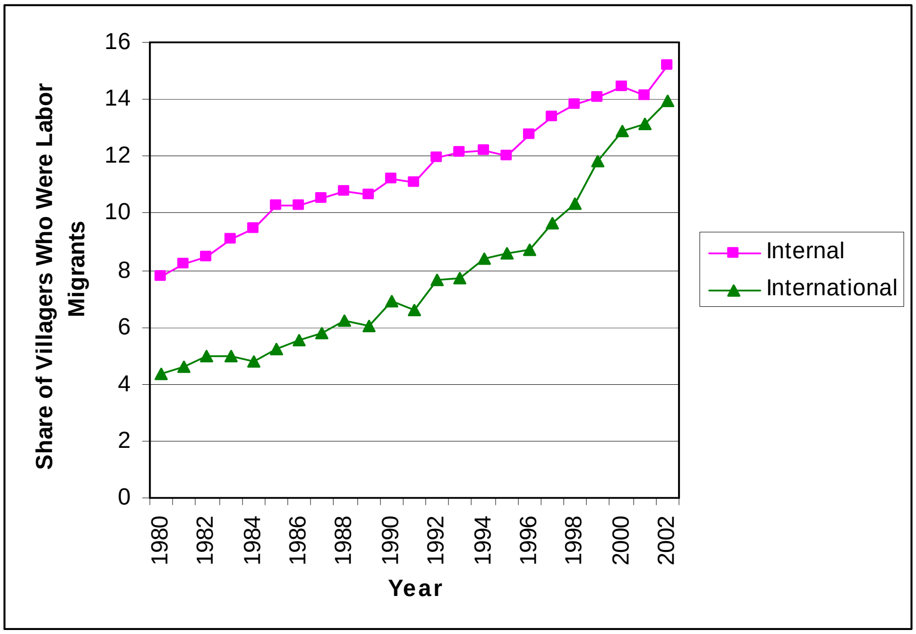


Figure 2. Mean Education of Migrants and Stayers (excludes children under 18)

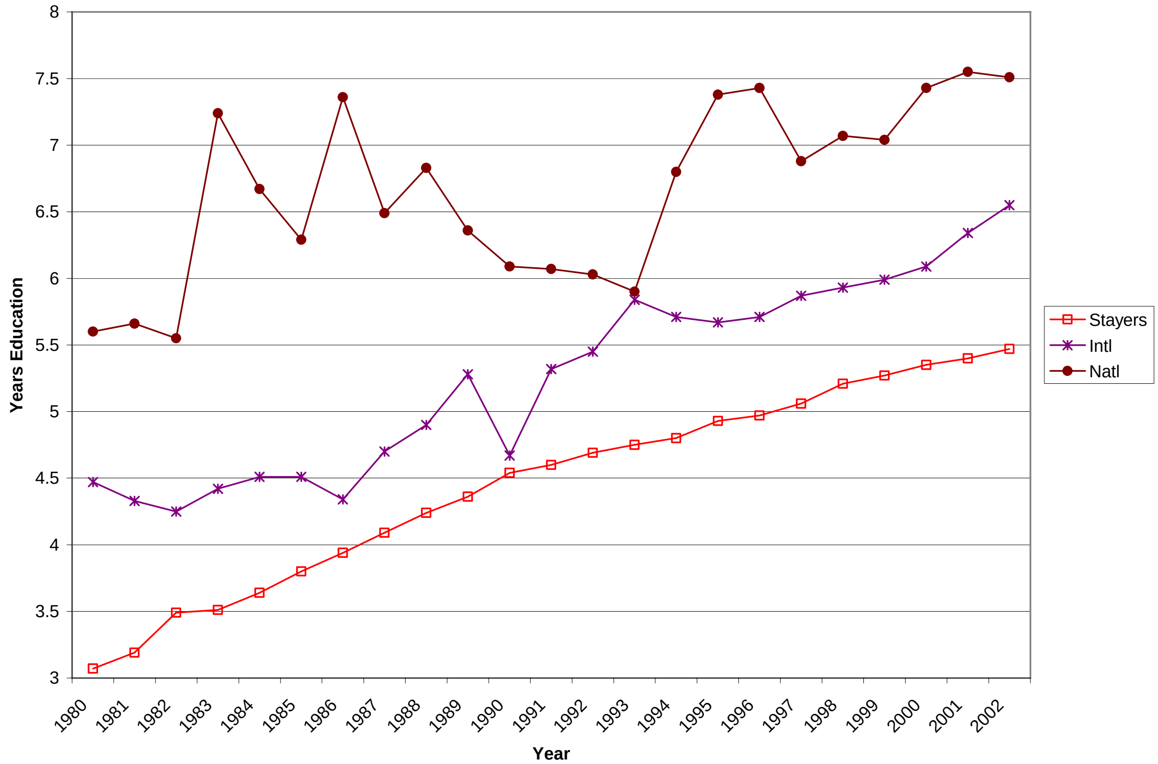
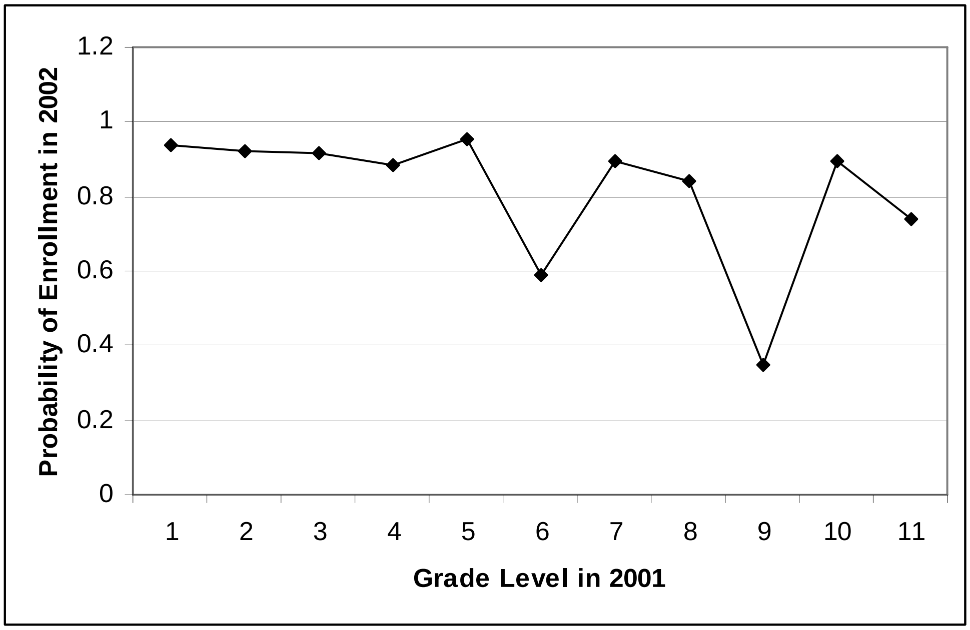


Figure 3. Probability of 2002 School Enrollment of Rural Mexican Children Age 6 to 18, by Grade Level of Enrollment in 2001[9]



[9] The horizontal axis measures the child's observed grade level in 2001, the year prior to the survey year. The vertical axis measures the probability of enrollment (at the next grade level) in 2002.

Table 1. Descriptive Statistics of Education and Migration Levels

Variable	1980-2002		2002	
	Mean	Standard Deviation	Mean	Standard Deviation
Average schooling of village stayers (θ)	5.44	1.83	6.59	1.46
Percentage of villagers who were:				
-International migrants (P_I)	7.94	10.28	13.97	13.84
-Internal migrants (P_N)	11.64	10.40	15.20	12.98

The sample size (village-years) is 1,495.

Table 2. Regression Results for the Dynamic Migration and Education Model Using Arellano-Bond Procedure

Variable	Equation					
	Share of Villagers at International Destinations		Share of Villagers at Internal Destinations		Average Schooling of Stayers	
	Coefficient	z-statistic	Coefficient	z-statistic	Coefficient	z-statistic
θ_lag	-0.16	-0.56	**1.54**	**5.23**	**0.89**	**27.81**
P_I_lag(1)	**0.71**	**21.36**	0.02	0.57	0.00	-0.03
P_I_lag(2)	**0.19**	**6.63**	0.01	0.18	0.00	0.90
P_N_lag	-0.36	-1.29	**0.90**	**30.55**	**0.01**	**2.78**
T	**0.14**	**3.36**	**-0.16**	**-3.67**	0.01	0.95
Arellano-Bond m2 test (p-value)	0.52		0.88		0.39	
R-squared	0.945		0.933		0.981	
N (village-years)	1430					

Each equation was estimated with regional fixed effects.

Table 3. Average Schooling Expenditures per Pupil, by Schooling Level (US Dollars)

Schooling Expenditure	Elementary (1-6)	Lower Secondary (7-9)	Upper Secondary (10-12)
Lodging	3.16	10.46	80.56
Tuition and fees	11.05	22.01	115.23
Transportation	15.82	60.78	249.66
Meals	83.95	135.86	255.11
Uniforms	25.95	34.65	32.82
Supplies	21.16	28.84	49.56
Other	9.78	14.62	37.86
Total	170.87	307.23	820.79
Sample size (number of pupils)	1,287	502	304

Table 4. Probit Regression Results for High School Enrollment (Grade 10) in 2002, Conditional upon Enrollment (Grade 9) in 2001

Variable	Estimated Coefficient	T-Statistic	P-Value
Household size	-0.069	-1.050	0.294
Household children	-0.159	-1.020	0.306
Gender (Male=1)	0.075	0.330	0.739
2001 GPA	-0.021	-0.460	0.646
Education of head (Years)	0.102	3.250	0.001
Wealth index	0.051	0.740	0.462
Internal migration network:			
Low education	-0.322	-2.200	0.028
High education	1.629	2.990	0.003
International migration network:			
Low education	-0.038	-0.190	0.852
High education	-0.163	-0.400	0.690
High school in village	-0.139	-0.380	0.703
Value of landholdings	0.000	-0.260	0.797
PROGRESA transfers (Pesos)	0.000	1.390	0.164
Constant	-0.482	-0.880	0.377

N (Students in ninth grade in 2001) 180

Log Likelihood -92.04

Pseudo R^2 0.21 LR $\chi^2(13)$ 49.00

Table 5. Remittances by Education Level of Internal and International Migrants

Migrant Destination	Annual Remittances	Schooling Level of Migrant		All Migrants
		0-9 Years	> 9 Years	
Internal	Mean	810	1,003	835
	Standard deviation	3,747	3,006	3,658
	Sample size	1,463	222	1,685
International	Mean	15,037	15,045	15,038
	Standard deviation	30,816	30,678	30,782
	Sample size	729	98	827
Total	Mean	5,542	5,303	5,511
	Standard deviation	19,232	18,288	19,111
	Sample size	2,192	320	2,512