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

By STEVE BOUCHER, ODED STARK, AND J. EDWARD TAYLOR

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1 Introduction

Recent theoretical work suggests conditions under which a positive probability of migration from a developing country stimulates human capital formation in that country and improves the welfare of migrants and nonmigrants alike (Stark et al., 1997, 1998; Stark and Wang, 2002). This 'brain gain' hypothesis contrasts with the received, long-held '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 strictly positive probability of migrating to destinations where the returns to human capital are higher than at origin creates incentives to acquire more human capital in migrant-sending areas.

If there are positive education externalities, as modeled by Stark and Wang (2002), then, in the absence of a prospect of migration, the optimal level of human capital that individuals choose to form falls short of the socially optimal level of human capital. In this case, migration could conceivably nudge the level of investment in human capital towards its socially optimal level.

A helpful step towards assessing the validity of the brain gain hypothesis is to conduct an empirical examination of the relationship between the probability of migration and education in migrant-sending areas. Using data from 37 developing countries, Beine et al. (2001) tested the hypothesis of Stark et al. (1997, 1998) and of Stark and Wang (2002) and found evidence that the migration of highly-educated individuals from developing countries has a positive impact on aggregate human capital formation in those countries. While providing some support for the brain gain hypothesis, the value of the study by Beine et al. is limited by the use of aggregate cross-sectional

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data, which requires working with 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.

The objective of the present chapter is to help fill in this void using household data from rural Mexico. Specifically, we seek to test the hypothesis that, other things being equal, the average level of human capital of non-migrants is higher in villages from which a larger share of individuals have migrated to destinations in which the economic returns to schooling are higher than at origin. The received brain drain literature argues that the migration of relatively highly educated individuals depletes human capital stocks at origin. It neglects the consideration that high returns to schooling at migrant destinations may create incentives to invest in schooling at origin. If some of the individuals who respond to these incentives by acquiring more schooling end up not migrating, then the average level of schooling (human capital) at origin may rise. Workers respond to the expected returns that they face, rather than to certain returns, and the higher the expected returns, the higher the acquired education. When the state of nature unfolds, some workers usefully apply their acquired education at destination, others do not end up migrating, but all workers are aware of this ex post variety of possible outcomes when they elect to acquire education in the first place. A brain gain occurs if the 'gain' in human capital by those individuals who end up as non-migrants exceeds the migration-caused 'drain' of human capital.

In the theoretical work on the brain gain (Stark and Wang, 2002), the probability of successful migration is exogenous and is determined by government policy. Such, for example, is the case studied by McKenzie et al. (2006), in which Tongan immigrants to New Zealand are selected by a lottery. In Mexico, where migration policies are at best an imperfect deterrent to international migration and where there is no policy deterrent to internal migration, the ex ante probability of migration is unobservable to the researcher and is endogenous. In particular, it depends upon the networks that a community has developed through past migration (Massey et al., 2005; Munshi, 2003). Rural Mexico is an interesting laboratory setting to test the effect of migration on human capital formation, especially in view of the massive outflow of migrants in recent decades and the resulting concern that this migration is depleting the rural areas of valuable human resources. Rural Mexico has a dichotomy of migration flows (internal and international) for which the selectivity of migration and the signals that migrants send home regarding the returns to, hence the value of, their education are likely to differ.

Our empirical investigation has two components. First, we develop and estimate a dynamic model using village-level data on education and on international and internal migration. This approach is similar in spirit to a country-level study of the brain gain, but with a longitudinal dimension that is lacking in existing studies. The approach yields cautious but illuminating support for the brain gain hypothesis. 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 effect counteracts and even reverses the static, depletion effect of migration on schooling.

A brain gain explanation for this aggregate village finding implies that children in households with a positive probability of high-skill internal migration have a higher probability of being enrolled in school than do children in households where there is only a low probability of high-skill internal migration. The second component of our empirical strategy attempts to 'unpack' the effect of migration on schooling at a finer micro level, using data on households' access to high-skill internal migration networks and other variables that may influence schooling enrollment. Cross-section findings indicate that access to high-skill internal migration networks significantly increases the probability that children will attend school beyond the compulsory level, whereas access to low-skill internal networks does not. In contrast with internal migration, migration from rural Mexico to the United States does not select positively on schooling, and human capital formation is not higher in households that have high-skill migrants abroad. When there are no returns to schooling upon migration, migration does not encourage schooling. Low-skill international networks do have a modest positive effect on schooling investments. This effect can be attributed to remittances from Mexican migrants in the United States far outweighing remittances from internal (including skilled) migrants, and of schooling investment being a normal good.

Section 2 illustrates the brain gain argument. Section 3 describes the data. Findings from the dynamic model are presented in section 4. Section 5 presents the results of a micro cross-section analysis of school enrollment. Concluding remarks are provided in section 6.

2 Accounting for a brain gain

Let θ_t and θ_t^m denote, respectively, the average of schooling levels of stayers and of migrants, and let Δ_t be the change in the average level of human capital of stayers resulting from a new schooling investment at time t. For a community of origin that starts out at time $t-1$ with an average schooling level of θ_{t-1} and loses a share s_{t-1} of its population to migration, the resulting average human capital stock at period t, θ_t, is given by

$$\theta_t = \frac{\theta_{t-1} - s_{t-1}\theta_{t-1}^m}{1 - s_{t-1}} + \Delta_t. \tag{6.1}$$

Equation (6.1) shows that for a given migrants share of the population, s_{t-1}, the mean education level of the individuals remaining in the village, θ_t, is increasing in the level of their own average schooling investment, Δ_t, and decreasing in the average schooling level of the migrants, θ^m_{t-1}. Differentiation of equation (6.1) with respect to s_{t-1} decomposes the overall effect of migration on education at origin into two components:

$$\frac{\partial \theta_t}{\partial s_{t-1}} = \frac{\theta_{t-1} - \theta^m_{t-1}}{(1 - s_{t-1})^2} + \frac{\partial \Delta_t}{\partial s_{t-1}}. \quad (6.2)$$

The first term on the right-hand side of equation (6.2) is the static depletion effect, which results from migrants taking with them their average human capital. When migration selects positively on schooling, $\theta_{t-1} < \theta^m_{t-1}$, the static effect is negative. The second term is the dynamic investment effect, or the influence of migration on new investments in schooling by the stayers. The brain gain hypothesis is that this effect is positive; that is, if the returns to schooling are larger at destination than at origin, a positive probability of migrating (represented by s_{t-1}) creates an incentive to invest more in schooling at origin at time t. The net effect on the average schooling of the stayers depends upon which of these two effects dominates: a brain drain occurs when the average schooling of the migrants is higher than the average schooling of the non-migrants and the effect of investment in rural schooling is small or nil.[1] When the reverse holds, the result is a brain gain.

The effect of migration on average schooling at origin thus depends on two considerations. The first is whether migration selects positively on schooling. If it does not, then migration does not produce a brain drain, nor can it create the dynamic incentives that result in a brain gain.[2] If migration does select positively on schooling, then a second consideration is whether there is a positive investment effect and, if so, whether the ensuing brain gain is sufficient to counteract the negative depletion effect.

3 Data

The data used in our empirical analysis are taken from the Mexico National Rural Household Survey (*Encuesta Nacional a Hogares Rurales de Mexico*, or ENHRUM). The ENHRUM, carried out jointly by the University of California, Davis, and El Colegio de Mexico, Mexico City in 2003, provides retrospective data on migration by individuals from a nationally representative sample of rural households. The sample consists of between 22 and 25 households randomly selected 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 per cent of the population that INEGI considers to be rural.

The ENHRUM survey assembled complete migration histories from 1980 through 2002 in 65 of the 80 villages, and from 22 households in each of these villages.[3] For these 1,430 households, histories were constructed for: (i) the household head; (ii) the spouse of the household head; (iii) all the individuals who lived in the household for three months or more in 2002; and (iv) a random sample of sons and daughters of the head and of his/her spouse who lived outside the household for longer than three months in 2002. While the illustration in the preceding section implicitly assumes a single migrant destination, in real life individuals may migrate to different destinations with different returns to education. In our empirical analysis we consider two destinations: international and internal. Education is likely to have a different influence on migration to these two destinations. In the brain drain literature, it is assumed that international migration selects positively on education. However, in our case this is not so. Mora and Taylor (2005) find cross-section evidence that, for rural Mexicans, the association between schooling and migration probabilities is significant and positive for internal migration, but negative for migration to the United States, which usually entails unauthorized entry and work in low-skill jobs. Our findings using longitudinal village data, presented below, echo that evidence. Data from the migration histories make it possible to calculate the population shares of domestic and international migrants in each surveyed community and in each year from 1980 through 2002.

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 levels of village schooling 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 $(65 \times 23 =)$ 1,495 village-year observations on migration and average education.[4] The retrospective migration and schooling data were also used in the cross-section analysis of school enrollment, presented in section 5.

4 Migration and schooling: a dynamic village model

As already noted, a brain gain arises if migration selects positively on schooling and the dynamic investment effect dominates the static depletion effect. If migration selects positively on schooling, there can be either a brain drain or a brain gain. If migration is positively selective with respect to productive attributes such as educational level, then villages with a better educated workforce tend to generate more migration than villages with a poorly educated workforce. Thus, we first study the effect of the selectivity of internal and international migration from rural Mexico on schooling. We then examine the net effect of internal and international migration on the average schooling level in the origin villages.

Our dynamic econometric model is in the spirit of cross-country models of brain drain and brain gain, but with a time dimension that is lacking in those models due to the absence of harmonized time series data on country human capital and migration. The village panel data from Mexico make it possible to estimate a dynamic rather than a cross-section model of the impact of migration on human capital at migrant origins, and to include fixed effects to control for unobserved variables that may confound cross-section estimates.

The village is a natural unit of analysis for contemplating educational spillover effects in rural areas, and is more fitting than smaller units (households, individuals) for the study of the effect of migration on the average level of human capital in migrant-sending areas. Villages also have the advantage of being intuitive units with respect to information and networks, which impact upon and shape migration flows. Many of the variables that determine the net benefits of migration are essentially village-level variables: infrastructure, land quality, distance to migrant destinations, and so on, vary more amongst rather than within villages. We can control for the influence of the village level variables using village fixed effects.

Using the longitudinal data provided by the ENHRUM, we estimate a dynamic, three equation village migration and schooling model of the following form:

$$s^I_{t,i} = \beta_{0,i} + \beta_1 s^I_{t-1,i} + \beta_2 s^N_{t-1,i} + \beta_3 \theta_{t-1,i} + \beta_4 t + \varepsilon^I_{t,i} \tag{6.3a}$$

$$s^N_{t,i} = \gamma_{0,i} + \gamma_1 s^I_{t-1,i} + \gamma_2 s^N_{t-1,i} + \gamma_3 \theta_{t-1,i} + \gamma_4 t + \varepsilon^N_{t,i} \tag{6.3b}$$

$$\theta_{t,i} = \alpha_{0,i} + \alpha_1 s^I_{t-1,i} + \alpha_2 s^N_{t-1,i} + \alpha_3 \theta_{t-1,i} + \alpha_4 t + \varepsilon^\theta_{t,i} \tag{6.3c}$$

where $s^I_{t,i}$ and $s^N_{t,i}$ are the shares of individuals from village i who are international migrants and internal migrants in year t, respectively, and $\theta_{t,i}$ and $\theta_{t-1,i}$ denote mean years of schooling of adults in the community of origin in year t and $t-1$, respectively. The regressors include the lagged dependent variables and a time trend, t. The parameters $\beta_{0,i}$, $\gamma_{0,i}$ and $\alpha_{0,i}$ are village fixed effects. The errors $\varepsilon^I_{t,i}$, $\varepsilon^N_{t,i}$ and $\varepsilon^\theta_{t,i}$ are assumed to be approximately normally and independently distributed across equations and over time. Effects of time-invariant unobserved village variables and time-varying variables affecting migration and human capital investment in a similar fashion across all villages are picked up by the fixed effects and trend coefficients, respectively. Because of this, no village-level instruments to control for the endogeneity of migration shares, the value placed on schooling, or other variables are needed or, indeed, can be included in this model. The coefficients β_1, γ_2, and α_3 represent the dynamic adjustments to exogenous shocks that divert the

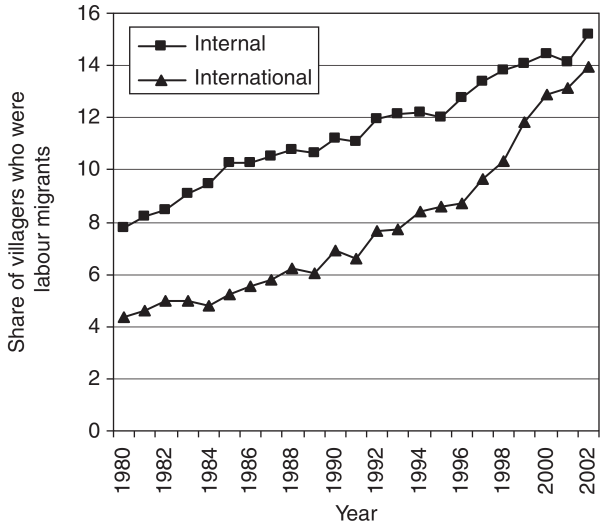

Figure 6.1 Trends in internal and international migration from rural Mexico, 1980–2002
Source: ENHRUM.

respective dependent variables from their trends. Stability of the dynamics requires that each of these coefficients is less than one.

Since equations (6.3a), (6.3b), and (6.3c) share the same right-hand side variables, there is no efficiency gain from estimating them as a system (cf., for example, Greene, 2003, p. 343). The lagged migration share and schooling variables are correlated with $\beta_{0,i}$, $\gamma_{0,i}$ and $\alpha_{0,i}$ because migration shares and schooling in a village are correlated with the village fixed effect in all periods. Thus, we estimate each equation in the model using the Generalized Method of Moments (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.

The effect of the selectivity of migration on schooling

Figures 6.1 and 6.2 illustrate trends between 1980 and 2002 in the three dependent variables, using the retrospective data on migration and on schooling gathered in the ENHRUM. The clear upward trends evident in both figures reveal that migration to internal and international destinations increased sharply during this period, as did the average schooling of migrants and of non-migrants. Table 6.1 reports mean adult education levels and migration shares for the sample villages over the entire 22-year period. The average shares of international and internal migrants in total village populations were 7.8 per cent and 11.5 per cent, respectively. With the exception

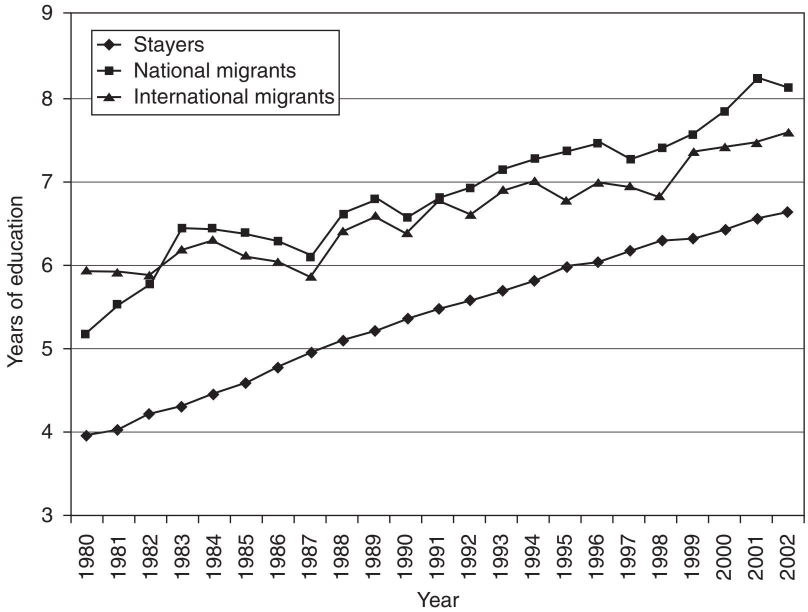

Figure 6.2 Mean education of migrants and stayers (excluding children under 18)
Source: ENHRUM.

of the first three years of the recall period, the average education of internal migrants ('National Migrants' in Figure 6.2) was slightly higher than that of international migrants. For the full 22-year period, the average completed schooling of internal migrants was 6.9 years, and of international migrants it was 6.7 years. The average completed schooling of adult stayers was only 5.4 years for the full 22-year period and was consistently and significantly below the average schooling levels of both migrant groups.

The parameter estimates for equations (6.3a) through (6.3c) are reported in Table 6.2. The results reveal that when we control for the other variables in equation (6.3a), international migration from rural Mexico does not select positively on schooling. The estimated coefficient on the lagged schooling variable in the international migration share equation (equation 6.3b) is −0.16, and is not significantly different from zero (first row of Panel (1)). It is likely that this finding reflects low returns to schooling for village migrants (who are mostly undocumented) in United States labour markets. We should not then expect international migration to result in a significant brain drain in the population represented in our data. Yet rewarding international migration by villagers with little human capital could negatively affect the incentive to invest in human capital by raising the opportunity cost of going to school. Alternatively, through remittances, this migration

Table 6.1 Mean education levels and migrant shares in the sample villages between 1980 and 2002

	Mean	*Standard deviation*
Completed years of schooling of:		
Adult international migrants	6.7	2.9
Adult internal migrants	6.9	2.9
Adult non-migrants	5.4	1.8
Share of villagers that were:		
International migrants	7.8	10.2
Internal migrants	11.5	10.4

Source: Authors' calculations using data from ENHRUM.

Table 6.2 Regression results for the dynamic migration and education model using the Arellano–Bond procedure

	Equation (1): Share of villagers at international destinations ($s^I_{t,i}$)		*Equation (2): Share of villagers at internal destinations* ($s^N_{t,i}$)		*Equation (3): Average schooling of stayers* ($\theta_{t,i}$)	
Variable	*Coefficient*	*z-statistic*	*Coefficient*	*z-statistic*	*Coefficient*	*z-statistic*
$\theta_{t-1,i}$	−0.16	−0.56	**1.54**	**5.23**	**0.89**	**27.81**
$s^I_{t-1,i}$	**0.71**	**21.36**	0.02	0.57	0.00	−0.03
$s^I_{t-2,i}$	**0.19**	**6.63**	0.01	0.18	0.00	0.90
$s^N_{t-1,i}$	−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 m[2] test (p-value)	0.52		0.88		0.39	
R-squared	0.94		0.93		0.98	
N (village-years)	1430					

Note: Each equation was estimated with village fixed effects.

could contribute to human capital formation by providing rural households with financial resources to invest in schooling.

By contrast, internal migration selects positively and significantly on schooling. Other things being equal, a 1-year increase in the average schooling of village adults in a given period is associated with an increase in migration to internal destinations of 1.54 percentage points in a subsequent period (the first row of Panel (2) in Table 6.2). Given that, on average, in 2002, 15 per cent of villagers were internal migrants, this amounts to a 10 per cent increase in internal migration.[5] In a static model, we could expect internal migration to considerably deplete human capital in rural areas. The question that we seek to answer is whether this static effect may be dampened or reversed as high returns to schooling from internal migration create incentives for human capital investment in villages.

Testing for a brain gain

Controlling for the underlying dynamics and village fixed effects, the brain drain hypothesis implies that $\alpha_2 < 0$. Given our finding that internal migration positively selects on schooling, a non-negative dynamic relationship between internal migration and average village schooling refutes the brain drain hypothesis and lends support to the hypothesis that internal migration creates incentives to invest in human capital that are powerful enough to at least cancel out the negative static effect of migration on the average level of the village human capital. To wit, if the dynamic investment effect more than compensates for the static human capital loss, the average village schooling level could even be higher with migration than without migration. No relationship is implied in the case of international migration, which does not select on schooling, however.

Panel 3 of Table 6.2 reports the parameter estimates of the schooling equation. As expected, international migration does not have a significant effect on the next period's average schooling of non-migrants. In contrast, internal migration has a small, but statistically significant, *positive* effect on the average schooling of non-migrants. This finding suggests that the dynamic incentive effect of internal migration on human capital formation more than offsets the static brain drain effect.

We might suspect that the positive effect of internal migration on schooling is the result of a relaxation of liquidity constraints via remittances instead of being the result of the incentive effect. While we do not have in hand longitudinal data on remittances which would enable us to distinguish empirically between these two effects, we believe that the latter effect does not drive the positive association between internal migration and schooling.[6] Remittances from internal migrants in the sample averaged US$83 in 2002. By contrast, as shown in Table 6.3, 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 elementary schools 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 per cent of villages in the sample had a high school; 69 per cent 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

Table 6.3 Average schooling expenditures per pupil, by schooling level in 2002 (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

Source: Authors' calculations using data from ENHRUM.

through 12 is even higher, and the discrepancy between this cost and the cost of attending lower grades is correspondingly larger.

The remaining results in Table 6.2 indicate that the village migration and schooling equations are stable (the estimated coefficients on each of the lagged-dependent variables are significantly less than 1.0). Nevertheless, there is strong persistence both in the 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.

5 Migration and school enrollment: an individual retrospective

The findings from the dynamic model suggest that the positive investment effect of internal migration on schooling is sufficiently strong to reverse the negative depletion effect. The brain gain hypothesis implies that, other things being equal, children in households with a positive probability of lucrative high-skill migration are more likely to be enrolled in school than children in households where there is only a low probability of such migration.

In this section, we use individual-level, retrospective data to test how the number of high-skill family migrants at internal destinations affects the likelihood of school enrollment in the *households* at origin. By using retrospective household information on migration and schooling of individuals, it is possible to estimate the impact of household migration networks, by skill level, on each child's enrollment status at time t, given that the child was enrolled in school at time $t-1$, and controlling for selected individual and household characteristics, as well as for village fixed effects.

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 labour market outcomes.

Migrant networks can affect the evaluation by a potential migrant (or the evaluation 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 who lack such 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, will tend to reinforce the positive access and placement effect.

Let E_{jht} denote the enrollment status of child j in household h at time t. The variable E_{jht} takes on the value of 1 if the child is enrolled, and 0 otherwise. The child is enrolled if the net benefits of enrollment, B_{jht}, are positive. This general formulation is akin to other models of schooling investment, including Todd and Wolpin's (2006) matching estimators of program effects, and the grade progression models of Cameron and Heckman (2001). Net benefits from enrollment have a deterministic (b_{jht}) as well as a random (v_{jht}) component; that is, $B_{jht} = b_{jht} + v_{jht}$. The probability of observing enrollment is then

$$\Pr[B_{jht} > 0] = \Pr[-v_{jht} < b_{jht}] = F(b_{jht}), \tag{6.4}$$

where F is the cumulative distribution function of $(-v_{jht})$. The deterministic component of net benefits depends on individual and household characteristics, Z_{jht}, that may vary over time. Our hypotheses center on how the destination (d = internal, international) and skill level (s = high, low) of the household level migration networks of child j at time t, NET_{jhtds}, affect the enrollment decision via their influence on the net benefits of schooling. Therefore,

$$b_{jht} = \alpha + Z_{jht}\beta + \sum_{d,s} NET_{jhtds}\gamma_{ds} + \delta t + G_{t-1}\phi \tag{6.5}$$

where G_{t-1} is a vector of dummy variables indicating the grade in which the child was enrolled at time $t-1$, and ϕ is a vector of parameters measuring the net benefits of continuing enrollment at each grade level. The null hypothesis that the skill composition of networks does not affect the net benefits of enrollment is H_0: $\gamma_{ds} = \gamma_{ds'}$ for $s \neq s'$. The null hypothesis that the effects of networks of different skill levels do not differ across migrant destinations is $H_0 : \gamma_{ds} = \gamma_{d's}$ for $d \neq d'$.

The variables measuring the skill level of migration networks include the number of family members with low (grades 0–9) and high (10 or greater) school completion levels at internal and international migrant destinations in the year prior to the year in which the successive enrollment decision is observed.[7] Variables in the vector Z_{jht} include the child's grade level at $t - 1$; the number of school-aged children in the household; the child's gender; and the child's grade-point average in the final year at school, a proxy for intellectual ability. The child's age in 2002 is used to control for t. The model also controls for the maximum level of schooling obtained by either the household head or his or her spouse. In addition, the model includes a dichotomous variable equal to 1 if at least one of the child's maternal grandparents was literate and zero otherwise, and an identical variable measuring paternal-grandparent literacy. These variables control for unobserved parental characteristics such as attitudes towards schooling or the role model effect of parents regarding schooling. We also control for the gender of the household head (1 if male, 0 if female), and we include a dichotomous variable equal to 1 if an indigenous language is spoken in the household, and zero otherwise. Because income data are only available for 2002 and the enrollment data cover a 23-year period (from 1980 to 2002), income could not be included in the regression. The inclusion of determinants of income other than parental education and family size, including landholdings and wealth measured in 2001, did not alter any of the key findings presented below, nor did the use of village migration instruments, including village participation in the Bracero programme, or the incorporation of dummies indicating whether or not the village sample had at least one United States migrant in 1980, in lieu of the village fixed effects.[8]

School attendance in Mexico is compulsory through grade 9.[9] Logit estimates of equation (6.5) using a sample of all children between the ages of 6 (potential first graders) and 17 (potential 12th graders), and controlling for grade level at time $t - 1$, revealed no significant relationship between any of the migration variables and the likelihood of enrollment. Figure 6.3 summarizes the probability of enrollment at time t by grade level of children enrolled at time $t - 1$ during the 1980–2002 period. 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, more sharply, between the 9th and 10th grades. The trends depicted in Figure 6.3 mirror those presented in Sadoulet and de Janvry (2004) who draw on a large, government-generated PROGRESA data set.

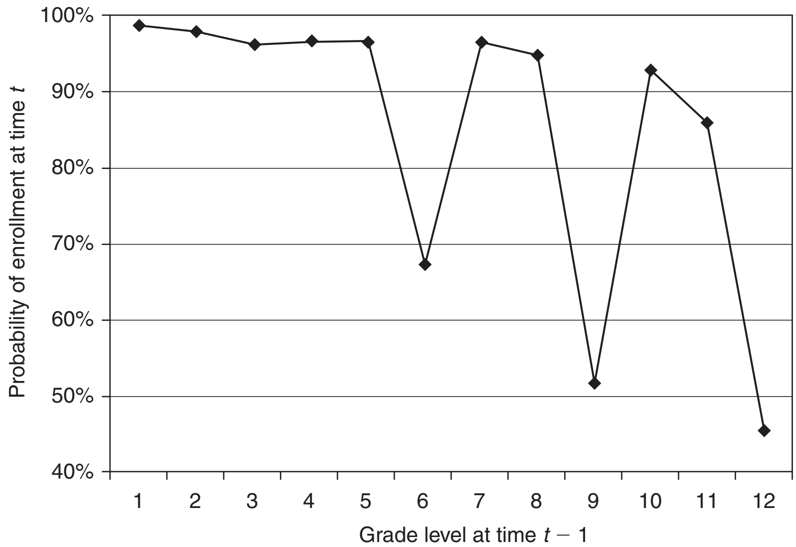

Figure 6.3 Probability of school enrollment of rural Mexican children aged 6 to 18 at time t, by grade level of enrollment at time $t - 1$, 1980–2002[12]
Source: ENHRUM.

Table 6.4 presents the results of the logit estimation when we restrict our sample to include only children who were in the 9th grade at time $t - 1$. We find that high-skill internal migrant networks significantly *increase* the likelihood of high-school enrollment at time t (significant at below the 0.05 level).[10] In contrast, low-skill internal and high-skill international migrant networks have no significant effect on enrollment probabilities.[11] Apparently, the network effect on additional schooling in international high-skill migration is weak. We return to this finding shortly. McKenzie and Rapoport (2006) and Hanson and Woodruff (2003) find significant cross-section effects of household United States migration experience on grade-years of schooling, negative in the first case and positive in the second. These studies do not consider the effect on schooling attainment of the skill composition of migrant networks or of the potentially heterogeneous effect of internal versus international migrant networks. Consistent with their estimates, we find that parent (household head) levels of school completion have a significant positive influence on schooling investment. Intellectual ability, proxied by grade point average in the final year at school, also has a significant positive effect.

It might be argued that a positive effect of networks on school enrollment is due, at least in part, to a positive income effect of remittances that loosens the financial constraints on investment in schooling. If this

Table 6.4 Logit estimation of students' probability of continuing their education after the ninth grade

Variable definition	*Variable mean*	*Standard deviation*	*Coefficient estimate*	*z-statistic*
Age in 2002	22.80	5.80	−0.062	4.26[a]
Sex (1 = male)	0.50	0.50	−0.202	1.45
No. of school-age children in household	3.2	1.62	−0.229	4.68[a]
GPA (out of 10)	8.3	0.87	0.298	3.55[a]
Education of household head	6.4	1.62	0.158	5.53[a]
Sex of the household head (1 = male)	0.88	0.33	0.509	2.41[b]
Indigenous (indicator)	0.13	0.34	−0.059	0.19
Paternal grandparents can read and write (indicator)	0.71	0.46	0.218	1.15
Maternal grandparents can read and write (indicator)	0.59	0.49	−0.310	1.65[c]
International migration network-low education	0.14	0.48	0.483	3.06[a]
International migration network-high education	0.04	0.27	−0.044	0.16
Internal migration network-low education	0.16	0.50	−0.097	0.66
Internal migration network-high education	0.04	0.22	1.059	2.49[b]
Village fixed effects	N/A	N/A	N/A	included
Sample Size[d]	1,259			

Notes: [a] significant at 1%, [b] significant at 5%, [c] significant at 10%.
[d] This sample includes all household members who are not household heads (or spouses of household heads), and the random sample of sons and daughters of either the head or his/her spouse living outside the household who were chosen for the detailed survey, so that the GPA variable could be included. A similar regression was performed that included the children living outside the household not chosen for the detailed survey, which increases the sample to 1829. The significance increases for all the variables of interest, but the results to not change.

were the case, we would expect the largest network effect to be associated with the largest remittance-generating migrant destination. Table 6.5 compares average annual remittances from (relatively) highly-educated migrants and little-educated migrants at internal and international destinations, using the 2002 cross-sectional data. Remittances from highly-educated internal migrants are 25 per cent higher than remittances from little-educated internal migrants. However, remittances from international migrants, both little-educated and highly-educated, are 1,500 per cent higher than remittances from highly-educated internal migrants. In addition to suggesting that remittances from United States migrants are not sensitive to migrants' schooling,

Table 6.5 Remittances by education level of internal and international migrants (US dollars)

Migrant destination	*Annual remittances*	*Schooling level of migrant* 0–9 Years	*Schooling level of migrant* >9 Years	*All migrants*
Internal	Mean	81	100	83
	Standard deviation	375	300	366
	Sample size	1,463	222	1,685
International	Mean	1,504	1,505	1,504
	Standard deviation	3,082	3,068	3,078
	Sample size	729	98	827
Total	Mean	554	530	551
	Standard deviation	1,923	1,829	1,911
	Sample size	2,192	320	2,512

Source: Authors' calculations using data from ENHRUM.

these findings demonstrate that international migration is vastly superior to internal migration in terms of generating income that *could* be used to finance school expenditures. Although international high-skill networks do not promote human capital investment, low-skill networks have a modest positive effect that is consistent with a financial constraints argument. The finding that high-skill networks do not have this effect suggests that educated family members who migrate abroad remit not only money, but also a signal that discourages schooling investment, and this negative signal is sufficiently large to counteract any positive financial effect that remittances might have.

Strictly speaking, it is high-skill migrant networks that lead to high-skill jobs, and not high-skill migrant networks as such, that should be presumed to create an incentive for human capital formation in the village. Suppose, though, that we were to find that belonging or being linked 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 effective as a skilled-jobs network. Otherwise, the network association would have indicated that skill 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 if the network connection led to jobs that were 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 for or tendency to acquire skills, 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 investment in schooling. A dollar remitted from a poorly educated family migrant in the United States 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 in the period 1983–94, the urban rate of return to schooling affects the incidence of rural schooling, especially among the rural households most likely to seek urban employment. Kochar found that among rural households likely to engage in rural-to-urban migration – that is, landless as opposed to land-owning households – the urban rate of return to schooling made it significantly more likely that children will complete rural middle school. This effect was larger than the corresponding effect for landowning households. Our findings link educational levels in the wake of migration to the human capital content of family migration networks.

6 Conclusions

The 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 incentives for investment in schooling which, in turn, reverse the static, human capital depleting effect of internal migration. International migration from rural Mexico does not select on schooling and has no significant effect on the average education of non-migrants.

Cross-section grade-progression 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. In contrast, low-skill internal networks and high-skill international networks have no significant effect on school enrollment. That high-skill international migration does not have a significant positive effect on schooling is not inconsistent with the brain gain hypothesis advanced by Stark and Wang. The brain gain model *assumes* that the 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 United States does not significantly select on schooling since the returns to schooling for unauthorized migrants are low.

Rural Mexico, with its poorly educated population, presents a particularly challenging setting in which to test a 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 per cent 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 could have depleted rural human capital stocks. The fact that it *increases* the schooling of non-migrants is consistent with the existence of a positive incentive effect of gainful internal migration on rural human capital formation. The finding that high-skill internal migration networks increase the probability of enrollment in post-compulsory (high-school) education provides further evidence that the probability of migration encourages investment in schooling in rural Mexico.

Notes

1. If migration competes with schooling by raising the opportunity cost of attending school, the investment effect could be negative. However, this will probably occur upon low-skill international migration, that is, upon migration for which $\theta_{t-1} < \theta^m_{t-1}$.
2. Obviously, migration by relatively low-skill individuals could, in and by itself, raise the average schooling of those left behind. This increase in average does not occur as a result of enhanced formation of human capital.
3. 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 our empirical analysis.
4. In the regression analysis, one year per village is lost due to the use of lagged education and lagged migration variables. Thus, the sample size becomes 1,430. The sample is balanced in the sense that each of the villages appears in each of the 22 years of the panel.
5. 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 internal migration equation.
6. Remittance data are available only in the 2002 cross-section.
7. For example, if a household had 1 family member with low schooling and 3 family members with high schooling at an internal migrant destination, 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.

8. Landholdings changed little during this time period because most were *ejido*, or reform-sector lands that could not be bought or sold until recent (Article 27) reforms.
9. As in other contexts and settings, laws are not necessarily enforced.
10. This estimation controls for village fixed effects. However, for individuals in the same household who completed the 9th grade, there were not sufficient observations of successive enrollment to estimate this model-controlling for household fixed effects. Of course, it is not possible to control for individual fixed effects while restricting the sample to individuals in a given grade level.
11. We repeated this procedure considering only children who were in the 6th grade in 2001, but none of the network variables was found to be significant.
12. 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.

References

Arellano, Manuel and Stephen R. Bond (1991) 'Some Tests for Specification of Panel Data: Monte Carlo Evidence and an Application to Employment Equations', *Review of Economic Studies* 58: 277–97.

Beine, Michel, Frédéric Docquier, and Hillel Rapoport (2001) 'Brain Drain and Economic Growth: Theory and Evidence', *Journal of Development Economics* 64(1): 275–89.

Blomqvist, Ake G. (1986) 'International Migration of Educated Manpower and Social Rates of Return to Education in LDCs', *International Economic Review* 27(1): 165–74.

Cameron, Stephen V. and James J. Heckman (2001) 'The Dynamics of Educational Attainment for Black, Hispanic and White Males', *Journal of Political Economy* 109(3): 455–99.

Greene, William H. (2003) *Econometric Analysis*, 5th edition. Upper Saddle River, NJ: Prentice Hall.

Hanson, Gordon H. and Christopher Woodruff (2003) Emigration and Educational Attainment in Mexico. Mimeo, University of California at San Diego.

Kochar, Anjini (2004) 'Urban Influences on Rural Schooling in India', *Journal of Development Economics* 74: 113–36.

Massey, Douglas S., Joaquin Arango, Graeme Hugo, Ali Kouaouci, Adela Pellegrino and J. Edward Taylor (2005) *Worlds in Motion: Understanding International Migration at the End of the Millennium*. New York: Oxford University Press.

McKenzie, David, John Gibson and Steven Stillman (2006) 'How Important is Selection? Experimental Versus Non-experimental Measures of the Income Gains from Migration', The World Bank Policy Research Working Paper Number 3906.

McKenzie, David and Hillel Rapoport (2006) 'Can Migration Reduce Educational Attainment? Evidence from Mexico', The World Bank Policy Research Working Paper Number 3952.

Mora, Jorge and J. Edward Taylor (2005) 'Determinants of Migration, Destination, and Sector Choice: Disentangling Individual, Household, and Community Effects', in

Çaglar Özden and Maurice Schiff (eds), *International Migration, Remittances, and the Brain Drain*. New York: Palgrave Macmillan.

Munshi, Kaivan (2003) 'Networks in the Modern Economy: Mexican Migrants in the US Labor Market', *Quarterly Journal of Economics* 18(2): 549–99.

Sadoulet, Elisabeth and Alain de Janvry (2004) 'Making Conditional Cash Transfer Programs More Efficient: Designing for Maximum Effect of the Conditionality', *The World Bank Economic Review* 20(1): 1–29.

Stark, Oded, Christian Helmenstein, and Alexia Prskawetz (1997) 'A Brain Drain with a Brain Gain', *Economics Letters* 55: 227–34.

Stark, Oded, Christian Helmenstein, and Alexia Prskawetz (1998) 'Human Capital Depletion, Human Capital Formation, and Migration: A Blessing or a "Curse"?', *Economics Letters* 60: 363–7.

Stark, Oded and Yong Wang (2002) 'Inducing Human Capital Formation: Migration as a Substitute for Subsidies', *Journal of Public Economics* 86: 29–46.

Todd, Petra E. and Kenneth I. Wolpin (2006) 'Assessing the Impact of a School Subsidy Program in Mexico: Using a Social Experiment to Validate a Behavioral Model of Child Schooling and Fertility', *American Economic Review* 96: 1384–417.

Usher, Dan (1977) 'Public Property and the Effects of Migration upon Other Residents of the Migrants' Countries of Origin and Destination', *Journal of Political Economy* 85(5): 1001–20.