ELSEVIER

Journal of Development Economics 78 (2005) 215–240

JOURNAL OF Development ECONOMICS

www.elsevier.com/locate/econbase

Self-selection among undocumented immigrants from Mexico

Pia M. Orrenius[a,*], Madeline Zavodny[b]

[a]*Research Department, Federal Reserve Bank of Dallas, 2200 N. Pearl St., Dallas, TX 75201, United States*
[b]*Department of Economics, Agnes Scott College, Decatur, GA 30030, United States*

Received 1 November 2002; accepted 1 July 2004

Abstract

This paper examines the effect of changes in migration determinants on the skill level of undocumented Mexican immigrants. We focus on the effect of changes in economic conditions, migrant networks, and border enforcement on the educational attainment of men who cross the border illegally. Results from hazard models using data from the Mexican Migration Project indicate that migrants are not negatively selected with regard to education. However, improvements in U.S. and Mexican economic conditions are associated with a decline in the average education of undocumented immigrants, while stricter border enforcement is associated with higher average skill levels.

JEL classification: F22; J61
Keywords: Undocumented immigrants; Illegal aliens; Mexican migration; Self-selection

1. Introduction

Illegal immigrant flows from Mexico to the U.S. are substantial. More than 1.6 million apprehensions were made along the U.S. border in fiscal year 2000, the vast majority of them individuals originating in Mexico (U.S. Immigration and Naturalization

* Corresponding author. Tel.: +1 214 922 5747.
E-mail address: pia.orrenius@dal.frb.org (P.M. Orrenius).

0304-3878/$ - see front matter © 2005 Elsevier B.V. All rights reserved.
doi:10.1016/j.jdeveco.2004.07.001

Service, 2000). The estimated increase in the stock of undocumented Mexican immigrants – from 1 million in 1990 to 3.9 million in 2000 – is consistent with a net inflow of 290,000 such aliens per year (Costanzo et al., 2001). The passage of the Immigration Reform and Control Act (IRCA) in 1986 briefly slowed the flow of undocumented migrants by granting legal status to 2.3 million Mexicans, but flows during the 1990s economic boom returned to near pre-IRCA levels (Donato et al., 1992). Adding to the controversy over Mexico–U.S. migration is the notion that Mexican migrants are negatively selected, i.e., they have below-average skill levels compared with other Mexicans (Borjas, 1987).

The expected benefits, the opportunity cost, and the actual cost of migrating to the U.S. affect the size of undocumented migrant flows from Mexico. Economic conditions in both countries, particularly real Mexican wages, play a large role. Hanson and Spilimbergo (1999) estimate that a 10% decrease in the real Mexican manufacturing wage leads to at least a 6% increase in attempted illegal border crossings. Declines in agricultural income in Mexico similarly raise the likelihood of both first-time and repeat migration from rural areas (Orrenius, 1999). Higher U.S. wages relative to Mexican wages are also associated with larger illegal alien flows (White et al., 1990). However, migration flows were low during the Mexican economic crisis in 1982–1983, perhaps because potential migrants had difficulty raising the funds necessary to cross the border (Donato et al., 1992). Tighter border control policies and higher fees charged by smugglers ("coyotes") also are negatively associated with attempted and actual border crossings by undocumented aliens (Hanson and Spilimbergo, 1999; Orrenius, 1999).

The premise of this paper is that changes in economic conditions and in migration costs affect the skill composition of the migrant flow as well as the number of migrants. For example, increases in real Mexican manufacturing wages may slow immigration of skilled Mexicans who work in the nonagricultural sector, while increases in agricultural incomes may reduce immigration flows of unskilled workers from rural areas. Increases in Mexican incomes may also enable more individuals to bear the cost of illegally entering the U.S., shifting the distribution of undocumented immigrants toward individuals with fewer resources and presumably less education. This paper focuses on undocumented immigrants both because undocumented flows are much larger than legal flows from Mexico, particularly among migrants making their first trip to the U.S. (Massey, 1986; Massey et al., 1994), and because of data issues, as discussed below.

Although studies have examined the effect of changes in economic costs on the number of undocumented immigrants, little is known about their effect on the skill composition of illegal aliens. Traditionally, undocumented immigrants from Mexico are young men who have little formal education and are from rural areas. Since the 1980s, however, a growing proportion of illegal aliens from Mexico have been from urban areas, and the economic crises in Mexico in 1982–1983 and 1986 reportedly boosted out-migration from cities (Cornelius, 1992; Durand and Massey, 1992). Sorensen and Bean (1994) report that mean years of education among recent immigrants from Mexico rose relative to U.S. natives and earlier Mexican immigrants after passage of IRCA but do not investigate the reason for the increase. Chiquiar

and Hanson (2002) find that, contrary to the negative selection hypothesis advanced by Borjas (1987), Mexican immigrants – although much less educated than U.S. natives – have a higher average level of education than the overall Mexican population.

Changes in the composition of Mexican immigrants have implications for both the U.S. and Mexico. Higher immigration of unskilled individuals depresses the wages of low-skilled immigrants already present in the U.S. as well as the wages of low-skilled U.S. natives (Borjas et al., 1997; Jaeger, 1996; Johnson, 1998).[1] Because low-skilled immigrants appear to be a complement to the labor of skilled workers, larger flows of unskilled immigrants boost the earnings of skilled U.S. natives and skilled immigrants (Jaeger, 1996; Johnson, 1998). Previous research suggests that higher levels of skilled migration have little effect on the wages of U.S. natives (Borjas et al., 1997). However, estimates may be biased by responses by natives, earlier immigrants, and firms that mitigate the negative wage effects of immigration. Recent work looking at wage effects within education–experience cells while holding the capital stock constant implies adverse wage effects that are not only larger than previous findings but also include skilled workers such as college graduates (Borjas, 2003).

While pushing wages down in the destination country, out-migration can have beneficial effects in the origin country. Mishra (2003) finds that a 10% increase in emigration from Mexico raises wages in that country by 4%. Higher out-migration of skilled individuals may also promote economic development in Mexico because remittances are positively associated with education, and the likelihood that remittances are invested in housing or productive capital instead of spent on consumption increases with the educational attainment of the migrant (Durand et al., 1996).

This analysis examines the determinants of self-selection among undocumented male immigrants from Mexico. Using data from the Mexican Migration Project, we first estimate the determinants of the likelihood that a man makes an initial illegal trip to the U.S. during the period 1965–1996.[2] We find that economic conditions in both the U.S. and Mexico are important determinants of migration and that increased border enforcement deters illegal migration. Having access to a network of previous migrants provides powerful incentives to migrate. We also find that Mexican migrants, as compared with nonmigrants, are more likely to be in the middle of the skill distribution than in the low or high end.

We then focus on the effect of changes in migration determinants on the skill level of undocumented immigrants. The results indicate that changes in migration determinants affect the self-selection of illegal immigrants to the U.S. Higher minimum and average

[1] General equilibrium studies (Borjas et al., 1997; Jaeger, 1996; Johnson, 1998) report larger adverse wage effects than cross-area studies, such as Card (2001) and the papers surveyed in Borjas (1994) and Friedberg and Hunt (1995). The smaller effects in cross-area studies may be due to migration of labor or capital or to changes in output mix at the area level in response to immigrants' locational choices.

[2] The analysis does not examine female immigrants because men tend to be the primary labor migrants to the U.S. whereas Mexican females are typically tied movers who migrate more for family reunification reasons than because of economic factors. Delaunay (1995) reports that for Mexico–U.S. migrants aged 20–24 years, over 50% of females are married, whereas only 20–28% of males are married. Examining selection among female migrants is a topic for future research.

wages in the U.S. result in greater negative selection (lower average skill levels) among immigrants from Mexico. Better economic conditions in Mexico appear to provide a greater disincentive to migrate among skilled Mexican men than among the unskilled. Increased positive selection (higher average skill levels) among Mexico–U.S. migrants occurs in response to worsened conditions in Mexico and tighter border enforcement. Access to a migration network does not appear to have differential impacts on migration behavior across skill groups.

2. Theoretical model

Beginning with Sjaastad (1962), locational choice models posit that individuals decide where to live by comparing their utility in their current location to their expected utility in all other possible locations, including the disutility of moving to those locations, and choose the location with the highest utility. The literature on international migration has focused on the earnings component of utility, positing that individuals become immigrants when their expected earnings in another country, less migration costs, are higher than their earnings in the country of origin (Borjas, 1987; Chiswick, 1999; Taylor, 1987).

In the simple model developed here, individuals move if their expected earnings in the destination country exceed their earnings in their home country plus migration costs. As in Borjas (1987) and Taylor (1987), an individual migrates from country 0 to country 1 if

$$\ln w_1 > \ln w_0 + \ln M, \tag{1}$$

where w is earnings and M is migration costs.

In addition, an individual must be able to pay the cost of migrating, M, up front in order to migrate. For example, an illegal immigrant hiring a smuggler to assist in his first border crossing must pay in advance.[3] This migration cost is paid out of savings, and individuals can migrate only if their savings are at least as large as the migration cost. With the growth of U.S.-based migrant networks that can help fund other migrants, the credit constraint is likely to be less binding than we assume here. Even if a migrant's network helps finance the move, however, the expectation is that the migrant will either pay the loan back or finance the next migrant's move (Massey et al., 1987). In any case, because savings and access to capital markets (both formal and informal) depend largely on earnings, expected earnings and wealth, which in turn depend on skill, savings are modeled as a function of an individual's skill. Savings are hypothesized to increase with skill. Skill is denoted by x and is distributed normally with mean zero and variance σ_x^2. If the savings of an individual with skill level x are given by $(S+sx)$, an individual can migrate only if $(S+sx) \geq M$.[4] This

[3] The migrant most commonly pays a portion of the smuggler's fee in advance and the remaining part is paid by his U.S.-based relatives upon reaching the destination. The staggered payment gives the coyote an incentive to deliver the migrant and not abandon him or allow him to be captured by the Border Patrol. The migrant (and his network) still must have the money ready when the trip begins, however.

[4] An individual may be able to utilize household resources to pay the migration cost. The predictions of the model are similar if ability is correlated across household members or if the willingness of a household to use the household's savings to pay an individual's migration cost depends on that individual's ability.

"cash in advance" constraint is consistent with the observation that the least-skilled Mexicans do not migrate (Stark and Taylor, 1991).

Immigrants' earnings in both the home and destination country also depend on skill, which is perfectly observable. In the home country, the distribution of wages, w_0, is given by

$$\ln w_0 = \mu_0 + \eta x, \tag{2}$$

and the distribution of earnings in the destination is

$$\ln w_1 = \mu_1 + x + \varepsilon. \tag{3}$$

Mean earnings in the home and destination country are μ_0 and μ_1, respectively, and η is the return to skill in the home country relative to the destination country. Because the return to skill in Mexico is higher than the return to skill in the U.S. (Chiquiar and Hanson, 2002), η is greater than one. The term ε is a random component of earnings in the destination country and is distributed normally with mean zero, and its value is realized after an individual migrates. We assume that earnings in the home country are known with certainty.

The migration decision is determined by the sign of the index function

$$I = \frac{\mu_0 - \mu_1 - \varepsilon + m}{(1-\eta)}, \tag{4}$$

where m is the log of M, migration costs. Migration to the U.S. from Mexico occurs when $I>0$ and an individual's skill is high enough that savings can cover the migration cost ($x \geq (M-S)/s$). Solving Eq. (4) for the average skill level of immigrants gives

$$E(x|I>0) = -\frac{\sigma_x}{\sqrt{2\pi}} \exp\left[-\left(\frac{\mu_0 - \mu_1 + m}{1-\eta}\right)^2 \Big/ 2\sigma_x^2\right] + \frac{\sigma_x}{\sqrt{2\pi}} \exp\left[-\left(\frac{M-S}{s}\right)^2 \Big/ 2\sigma_x^2\right], \tag{5}$$

which is less than the average skill level in the home country if

$$\left(\frac{M-S}{s}\right)^2 > \left(\frac{\mu_0 - \mu_1 + m}{1-\eta}\right)^2. \tag{6}$$

When the inequality in Eq. (6) holds, the model predicts negative selection of Mexican immigrants. Negative selection of emigrants from a country with a wider income distribution than the U.S. – such as Mexico – would be consistent with the prediction of Borjas's (1987) selection model. However, empirical work on the education and earnings distribution of Mexican migrants relative to nonmigrants suggests there is either intermediate or positive selection on migrants' observable characteristics (Chiquiar and Hanson, 2002).

Fig. 1 shows which individuals move from Mexico to the U.S. in this model. The least-skilled individuals do not migrate because they do not have enough savings to pay the up-front cost of migration. The most-skilled individuals do not migrate because the return to skill is higher in Mexico than in the U.S. The cutoff point for the skill level beyond which individuals do not become immigrants is positive in the figure because mean

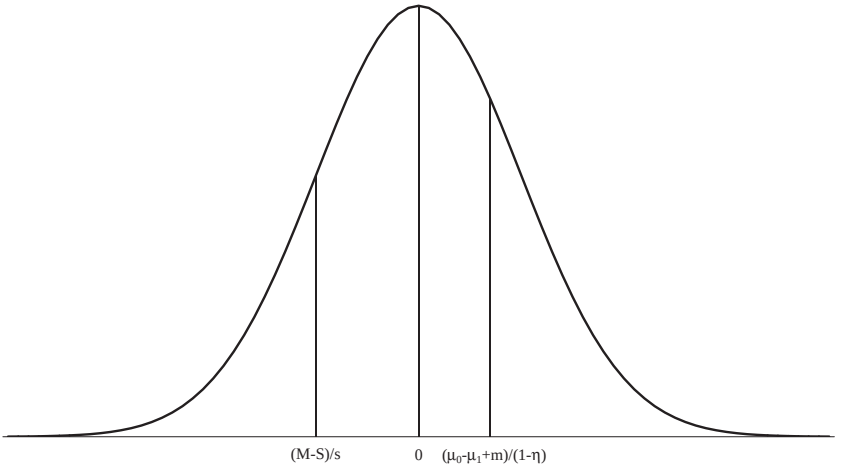

Fig. 1. Distribution of skill in source country. Individuals with skill levels below the left cutoff and with skill levels above the right cutoff do not migrate.

income in the U.S. is higher than in Mexico. Individuals with skill levels between the two cutoff points become immigrants.

The average skill level of immigrants will change as the various factors in the model change. Based on Eq. (5), the average skill level of immigrants will decrease as average income in Mexico, μ_0, increases. The average skill level of immigrants will rise as average income in the U.S., μ_1, increases. The effect of a change in migration costs, M, is ambiguous in the model. This suggests that changes in border enforcement or in access to a network of earlier migrants who can help an individual cross the border may either increase or decrease the average skill level of immigrants. The effect of an increase in the skill-invariant portion of savings, S, lowers the average skill level of migrants as poorer households are able to afford the migration cost.

This model makes several simplifying assumptions. It does not include multiple destinations, although individuals presumably choose between home and several alternative locations. For example, Mexicans may migrate to the U.S.–Mexico border and work in the *maquiladora* industry instead of crossing into the U.S. In addition, the model does not distinguish between different types of immigration, such as legal and illegal immigration. Legal and illegal immigrants differ with regard to moving costs and the earnings distribution they face once they arrive in the U.S. Nevertheless, the bulk of Mexico–U.S. migration is undocumented, at least on initial trips. Over time, many migrants adjust to legal status.[5]

The model also does not incorporate return migration. As discussed below, we use a data set collected in Mexico, so our sample includes a disproportionately high fraction of return migrants among those individuals who have ever migrated to the U.S.[6] The decision

[5] There is usually a long time lag between applying for and receiving U.S. permanent resident status, causing many Mexicans to initially migrate illegally despite facing higher direct costs of crossing the border and lower wages in the U.S. than legal migrants.

[6] As discussed below, this concern applies primarily to our sample of household heads, not sons.

to return involves another round of self-selection that is not our focus here and hence is not incorporated into the model or the empirical work, which focuses exclusively on explaining a migrant's initial trip. Nevertheless, the model could incorporate return migration if, for example, those migrants that draw a negative value of ε are prompted to return migrate. None of the model's predictions of the effect of changes in average income, returns to skill, or migration costs on the decision to undertake an illegal first trip to the U.S. change if return migration is incorporated into the model in this way.[7] Although return migration may not affect the skill interactions, the over-representation of return migrants in MMP data will likely bias the results in the baseline regression toward finding negative selection (as discussed further below).

3. Data

We use data from the Mexican Migration Project (MMP) to test the predictions of the model. The MMP is a household survey conducted primarily in December and January of 1982–1983 and 1987–1997 in 52 communities in Mexico.[8] The survey focused on areas in Mexico that have traditionally sent the majority of migrants to the U.S. About 200 households were randomly sampled in each community, and a complete life history was gathered from the household head. This retrospective history emphasizes migration experience, work history, marriage and fertility behavior, and property ownership. In addition, questions were asked about the first and most recent trips to the U.S. by the spouse and all children, including nonresident children who have formed their own households.

The MMP offers several advantages over other migration data sources. The MMP data include both migrants and nonmigrants, whereas the decennial Census and other U.S. data sources include only individuals currently residing in the U.S. Observing both types of individuals allows us to estimate the direction of selection by comparing the characteristics of migrants and nonmigrants. The MMP includes legal status at migration, allowing us to focus on undocumented migration, whereas most U.S. surveys do not ask about legal status. Most U.S. data sources undersample undocumented immigrants, although over time this has improved. For example, while the 1980 Census captured only about 50 to 60% of undocumented Mexican immigrants (Bean et al., 1988), the 1990 and 2000 Census undercounts of unauthorized foreign born were between 15 and 20% (Costanzo et al., 2001). In any case, if the likelihood of an undocumented immigrant being included in the Census depends on skill, then results based on Census data will be biased.[9] Because the determinants of migration may differ between legal and undocumented immigrants, using a survey that includes legal status is important when examining determinants of Mexican

[7] Nor would the predictions change if other motivations for return migration, such as target saving, were incorporated. As long as target saving is not systematically correlated with migrant skill level, the implications for self-selection remain the same.

[8] Additional communities have been included since 1997, but we do not include these data because they were not available when this project commenced.

[9] Undocumented immigrants who permanently reside in the U.S. were more likely to be covered in the 1980 Census than non-settlers, and these individuals are likely to be positively selected because unsuccessful immigrants are more likely to return to their country of origin than successful immigrants (Bean et al., 1988; Massey, 1987).

migration. Selective emigration also complicates use of Census data. In addition, the Census reports year of arrival in the U.S. in intervals, making it difficult to ascertain the effect of economic conditions and border enforcement on migration.

We use data from the 1987–1997 MMP surveys, which encompass 47 communities in nine states that are predominately rural and agricultural. We focus on male household heads and sons aged 15–64 and examine whether they made an undocumented first trip to the U.S. in 1965 or later. Because of the structure of the MMP, we use a sample of male household heads and a separate sample of sons of household heads. In addition, the determinants of migration may have changed over time, causing the factors that lead sons to migrate to differ from those that prompt heads to migrate.

About 70% of men report having never migrated to the U.S. We include one observation per year from age 15 (or 1965) until age 64 or their age at the time of the survey for these men. For the 30% of men who migrated to the U.S. illegally, we exclude observations after the first undocumented trip to the U.S. The samples are unbalanced panels. Individuals who first migrated to the U.S. legally are not included in the sample, although the results are robust to including these observations and not differentiating between legal and illegal migration.[10] The sample of heads includes 5878 individuals and a total of 110,334 observations. The sample of sons includes 101,003 observations on 9559 individuals.

The MMP includes several characteristics of household heads that are likely to affect the probability of migration, such as marital status and the number of minor and adult children the head has each year. These demographic characteristics are not available for the sons, so they are included only in the empirical model for the heads.[11] The empirical model estimated below also includes a time-invariant indicator variable for whether an individual lives in an urban area in Mexico, which is determined based on the size of an individual's community of residence at the time of the survey.[12]

The number of years of schooling an individual has completed provides the measure of skill used here. We use five categories of educational attainment: no or little formal schooling (0–1 years), some schooling (2–5), completed primary school (6–8), completed secondary school (9–11), and preparatory school or above (12 and up). Household heads' schooling category can change over time because the life histories compiled by the MMP include education each year; however, most heads' schooling category does not change because very few men in the sample attended school after age 15. Sons' schooling category does not vary over time and is their educational attainment as of the time of the survey.

Access to a network of prior migrants is also likely to influence whether an individual migrates (Winters et al., 2001). Knowing previous migrants who can provide information

[10] The first migration was legal for 114 household heads (1198 observations) and 315 sons (2346 observations). The results may be robust to including these individuals because they compose less than 10% of migrants, not because the determinants of undocumented and legal migration are similar. Individuals who migrated legally but without permission to work in the U.S. (such as on a tourist visa) and still worked in the U.S., or who had forged documents, are coded as illegal migrants.

[11] We note that marital status and children are potentially endogenous with regard to migrant status, although probably less so on initial trips than subsequent trips. In any case, all of the results for male household heads were robust to omitting these variables from the analysis.

[12] For sons present in the U.S. at the time of the survey, the community is the community in Mexico in which the household head resides.

about crossing the border and finding employment in the U.S. lowers an individual's migration cost. Networks are also an important source of loans for migrants who have to pay the smuggler's fee in advance. The MMP reports whether an individual's father has ever migrated to the U.S. and how many of a man's siblings have ever migrated to the U.S We also include a variable that measures how many of a man's sisters have ever migrated to the U.S. because previous research suggests that sister and brother networks have different effects (Orrenius, 1999).[13] Family network variables may capture an underlying propensity for members of a family to migrate, such as the effect of family income and land holdings, in addition to reflecting the effect of access to a migrant network. The network variables are time varying, and we only include networks before the migrant himself has migrated in order to avoid endogeneity problems.[14]

The data are merged with annual data on economic conditions in Mexico and the U.S. For Mexico, the value of agricultural output per capita, gross domestic output (GDP) per capita, real manufacturing wage, and the real interest rate (deflated by the Mexican consumer price index) are used. For the U.S., the average hourly wage for hired agricultural workers, average nonagricultural wage, and federal minimum wage are included.[15] These variables are deflated by the U.S. CPI for urban consumers. A measure of the U.S. unemployment rate is also included. As in Hanson and Spilimbergo (1999), the nonagricultural wage and the unemployment rate are constructed based on the industry distribution and location, respectively, of Mexican-born men in the U.S. in order to reflect expected economic conditions and are not simple national averages.[16] All economic variables are annual averages.

Total annual hours spent by U.S. Border Patrol agents on linewatch duty are included to measure border enforcement. Previous research suggests that apprehensions are positively associated with linewatch hours, but it is not clear whether increased enforcement deters illegal immigration because almost all persons attempting to cross the border eventually do so even if they are first apprehended several times (Kossoudji, 1992). Nevertheless,

[13] We also include a dummy variable indicating that the father's migration history is unknown in the specifications for sons; the sample mean of this variable is 0.23. The estimated coefficient on this variable is not statistically significant in any of the regressions, and the results are similar when sons whose father's migration history is not reported are excluded from the sample. Among household heads, the number of siblings whose migration history is reported is truncated at six.

[14] The selection results are qualitatively similar if the network variables are not included in the regressions.

[15] We use different variables to measure economic conditions in Mexico than in the U.S. because of the unreliability of the available data on agricultural wages and unemployment rates in Mexico during our sample period. We do not use sub-national Mexican data because reliable regional data are only available during the 1990s, toward the end of our sample. In addition, using national-level data on economic conditions in Mexico may be more appropriate because Mexicans can migrate internally within Mexico as well as come to the U.S.

[16] The U.S. nonagricultural wage is a weighted average of hourly earnings for production workers in eight industries (mining, construction, manufacturing, wholesale trade, retail trade, transportation and public utilities, finance/insurance/real estate, and services). The weights are based on the industry distribution of Mexican-born men aged 15–64 in the 1960, 1970, 1980 and 1990 decennial Censuses who immigrated in the last 5 years and do not report being a citizen (except for 1960, when citizenship was not asked). The industry shares are linearly interpolated, and the weights vary by year. The U.S. unemployment rate is constructed in an analogous manner using state unemployment rates and the distribution of Mexican-born men across states. Using unweighted national averages gives similar results.

increased border enforcement raises the cost of crossing the border by causing migrants to cross in more remote areas or hire a coyote to smuggle them into the U.S. In addition, being apprehended increases the amount of time it takes an immigrant to successfully cross the border, creating an opportunity cost of foregone workdays.

Table 1 reports sample means stratified by migrant status for the variables used in this analysis.[17] The sample means indicate that men who become undocumented migrants tend to come from the middle of the educational distribution. A larger proportion of nonmigrant men have little or no formal education than do men who migrate, particularly among household heads. In addition, nonmigrants are more likely to have a high school degree or some university-level education than are migrants. The sample means also indicate that the second generation is more educated than the first generation, with a considerably higher proportion of both migrant and nonmigrant sons having at least 5 years of schooling than among the household heads.

The descriptive statistics in Table 1 suggest few differences in average economic conditions and border enforcement faced by individuals who chose to migrate illegally at some point and individuals who are not observed to migrate. However, there are clear differences in access to a network of previous migrants between the two groups. The fraction of men with a father who migrated to the U.S. is higher among migrants than among nonmigrants, and migrants tend to have more siblings who have migrated to the U.S. than do nonmigrants.

3.1. Is the MMP representative of Mexican immigrants?

A potential concern about the MMP data is that the survey does not include Mexican-born household heads who migrate to the U.S. permanently. We investigate the representativeness of the MMP by comparing educational attainment in our two samples to a survey of undocumented immigrants who permanently settled in the U.S. and to a survey of agricultural workers. The 1989 Legalized Population Survey (LPS) contains data on the characteristics of undocumented immigrants who applied for legal permanent resident status in the U.S. under the amnesty provision of IRCA in 1986. To be eligible for the amnesty program, these individuals must have resided continuously in the U.S. since January 1, 1982.[18] The 1993–2000 National Agricultural Workers Surveys (NAWS) have data about the characteristics of farmworkers in the U.S., including current immigrant status.

Our samples from the LPS and the NAWS include men who first migrated to the U.S. from Mexico in 1965 or later and were aged 15–64 at the time of first migration; all men in the LPS were presumably undocumented immigrants at one time, while only men who applied for amnesty under IRCA or are currently undocumented are included in the NAWS

[17] The panel data used to generate these sample means include all observations in the sample and are not a snapshot of individuals at a point in time. For example, the sample means suggest that migrants are younger than nonmigrants because observations on migrants are truncated after they migrate, whereas nonmigrants remain in the sample until age 64 or the time of the survey, whichever comes first.

[18] About 4% of the sample reported that their last year of education was received in the U.S. In our MMP sample, all of an individual's education at the time at migration was obtained in Mexico. The LPS sample would therefore be expected to have slightly higher educational attainment, on average.

Table 1
Summary statistics by migrant status

	Male household heads		Sons	
	Migrants	Non-migrants	Migrants	Non-migrants
Age	25.0 (8.6)	34.9 (12.7)	20.0 (6.3)	24.4 (9.0)
Married	0.51	0.74	–	–
Number of minor children	1.52	2.46	–	–
Number of older children	0.12	0.80	–	–
Urban resident	0.12	0.33	0.05	0.27
Educational attainment (years):				
No or little schooling (0–1)	0.17	0.24	0.06	0.07
Some schooling (2–5)	0.37	0.26	0.26	0.18
Primary school (6–8)	0.28	0.24	0.38	0.31
Secondary school (9–11)	0.11	0.11	0.19	0.19
Preparatory school and higher (≥12)	0.07	0.15	0.11	0.25
Ln(border enforcement hours, 1000 s)	58.1 (4.2)	60.3 (4.5)	60.5 (4.0)	62.1 (3.9)
Migration network:				
Father has ever migrated	0.22	0.09	0.45	0.27
Number of siblings have migrated	0.49	0.28	0.80	0.50
Mexican economic conditions:				
Ln(agricultural GDP per capita)	8.57 (.04)	8.57 (.04)	8.57 (.04)	8.57 (.04)
Ln(GDP per capita)	10.89 (.18)	10.96 (.17)	10.98 (.16)	11.02 (.14)
Ln(real manufacturing wage)	3.37 (.17)	3.31 (.22)	3.33 (.22)	3.25 (.23)
Real interest rate	−7.28 (13.27)	−9.58 (16.40)	−11.23 (16.67)	−11.52 (18.55)
U.S. economic conditions:				
Ln(agricultural hourly wage)	1.46 (.07)	1.46 (.06)	1.47 (.05)	1.46 (.05)
Ln(nonagricultural hourly wage)	2.22 (.05)	2.20 (.05)	2.21 (.05)	2.19 (.05)
Ln(minimum wage)	1.33 (.12)	1.26 (.14)	1.26 (.14)	1.20 (.14)
Unemployment rate	6.45 (1.54)	6.74 (1.46)	6.85 (1.42)	6.94 (1.33)
Number of individuals	1742	4136	3140	6419
Number of observations	17,126	93,208	22,773	78,230

Sample means (and standard deviations) are shown. All economic variables are real. The U.S. nonagricultural wage and unemployment rate are constructed based on the distribution of recent Mexican-born immigrants in the 1960, 1970, 1980 and 1990 Censuses across industries and states, respectively (see text for details).

sample here. All of these individuals were unlikely to have been observed in Mexico by the MMP surveys because they were present in the U.S. when surveyed by the LPS or the NAWS.

Older migrants in the MMP, the household heads, tend to be less educated than men in the LPS and than currently undocumented men in the NAWS but similar to NAWS men who received amnesty under IRCA. In the Appendix, Table A1 reports the educational distribution of migrants in the various samples. The educational distribution of the currently undocumented NAWS sample appears quite similar to that of the sons sample in the MMP. Men in the LPS meanwhile seem to represent a combination of heads and sons in the MMP, except that a higher fraction of men in the LPS finished preparatory school (equivalent to high school) and/or attended university. This difference

results in part from the LPS not including illegal aliens who applied for amnesty under the special agricultural worker (SAW) provision of the IRCA. Agricultural workers tend to have less education than other workers, and a substantial fraction of migrants in the MMP worked in agriculture in the U.S., making the MMP migrants similar to the NAWS samples.[19]

Although the MMP is not limited to agricultural workers, this comparison of the MMP data to other data sets suggests that the educational composition of the MMP sons sample is reasonably representative of undocumented Mexican male immigrants working in agriculture during the 1990s, and the MMP household heads sample is reasonably representative of pre-IRCA undocumented male migrants who worked in agriculture in the U.S.

4. Methodology

The determinants of whether an individual migrates to the U.S. illegally are addressed using a Cox proportional hazard rate model.[20] We use a hazard rate model instead of a logit or linear probability model because we model the likelihood that an individual undertakes a first undocumented trip to the U.S. at a given point in time, conditional on the individual not having previously migrated. A hazard model also easily incorporates censoring, which arises in the data because some individuals are at risk of a first migration after they are surveyed. The hazard model corrects for this right-censoring by taking into account the probability that a censored individual migrates after he is no longer observed in the sample.

In the Cox hazard model, the hazard rate is modeled as a function of both the current duration, t, and a set of independent variables, x, or

$$\lambda(t|X) = \lambda_0(t)\exp\left(\beta' x\right). \tag{7}$$

The baseline hazard, $\lambda_0(t)$, is not specified in the Cox model and controls for changes over time in the likelihood that an individual migrates. The model restricts the coefficients to be the same across time, implying that the proportional effect of a change in x on the hazard is the same at all durations. In other words, the effect of education on the likelihood of migration is the same if an individual is 20 years old or 60 years old, given that the individual has not yet migrated. The coefficients, β, give the estimated change in the hazard rate for a one-unit change in x. For ease of interpretation, we report exponentiated coefficients instead of hazard ratios. The hazard model treats all individuals who have not migrated at the time of the survey as right censored. Using

[19] About 40% of household heads and 31% of sons worked in agriculture during their first undocumented trip to the U.S.

[20] Results using a logit model with the dependent variable equal to one in the period a man first migrated generally gave similar results. Exceptions are noted below.

a logit or linear probability model would require imposing functional form on the duration dependence instead of the relatively unrestrictive functional form allowed by the Cox hazard model.

The set of independent variables includes measures of demographic characteristics, human capital, border enforcement, access to a network of previous migrants, and economic conditions in Mexico and the U.S.[21] Based on previous research, stricter border enforcement is expected to lower the hazard of migrating, and having a father or siblings who have already migrated should raise the migration hazard. Better Mexican economic conditions are expected to be negatively associated with migration, and better U.S. economic conditions should be positively associated with migration.

To examine the effect of changes in the costs and benefits of migrating on selection, we run separate regressions in which the education indicator variables are interacted with covariates measuring border enforcement, migrant networks, and economic conditions.[22] Selection effects are evident if the effect on the probability of migration differs by education level as a covariate changes. Together with the main effect, the interaction terms indicate the direction of selection. For example, the theoretical model predicts that better economic conditions in Mexico lead to more negative selection. Empirical results consistent with the model would show a negative coefficient on the main effect for Mexican wages or agricultural GDP and that the estimated coefficients on the interactions with the economic variable become more negative as education increases, indicating that skilled individuals were less likely than the unskilled to undertake migration as economic conditions in Mexico improved.

The model also predicts that improved economic conditions in the U.S. lead to more positive selection. The coefficients on the interactions with U.S. wage variables should therefore become larger as education increases if an increase in U.S. wages led to more positive selection. The model does not give a clear prediction for the effect on migrant skill levels of changes in border enforcement and networks, which proxy for the cost of migration, M, in the model.[23] The model does predict, however, that increases in exogenous savings, S, lead to more negative selection. If family networks share savings with the potential migrant, then empirical results consistent with this prediction would show network skill interactions decreasing in education level. The model predicts that having a larger network of previous migrants makes migration easier for all Mexicans, but

[21] All regressions also include a linear time trend and its square, 8 dummy variables for state of residence in Mexico, a post-IRCA dummy variable, and a post-Immigration Act of 1990 dummy variable. Given that economic variables vary across years and not communities, the economic variables (and the trends and dummy variables for IRCA and the 1990 Immigration Act) are not identified if year fixed effects are included in the specifications.

[22] In regressions that included all of the education interactions instead of interactions with only one main variable, the results were generally too noisy to be informative and few of the coefficients were statistically different from zero. However, most of the coefficients showed patterns similar to those observed in Tables 3 and 4. Inadequate sample size or multicollinearity could underlie the weaker results.

[23] The sign on the partial derivative $\partial E(x|I>0)/\partial M$ is indeterminate. One effect of increasing costs is to make the cash-in-advance constraint binding for more low-skilled migrants (the lower bound on skill moves to the right in Fig. 1). The other effect of increasing costs is to not make migration worthwhile for high-skilled migrants (the upper bound moves to the left in Fig. 1). The dominant impact can only be determined empirically.

disproportionately so for less-educated Mexicans, who are more credit constrained from migrating absent having a network than are more-educated Mexicans.

5. Results

5.1. Baseline regression results

Table 2 shows the results for the baseline regressions of probability of first migration for household heads and sons, respectively. The results for household heads indicate that married men are less likely to migrate. Conditional on marital status, the number of minor

Table 2
Hazard rate estimates of undocumented migration

	Heads (1)	Sons (2)
Married	−0.113* (.068)	–
Number of minor children	0.046*** (0.016)	–
Number of older children	0.005 (0.039)	–
Urban resident	−1.092*** (0.083)	−1.492*** (0.087)
Educational attainment:		
Some schooling	0.245*** (0.077)	0.374*** (0.090)
Primary school	0.146* (0.083)	0.382*** (0.087)
Secondary school	−0.190* (0.107)	0.307*** (0.092)
Preparatory school	−0.867*** (0.117)	−0.558*** (0.100)
Ln(border enforcement hours)	−0.030 (0.037)	−0.036 (0.026)
Migration network:		
Father has ever migrated	0.470*** (0.063)	0.440*** (0.041)
Number of siblings have migrated	0.314*** (0.022)	0.212*** (0.011)
Mexican economic conditions:		
Ln(agricultural GDP per capita)	−3.872*** (1.219)	−1.824* (0.940)
Ln(GDP per capita)	1.857 (1.457)	−0.075 (1.193)
Ln(manufacturing wage)	−0.666 (0.574)	−0.076 (0.447)
Real interest rate	0.001 (0.002)	0.005*** (0.001)
U.S. economic conditions:		
Ln(agricultural hourly wage)	4.140** (1.628)	−1.667 (1.406)
Ln(nonagricultural hourly wage)	0.628 (1.943)	3.808** (1.751)
Ln(minimum wage)	0.347 (0.716)	2.083*** (0.645)
Unemployment rate	0.001 (0.027)	−0.034 (0.022)
Log likelihood	−13210	−25429

No or little schooling is the omitted education category. The regressions also include 8 dummy variables for state of residence in Mexico, a linear time trend and trend squared, a post-IRCA dummy variable, and a post-Immigration Act of 1990 dummy variable. Standard errors are in parentheses. The data consist of 110,334 observations on 5878 male household heads and 101,003 observations on 9559 sons.

* Significant at 0.10 level.
** Significant at 0.05 level.
*** Significant at 0.01 level.

children in the family is positively related to migration. Urban residence lowers the hazard of migration for both heads and sons.

Very high and very low levels of schooling are associated with lower migration hazards, implying intermediate selection of Mexican migrants. For household heads, those who have completed high school are the least likely to migrate, followed by heads who have completed secondary school (9–11 years of schooling) and those with no or little education (the omitted group with 0–1 years of schooling). For sons, high school graduates and those with no schooling are the least likely to migrate. These results are consistent with Chiquiar and Hanson's (2002) findings and with our model's formulation of a budget constraint on the poorest, least-skilled households. They do not support Borjas' negative selection model, at least not with regard to observable migrant characteristics such as education. We should also note that the result of intermediate self-selection occurs despite the bias in the MMP data, particularly among household heads, in favor of finding negative selection because the data over-represent return migrants. If the data were representative of permanent out-migrants rather than return migrants, we would expect to find even more evidence against negative self-selection, assuming that the least successful migrants are those who return to Mexico.

Among the older generation, household heads with some schooling, defined as 2–5 years of education, are the most likely to migrate. In the sons sample, those with a primary-school education (6–8 years of schooling) have the highest migration hazard, followed closely by sons with 2–5 years of education. Among the heads, the relationship between schooling and migration turns negative with the group that has 9–11 years of education, whereas for sons, the relationship does not turn negative until at least 12 years of education. This suggests, as others have noted, that the educational attainment of illegal Mexican immigrants has increased over time.[24] We also note that these results are robust to including year fixed effects in the regression and dropping the aggregate economic variables (Appendix, Table A2).

Border enforcement appears to have a negative but statistically insignificant effect on the migration decisions of heads and sons. In contrast, access to a network of previous migrants significantly increases the hazard of migration. This is consistent with the hypothesis that having a migrant network lowers the costs of migration, promoting more migration, and with the findings of previous research that networks have a large effect on first trips.

Mexican economic conditions are also important determinants of whether an undocumented trip occurs. Improvements in the Mexican rural economy, as measured by agricultural output, significantly reduce the hazard of migration among both heads and sons. Changes in the national economy, measured by per capita GDP and manufacturing wages, do not have a statistically significant effect. Higher real Mexican interest rates increase the hazard of migration among the sample of sons. This effect is likely a result of

[24] It should be noted, however, that average education levels in the U.S. have been increasing at least as quickly. Hence, improvements in the education levels of illegal Mexican immigrants have still left them relatively unskilled compared with natives. More generally, there appears to be a persistent education gap between Mexican immigrants, their descendants, and natives (Grogger and Trejo, 2002).

the cost of borrowing. U.S.-bound migrants often cite the need to accumulate capital for investment (such as opening a business) or to fund a lumpy expenditure (such as a medical procedure) as a reason for migrating (Massey et al., 1987).

The effect of U.S. economic conditions varies across generations. For household heads, the only significant variable is average hourly wages in the agricultural sector. Increases in U.S. farm wages increase the hazard of migration among the older generation. Average nonagricultural wages and the minimum wage, in contrast, appear to influence sons' migration decisions. Increases in average wages and in the minimum wage are associated with increased hazards of migration in column 2 of Table 2.

The results for U.S. economic conditions are consistent with the incentives that U.S. labor markets offer Mexican workers and with how those incentives have changed over time. Relatively high U.S. wages attract Mexican labor. The older immigrants held largely agricultural sector jobs, so their migration behavior responded to changes in farm wages. More recent immigrants are more likely than previous immigrants to work in nonagricultural industries, such as manufacturing, services, and construction (Donato, 1994). Consequently, sons' migration behavior is more affected by nonagricultural wages and the minimum wage.

5.2. Selection results

Tables 3 and 4 report the findings on the selection effects of migration determinants in the hazard models for heads and sons, respectively. The regressions control for all of the main effects and interact one of the migration determinants with the education indicator variables.

As seen in column 1, migrants with less education are more deterred by increases in border enforcement than are migrants with more education. This result is most obvious in the sons regression (Table 4), where the deterrent effect is the strongest on the least educated, the omitted group, with a coefficient of -0.065. The deterrent effect of more border enforcement then decreases monotonically in education to the point where the net effect of increased border enforcement on migrants with a high school diploma or more education is no longer negative ($-0.065+0.096=0.031$). These results are consistent with heightened border enforcement leading to a more positively selected illegal immigrant population.

The interaction results for the father and sibling network effects did not indicate any significant differences across skill groups for fathers or sons and are not shown here.[25] The model did not give a clear prediction for the selection effect of changes in these variables. One might expect access to a network of previous migrants to have a larger effect on low-skilled individuals than on high-skilled individuals, who have more money to pay for a guide or smuggler, but our data do not bear out this hypothesis.

The results of interactions with Mexican agricultural GDP are consistent with the model. Among household heads, an improved rural economy leads to significantly lower

[25] The sibling network interaction terms were statistically significant and indicated negative selection when a logit or linear probability model was used instead of the hazard rate model.

Table 3
Hazard rate estimates of undocumented migration—interactions with education variables, male household heads

Interacted variable:	Border Enf. (1)	Mexican Ag. GDP (2)	Mexican Wage (3)	U.S. Ag. Wage (4)	U.S. Nonagricultural Wage (5)	U.S. Min. Wage (6)
Interactions with education:						
Some schooling	−0.029* (0.017)	−2.893* (1.722)	−0.217 (0.400)	−0.473 (1.350)	0.314 (1.663)	0.706 (0.536)
Primary school	−0.013 (0.018)	−3.450* (1.803)	−0.669* (0.399)	−2.753** (1.409)	−3.670** (1.677)	0.066 (0.550)
Secondary school	0.042 (0.029)	−6.678*** (2.240)	−1.755*** (0.476)	−6.292*** (1.893)	−7.543*** (2.157)	−1.679** (0.715)
Preparatory school	0.003 (0.033)	−6.065** (2.483)	−1.722*** (0.512)	−7.177*** (2.082)	−5.991*** (2.339)	−1.184 (0.808)
Main effects of education:						
Some schooling	1.988** (0.987)	25.028* (14.753)	0.985 (1.353)	0.943 (1.996)	−0.443 (3.706)	−0.666 (0.707)
Primary school	0.943 (1.086)	29.709* (15.450)	2.407* (1.351)	4.211** (2.083)	8.301** (3.730)	0.065 (0.717)
Secondary school	−2.831 (1.764)	57.024*** (19.186)	5.633*** (1.587)	9.069*** (2.780)	16.471*** (4.766)	1.851** (0.896)
Preparatory school	−1.072 (2.006)	51.104** (21.280)	4.849*** (1.707)	9.687*** (3.058)	12.382** (5.174)	0.577 (1.011)
Border enforcement hours	−0.021 (0.040)	−0.032 (0.037)	−0.029 (0.037)	−0.022 (0.037)	−0.022 (0.037)	−0.029 (0.037)
Migration network:						
Father has ever migrated	0.464*** (0.063)	0.470*** (0.063)	0.462*** (0.063)	0.466*** (0.063)	0.461*** (0.063)	0.461*** (0.063)
Number of siblings have migrated	0.314*** (0.022)	0.315*** (0.022)	0.313*** (0.022)	0.315*** (0.022)	0.313*** (0.022)	0.313*** (0.022)
Mexican economic conditions:						
Ln(agricultural GDP per capita)	−3.863*** (1.219)	−0.533 (1.823)	−3.811*** (1.218)	−3.802*** (1.222)	−3.900*** (1.224)	−3.737*** (1.219)
Ln(GDP per capita)	1.852 (1.458)	1.792 (1.458)	1.931 (1.454)	1.901 (1.457)	1.568 (1.459)	2.039 (1.458)
Ln(manufacturing wage)	−0.649 (0.574)	−0.700 (0.575)	−0.051 (0.659)	−0.714 (0.575)	−0.617 (0.574)	−0.674 (0.573)
Real interest rate	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)
U.S. economic conditions:						
Ln(agricultural hourly wage)	4.185*** (1.627)	4.011** (1.630)	3.895** (1.629)	6.338*** (1.961)	4.094** (1.625)	4.287*** (1.631)
Ln(nonagricultural hourly wage)	0.615 (1.944)	0.646 (1.943)	0.662 (1.941)	0.220 (1.943)	2.114 (2.294)	0.688 (1.943)
Ln(minimum wage)	0.347 (0.715)	0.497 (0.715)	0.365 (0.716)	0.341 (0.716)	0.304 (0.717)	0.285 (0.815)
Unemployment rate	0.003 (0.027)	0.000 (0.027)	−0.001 (0.027)	−0.003 (0.027)	−0.006 (0.027)	0.004 (0.027)
Log likelihood	−13205	−13205	−13196	−13199	−13197	−13201

No or little schooling is the omitted education category in the main effects and the interactions. The regressions also include dummy variables for married and urban resident, linear variables for the number of minor and adult children, 8 dummy variables for state of residence in Mexico, a linear time trend and trend squared, a post-IRCA dummy variable, and a post-Immigration Act of 1990 dummy variable. Standard errors are in parentheses. The data consist of 110,334 observations on 5878 men.

* Significant at 0.10 level.

** Significant at 0.05 level.

*** Significant at 0.01 level.

Table 4
Hazard rate estimates of undocumented migration—interactions with education variables, sons

Interacted variable:	Border Enf. (1)	Mexican Ag. GDP (2)	Mexican Wage (3)	U.S. Ag. Wage (4)	U.S. Nonagricultural Wage (5)	U.S. Min. Wage (6)
Interactions with education:						
Some schooling	0.005 (0.022)	1.847 (2.066)	−0.422 (0.428)	−5.692*** (1.924)	−4.753** (1.992)	−0.474 (0.642)
Primary school	0.013 (0.022)	−0.040 (1.978)	−0.701** (0.413)	−4.177** (1.870)	−3.769* (1.951)	−0.814 (0.627)
Secondary school	0.055** (0.025)	−2.184 (2.040)	−1.404*** (0.435)	−6.777*** (2.043)	−7.280*** (2.121)	−2.094*** (0.682)
Preparatory school	0.096*** (0.030)	−2.278 (2.231)	−2.197*** (0.480)	−9.485*** (2.219)	−9.720*** (2.318)	−3.372*** (0.765)
Main effects of education:						
Some schooling	0.074 (1.320)	−15.451 (17.705)	1.794 (1.439)	8.780*** (2.854)	10.903** (4.421)	0.985 (0.821)
Primary school	−0.371 (1.321)	0.727 (16.949)	2.740** (1.388)	6.566** (2.775)	8.759** (4.330)	1.427* (0.799)
Secondary school	−3.145** (1.561)	19.003 (17.477)	4.905*** (1.450)	10.290*** (3.020)	16.340*** (4.689)	2.827*** (0.852)
Preparatory school	−6.565*** (1.855)	18.955 (19.115)	6.584*** (1.588)	13.381*** (3.272)	20.818*** (5.115)	3.455*** (0.942)
Border enforcement hours	−0.065** (0.033)	−0.035 (0.026)	−0.035 (0.026)	−0.033 (0.026)	−0.031 (0.026)	−0.036 (0.026)
Migration network:						
Father has ever migrated	0.436*** (0.041)	0.441*** (0.041)	0.440*** (0.041)	0.440*** (0.041)	0.438*** (0.041)	0.438*** (0.041)
Number of siblings have migrated	0.214*** (0.011)	0.213*** (0.011)	0.214*** (0.011)	0.213*** (0.011)	0.214*** (0.011)	0.214*** (0.011)
Mexican economic conditions:						
Ln(agricultural GDP per capita)	−1.816* (0.941)	−1.609 (2.054)	−1.761* (0.940)	−1.872** (0.940)	−1.889** (0.941)	−1.604* (0.942)
Ln(GDP per capita)	−0.171 (1.195)	−0.124 (1.192)	0.009 (1.188)	0.043 (1.192)	−0.217 (1.192)	0.119 (1.194)
Ln(manufacturing wage)	−0.025 (0.447)	−0.130 (0.448)	0.739 (0.577)	−0.144 (0.449)	−0.058 (0.447)	−0.127 (0.447)
Real interest rate	0.005*** (0.001)	0.005*** (0.001)	0.005*** (0.001)	0.005*** (0.001)	0.005*** (0.001)	0.005*** (0.001)
U.S. economic conditions:						
Ln(agricultural hourly wage)	−1.601 (1.406)	−1.867 (1.409)	−1.989 (1.410)	3.544 (2.193)	−1.840 (1.406)	−1.541 (1.408)
Ln(nonagricultural hourly wage)	3.729** (1.757)	3.889** (1.750)	3.891** (1.747)	3.651** (1.754)	8.254*** (2.463)	3.840** (1.756)
Ln(minimum wage)	2.110*** (0.646)	2.247*** (0.647)	2.099*** (0.646)	2.103*** (0.645)	2.091*** (0.645)	3.176*** (0.856)
Unemployment rate	−0.033 (0.022)	−0.033 (0.022)	−0.035 (0.022)	−0.035 (0.022)	−0.040* (0.022)	−0.028 (0.022)
Log likelihood	−25418	−25423	−25404	−25418	−25415	−25407

No or little schooling is the omitted education category in the main effects and the interactions. The regressions also include a dummy variable for urban residence, a dummy variable for father's migration history not observed, 8 dummy variables for state of residence in Mexico, a linear time trend and trend squared, a post-IRCA dummy variable, and a post-Immigration Act of 1990 dummy variable. Standard errors are in parentheses. The data consist of 101,003 observations on 9559 men.

* Significant at 0.10 level.

** Significant at 0.05 level.

*** Significant at 0.01 level.

hazard rates in all skill categories but has the greatest impact among the two highest skill groups. Selection becomes more negative as the Mexican economy improves. The same result holds among sons but none of the coefficients are statistically significant, suggesting that the importance of the agricultural sector in Mexico has diminished over time. The greater responsiveness of the high-skilled groups also implies that these men experience the largest increase in hazard rates if conditions worsen. Modest improvements in the rural Mexican economy may therefore have led to slightly more negative selection of illegal immigrants in the mid-1990s than there would otherwise have been.

The interaction results for Mexican manufacturing wages are similar to those for agricultural income. Among both heads and sons, the interaction terms suggest that selection becomes more negative as Mexican wages increase. For a given increase in the Mexican wage rate, skilled individuals delay migration longer (or never migrate) relative to the unskilled. The interaction terms with the Mexican interest rate were all insignificant and did not show a clear pattern, so they are not shown here.

The last three columns in Tables 3 and 4 show skill interactions with U.S. economic conditions—the agricultural wage, the nonagricultural wage, and the minimum wage.[26] The results for all three sets of interactions indicate that low-skilled men are relatively more likely to migrate than their high-skilled counterparts as U.S. wages rise. This is the opposite result of that predicted by the theoretical model. For example, column 4 indicates that higher agricultural wages lead to greater migration by the least skilled (coefficients of 6.338 and 3.544 for the omitted group in the heads and sons regressions, respectively, although only the result for heads is significant). The net effect of higher agricultural wages is positive and significant for the three lower skill groups among the older generation. These results are consistent with more negative selection of male household heads from Mexico as U.S. farm wages rise.

Among sons, it appears that higher agricultural wages may attract the least skilled while discouraging the slightly more skilled from migrating. The net effect on sons with at least 2 years of education is negative. The same result is observed for nonagricultural wages among household heads—higher non-farm compensation effectively deters migration by heads in the three upper skill groups. A potential explanation for both of these results is a family-based migration strategy in which not all members migrate at once, but migration by some substitutes for migration by others (Taylor, 1987). When farm wages are high, the family optimizes by sending members who are agricultural workers (often the older family members or household head). When non-farm wages are relatively high, younger family members such as the sons are more likely to migrate.

As with farm wages, the results for nonagricultural wages shown in column 5 of Tables 3 and 4 indicate more negative selection as wages rise. For sons with some schooling, the net effect of higher nonagricultural wages on the hazard of migration is 3.501, compared to 8.254 among sons with no education. The net effect for the primary-school group is 4.485; secondary school, 0.974; and preparatory school, − 1.466.

[26] In results not shown here, the interactions of education with the U.S. unemployment rate did not indicate clear differences across educational groups.

Among sons, the migration behavior of the least skilled group is also the most responsive to the U.S. minimum wage (Table 4, column 6). An increase in the minimum wage increases the hazard of migration by 3.176 for the no schooling group. The effect then decreases as skill increases; the net effect for the some schooling group is 2.702; primary, 2.362; secondary, 1.082; preparatory or above, −0.196. The finding that a higher U.S. minimum wage leads to greater negative selection among undocumented immigrants could result from a scenario in which boosting the minimum wage increases the demand for low-skilled migrant workers who are more willing to work for sub-minimum wages. Another potential explanation for our finding is that increases in the minimum wage may be correlated with wage growth more generally, and the regression may not properly identify the minimum wage effect.

In general, the empirical results do not bear out the theoretical prediction of more positive selection as U.S. economic conditions improve. The results suggest that skilled individuals might be more responsive to push factors (conditions within Mexico) and the unskilled more responsive to pull factors (conditions within the U.S.). However, there are several caveats to these simple measures of average economic conditions. Most importantly, the model assumes that economic changes in the two countries are of equal persistence. The structural changes in the Mexican economy in recent decades may translate into relatively more permanent changes in Mexico than in the U.S., where the business cycle is more transitory. If skilled workers are more tied to the Mexican economy because of their human and physical capital investments, they may have lower discount rates and respond more to permanent than transitory changes in economic conditions than low-skilled workers.[27] They are also more likely to have savings with which to smooth consumption during bad economic times, another reason for them not to respond as readily to temporary changes.

The model also assumes a constant relative rate of return to human capital. If the return to skill in Mexico is rising as nonagricultural wages rise in the U.S., for example, then skilled individuals in Mexico will appear unresponsive to changes in U.S. wages. A solution would be to include a time-varying measure of the return to skills in Mexico in the regressions.

5.3. Recall bias

The MMP data are collected retrospectively, with respondents interviewed once and asked to recall past events. If recall errors in the migration histories are systematically related to the explanatory variables of interest, our estimates are biased. However, our measures of economic conditions and border enforcement are aggregate variables, not reported by individuals. In order for recall error to bias our results, respondents would not only have to err in dating their first trip to the U.S., but they would also have to

[27] Limited transferability of skills provides a larger disincentive to migrate as skill increases. If skilled Mexicans cannot qualify for high-end jobs in the U.S. due to language or licensing problems or simply a lack of institutional knowledge, then higher average wages may have a smaller impact among the high skilled than among the low skilled.

systematically associate the year of first migration with the year of a particular economic event, such as a downturn in the Mexican economy or a poor agricultural year. We would then estimate a stronger relationship between Mexican economic conditions and migration than would actually be present among the population at risk of migrating.

Despite the long retrospective period, there are several reasons why it is unlikely that recall bias is driving our results. First, the timing of trips in the MMP is highly correlated with INS data on Border Patrol apprehensions, suggesting that any bias in the dating of trips is not severe (Orrenius, 2001). At the individual level, previous research indicates that salient events are more likely to be recalled and reported accurately. Since a first migration to the U.S. – considered by many Mexicans as a rite of passage – is a landmark event in itself, it is more likely to be remembered accurately than other events of less meaning or significance (Beckett et al., 2001). It is also likely to coincide with other events, like leaving school or starting a new job, which further improves recall (Smith and Thomas, 1997). It is also possible that recall error is less pronounced among more educated respondents, and less educated individuals are more likely to associate first trips with macroeconomic events; if so, we would expect to see consistently stronger relationships between economic conditions and migration among less educated than among more educated individuals, a pattern not present in our results.

To test the influence of recall bias on our results, we run separate regressions with only recent (within the last 3 years) or long-ago (at least 10 years ago) migrations. Table 5 shows the results for household heads for two key migration determinants, Mexican agricultural GDP and U.S. farm wages. Although the coefficients are not as precisely identified as in the earlier specifications because of the shorter time periods and resultant smaller sample sizes, the result that the migration behavior of medium- to high-skilled workers is more responsive to Mexican economic conditions while low-skilled workers respond more to U.S. wages still holds. Neither the recent nor the long-ago migration specifications suggest negative selection on education levels.

5.4. The role of migration costs

In the model presented here, migration costs underlie the intermediate-to-positive selection among Mexican migrants to the U.S. If this constraint is removed, the model predicts negative selection of Mexican migrants because the return to education is higher in Mexico than in the U.S. To test the role of migration costs in driving the selection result, we divide the sample into communities with low and high migration costs, using the prevalence of networks as a proxy for migration costs. Low- (high-) cost communities have father and sibling networks one-half of a standard deviation above (below) the mean for all communities. Defining MMP communities in this way, the number of observations in each category (for household heads) is as follows: 16,692 low-cost, 66,391 average-cost, and 27,251 high-cost communities. The rates of migration are as expected: about 38% of heads in low-cost communities ever migrated to the U.S., compared with 30% in average-cost communities and 17% in high-cost communities. The statistics are similar in the sample of sons.

The regression results when the data are stratified by community migration costs are consistent with the predictions of the model and indicate that positive selection is most

Table 5
Hazard rate estimates of recent or long-ago undocumented migration, male household heads

Interacted variable:	Within last 3 years			At least 10 years ago		
	None (1)	Mexican Ag. GDP (2)	U.S. Ag. Wage (3)	None (4)	Mexican Ag. GDP (5)	U.S. Ag. Wage (6)
Interactions with education:						
Some schooling		−5.976 (6.830)	−3.503 (3.310)		−3.345 (2.142)	−1.121 (1.459)
Primary school		−12.291* (7.108)	−2.647 (3.707)		−2.054 (2.280)	−3.385**
Secondary school		−18.319** (7.662)	−6.772 (4.448)		−4.701 (3.217)	−5.755** (2.303)
Preparatory school		−7.437 (11.094)	−10.104 (6.174)		−6.230 (3.827)	−7.684*** (2.417)
Main effects of education:						
Some schooling	−0.012 (0.235)	51.087 (58.418)	4.962 (4.719)	0.263*** (0.083)	28.911 (18.348)	1.923 (2.169)
Primary school	0.008 (0.237)	105.065* (60.767)	3.754 (5.327)	0.163* (0.096)	17.748 (19.538)	5.193** (2.286)
Secondary school	−0.213 (0.280)	156.271** (65.467)	9.499 (6.406)	−0.376*** (0.140)	39.914 (27.579)	8.177** (3.412)
Preparatory school	−1.245*** (0.368)	62.378 (94.701)	13.260 (8.873)	−1.017*** (0.153)	52.393 (32.902)	10.389*** (3.580)
Border enforcement hours	−0.211* (0.126)	−0.218* (0.126)	−0.207* (0.125)	−0.003 (0.054)	−0.006 (0.054)	0.008 (0.054)
Migration network:						
Father has ever migrated	0.580*** (0.177)	0.577*** (0.177)	0.586*** (0.176)	0.517*** (0.073)	0.519*** (0.073)	0.516*** (0.073)
Number of siblings have migrated	0.252*** (0.049)	0.248*** (0.049)	0.255*** (0.049)	0.339*** (0.029)	0.340*** (0.030)	0.340*** (0.029)
Mexican economic conditions:						
Ln(agricultural GDP per capita)	12.419* (6.767)	21.959** (9.241)	12.301* (6.732)	−4.433*** (1.520)	−1.724 (2.217)	−4.309*** (1.523)
Ln(GDP per capita)	−8.950 (6.129)	−8.500 (6.195)	−8.625 (6.147)	1.116 (2.133)	1.056 (2.136)	1.226 (2.131)
Ln(manufacturing wage)	0.936 (2.168)	1.021 (2.190)	0.996 (2.174)	−0.841 (0.724)	−0.827 (0.724)	−0.910 (0.727)
Real interest rate	0.006 (0.006)	0.005 (0.006)	0.006 (0.006)	0.003 (0.005)	0.003 (0.005)	0.003 (0.005)
U.S. economic conditions:						
Ln(agricultural hourly wage)	8.865 (8.918)	9.418 (8.893)	12.432 (9.369)	2.545 (2.835)	2.488 (2.834)	5.148* (3.107)
Ln(nonagricultural hourly wage)	−7.844 (9.717)	−8.605 (9.683)	−7.844 (9.644)	0.216 (2.431)	0.157 (2.434)	−0.106 (2.431)
Ln(minimum wage)	−1.761 (3.992)	−2.097 (3.943)	−1.832 (3.965)	0.007 (0.965)	0.025 (0.965)	0.020 (0.963)
Unemployment rate	0.018 (0.150)	0.017 (0.150)	0.022 (0.151)	−0.012 (0.049)	−0.013 (0.049)	−0.015 (0.049)
Log likelihood	−1097	−1093	−1095	−8608	−8606	−8600

Columns 1–3 include only the 3 years prior to the survey (which took place between 1987 and 1997), and columns 4–6 include only years at least 10 years prior to the survey. No or little schooling is the omitted education category in the main effects and the interactions. The regressions also include dummy variables for married and urban resident, linear variables for the number of minor and adult children, 8 dummy variables for state of residence in Mexico, a linear time trend and trend squared, a post-IRCA dummy variable, and a post-Immigration Act of 1990 dummy variable. Standard errors are in parentheses. The data for columns 1–3 consist of 16,992 observations, and 74,526 observations for columns 4–6.

* Significant at 0.10 level.

** Significant at 0.05 level.

*** Significant at 0.01 level.

pronounced in the high-cost communities with little migration prevalence. In these high migration cost communities, Mexicans with 9–11 years of education have the highest migration probability whereas Mexicans with 2–5 years of education have the highest migration probability in low and average migration cost communities. In the samples of both heads and sons, we observe more positive selection in high migration cost communities than in low-cost, high-migration and average-migration communities, which are characterized by intermediate instead of negative selection. Given the MMP communities were chosen based on their migration prevalence, the greater incorporation of populations facing low migration costs suggests our selection results are again biased away from finding patterns of positive selection.

6. Conclusion

This paper has examined how changes in migration determinants affect the skill composition of undocumented immigrants from Mexico. Although many studies have shown that economic conditions, migrant networks, and border enforcement influence the size of the Mexico–U.S. migrant flow, research has not addressed the impact of these variables on migrant self-selection by skill level. We develop a model that predicts the direction of self-selection among migrants in response to changes in the above migration determinants. The model assumes the least-skilled workers are budget constrained and the high-skilled workers earn higher relative returns to skill in the home country.

Our empirical results for the main effects of economic variables, demographic characteristics, access to a network of previous migrants, and border enforcement support previous findings. Our finding that illegal immigrants from Mexico come from the middle of the sample's education distribution, while not consistent with Borjas's (1987) negative selection hypothesis, is similar to Chiquiar and Hanson's (2002) result using Mexican and U.S. Census data. When the migration determinants are interacted with skill levels, our findings indicate that increased border enforcement has resulted in an illegal immigrant stream that is more positively selected, whereas higher U.S. wages and improved conditions in Mexico have had the opposite effect. Higher average U.S. wages and a higher minimum wage are associated with more immigration and with more negative selection among illegal immigrants from Mexico. Improved Mexican economic conditions are associated with less immigration but also with relatively lower education levels among those who do migrate. The results imply that when Mexican economic crises occur, they lead to more out-migration and to a shift toward relatively more skilled immigrants.

More generally, the empirical results indicate an asymmetric response of migrants in different skill groups to Mexican and U.S. economic conditions. Our results suggest that less-skilled migrants are more responsive than skilled migrants to changes in U.S. wages while the opposite holds for changes in Mexican economic conditions. Future work should look more closely into the factors that underlie this result. The disparate impact on the skilled versus unskilled could stem from the persistence of shocks rather than the location of shocks, for example. Differences in savings or discount rates could also cause the observed differences in migration behavior.

In any case, it is important for policy makers in both countries to understand the factors that determine the size and composition of Mexico–U.S. migration flows. Policy makers and researchers also should focus on total effects rather than the marginal effects reported here. Although a Mexican economic crisis may generate a more positively selected immigrant flow, as our findings suggest, this could still imply a larger number of low-skilled immigrants than would be the case in an average year. Indeed, our results suggest that immigration increases among all skill groups when economic conditions worsen in Mexico, with larger increases occurring among more skilled workers.

The question of who stays and for how long is also of great relevance but is not addressed here. If low-skilled immigrants have shorter trip durations and are less likely to settle permanently in the U.S. than their skilled counterparts, then policy makers may not be justified in worrying so much about the skill composition of the initial migrant cohort. Skill differences in trip duration and return migration are an important area for further research.

Acknowledgements

We thank Gordon Hanson for the helpful comments and for providing the data on Mexican economic conditions and border enforcement and Steve Logan of the U.S. Department of Agriculture for providing the agricultural wage data. We also thank Janet Currie, Andrew Davenport, Wei Hu, Marie Mora, and participants of the Center for Comparative Immigration Studies seminar for their helpful comments. The second author was with the Federal Reserve Bank of Atlanta and Occidental College during various stages of this research. The views expressed here are those of the authors and do not necessarily reflect those of the Federal Reserve Bank of Dallas, the Federal Reserve Bank of Atlanta, or the Federal Reserve System.

Appendix A

Table A1
Comparison of educational attainment of migrants in MMP with LPS and NAWS

	MMP		LPS	NAWS	
	Male heads	Sons		IRCA	Undocumented
Educational attainment (years)					
No or little schooling (0–1)	0.14	0.05	0.08	0.13	0.07
Some schooling (2–5)	0.36	0.22	0.28	0.36	0.24
Primary school (6–8)	0.31	0.41	0.35	0.35	0.42
Secondary school (9–11)	0.11	0.23	0.14	0.10	0.19
Preparatory school ($\geq$12)	0.08	0.09	0.15	0.06	0.07

Educational attainment is as of the time of first migration for MMP male household heads and as of the time of the survey for MMP sons and the LPS and NAWS samples. All samples consist of Mexican-born men who migrated illegally to the U.S. between the ages of 15 and 64 in 1965 or later.

Table A2
Hazard rate estimates of undocumented migration with year fixed effects

	Heads (1)	Sons (2)
Married	−0.111* (0.068)	–
Number of minor children	0.045*** (0.016)	–
Number of older children	0.005 (0.040)	–
Urban resident	−1.096*** (0.084)	−1.470*** (0.088)
Educational attainment		
Some schooling	0.247*** (0.078)	0.381*** (0.092)
Primary school	0.147* (0.084)	0.394*** (0.089)
Secondary school	−0.183* (0.108)	0.324*** (0.093)
Preparatory school	−0.865*** (0.117)	−0.543*** (0.102)
Migration network		
Father has ever migrated	0.455*** (0.064)	0.433*** (0.042)
Number of siblings have migrated	0.314*** (0.022)	0.212*** (0.011)
Log likelihood	−12769	−24072

No or little schooling is the omitted education category. The regressions also include 30 year dummies and 8 dummy variables for state of residence in Mexico. Standard errors are in parentheses. The data consist of 110,334 observations on 5878 male household heads and 101,003 observations on 9559 sons.

* Significant at 0.10 level.

** Significant at 0.05 level.

*** Significant at the 0.01 level.

References

Bean, F.D., Lowell, B.L., Taylor, L.J., 1988. Undocumented Mexican immigrants and the earnings of other workers in the United States. Demography 25, 35–52.

Beckett, M., DaVanzo, J., Sastry, N., Panis, C., Peterson, C., 2001. The quality of retrospective data. Journal of Human Resources 36, 593–625.

Borjas, G.J., 1987. Self-selection and the earnings of immigrants. American Economic Review 77, 531–553.

Borjas, G.J., 1994. The economics of immigration. Journal of Economic Literature 32, 1667–1717.

Borjas, G.J., 2003. The labor demand curve is downward sloping: reexamining the impact of immigration on the labor market. Quarterly Journal of Economics 118, 1335–1376.

Borjas, G.J., Freeman, R.B., Katz, L.F., 1997. How much do immigration and trade affect labor market outcomes? Brookings Papers on Economics, 1–90.

Card, D., 2001. Immigrant inflows, native outflows, and the local labor market impacts of higher immigration. Journal of Labor Economics 19, 22–64.

Chiquiar, D., Hanson, G.H., 2002. International migration, self-selection, and the distribution of wages: evidence from Mexico and the United States. NBER Working Paper 9242.

Chiswick, B.R., 1999. Are immigrants favorably self-selected? American Economic Review Papers and Proceedings 89, 181–185.

Cornelius, W., 1992. From sojourners to settlers: the changing profile of Mexican immigration to the United States. In: Bustamante, J.A., Reynolds, C.W., Hinojosa-Ojeda, R.A. (Eds.), U.S.–Mexico Relations: Labor Market Interdependence. Stanford University Press, Stanford, CA, pp. 155–195.

Costanzo, J., Davis, C., Irazi, C., Goodkind, D., Ramirez, R., 2001. Evaluating components of international migration: the residual foreign-born. U.S. Census Bureau Population Division Working Paper Series No. 61.

Delaunay, D., 1995. Mujeres migrantes: las mexicanas en Estados Unidos. Estudios Demograficos y Urbanos 10, 607–650.

Donato, K.M., 1994. U.S. policy and Mexican migration to the United States, 1942–92. Social Science Quarterly 75, 705–729.

Donato, K.M., Durand, J., Massey, D.S., 1992. Stemming the tide? Assessing the deterrent effects of the Immigration Reform and Control Act. Demography 29, 139–157.

Durand, J., Massey, D.S., 1992. Mexican migration to the United States: a critical review. Latin American Research Review 27, 3–42.

Durand, J., Kandel, W., Parrado, E.A., Massey, D.S., 1996. International migration and development in Mexican communities. Demography 33, 249–264.

Friedberg, R.M., Hunt, J., 1995. The impact of immigrants on host country wages, employment, and growth. Journal of Economic Perspectives 9, 23–44.

Grogger, J., Trejo, S.J., 2002. Falling behind or moving up? The intergenerational progress of Mexican Americans. Public Policy Institute of California, San Francisco.

Hanson, G.H., Spilimbergo, A., 1999. Illegal immigration, border enforcement, and relative wages: evidence from apprehensions at the U.S.–Mexico border. American Economic Review 89, 1337–1357.

Jaeger, D.A., 1996. Skill differences and the effect of immigrants on the wages of natives. U.S. Bureau of Labor Statistics Working Paper No. 273.

Johnson, G.A., 1998. The impact of immigration on income distribution among minorities. In: Hamermesh, D.S., Bean, F.D. (Eds.), Help or Hindrance? The Economic Implications of Immigration for African Americans. Russell Sage Foundation, New York.

Kossoudji, S.A., 1992. Playing cat and mouse at the U.S.–Mexican border. Demography 29, 159–180.

Massey, D.S., 1986. The settlement process among Mexican migrants to the United States. American Sociological Review 51, 670–684.

Massey, D.S., 1987. Understanding Mexican migration to the United States. American Journal of Sociology 92, 1372–1403.

Massey, D.S., Alarcon, R., Durand, J., Gonzalez, H., 1987. Return to Aztlan: the social process of international migration from western Mexico. University of California Press, Berkeley, CA.

Massey, D.S., Arango, J., Hugo, G., Kouaouci, A., Pellegrino, A., Taylor, J.E., 1994. An evaluation of international migration theory: the North American case. Population and Development Review 20, 699–751.

Mishra, P., 2003. Emigration and Wages in source countries: evidence from Mexico. Columbia University Department of Economics.

Orrenius, P.M., 1999. The role of family networks, coyote prices and the rural economy in migration from Western Mexico: 1965–1994. Federal Reserve Bank of Dallas Working Paper No. 99-10.

Orrenius, P.M., 2001. Illegal immigration and enforcement along the U.S.–Mexico border: an overview. Federal Reserve Bank of Dallas Economic and Financial Review, 2–11.

Sjaastad, L., 1962. The costs and returns of human migration. Journal of Political Economy 70, 80–93.

Smith, J.P., Thomas, D., 1997. Migration in retrospect: remembrances of things past. RAND Working Paper Series, 97-06.

Sorensen, E., Bean, F.D., 1994. The Immigration Reform and Control Act and the wages of Mexican origin workers: evidence from the Current Population Survey. Social Science Quarterly 75, 1–17.

Stark, O., Taylor, J.E., 1991. Migration incentives, migration types: the role of relative deprivation. Economic Journal 101, 1163–1178.

Taylor, J.E., 1987. Undocumented Mexico–U.S. migration and the returns to households in Mexico. American Journal of Agricultural Economics 69, 626–638.

U.S. Immigration and Naturalization Service, Office of Policy and Planning, 2000. September 2000 Monthly Statistical Report. Washington, DC: Immigration and Naturalization Service.

White, M.J., Bean, F.D., Espenshade, T.J., 1990. The U.S. Immigration Reform and Control Act and undocumented migration to the United States. Population Research and Policy Review 9, 93–116.

Winters, P., de Janvry, A., Sadoulet, E., 2001. Family and community networks in Mexico–U.S. migration. Journal of Human Resources 36, 159–184.