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Emigration and Wages in Source Countries: Evidence from Mexico

Prachi Mishra

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Prepared by Prachi Mishra¹

Authorized for distribution by David O. Robinson

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Abstract

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This paper empirically examines the effect on wages in Mexico of Mexican emigration to the United States, using data from the Mexican and United States censuses from 1970–2000. The main result in the paper is that emigration has a strong and positive effect on Mexican wages. There is also evidence for increasing wage inequality in Mexico due to emigration. Simple welfare calculations based on a labor demand-supply framework suggest that the aggregate welfare loss to Mexico due to emigration is small. However, there is a significant distributional impact between labor and other factors.

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Author(s) E-Mail Address: pmishra@imf.org

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I. INTRODUCTION

A vast theoretical and empirical literature considers the labor-market impact of immigration. In contrast, the literature on the labor-market impact of *emigration* or the outflow of workers is almost exclusively theoretical.² The absence of an empirical literature on the labor-market impact of emigration is surprising because the shares of the labor force leaving many individual source countries is considerably higher than the proportionate changes in the labor force of many receiving countries due to immigration.

To cite a few examples, the labor forces in El Salvador, Jamaica, Barbados, Guyana, and Belize have been reduced by 15 percent or more due to emigration to the United States between 1970–2000.³ In comparison, immigrants constitute about 12 percent of the U.S. labor force (Davis and Weinstein, 2002).

This paper is the first econometric study of the effect of emigration on national wages in a source country. I examine empirically the effect of Mexican emigration to the United States on wages in Mexico using data from the Mexican and the United States censuses from 1970–2000. The questions addressed in this paper are: How does emigration affect real wages in Mexico? What is the direction and magnitude of the impact? What are the implications of emigration for: (i) wage inequality across schooling groups; and (ii) national income distribution between labor and the other factors in Mexico?

My identification strategy to estimate the impact of emigration on Mexican wages follows Borjas (2003) in that I utilize variation across schooling and experience groups in the labor force, and over time. Emigration is assumed to be exogenous in the basic specifications. However, I also address concerns about endogeneity and self-selection biases in the estimates.

I find a strong and positive impact of the outflow of workers on wages in Mexico. A 10 percent decrease in the number of Mexican workers due to emigration in a skill group (defined by schooling and experience), increases the average wage in that skill group by about 4 percent. The estimates suggest that the outflow of Mexican workers to the United States between 1970 and 2000 has increased the wage of an average Mexican worker by about 8 percent.

² See Borjas (1994, and 1995) and Friedberg and Hunt (1995) for surveys of the empirical literature. The theoretical literature on international movement of factors includes for example, Bhagwati and Hamada (1974), Rivera-Batiz (1989) and Quibria (1989).

³ In several source countries, the reduction in the labor force due to emigration to the United States, is in the range of 7–27 percent. In countries like Turkey and Algeria, the labor force has been reduced by about 10 percent due to emigration to Western Europe. There is also anecdotal evidence of sizeable flows to the gulf countries for which no systematic data exists. (Sources: United States Census, OECD Migration Statistics, *World Development Indicators*).

The impact on wages, moreover, differs dramatically across schooling groups, with the greatest increase in wages being for the higher wage earners (those with 12–15 years of schooling). Hence, the estimates in this paper suggest that emigration could serve as one possible explanation for the increasing wage inequality in Mexico. Emigration as a channel to explain the increasing wage inequality in developing countries has received little attention in the literature.⁴

Simple welfare calculations in a competitive partial equilibrium framework show that the emigration loss to Mexico due to the outflow of workers between 1970 and 2000 is 0.5 percent of Mexico's GDP in 2000.⁵ The estimated welfare loss is lower than the official worker remittances to Mexico, which were about 1 percent of GDP in 2000 (IMF 2000).⁶ The emigration loss would also be easily outweighed by the large gains of the migrants themselves. However, there is a significant distributional impact. The gain to the workers who have stayed behind is 5.9 percent of GDP and the loss to the owners of fixed factors is 6.4 percent of GDP. Hence, the estimated distributional impact is about 12–13 times the aggregate economic impact.

It is a very difficult problem to examine empirically the impact of emigration because source countries, in general, do not record information on those who leave. Mexico offers an ideal case to study because almost all emigration from Mexico is to the United States. More than 95 percent of the international migrants from Mexico go to the United States (Woodruff and Zenteno, 2002). Hence it gives an excellent opportunity to use the United States data sources to study the effect on a source country's labor market. One important contribution of this paper is to merge two micro-level data sets to examine empirically the impact of emigration on a source country's labor market.⁷ The second reason why Mexico offers an ideal case is that the outflow of workers is sizeable in proportion to the Mexican labor force. In 2000, Mexican emigrants constituted about 16 percent of the Mexican labor force or approximately one out of seven Mexican workers migrate to the United States.

There are three types of studies on emigration that are related to this paper: first, there are a few case studies by the International Labor Organization (Stalker, 1994). Second, there are a few studies based on simulation exercises (e.g., O'Rourke and Williamson, 1999; Boyer et al., 1994). Third, there are some region/sector specific studies (see Hanson et al., 2002;

⁴ Robbins (2002) and Zhu and Trefler (2005) provide evidence for increasing wage inequality in developing countries.

⁵ This is analogous to the estimates of immigration surplus that exists in the migration literature (Borjas, 1995). The concept was first given by MacDougall, (1960) in the context of capital flows. Based on the simple textbook model of labor demand and supply, emigration leads to second order triangle losses for the aggregate economy (excluding the migrants) but there are large redistribution effects between workers and other factors.

⁶ The figure, however, excludes large amounts of unrecorded remittances.

⁷ Chiquiar and Hanson (2005) also merge United States and Mexican census data for 1990 to examine who migrates from Mexico to the United States. They find evidence of intermediate/positive self-selection in terms of observable skills, which is consistent with the findings in this paper.

Hanson, 2003; and Lucas, 1987). The present paper differs from the above studies in that I estimate the effect of overall emigration (legal and illegal, temporary and permanent) on a source country's national (not regional) wages.⁸

The paper is organized as follows. Section II presents the empirical specifications, Section III describes the data and evidence, Section IV discusses the results, Section V presents the quantifiable implications of the results, and Section VI concludes.

II. EMPIRICAL FRAMEWORK

A. Empirical Specification

Following Borjas (2003), I specify the regression equation as:

$$w_{ijt} = \delta m_{ijt} + s_i + v_j + \pi_t + s_i * \pi_t + v_j * \pi_t + s_i * v_j + \varepsilon_{ijt} \quad (1)$$

where w_{ijt} is the mean value of monthly earnings (in logs) for workers in Mexico with education level i , experience j and observed in year t .⁹

The measure of the emigrant supply shock in schooling-experience-time cell (i, j, t) is

denoted by $m_{ijt} = \frac{M_{ijt}}{N_{ijt}}$, where M_{ijt} is the number of Mexican emigrants in the United States

in cell (i, j, t) and N_{ijt} is the national workforce in Mexico in cell (i, j, t) . An emigrant from Mexico in the United States is defined as a person whom the United States Census records as being born in Mexico. Hence, by this definition, an emigrant is a Mexican-born person in the United States, who may be a naturalized citizen or a noncitizen. Using the census data, it is not possible to distinguish between legal and illegal immigrants in the United States. However, there exists evidence of an undercount of the illegal migrants in the census data, and hence also of emigration from Mexico (Costanzo et al., 2001). A worker in Mexico is defined as a person who is counted by the Mexican census as residing in Mexico in a given year, and is a part of the labor force.

⁸ Robertson (2000a) looks at United States-Mexico wage convergence in the border cities of Mexico and the United States. He finds that the convergence is stronger in Tijuana (the border city with the highest INS apprehensions) than in other border cities. Based on the predictions of 3-good, 3-factor Heckscher-Ohlin model, Mahmood (1991) conjectures that the rise in real wages in Pakistan in the mid-1970s could be due to emigration.

⁹ The reduced form empirical specification is derived assuming a 3-level CES production function for the national economy and perfectly competitive markets. The detailed derivation can be obtained upon request from the author. Using emigrant *share* as a measure of the emigrant supply shock follows the immigration literature which uses the immigrant share of the native population as a measure of the immigrant supply shock (e.g., Borjas, 2003 and 1994; Friedberg, 2001; Altonji and Card, 1991; for representative studies).

The terms s_i , v_j and π_t are vectors of fixed effects indicating the group's schooling, work experience and time respectively, which control for differences in wages across schooling, experience groups and over time. The interaction terms $(s_i * \pi_t)$ and $(v_j * \pi_t)$ are introduced to control for the possibility that the returns to schooling and experience could change over time. The interaction terms, $(s_i * v_j)$, control for the possibility that the experience profile for the wages could differ across schooling groups. The impact of the economy-wide shocks would be captured through the period fixed effects. The shocks, which have differential impact on schooling and age groups, would be captured through the interaction of the period fixed effects with schooling and experience respectively.

The regressions are weighted by the number of workers in Mexico in cell (i, j, t) . The parameter δ gives the percentage change in wages due to a 1 percent change in the number of Mexican workers due to emigration; δ is identified within skill-group changes in emigrant shares over time.

B. Using Individual Level Data

It is also possible to estimate the effect of emigration on Mexican wages by estimating an individual level wage regression, including the emigrant supply shock as one of the explanatory variables. Friedberg (2001) also uses an individual level wage regression to estimate the impact of immigration on the wages of natives.

The regression equation is specified as:

$$w_{ijt}^I = \delta m_{ijt}^I + \beta X_{ijt}^I + \pi_t + \varepsilon_{ijt}^I \quad (2)$$

where w_{ijt}^I is the real wage (in logs) for individual I in schooling group i , experience j , counted in year t ; m_{ijt}^I is the ratio of emigrants to the workforce in Mexico in the cell to which individual I belongs— m_{ijt}^I is a group variable and is same for all individuals within a cell; π_t is a year dummy. X_{ijt}^I is the vector of standard control variables used in the labor literature like experience, schooling, marital status, nativity, occupation, industry and the interactions of these variables with the year dummy.

There are two advantages of using individual level regression specified in equation (2) as compared to the group regressions specified in equation (1): (i) the individual level regression can control for many individual level factors affecting wages, and (ii) greater efficiency because of more observations. Since the emigrant supply shock is the same for all individuals in the same cell, the errors ε_{ijt}^I may be correlated within the cell, which may lead to inefficient estimates. Therefore, the standard errors have to be adjusted for clustering at the schooling experience time level. The grouped regression nevertheless is important since the regressor of interest, that is, the emigrant supply shock is a group variable.

III. DATA AND EVIDENCE

Data on the Mexican born population in the United States are drawn from the 1970, 1990 and 2000 Public Use Microdata Samples (PUMS) of the Decennial Census of United States. Data on the population in Mexico are drawn from the 1970, 1990, and 2000 PUMS of the Decennial Census of Mexico.¹⁰ The emigrant extracts form a 1 percent random sample in 1970 and 2000, and a 5 percent random sample in 1990. The extracts of the population in Mexico form a 1 percent random sample for 1970, 1990 and 2000.

The individuals in the sample are divided into schooling and experience groups. The workers are divided into four schooling categories (i) high school dropouts (HSD)—less than 12 years of schooling, (ii) high school graduates (HSG)—exactly 12 years of schooling, (iii) some college (SC)—13–15 years of schooling, and (iv) college graduates (CG)—16 years or more of schooling. Since the largest proportion of Mexicans are high school dropouts, for the regressions, I use a finer set of schooling categories where HSD are further divided into those with 0, 1–4, 5–8 and 9–11 years of schooling. The measure of work experience is defined as Age-AT, where AT is the assumed age of entry into the labor market for the typical worker. AT is assumed to be 17, 19, 21 and 23 years for HSD, HSG, SC and CG respectively. The assumed values of AT reflect the assumption that individuals enter the labor force immediately after school. In order to focus on individuals in the working age group, the sample is restricted to individuals with experience ranging from 1–40 years (18–63 years of age). The data contains samples only of males due to issues related to self-selection biases into the workforce. Also, the measure of work experience is a more appropriate measure for males.

Figure 1 shows the measure of the emigrant supply shock—that is the ratio of emigrants to the workforce in Mexico, in aggregate and by schooling groups. In 1970, the emigrants constituted around 3 percent of the Mexican labor force and it increased to 11 percent in 1990 and 16 percent in 2000.

The aggregate migration rates, however, mask a lot of variation by schooling. It is a well-known fact that immigration has increased by the greatest proportion the supply of high school dropouts in the United States (Borjas et al., 1997). However, there is a sharp contrast when we look at migration from the perspective of the source country. As shown in Figure 1, the bigger proportionate losses are amongst the high school graduates and those with some college education. In 2000, Mexican emigrants with 12 years of schooling constituted 47 percent while emigrants with 13–15 years of schooling constituted about 52 percent of the corresponding labor force in Mexico in the same schooling groups. In contrast, Mexican emigrants who are high school dropouts constituted only 16 percent of the corresponding labor force in Mexico. The reason is, though Mexican migrants are predominantly high school dropouts in absolute numbers, Mexico is so abundant in high school dropouts that the emigrant supply shock in the high school dropout category is relatively small. Around

¹⁰ The data used in this paper is publicly available at www.ipums.org. The earthquake of 1985 destroyed the Mexican Census Agency computing facilities before a national microdata sample could be constructed from the 1980 enumeration.

80 percent of Mexican workers are high school dropouts, whereas only about 12 percent have 12–15 years of schooling.¹¹

An important issue in measuring emigration by schooling categories is where the emigrant acquired the education—in the United States or in Mexico. The United States Census does not provide information on this. Even if this information were available, it is not clear what the counterfactual level of educational attainment of the migrant would have been, had he not migrated and whether his emigration could constitute shocks to the same schooling groups in Mexico. The strategy I follow in this paper is to exclude from the migrant sample those who are more likely to have got their schooling in the United States. The literature on Mexican migration to the United States, (e.g., Grogger and Trejo, 2002, Gonzalez, 2002, Chiquiar and Hanson, 2005, Clark and Jaeger, 2002) provides strong evidence that those who arrive in late teens or later are less likely to complete high school in the United States.

Following Chiquiar and Hanson (2005), I exclude from the migrant sample individuals who were less than 17 years of age at the time of entry into the United States.¹² In the restricted migrant sample, there is a higher probability that these individuals got their schooling in Mexico. The emigrant supply shock (not shown) in the 12–15 years of schooling category remains high. In 2000, Mexican emigrants who are high school graduates constituted 31 percent while emigrants with some college education constituted 33 percent of the corresponding labor force in Mexico.

Annex Figure 1 shows the emigrant supply shocks by schooling and experience. The emigrant sample excludes those who migrated as children, as defined above. The emigrant supply shocks are not balanced across experience groups within particular schooling categories. The central message is that there is variation in the emigrant supply shock across schooling and experience groups and over time that we can utilize to estimate the impact on Mexican wages.

Figure 2 shows the average real monthly earnings (nominal earnings deflated by Consumer Price Index from the IMF's *International Financial Statistics*) in Mexico. Between 1970 and 2000, the real wage in Mexico decreased both on average, as well as for each schooling group.

¹¹ It is surprising that the emigrant supply shock in the college graduate category is very small. One possible reason could be that the highly educated Mexicans want to live in Mexico and consume the cheap nontraded goods and have a high standard of living.

¹² The estimates of the effect of emigration on Mexican wages are robust to assuming higher cutoffs like 18, 19, or 21 years.

IV. RESULTS AND INTERPRETATION

A. Basic Regressions

Table 1 shows the estimates of δ , that is the effect of emigration on the wages in Mexico. There are 840 schooling-experience-time cells (7 schooling groups, 40 experience groups and 3 time periods). Specification I includes fixed effects for schooling (s_i), experience (v_j) and time (π_t). The estimate shown in column I is 0.33 (se = 0.06). Specification II includes the interactions of period fixed effects with the education and experience fixed effects respectively. The interaction terms control for the changing wage structure for different schooling and age groups respectively over time. The estimate of δ is 0.42 (se = 0.08) in Specification II. Specification III shows the estimates from the fully specified regression model with both the individual fixed effects as well as the pair-wise interactions between the vectors of fixed effects. The estimate of the impact of emigration, shown in the third column of Table 1, is 0.44 (se = 0.10).¹³ To summarize, the basic regressions indicate that there exists a positive, strong and statistically significant (at 1 percent level) relationship between emigration and Mexican wages. A 10 percent decrease in the supply of workers in any skill group due to emigration (where skill is defined by schooling and experience) increases the average wage in that skill group, by about 4 percent.¹⁴

B. Using Individual Level Data

The estimates from the individual wage regressions are shown in Table 2. The explanatory variables include additional individual level controls that can affect wages—marital status, nativity (whether the person is born in Mexico or outside Mexico), occupation, industry, state and the interaction of these with the year dummy. The estimated coefficient is 0.31 (s.e. = 0.06). This estimate is similar to that of the group level regressions in Table 1. The individual wage regression with additional regressors supports the result that emigration has a positive and strong effect on wages in Mexico.¹⁵

¹³ When four schooling categories are used instead of seven, the coefficient estimate in Specification III, Table 1 is 0.38 (s.e. = 0.16).

¹⁴ I also estimate the model in differences. Regressing the difference in wages on difference in the emigrant supply shocks, controlling for schooling, experience and period effects gives an estimate of 0.37 (s.e. = 0.09).

¹⁵ One concern is that of unemployment in Mexico. Surprisingly, the national unemployment rate in Mexico for males is about 1 percent (Source: Mexican Census, 2000). The unemployed are defined as those who are out of work and actively seeking work, and is much lower than that in the United States. One reason for the low unemployment could be that there is no unemployment insurance program in the country. However, there could also be measurement errors or underemployment in Mexico that is not measured.

C. Self Selection Issues

The estimates of impact of emigration on Mexican wages may be biased if the workers in Mexico constitute a nonrandom sample from the population. Selectivity bias may arise because wages in Mexico are observed only for the selected workers who decide not to migrate. If the “lowest ability” individuals are the most likely to migrate from every skill group, then the positive correlation between emigration and wages might not be due to the favorable impact of emigration on Mexican wages. Instead it could be due to the “lowest ability” individuals leaving and raising the average wage in that skill group.

It is difficult to ascertain who emigrates in terms of the unobserved characteristics from each skill group; hence it is difficult to predict the direction of the sample-selection bias. I follow one approach taken to address the classical sample selection problem encountered in estimating wage equations in the labor literature where the issue is that the wages are observed only when the individual decides to participate in the labor force. It is argued that the sample selection bias is less severe in a sub-sample of male workers whose labor force participation rates are very high, so that in this restricted sample, almost everyone participates in the labor force (Pencavel, 1986).

Applying the same logic to the case of emigration, the analysis is undertaken for a sub-sample of Mexican workers who are least likely to emigrate implying that we would observe “all” the individuals and not just the ones who decide not to migrate. In this sub-sample, it cannot be the case that those left behind in schooling-experience cells are different from those who emigrate from these cells simply because almost no one (or very few) emigrate from these cells.

The literature on Mexican migration provides plenty of evidence that some states send more migrants than others due to long-standing regional networks. (The United States Census does not ask the migrant from which state in Mexico does he/she originate). There has also been continuity in the state migration patterns over time (e.g., Woodruff and Zenteno, 2002; Massey and Espinoza, 1997). Woodruff and Zenteno (2002) estimate that the states in central-west Mexico have very high migration rates, with 10–15 percent of the households having an external migrant. There are eight states mostly in southeast Mexico, where 2 percent or less of the households have an external migrant.

I estimate the impact of national emigrant supply shocks on wages of workers in the low migration states of Mexico. The assumption here is that the Mexican labor market is integrated at the margin i.e., that the wage impact of emigration gets transmitted to the economy as a whole.¹⁶ The regression model in equation (1) is estimated using the wages from the sample of workers from the low-migration states. The emigrant supply shocks are national shocks, as measured before. The results for the fully specified regression model are

¹⁶ It is important to note that I am looking at wage adjustments over very long periods of time (10 or 20 years span). Robertson (2000a) also provides evidence for comovement of wages between the interior and border regions of Mexico. Chiquiar (2003) finds that for the period 1970–85, there was convergence in per capita state GDP levels across U.S. states.

shown in Table 3. The estimates of the coefficient of emigration are positive and statistically significant (at the 1 percent level) and similar to that in Table 1 when we consider the wages of the entire sample of workers in Mexico. The fact that the impact of emigrant supply shocks gets transmitted to the country as a whole provides evidence that the results are not driven by sample selection but rather through supply effects that are transmitted throughout the integrated Mexican labor market.¹⁷

D. Endogeneity Issues

Another potential concern about the empirical strategy used for the estimations is the issue of endogeneity i.e., the emigrant supply shock may be correlated with the unobserved component of wages. There is evidence that migration increases when wages decline in Mexico (Hanson and Spilimbergo, 1999; Hanson et al., 2001). If lower wages lead to increased emigration then the estimated coefficient on emigration would be an underestimate of the impact of emigration on Mexican wages.

To check the robustness of the results, I use an instrumental variable (IV) strategy. An ideal instrument should be exogenous to the wages in Mexico and should be strongly correlated with emigration. The sociology literature argues that an important factor driving United States-Mexico migration is social capital, that is, social connections to the U.S. migrants (Massey and Espinoza, 1997). Each migrant creates additional social capital capable of sustaining further migration. I apply this idea and use a measure of networks as an instrument for the emigrant supply shock. Networks are usually based on relatives and friends where schooling and occupation are similar. I use lagged migration rates by schooling as a measure of social networks.¹⁸ The correlation between the past and current emigrant supply measures is high, around 0.8.

The results of the instrumental variable regressions are shown in Table 4. The IV regressions are implemented using the individual wage specification. Specification I includes wages from the full sample of Mexican workers as the dependent variable. Specification II includes the wages of only workers from low migration states. In Specification II, both the concerns—sample-selection and endogeneity, are addressed together. The IV regressions do not include

¹⁷ One potential concern is that lower ability individuals may be migrating internally. However, there is not much evidence for internal migration within Mexico. For 80 percent of the individuals in the sample, the state of current residence is the state of residence five years ago (see also Hanson, 2003). The wage impact could be transmitted to the country as a whole through movement of goods, capital or labor. It is not necessary that there should be *perfect* mobility of labor. How are wage impacts transmitted throughout the country, is an interesting question. However, given the dataset, addressing this question is beyond the scope of the paper and would be an interesting area for future research.

¹⁸ Network connections based on experience may not be very plausible. However, the IV estimate is higher if past migration rate by *schooling and experience* is used as instrument. One potential concern with using lagged explanatory variable as instrument is that if the dependent variable is correlated over time, then the instrument may not be exogenous. However, this is less of a concern here because I am using data over very long periods of time. The concern would be more severe if I were using high-frequency data.

dummies for schooling. This is a necessary identification assumption to use past migration rates by schooling as instrument.

The first stage regression (not shown) indicates a significant and positive relationship between the past and current emigrant supply shocks. In the first stage regression, the coefficient of the lagged emigrant supply shock is 1.0 (s.e. = 0.0) and the R-squared = 0.7. The second stage IV estimate (shown in Table 4) is about 0.3 to 0.4 (se = 0.1). The IV estimate of 0.42 in Table 4 (Specification I) is higher than the non-IV regression estimate of 0.31 (see Table 2). To summarize, the instrumental variable regression results support that emigration has a large and positive effect on Mexican wages.

E. How Long Do the Labor Supply Shocks Last?

In the empirical exercise above, the emigrants are grouped into schooling-experience cells irrespective of how long ago they left Mexico. The emigrant supply shocks are assumed to be permanent. One possibility is that the shocks persist for a shorter duration. The question that follows is how long do the shocks last, and whether the entire stock of emigrants should affect wages in Mexico, even when some of them have been out of the country for two or three decades.

In order to address this concern, I break up the emigrant supply shock into two parts. The emigrant sample is divided into: (i) recent emigrants defined as those who emigrated in the last decade—the 1990 emigrant sample is restricted to those who emigrated between 1980–90, and the 2000 emigrant sample is restricted to those who emigrated between 1990–2000; and (ii) those whose emigrated more than a decade back—the 1990 emigrant sample is restricted to those who emigrated before 1980, and the 2000 emigrant sample is restricted to those who emigrated before 1990.

I run an alternative empirical specification given by:

$$w_{ijt} = \delta_{SR} m_{ijt}^{SR} + \delta_{LR} m_{ijt}^{LR} + s_i + v_j + \pi_t + s_i * \pi_t + v_j * \pi_t + s_i * v_j + \varepsilon_{ijt} \quad (3)$$

where $m_{ijt}^{SR} \equiv \frac{M_{ijt}^{SR}}{N_{ijt}}$, $m_{ijt}^{LR} \equiv \frac{M_{ijt}^{LR}}{N_{ijt}}$; M_{ijt}^{SR} = number of emigrants who migrated in the last decade; and M_{ijt}^{LR} = number of emigrants who migrated more than a decade back. δ_{SR} can be termed as the “short-run” effect, and δ_{LR} can be termed as the “long-run” effect of emigration on wages.

The results are shown in Table 5, column I. Since the sample of emigrants in 1970 is small, I do not include 1970 in the analysis. The estimated short-run effect is 0.34, and it is statistically significant at 1 percent level (p -value = 0.00). The estimated long-run effect is 0.53 (p -value = 0.00). The significant long-run effect suggests that the effect of emigration on wages tends to persist and does not die out over time.

For comparison, the estimates obtained when all emigrants are included in one measure, are shown in column II. The coefficient is 0.42 (p -value = 0.00), it lies in between the short-run and the long-run effect, and can be termed as the “average effect” of emigration on wages. The basic empirical specifications used in the paper essentially capture this “average effect.”

F. Additional Robustness Checks

Alternative categories of experience

To check for the robustness of the results I also allow for alternative experience categories. The workers are divided into eight instead of forty categories as used in the earlier analysis (Table 1). The idea behind having broader experience groups is to allow for the possibility of nonindependence of earnings in adjacent schooling-experience cells, which could be a source of bias in the standard errors. The results are shown in Annex Table 1 (column I). The estimate when broader experience groups are used is much higher than the basic regressions in Table 1, when work experience was divided into finer categories. One possible reason could be that there is measurement error in the emigrant supply shock when using finer experience categories, which leads to attenuation bias in the estimates. Using broader experience categories reduces the measurement error.

Labor demand shocks

The aim of the paper is to isolate the impact of emigration, controlling for other variables that are correlated with emigration and affect wages. If there are labor demand shocks that are correlated with emigration and drive up the wages, then the estimates will be biased. Two possible sources of labor demand shocks are technology shocks and capital flows. However, based on the identification strategy used in the paper, shocks correlated with both emigration and wages, which are not controlled for in the framework must be skill (schooling and experience) specific, and must vary at the schooling-experience-time level. Other shocks are controlled for by the fixed effects and the two-way interactions specified in equation (1).

Positive technological shocks and capital flows to particular schooling-experience cells would increase labor demand. This would increase wages and thus discourage emigration implying that emigration is negatively correlated with the unobserved component of wages. Hence the positive estimates would be biased downwards. In this case, the true effect of emigration on wages would be larger in magnitude than the estimated effect.

However, if there exist technology shocks, which are positively correlated with emigration, then this would imply that the impact of emigration on wages is overestimated and raise serious concerns. For example, there could be positively correlated labor demand shocks in the United States, and Mexican labor markets that raise labor demand and wages in Mexico but also attract Mexican migrants to the United States. To address this concern, I control for average wages in the United States in the schooling-experience-time cell in Annex Table 1, column II. The estimate of the coefficient of emigration is similar to those in the basic specifications. I also control for the average wage of Mexican migrants in the United States in the schooling-experience-time cell. Wages of migrants can be considered as a proxy for

remittances as well. The coefficient on emigration (not shown) is similar to that shown in Annex Table 1, column II.

Undercount of illegal migrants

Another issue is that of undercount of illegal migrants in the United States Census. To correct for the undercount, I make adjustments to the measure of emigrant supply shock making the following two assumptions: (i) all illegal migrants are high school dropouts; and (ii) that the census undercounts by 15 percent or 30 percent the number of emigrants in each of the schooling-experience cells with high school dropouts in the age group of 26–45 (or 9–28 years of experience) (Costanzo et al., 2001, Jordan and Terán, 1996). The basic regression model in equation (1) is estimated by revising the number of emigrants by the estimates of the undercount. The estimates (shown in Annex Table 1, columns III and IV) are similar to the estimates in Table 1. Thus, the results are robust to the undercount of illegal migrants.

Cross skill effects

The empirical specification in equation (1) does not control for emigration in other skill categories. To allow for cross-effects, I augment the empirical specification in equation (1) to allow for emigration in other schooling categories (in the same experience group). The coefficient of emigration in the own schooling-experience cell is constrained to be the same for all schooling groups. The regression model is specified as:

$$w_{ijt} = \delta m_{ijt} + \sum_{s \neq i} \delta_s m_{sjt} + s_i + v_j + \pi_t + s_i * \pi_t + v_j * \pi_t + s_i * v_j + \varepsilon_{ijt} \quad (4)$$

where m_{sjt} is the ratio of emigrants to workers in Mexico in the schooling group $s, s \neq i$, experience cell j , at time t . The estimates (shown in Annex Table 1, column V) of the own-effect (δ) are positive and statistically significant (at least at 5 percent level), and the magnitude is similar to those in Table 1. Additionally, I also control for emigration in two closest experience groups in the same schooling groups, using the individual wage specification. The estimate of the own-effect (not shown) is positive, statistically significant and similar to the estimates in Table 2.

To summarize, controlling for emigration in other schooling groups and experience cells, reinforces the strong and positive own-effect of emigration in a particular skill group on wages in that skill group.

Additional specification checks

Annex Table 2 shows some additional specification checks. Column I shows the result when the regressions in Table 1 are not weighted by the number of Mexican workers in the skill group. Column II shows the results when both males and females are included in the measurement of the emigrant supply shock. Column III controls for the number of Mexican workers in the schooling-experience-time cell to address the concern that changes in the size

of the Mexican workforce due to reasons other than emigration could be driving the results. Column IV shows the result when the migrant sample excludes those who migrated at less than 21 years of age, to increase the likelihood that the migrants received their schooling back in Mexico. The estimates in all these specifications remain positive and statistically significant and comparable to the estimates in Table 1.

V. IMPLICATIONS OF THE RESULTS

There are at least two key quantifiable implications of the impact of emigration on real wages. First, the variation across schooling groups has implications for wage inequality within Mexico. Secondly, the estimated elasticity can be used to compute simple welfare measures based on a standard partial equilibrium model of labor demand and labor supply.

A. Implications for Wage Inequality

Since the mid-1980s, Mexico has experienced a widening wage inequality and this has been attributed mainly to an increase in relative demand for skill owing to trade and investment liberalization in Mexico (Hanson, 2003; Robertson, 2000b; Hanson and Harrison, 1999; Feenstra and Hanson, 1997; and Cragg and Epelbaum, 1996). This section focuses on an alternative channel—the impact of emigration on wage inequality.

The estimates of the effect of emigration on wages (Table 1) can be used to calculate the wage impact in different schooling groups. The estimate of 0.4 implies that a 10 percent decrease in the supply of workers owing to emigration in a particular schooling-experience group increases the wages in that group by 4 percent. To estimate the wage impact of emigration in a particular schooling category, we have to aggregate the impact in all experience cells within that schooling category.

The Ideal Log Change Index Number measures the percentage change in unit labor costs between two time periods. Following Sato (1976), the “Ideal Log Change Index Number”, or the change in log wage for schooling group S between 1970 and 2000, can be expressed as:

$$\Delta \ln w_{S,2000-70} = \sum_j \phi_{jS} \Delta \ln w_{Sj,2000-70} \quad (5)$$

where ϕ_{jS} is the weight for experience cell (j) within a schooling group (S), consistent with the CES production function and can be expressed as:

$$\phi_{jS} = \frac{\Delta E_{jS} / DE_{jS}}{\sum_j (\Delta E_{jS} / DE_{jS})} \quad (6)$$

where E_{jS} is the earning share of experience group j in total earnings in schooling group S , $\Delta E_{jS} = E_{jS,2000} - E_{jS,1970}$; $DE_{jS} = \log E_{jS,2000} - \log E_{jS,1970}$. Using the estimated impact of emigration on wages (column III in Table 1), and using equations (5)–(6),

emigration between 1970 and 2000 increased the wages of high school dropouts by 5 percent of high school graduates by 15 percent, those with some college education by 13 percent, and of college graduates by around 2 percent. Aggregating the wage impact over the schooling groups, the emigrant outflow between 1970 and 2000 increased the wage of the average Mexican worker by 8 percent.

It is useful to look at the estimated increase in wages due to emigration between 1990 and 2000 because the Mexican census data shows increasing wage inequality during this period. As shown in Figure 3, between 1990 and 2000, the relative wages of high school graduates increased by 11 percent, of those with some college education by 21 percent and of college graduates by 8 percent (relative to high school dropouts). Using equations (5) and (6), the outflow of workers between 1990 and 2000 increased the relative wages of high school graduates by 4 percent and those with some college education by 3 percent (relative to high school dropouts). Thus, the estimated impact of emigration accounts for approximately 37 percent of the increase in relative wages of high school graduates and 14 percent of the increase in relative wages of those with some college education. The greater impact of emigration on wages of workers with 12–15 years of schooling is driven by the fact that this group exhibits the highest emigration rates given that we assume constant labor demand elasticity across schooling groups.¹⁹

Emigration does not explain the increase in relative wages of college graduates. The magnitude of the positive effect of emigration on the wages of high school dropouts is higher than that on the wages of college graduates; hence emigration leads to a decrease in the relative wage of college graduates. Since emigration does not explain the entire rise in wage inequality, it should be considered as a complementary explanation for the rising wage inequality in Mexico.

Emigration as a channel to explain increasing wage inequality in developing countries has received little attention in the literature (Robbins 2002). The estimates in the case of Mexico suggest that it could potentially be an important factor.

B. Welfare Implications

In this section, I use the estimated impact of emigration on Mexican wages to compute simple welfare measures based on the standard textbook model of labor demand and supply. The simple economic model of labor demand and supply is an important starting point to quantify the welfare implications and has been used in the literature in the context of immigration and capital flows (Borjas, 1995, MacDougall, 1960). The calculations in this paper differ in one important aspect from that of the gains from immigration that exist in the

¹⁹ I also allow for different coefficients across schooling categories. However, only experience and period fixed effects can be included in these regressions (and not their interactions). The estimates are imprecise but the effect is much higher in the higher schooling categories. One possible reason for the small effect in the lower schooling category could be unemployment.

literature. Prior work calculates the impact based on the estimates of labor demand elasticity drawn from studies unrelated to migration. This paper uses the elasticity of wages with respect to emigration estimated from the Mexican data to undertake the calculations.

Welfare is measured by GDP accruing to those who have stayed behind (TSB) in Mexico. Consider a single good which is the numeraire and its production function is given as:

$$Q = F(K, L) \quad (7)$$

where K is the fixed factor assumed to be internationally immobile, L is the labor employed in production, and Q is the gross domestic product. Figure 4 shows the simple model of labor demand and supply. The initial equilibrium wage is w_0 . A large emigration flow of a magnitude M of workers reduces the labor force from $(N+M)$ to N . The wage rate as a result increases from w_0 to w_1 . The workers who have stayed behind gain an area equal to $w_0 w_1 ab$ (rectangle region A), owners of the fixed factors in the economy lose an area equal to $w_0 w_1 ac$ (rectangle region A+ triangle region B) and the country as a whole loses the triangle abc (region B). The triangle abc (region B) can be termed as the “emigration loss.”

As a fraction of the post-emigration GDP:

$$\text{Emigration loss (triangle B in Figure 4)} = (1/2)sem^2 \quad (8)$$

$$\text{Gain to workers who have stayed behind (rectangle A in Figure 4)} = sem \quad (9)$$

$$\text{Loss to the owners of fixed factors (A +B in Figure 4)} = \frac{1}{2}sem^2 + sem \quad (10)$$

where $e = e_{LL}|_{L=N} = \frac{\Delta w}{\Delta L} \frac{N}{w}$, $s = \frac{wN}{wN + rK}$, $m = \frac{M}{N}$, s is the share of labor in GDP, e is the percent change in wages due to a 1 percent change in the labor force, where the elasticity is measured at the post-emigration labor-force and m is the ratio of emigrants to the workforce in Mexico. The expressions in equations (8)–(10) are analogous to Borjas (1995) study of immigration.

The emigration loss and distributive impact as a result of the flow of workers between 1970 and 2000 can be estimated using equations (8)–(10). From Section V, the estimated change in wages of a typical worker in Mexico due to flow of emigrants between 1970 and 2000 ($e * m$) is around 8 percent. The assumed share of labor income in GDP (s) is 0.7 (Borjas, 1995 and 2003; Hall and Jones, 1999).²⁰ The emigrant share of the Mexican workforce (m)

²⁰ According to Mexico’s national accounts, the labor share of GDP is about 0.35; this figure seems to be highly underestimated. However, the welfare results are qualitatively unchanged under the alternative estimate of the labor share.

estimated from the 2000 Mexican and United States censuses is about 16 percent (including men and women).²¹

The estimated emigration loss to Mexico is about 0.5 percent of Mexico's GDP in 2000. The economic loss from emigration in a \$580 billion economy is about \$3 billion per year. The gain to the workers who have stayed behind is about 5.9 percent of GDP and the loss to the owners of the fixed factors is about 6.4 percent of GDP, the difference being the estimated aggregate economic loss to Mexico. Thus, the estimated distributive impact is about 12–13 times the aggregate economic loss to Mexico.

VI. CONCLUSIONS

This paper presents the first attempt to estimate the effect of emigration on national wages in a source country. The main result is that there is a strong and positive relationship between emigration and wages in Mexico. The impact of emigration on wages has important implications for wage inequality across schooling groups and for national income distribution between labor and other factors, which are assumed to be immobile in this paper.

The measured welfare impact on those who have stayed behind in the sending country is based on a simple static partial equilibrium framework. There may be other counteracting forces like the impact on human capital formation, positive external effects through networks and diaspora, remittances, and so forth, that can outweigh this loss and result in a net benefit to the source country. Also, if Mexico has some market power in the global economy, emigration may affect Mexico's terms of trade. Quantifying these additional channels through which emigration can affect the welfare of Mexican workers who have stayed behind, is a subject for further research.

²¹ The elasticity estimate used in the welfare calculations is from Table 1 (when only men are included in the analysis). However, the estimate is very similar when women are included (see Annex Table 2, column II).

Table 1. Estimated Effect of Emigration on Mexican Wages, 1970–2000

Dependent variable: Average Real Monthly Earnings (in logs)
in Schooling-Experience-Time Cell (i, j, t) in Mexico

	I	II	III
Ratio of the number of emigrants to the workforce in Mexico in cell (i, j, t)	0.33*** (0.06)	0.42*** (0.08)	0.44*** (0.10)
<i>p</i> -value	0.00	0.00	0.01
Schooling, experience and time fixed effects	Yes	Yes	Yes
Interaction between schooling and time fixed effects	No	Yes	Yes
Interaction between experience and time fixed effects	No	Yes	Yes
Interaction between schooling and experience fixed effects	No	No	Yes

Notes: There are 840 observations. The total number of schooling-experience-time cells is $7 \times 40 \times 3 = 840$. The standard errors reported (in parentheses) have been corrected for heteroskedasticity using White's correction. The regressions are weighted by the number of workers in Mexico in schooling-experience-time cell. *** indicates statistical significance at 1 percent level. An emigrant from Mexico in the United States is defined as a person whom the United States census records as being born in Mexico. A worker in Mexico is defined as a person who is counted by the Mexican census as residing in Mexico in a given year and is a part of the labor force.

Table 2. Estimated Effect of Emigration on Mexican Wages: Individual Wage Regressions, 1970–2000

Dependent Variable: Log Real Monthly Earnings of Individual Workers in Mexico

Ratio of the number of emigrants to the workforce in Mexico in the individual worker's schooling-experience-time cell	0.31*** (0.06)
<i>p</i> -value	0.00
Experience, experience squared, dummies for schooling, year, interaction of year dummy with schooling dummy and experience	Yes
Dummies for marital status, nativity, occupation, industry, state, interaction of year dummy with marital status, nativity, occupation, industry, state	Yes
Number of observations	321,346
R-squared	0.46

Notes: The standard errors (in parentheses) are adjusted for clustering at schooling-experience-time level. *** indicates statistical significance at 1 percent level. The principal regressor—ratio of emigrants to workforce in Mexico—measures the emigrant supply shock in the individual worker's schooling-experience-time cell. This is a group variable and is the same for all the individuals in the same schooling-experience-time cell. The data on Mexican wages are from a 1 percent random sample of the Mexican population in 1970, 1990 and 2000.

Table 3. Estimated Effect of Emigration on Mexican Wages: Sample Selection, 1970–2000

Dependent Variable: Average Real Monthly Sarnings (in logs) in Schooling-Experience-Time Cell (i, j, t) of Workers in Mexico from Low-Migration States

	I	II	III
Ratio of the number of emigrants to the workforce in Mexico in cell (i, j, t)	0.32*** (0.10)	0.54*** (0.11)	0.54*** (0.13)
<i>p</i> -value	0.00	0.00	0.00
Schooling, experience and time fixed effects	Yes	Yes	Yes
Interaction between schooling and time fixed effects	No	Yes	Yes
Interaction between experience and time fixed effects	No	Yes	Yes
Interaction between schooling and experience fixed effects	No	No	Yes

Notes: There are 840 observations. The total number of schooling-experience-time cells is $7 \times 40 \times 3 = 840$. The standard errors reported (in parentheses) have been corrected for heteroskedasticity using White's correction. The regressions are weighted by the number of workers in Mexico in schooling-experience time cell (i, j, t) . *** indicates statistical significance at 1 percent level. The wages are only for workers in eight low migration states of Baja California Sur, Campeche, Chiapas, Distrito Federal, Quintana Roo, Sonora, Tabasco and Yucatan. The emigrant supply shocks are national emigrant supply shocks for Mexico as a whole.

Table 4. Estimated Effect of Emigration on Mexican Wages: Instrumental Variable, 1990–2000

Dependent Variable: Log Real Monthly Earnings of Individual Workers in Mexico in 1990 and 2000

	I	II
	Full Sample of Workers in Mexico	Restricted Sub-Sample of Workers from Low Migration States in Mexico
Emigrant supply shock in 1990 and 2000 in the worker's schooling- experience group instrumented with emigrant supply shock in 1970, 1990 in the worker's schooling group	0.42*** (0.09)	0.32*** (0.09)
<i>p</i> -value	0.00	0.00
Number of observations	261,246	59,764
R-squared	0.36	0.42

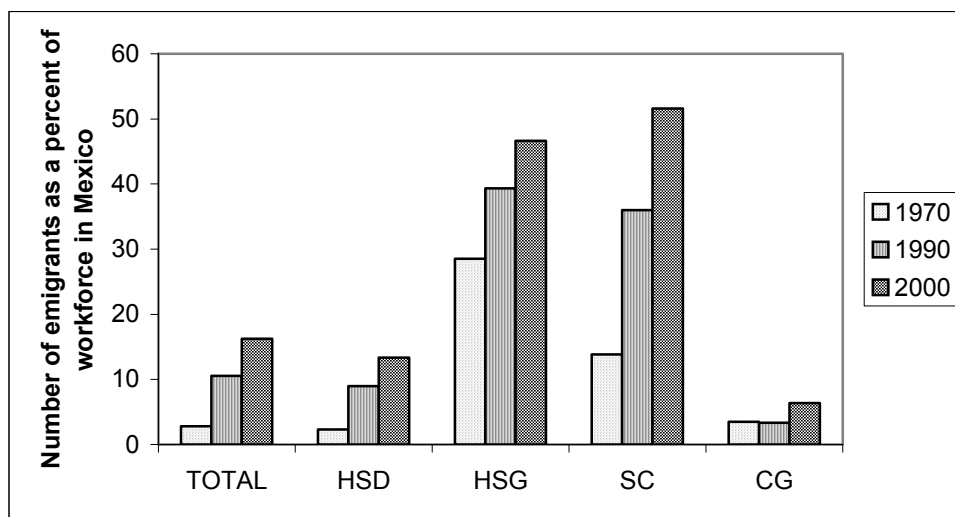
Notes: The standard errors (in parentheses) are adjusted for clustering at schooling-experience-time level. *** indicates statistical significance at 1 percent level. In the first stage regression, emigrant supply shock in 1990 and 2000 in a worker's skill group is regressed on lagged emigrant supply shocks in 1970 and 1990 in the worker's schooling group. The coefficient of lagged emigration is 1.00 and 0.97 (s.e. = 0.0) in specifications I and II respectively and the R-squared of the first stage regressions in both the specifications is 0.7. The first and second stage regressions include experience, experience squared, dummies for year, nativity, marital status, occupation, industry, state, and interactions of the year dummies with experience, nativity, marital status, occupation, industry and state.

Table 5. Estimated Effect of Emigration on Mexican Wages, 1990–2000

Alternative Definition of Emigrant Supply Shocks		
	I	II
Emigrant supply shock with recent migrants (who came within the last ten years)	0.34*** (0.08)	
<i>p</i> -value	0.00	
Emigrant supply shock with those migrants who have been out of the country for more than a decade	0.53*** (0.10)	
<i>p</i> -value	0.00	
Emigrant supply shock with all emigrants included		0.42*** (0.08)
<i>p</i> -value		0.00
Number of observations	560	560

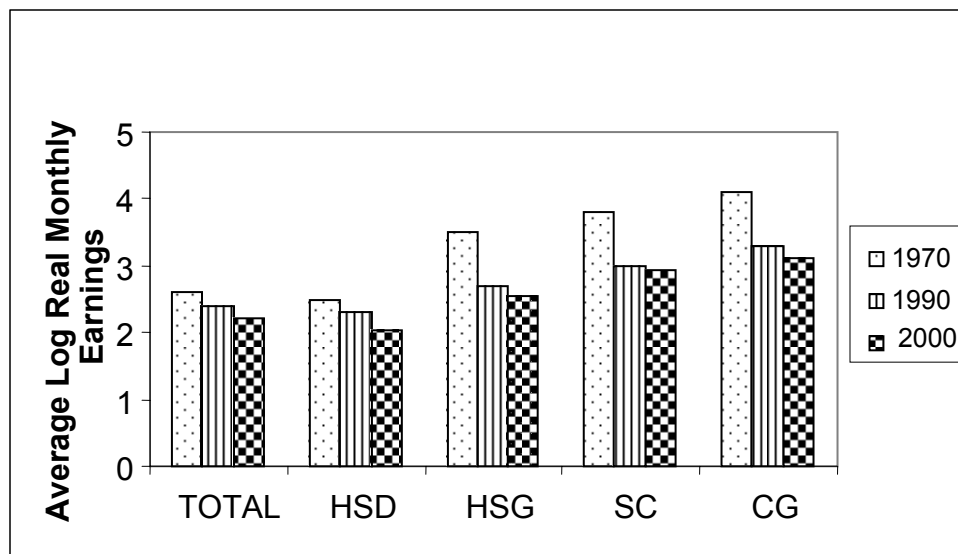
Notes: The standard errors reported (in parentheses) have been corrected for heteroskedasticity using White's correction. The regressions are weighted by the number of workers in Mexico in schooling-experience time cell (i, j, t) . *** indicates statistical significance at 1 percent level. The regressions include fixed effects for schooling, experience, time and all the two-way interactions.

Figure 1. Emigrant Supply Shock: By Schooling



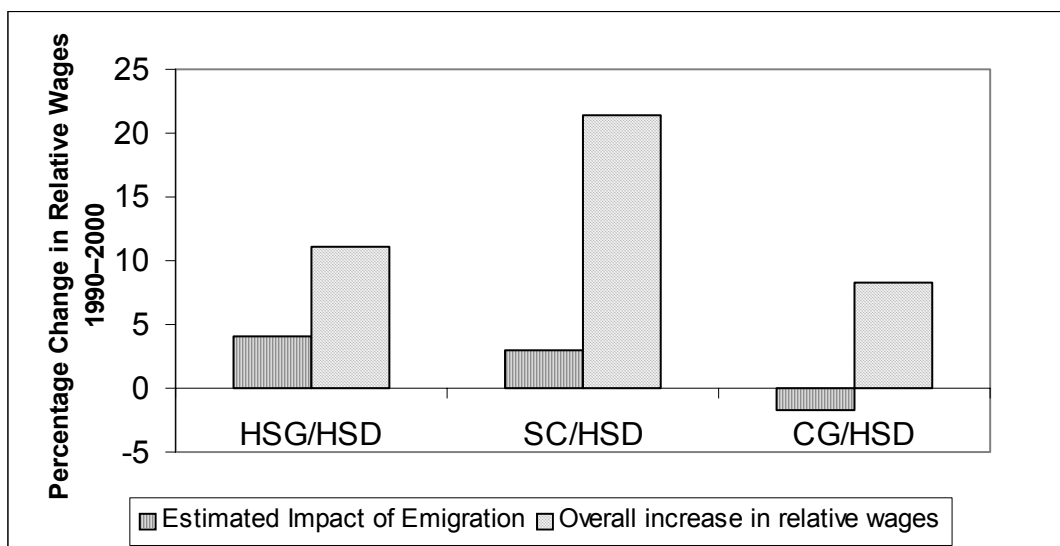
Notes: HSD = High School Dropouts (less than 12 years of schooling), HSG = High School Graduates (12 years of schooling), SC = those with some college (13–15 years of schooling), CG = College Graduates (16 or more years of schooling). All the figures are for males in the labor force, who were not enrolled in school at the time of the census, and have experience in the range of 1–40 years. An emigrant is defined as a person counted by the United States Census as being born in Mexico in a given year. A worker in Mexico is defined as person counted by the Mexican Census as residing in Mexico in the same year and is a part of the labor force in Mexico.

Figure 2. Real Wages in Mexico: By Schooling



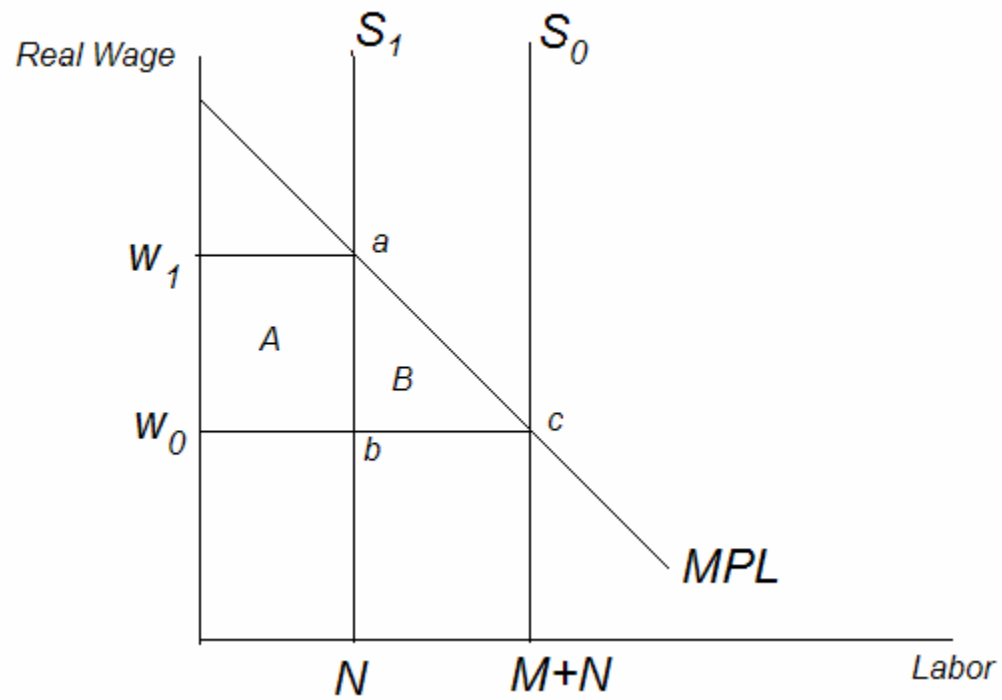
Notes: The wages shown above are the average of the logarithm of real monthly earnings. Monthly earnings are deflated by the CPI from the IMF. The figures are for males, in the labor force, who are not enrolled in school, and have work experience of 1–40 years, and report positive monthly earnings. HSD = High School Dropouts, HSG = High School Graduates, SC = those with some college, CG = College Graduates.

Figure 3. Wage Inequality in Mexico, 1990–2000



Notes: The figures are for males, in the labor force, who are not enrolled in school, and have work experience of 1–40 years, and report positive monthly earnings. HSD = High School Dropouts, HSG = High School Graduates, SC = those with some college, CG = College Graduates. Relative wages are measured by the ratio of the real monthly earnings in schooling category s ($s = \text{HSG, SC, CG}$) to the real monthly earnings of HSD. Monthly earnings are deflated by the CPI from the IMF.

Figure 4. Labor Demand-Supply Model: Welfare Impact of Emigration



Annex Table 1: Robustness Checks

	I	II	III	IV	V
	Eight Experience Groups	Controlling for Average Wages in the U.S. in Schooling- Experience- Time Cell	15 Percent Under- count of Illegal Migrants in the Census	30 Percent Undercount of Illegal Migrants in the Census	Controlling for Cross- Schooling Effects
Ratio of emigrants to the workforce in Mexico	1.1** (0.48)	0.38** (0.16)	0.42*** (0.15)	0.45*** (0.15)	0.31** (0.16)
<i>p</i> -value	0.03	0.02	0.01	0.00	0.05

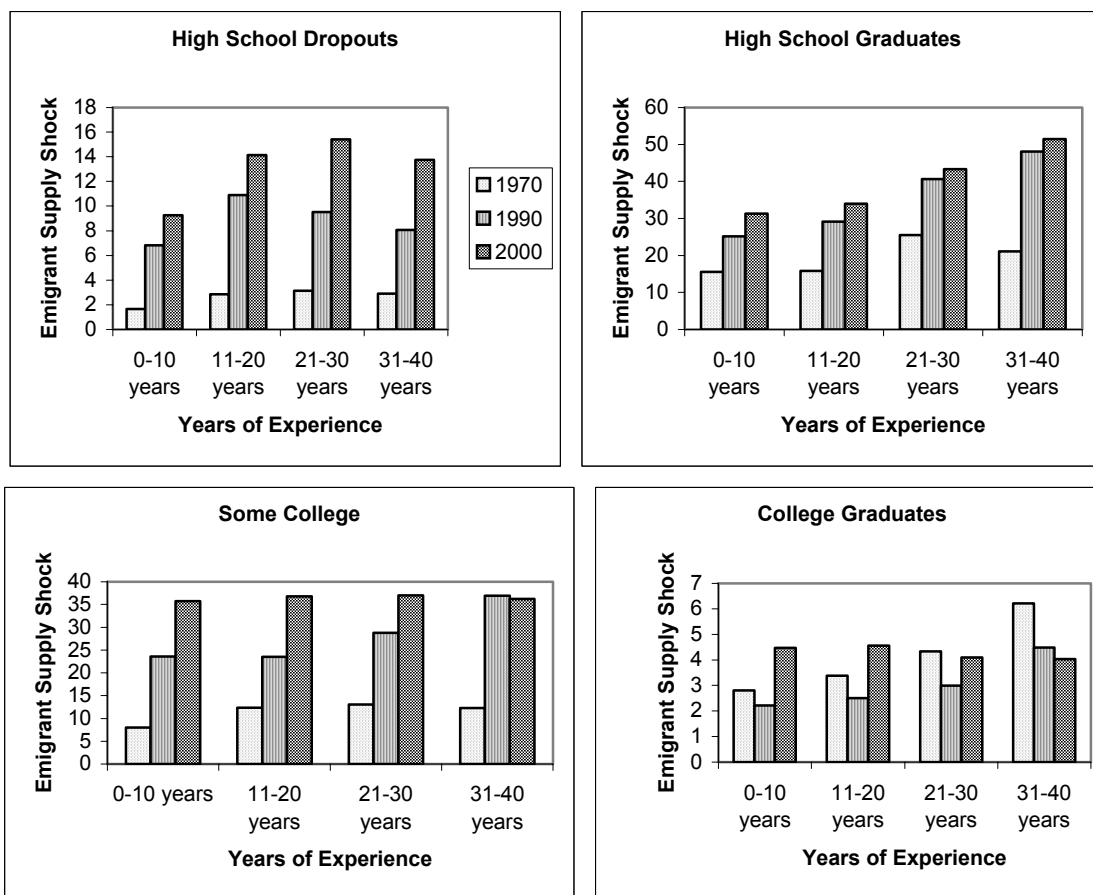
Notes: The standard errors reported (in parentheses) have been corrected for heteroskedasticity using White's correction. The regressions are weighted by the number of workers in Mexico in schooling-experience time cell (i, j, t) . ***, ** and * indicate statistical significance at 1 percent, 5 percent and 10 percent level respectively. All regressions include fixed effects for schooling, experience, time and all the two-way interactions.

Annex Table 2: Additional Specification Checks

	I	II	III	IV
	Unweighted	Females Included	Size of the Mexican Workforce (in logs) as Additional Regressor	Age at Arrival of the Emigrants Restricted to 21 years or More
Ratio of emigrants to the workforce in Mexico	0.35** (0.16)	0.30** (0.14)	0.33** (0.16)	0.55* (0.29)
<i>p</i> -value	0.03	0.03	0.03	0.06

Note: The standard errors reported (in parentheses) have been corrected for heteroskedasticity using White's correction. The regressions except in column I, are weighted by the number of workers in Mexico in schooling-experience time cell (i, j, t) . ** and * indicate statistical significance at 5 percent and 10 percent level respectively. All regressions include fixed effects for schooling, experience, time and all the two-way interactions.

Annex Figure 1. Emigrant Supply Shock: By Schooling and Experience



Notes: The emigrant supply shock is defined as the ratio of Mexican-born emigrants in the United States to the workforce in Mexico. The estimates are for males, in the labor force, who are not enrolled in school, and have work experience of 1–40 years. The emigrant sample excludes those who migrated at an age of less than 17 years.

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