The Great Mexican Emigration

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Abstract. In this paper, we examine net emigration from Mexico over the period 1960 to 2000. The data are consistent with labor-supply shocks having made a substantial contribution to Mexican emigration, accounting for two fifths of Mexican labor flows to the U.S. over the last two decades of the 20th century. Net emigration rates by Mexican state birth-year cohort display a strong positive correlation with the initial size of the Mexican cohort, relative to the corresponding U.S. cohort. In states with long histories of emigration, the effects of cohort size on emigration are relatively strong, consistent with the existence pre-existing networks.

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1. Introduction

In the last two and a half decades, migration from Mexico to the U.S. has surged. As a share of Mexico's national population, the number of Mexican immigrants living in the U.S. remained at 1.5% from 1960 to 1970, before rising to 3.3% in 1980, 5.2% in 1990, and 10.2% in 2005. Mexico is by far and away the largest source country for U.S. immigration, accounting for one third of the current U.S. foreign-born population.

Mexico-to-U.S. labor flows are a major policy issue for both countries. The U.S. spends large sums on enforcing borders against illegal immigration. In Mexico, the exodus of labor has reduced the population of working-age adults (Hanson, 2006), while creating a financial windfall in the form of remittances (Woodruff and Zenteno, 2006). Given the importance of migration for labor markets in North America, it is surprising there is little academic research on the *scale* of regional labor flows. Existing literature provides scant analysis of why–despite longstanding income differences between Mexico and the U.S.–labor outflows from Mexico have grown dramatically only recently.

There is work on other aspects of Mexican emigration, including how labor flows affect U.S. and Mexican wages (Mishra, 2006; Borjas and Katz, 2007; Aydemir and Borjas, 2007), the self-selection of emigrants (Chiquiar and Hanson, 2005; Ibarraran and Lubotsky, 2007; Fernandez-Huertas, 2006), and the assimilation of immigrants in the U.S. (Borjas, 1996; Grogger and Trejo, 2002; Smith, 2003; Blau and Kahn, 2007).[1] While there is research on individual migration decisions (Taylor, 1987; Massey and Espinosa, 1997; Orrenius and Zavodny, 2005; McKenzie and Rapoport, 2007), much of this work uses data from Mexican communities chosen for having high migration rates, making the

[1] See Hanson (2006) for a review of literature on Mexico-U.S. migration and Massey and Zenteno (1999) for work on migration dynamics using the Mexican Migration Project data.

results difficult to generalize to the country as a whole.

In this paper, we examine net emigration from Mexico from 1960 to 2000. To measure net labor outflows, we compare the size of birth cohorts in Mexican states between decennial censuses. By taking state birth cohorts as the unit of analysis, we ignore how migration varies with schooling, income, or other individual characteristics, on which previous literature dwells. The advantage of our approach is that we can study emigration across regions within Mexico over long time periods, during which there have been large changes in labor-market conditions in the country relative to the U.S.

One seemingly obvious explanation for labor outflows from Mexico–which to date has received little attention in the literature–is that labor supply in Mexico has grown relative to the U.S., putting downward pressure on relative wages and making emigration more attractive.[2] Figure 1 shows that the U.S. baby boom matched rapid population growth in Mexico between 1940 and 1960. Subsequently, Mexican birth cohorts continued to grow for another two decades, while the size of U.S birth cohorts actually began to fall. Between 1960 and 1980, there was a large shift in the relative size of U.S.-Mexican cohorts, from 4:1 to less than 2:1. Given that birth cohorts enter the labor market with a 15-20 year lag, the labor supply effects should have triggered emigration from Mexico beginning in the late 1970s, consistent with observed patterns. The focus of our analysis is to assess the contribution of relative labor supply shocks over the last four decades to Mexico's great wave of emigration.

There are clearly other factors besides labor supply that affect Mexican labor outflows. Since 1980, Mexico has been beset by periodic financial crises. Its per capita

[2] There is cross-country evidence on the relationship between demographic structure and international migration. See Hatton and Williamson (2003, 2005).

GDP fell sharply in 1983 (after the onset of the Mexican debt crisis) and again in 1995 (after the Mexican peso crisis), leaving the difference in Mexico-U.S. per capita income in 2005 little changed relative to two-and-a-half decades before (Table 1). Previous work finds that Mexico-to-U.S. migration increases following real wage declines (Hanson and Spilimbergo, 1999; Orrenius and Zavodny, 2005). U.S. immigration policy and migrant networks also affect migration. Illegal immigrants appear to account for most new arrivals from Mexico in the U.S. With the buildup in U.S. border enforcement since 1990, the fees smugglers charge migrants at the border have risen (Gathman, 2004). At the same time, expanding migrant networks have made moving abroad more attractive (Munshi, 2003; Orrenius and Zavodny, 2005). In the presence of network effects, migration may be self-reinforcing (Carrington et al., 1996). Our empirical framework attempts to control for how these other shocks have affected Mexican emigration.

In section 2, we present data on net labor outflows. In section 3, we outline a simple dynamic model of emigration, which yields an estimating equation that specifies the current emigration rate for a cohort in Mexico as a function of initial differences in Mexico-U.S. labor supply, plus other controls. The model allows for migration networks and for internal migration within Mexico. In section 4, we present estimation results, in which we control for the initial level of development in Mexican states, subsequent shocks to GDP, migration costs, and other factors.

To preview the findings, the data are consistent with labor-supply shocks having made a substantial contribution to Mexican emigration to the U.S. Our estimates indicate that Mexican population growth can account for two fifths of total out-migration for the 20 years prior to 1997. Initial cohort size in Mexico (relative to the U.S.) has a strong positive correlation with net emigration rates by Mexican state. The effects of cohort size are strongest in states with long histories of migration, consistent with network effects. Looking forward in time, as we do in section 5, recent rapid declines in Mexican fertility should diminish binational differences in labor-supply growth as a motivation for emigration from Mexico. The total fertility rate in Mexico was 7 in 1965, which then plummeted over the next several decades, dropping to 2.5 by 2000, close to the U.S. level of 2.1 (Tuiran et al, 2002). Holding other factors constant, the dramatic decline in Mexico's population growth implies that emigration rates from Mexico should peak with the 1980 birth cohort and decline for successive birth cohorts, such that those born in 2010 would have emigration rates less than half as large as those born in 1980.

2. Data

To calculate labor outflows from Mexico, we use the net-migration method, which takes Mexican state/gender/birth-year cohorts as the unit of analysis, and apply it to data from Mexico's population censuses in 1960, 1970, 1990, and 2000.[3] We begin by identifying the base size for a cohort, which is the population the first time a cohort is observed in the census. For example, we can count the number of men born in the state of Zacatecas aged 8 who appear in the 1960 Mexican census. By then observing how many men born in Zacatecas are age 18 in the 1970 census, age 38 in the 1990 census, and age 48 in the 2000 census, we are able to construct a series of 10-year emigration rates that are specific to gender, age, state of birth, and year of birth. For birth year i, gender j, and birth state s, the fraction of individuals which has emigrated as of time t is,

[3] Data are from www.Ipums.umn.edu. The 1980 census was conducted but never made available.

$$(1) \qquad m_{ijst} = \frac{base\ cohort\ size_{ijs} - current\ cohort\ size_{ijst}}{base\ cohort\ size_{ijs}}.$$

The ten-year time difference in m_{ijst} is the decadal emigration rate.[4] In the regression analysis, we exclude cohorts younger than 16, since their emigration is likely due to decisions made by their parents, or older than 50, after which age few individuals emigrate. These restrictions leave us with 6,081 observations on 10-year net emigration rates for cohorts born between 1920 and 1984.

The net-migration method has several advantages. At a mechanical level, because the Mexican census asks both the state of birth and the state of residence, we can calculate net emigration over the state of birth and avoid the bias in population by state of residence that results from internal migration within Mexico.[5] A more nuanced advantage can be seen in the debate over the composition of Mexican migrants to the U.S. Studies on Mexican immigrants using U.S. data find that emigrants have schooling levels close to Mexico's national mean (e.g., Chiquiar and Hanson, 2005; Orrenius and Zavodny, 2005), while some analyses based on Mexican data (which contain information on which family members have emigrated) find emigrants have below mean schooling (e.g., Ibarraran and Lubotsky, 2007; Fernandez-Hertas, 2007). Either data source is subject to bias, as the U.S. census may undercount lower-skilled recent immigrants, and estimates of migration based on Mexican household data miss higher-skilled households that have emigrated in their entirety. Martinez and Woodruff (2007) find that the net-migration method generates estimates of total emigration and emigrant schooling

[4] Wherever possible the base cohort size is taken from a cohort between the ages of one and ten. However in the case of cohorts born before 1950 or born between 1970 and 1980 we have no census which lets us measure this quantity, and so we use instead the population at the time the cohort first appears in the data.
[5] The U.S. census asks the country but not the state of birth for immigrants, and hence does not allow us to observe sub-national Mexican variation in labor supply or migration.

between those arising from U.S. and Mexican data, suggesting this method may be less subject to biases affecting other approaches.[6]

One concern about the net-migration method is that estimates tend to be noisy, particularly when constructed from the 1% population samples available for the 1960 and 1970 censuses. Also, older respondents appear to round their age (Martinez and Woodruff, 2006), which could cause us to misestimate age-specific net migration rates. The following table on cohort sizes and age illustrates this problem in a simple way:

	Age ends in 0,5	Age doesn't end in 0,5	Test of difference
Log base MX cohort size	9.588	9.632	0.044
	(0.034)	(0.016)	(0.038)
Subsequent migration rate	0.032	0.145	0.114
	(0.006)	(0.003)	(0.006)**

Standard errors in parentheses, ** significant at 1%

There is no significant difference in base size between cohorts whose age ends in 0 or 5 and other cohorts, meaning there is little misreporting in the ages of young children. However, the subsequent net emigration of cohorts ending in 0 or 5 is less than a quarter the rate of other cohorts. As respondents age, misreporting may cause them to 'leave' unrounded cohorts and 'enter' rounded cohorts. We address the issue by aggregating cohorts around years in which rounding occurs, using three- or five-year intervals.[7]

A final concern arises as a result of cohort-specific mortality. Martinez and Woodruff (2006), who use only 1990 and 2000 data, correct their net-migration estimates

[6] See Buck et al. (2007) for an application of the net-migration method in Brazil and Mexico.
[7] Age-specific fixed effects will absorb systematic errors in estimates of net migration which are particular to individuals of a given age. The three-year aggregation scheme calculates cohorts using birth years 1959, 60, and 61; then 62 and 63; then 64, 65, and 66; etc.; and the five-year scheme calculates cohorts using birth years 1958-62, then 63-67, etc. The intent is to center cohorts around years in which rounding occurs, thereby decreasing the likelihood that an individual is placed in the wrong birth cohort.

using cohort- and age-specific mortality rates. However, no such data exist for 1960 or 1970, and Mexican mortality data are based on the state in which the individual dies, making it impossible to ascribe mortality to the state of birth. For the period from 1990 to 2000, mortality is a non-negligible share of the observed net migration. In cohorts aged 23-27, only 8.8% of the observed decrease in cohort size comes from mortality, but in cohorts aged 43-47 observed net migration has fallen to 7.4% and mortality is 3.1%, meaning that deaths account for 42% of the missing individuals. Since we use state and birth-year fixed effects, mortality would introduce bias into our parameter estimates only if there is variation that is both cross-state and cross-time. To examine this possibility, we regress 2000 state/cohort-level mortality rates on 1990 rates, including fixed effects for the state and five-year birth-year cohorts. The R^2 in the regression is 0.96, suggesting that the fixed effects absorb most (but not all) of the regional heterogeneity in mortality[8]

Subject to these caveats, what do estimates of net-migration tell us? Not surprisingly, net labor outflows from Mexico have increased sharply over time. In 1970, 57,000 individuals aged 26 had left Mexico over the previous decade, in 1990 165,000 26-year olds had left over the previous decade, and in 2000 336,000 individuals had left over the previous decade. Figure 2 plots smoothed age- and gender-specific net emigration rates. For men, a substantial fraction of individuals migrate by age 16, with emigration increasing sharply until around 30 and decreasing thereafter, presumably as a result of return migration. The pattern for women is different. There is less emigration by age 16, with subsequent rates being relatively stable over the course of their lives. By age 50, women have a net emigration rate that is similar to that for men.

[8] In addition, an unreported analysis of the 1990-2000 changes in birth cohort ratios and cohort-level mortality rates found the cross-state, cross-time correlation in these variables to be insignificant.

To examine how labor supply affects emigration from Mexico, we exploit inter-temporal and inter-regional variation in the relative size of birth cohorts. Table 1 shows the data behind Figure 1. The increase in Mexico's population relative to the U.S. is a result of differences in the timing of the demographic transition in the two countries. In the U.S., fertility rates began to fall in the late 1950s, while in Mexico they did not drop for another two decades. Between 1950 and 1980, the Mexico-U.S. ratio of birth cohort size grew from 0.31 to 0.66.

Table 1 also shows the number of U.S. natives that fail to complete high school according to birth year (where the number of high school dropouts is measured the first time a cohort is observed after age 19).[9] U.S. high school dropouts are the group Mexican immigrants appear mostly likely to compete with (Aydemir and Borjas, 2007). As the share of U.S. natives without a high school education has declined, Mexico's relative labor supply has grown. In 1970, the ratio of 20-year olds born in Mexico to 20-year old high school dropouts born in the U.S. was 2.45; by 1990, it was 4.99.

Within Mexico, there is considerable regional variation in the timing of fertility declines. Figure 3 plots the number of children ever born to women over age 40 by year of birth for the states that represent the quintiles of the 1960 distribution of fertility rates. Fertility is lower and the demographic transition occurs earlier in wealthy, industrialized states, such as the Federal District, whereas states in Mexico's poor south, such as Chiapas, have a quite different fertility trajectory. This cross-state, cross-time variation in the timing of the demographic transition provides the identification for our analysis of Mexican labor supply shocks. Explanations for heterogeneity in timing include

[9] For cohorts aged 16-19 we use the number of US high school dropouts observed in the *following* US census so as to avoid miscounting the size of cohorts which are still acquiring high school education.

differential changes in female job opportunities, industrialization, mortality, or inequality across states (Tuiran et al, 2002). Because realizations on migration are observed between 16 and 50 years after the shifts which caused the changes in birth cohort size, we take these changes to be pre-determined for our analysis. We assume that, given state, year, and cohort fixed effects, the most plausible explanation for correlation between state-level birth cohort size and subsequent migration is the cohort size itself. Of course, the size of birth cohorts may summarize more about a state than its labor supply. In section 4, we discuss alternative interpretations of our results.

Another source of variation among Mexican states is the strength and persistence of migration networks. The correlation in state-level emigration rates to the U.S. from the mid 1950s with those from the mid 1990s is 0.72 (Hanson, 2006). The literature relates the emergence of migration networks in Mexico to the hiring practices of U.S. agriculture, which utilized Mexico's railroad network to recruit workers in the country's interior. Communities close to rail lines have had the highest emigration rates in the country since at least the 1920s (Durand, Massey, and Zenteno, 2001). Following Woodruff and Zenteno (2006), we proxy for the strength of migration networks using historical state-level migration rates and state access to Mexico's railroad network.

3. Theory

3.1 Model

To understand emigration from Mexico, consider a model of two national labor markets that are linked by migration. In each economy, there is one sector of production. Workers from Mexico are differentiated by age but are not otherwise distinguished by their skill.[10] To highlight the workings of the model, we suppress internal migration in Mexico. An appendix extends the model to allow for internal migration. Our specifications of labor demand and labor-mobility costs build on the models of internal migration in Blanchard and Katz (1992) and Borjas (2006).

In Mexico, the national wage for age group i at time t is given by,

$$W_{it} = X_{it}(L_{it})^{\eta}, \tag{2}$$

where W_{it} is the wage, X_{it} is a labor-demand shifter, L_{it} is the population of working-age adults in Mexico, and $\eta \leq 0$ is the inverse labor-demand elasticity. The supply of labor in Mexico is the population of group i that has not emigrated, such that

$$L_{it} = L_{i0} - M_{it} \tag{3}$$

where L_{i0} is the pre-emigration population of group i and M_{it} is the number of individuals in i that have emigrated to the U.S. by period t. Putting (2) and (3) together,

$$\ln W_{it} = \ln X_{it} + \eta \ln L_{i0} - \eta m_{it}, \tag{4}$$

where $m_{it}=M_{it}/L_{i0}$ is the fraction of group i in Mexico that has emigrated.[11]

An individual in Mexico has the option of staying in the country or moving to the U.S., in which the wage for experience group i is

$$W^*_{it} = X^*_{it}(L^*_{i0} + \tau M_{it})^{\eta}, \tag{5}$$

where W^*_{it} is the U.S. wage, X^*_{it} is the U.S. labor-demand shifter, $\tau \in [0,1]$ is the productivity discount associated with immigrant labor, L^*_{i0} is the U.S. labor supply (assumed equal to the population of U.S. native-born high school dropouts), and η is the inverse labor-demand elasticity, assumed equal to that in Mexico.

[10] We ignore other aspects of skill because in order to measure net migration by state of birth in Mexico we need to track populations by characteristics which are invariant to time.
[11] In (4), we utilize the approximation that, for small values of X/Y, $\ln(X+Y) \approx \ln X + Y/X$.

The wage equation in (5) implies that when expressed in *productivity-equivalent units*, native and immigrant labor in the U.S. are perfect substitutes.[12] However, the productivity discount, τ, ensures that one immigrant worker substitutes for less than one native worker. Immigrant workers may be less productive because they are less-educated, have a weaker command of English, or are less knowledgeable about U.S. production practices. Expressing (5) in log form,

$$\ln W_{it}^{*} = \ln X_{it}^{*} + \eta \ln L_{i0}^{*} + \eta\tau\lambda m_{it}, \tag{6}$$

where $\lambda = L_{i0}/L^{*}_{i0}$ is the relative size of Mexico's initial population.

To allow for adjustment costs in labor mobility between countries, we assume that migration from Mexico to the U.S. in any period t is a function of the lagged difference in wages between the two countries:

$$v_{it}^{*} = \sigma^{*}\left(\ln W_{i,t-1}^{*} - \ln W_{i,t-1} - C_{i,t-1}\right), \tag{7}$$

where $v_{it}^{*} = \Delta M_{it} / L_{i0}$ is the net emigration rate for group i in Mexico at time t, σ^{*} is the supply elasticity, and $C_{i,t-1}$ is a wage discount that Mexican nationals associate with living in the U.S. The wage discount reflects the disamenity of living in the U.S. To capture network effects associated with emigration, we assume this disamenity is decreasing in the fraction of an individual's cohort that has previously migrated abroad, such that

$$C_{i,t} = C - \gamma \sum_{s=1}^{t-1} v_{is} \tag{8}$$

where we assume $0 \le \gamma \le C$ (to ensure migration stops at or before U.S. and Mexican wages are equalized). Using (7) and (8), the period t emigration rate from Mexico is,

[12] U.S. evidence on the substitutability of native and immigrant labor is mixed. While Aydemir and Borjas (2007) find native and immigrant workers are perfect substitutes (within skill groups), Ottaviano and Peri (2006) find they are not. Borjas, Grogger, and Hanson (2008) show that once one adopts conventional definitions of who is in the labor force, Ottaviano and Peri's results also support perfect substitutability.

(9) $$v_{it}^{*} = \sigma^{*}\left(\ln W_{i,t-1}^{*} - \ln W_{i,t-1} + \gamma\sum_{r=1}^{t-1} v_{ir} - C \right).$$

A larger existing stock of emigrants in the U.S. makes future emigration more attractive. In (9), migration networks operate within cohorts (through siblings and cousins) rather than between cohorts (through fathers and uncles).[13] In the empirical analysis, we control for networks between cohorts by allowing for birth-state fixed effects and by letting the supply elasticity, σ^{*}, vary according to the strength of historical migration networks.

To solve the model, define the pre-migration effective wage differential between the U.S. and Mexico as,

(10) $$\omega_{i0}^{*} = \ln W_{i0}^{*} - \ln W_{i0} - C = \eta \ln \ell_{i0}^{*} + \ln x_{i0}^{*} - C .$$

where $\ln \ell_{i0}^{*} = \ln L_{i0}^{*} - \ln L_{i0}$ is the log difference in U.S. and Mexico initial labor supplies and $\ln x_{i0}^{*} = \ln X_{i0}^{*} - \ln X_{i0}$ is the log difference in U.S. and Mexico initial labor demand shifters. The U.S.-Mexico pre-migration wage difference is decreasing in U.S.-Mexico relative labor supply (since $\eta < 0$), increasing in U.S.-Mexico relative labor demand, and decreasing in the migration disamenity.[14] Using (4), (6), and (9), we solve for the $t = 0$ emigration rate, and then iterate forward, solving for the wage and emigration rate in each period. This reveals that the emigration rate for age group *i* in period *t* is,[15]

(11) $$v_{it}^{*} = \omega_{i0}^{*}\sigma^{*} + \omega_{i0}^{*}\theta\left(t-1\right).$$

where $\theta = \left(\sigma^{*}\right)^{2}\left[\gamma + \eta\left(1+\tau\lambda\right)\right]$. The first term on the right of (11) indicates that the

[13] Orrenius and Zavodny (2005) find that the likelihood a young Mexican male migrates to the U.S. is positively correlated with the father having migrated and with the number of siblings that have migrated.
[14] Here, we assume that labor demand is constant over time such that $X_{it}=X_{i0}$ and $X^{*}_{it}=X^{*}_{i0}$. In an appendix, we generalize the model to allow for time-varying labor demand shocks.
[15] The precise solution to the model is $v_{it}^{*} = \sigma^{*}\omega_{i0}^{*}(1+\sigma^{*}[\gamma+\eta\left(1+\tau\lambda\right)])^{t-1}$. We obtain the expression in (11) by applying the approximation that $(1+x)^{t} \approx 1+tx$.

emigration rate is higher the larger is the initial wage differential between the U.S. and Mexico. Larger monetary gains to emigration naturally make emigration more attractive. Thus, emigration from Mexico will be greater the smaller is U.S. labor supply relative to Mexico (ℓ^*_{i0}) or the stronger is U.S. labor demand relative to Mexico (x^*_{i0}).

The second term in (11) captures emigration dynamics. Over time, emigration pushes wages up in Mexico and down in the U.S.[16] Assume for a moment that $\gamma = 0$, such that there are no network effects. In this case, $\theta = \left(\sigma^*\right)^2 \eta\left(1+\tau\lambda\right) < 0$, which implies that the emigration rate for group *i* declines over time as emigration across successive periods erodes the binational wage difference. Now, allow for network effects, such that $\gamma > 0$. The emigration rate may accelerate or decelerate over time. If $\gamma < -\eta\left(1+\tau\lambda\right)$, then $\theta < 0$ (recall that $\eta<0$). Network effects are weak and/or labor demand is inelastic ($\eta<<0$), meaning that networks effects are not strong enough to counteract the depressive effect that emigration has on the wage differential. Alternatively, if $\gamma > -\eta\left(1+\tau\lambda\right)$, then $\theta > 0$. Network effects are sufficiently strong to compensate for the emigration-induced decline in the wage differential, indicating that emigration accelerates over time until U.S.-Mexico wage parity (adjusted for the emigration disamenity) is reached.[17] The estimating equation follows directly from (11).

3.2 Specification Issues

For estimation purposes, we use (10) to rewrite (11) as

$$(12) \qquad v^*_{it} = \ln \ell^*_{i0}\left[\eta\sigma^* + \eta\theta\left(t-1\right)\right] + \left[\ln x^*_{i0} - C\right]\left[\sigma^* + \theta\left(t-1\right)\right]$$

[16] The key predictions of the model for Mexican emigration still apply even if migration from Mexico to the U.S. leaves U.S. wages unchanged. This case is equivalent to setting λ equal to zero in (11).

[17] Implicit in our setup is that emigration is reversible, in which case individuals re-optimize their migration decision in each period. There is no option value to delaying emigration, as in Carrington et al. (1996). Our approach thus allows for return migration, though it does not explicitly model why it might occur.

We use U.S. high school dropouts to measure U.S. labor supply (the numerator of ℓ^*_{i0}). Treating U.S. high school dropouts as the relevant labor market for Mexican immigrants follows the literature (e.g., Aydemir and Borjas, 2007). However, it may introduce endogeneity into the estimation. If the decision by U.S. natives to complete high school depends on the U.S. wage for high school dropouts, then shocks to Mexican emigration may play a role in determining the number of U.S. high school dropouts. Mexican emigration and the supply of low-skilled U.S. natives would then be jointly determined. A related concern is that the number of high school dropouts may be a poor measure of the supply of low-skilled U.S. workers, introducing measurement error into the estimation. Many high school dropouts in the U.S. appear to have a weak attachment to the labor force (see, e.g., Borjas, Grogger, and Hanson, 2008), meaning they may not compete with full-time immigrant workers for jobs.

We address concerns regarding endogeneity and measurement error in U.S. labor supply by instrumenting for the number of U.S. high school dropouts using the size of the corresponding U.S. birth cohort. Our identifying assumption is that the size of current U.S. birth cohorts is uncorrelated with expected immigration from Mexico (20 years in the future). In the first stage estimation, the log size of U.S. birth cohorts, along with dummy variables for gender, census year, and birth year, can account for 97% of the variation in the log number of U.S. native high-school dropouts.

We model the initial wage in a Mexican state relative to the U.S. as a function of the size of a state birth cohort relative to the size of the corresponding U.S. birth cohort (as well as initial differences in labor demand). To allow for the fact that similarly aged individuals are likely to be highly substitutable in production, we group birth cohorts by three or five-year intervals (which also mitigates rounding error in birth years). The implicit assumption is that each age group has its own production function and that other production factors, including younger or older groups, can be subsumed into state per capita GDP, or the gender, birth-year, and birth-state fixed effects included in the regression. In the estimation, we consider the robustness of the results to this assumption by adding controls for the size of adjacent birth cohorts. We also examine how the results are affected by different aggregation schemes.

4. Empirical Results
4.1 Empirical Specification

The dependent variable for our analysis is the flow of net emigration, Δm_{ijst}, which is the ten-year time difference in the emigrant stock in (1) and which corresponds exactly to v_{it}^{*} in (12). This value is the net share of a birth year (i), gender (j), and birth state (s) cohort that has emigrated during the previous ten-year interval. In the main results, we group birth cohorts by three-year intervals and in later results we use one- and five-year intervals. Following (12), the regression equation we estimate is

$$(13) \qquad \Delta m_{ijst} = \ln l_{ijs}\left[\alpha_1 + \alpha_2\left(t-1\right)\right] + \ln x_{is}\left[\beta_1 + \beta_2\left(t-1\right)\right] + z_{st}\phi + I + J + S + T + \varepsilon_{ijst}\,,$$

where l_{ijs} is the size of a Mexican state birth cohort relative to the number of U.S. high school dropouts in that birth cohort, x_{is} is initial labor demand for a state birth cohort relative to the U.S., z_{st} captures labor-market shocks to state s in year t, and I, J, S, and T are fixed effects for birth year, gender, birth state, and census year.[18] By (12), the relative initial size of a Mexican birth cohort (l_{ijs}) should be positively correlated with

[18] To be precise, comparing (12) and (13) l_{ijs} is the inverse of ℓ_{i0}^{*} and x_{is} is the inverse of x_{i0}^{*}. We use the inverses to make the regression results easier to interpret (such that in Mexico positive labor supply shocks increase emigration and positive labor demand shocks decrease emigration).

emigration, while relative initial labor demand in Mexico (x_{is}) should be negatively correlated with emigration. We specify the initial difference in labor demand as the log ratio of state per capita GDP to U.S. per capita GDP in the year a cohort first enters the labor market (assumed to be age 16). This is an admittedly crude measure of labor demand and we view the variable as controlling for initial conditions in a state more broadly. We control for current-period labor-market shocks in a state using the 10-year change in state per capita GDP. We discuss results using other variables, as well.

From (12), the coefficient on initial relative labor supply in (13), $\alpha_1 = \eta\sigma^*$, depends on the emigrant supply elasticity, σ^*, which may vary by gender, age, or region. We begin with results that pool across gender, age, and state, and then disaggregate across Mexican states and report results for specific age and gender subgroups. Under the dynamics specified by the model, the impact of initial labor-market conditions on the emigration rate may increase or decrease as a cohort ages, depending on whether network effects dominate wage-convergence effects. As specified by (13), we interact initial labor-market conditions with the time since a cohort entered the labor market (t-1). Networks may also affect the responsiveness of emigration to labor-market shocks (σ^*), which we allow for by interacting initial state labor-market conditions with measures of historical state migration networks.

4.2 Baseline Estimation Results

We begin with results for a sample of national aggregate birth cohorts for Mexico and the U.S., shown in Table 2. Though we have only 166 observations on one-year birth/gender cohorts at the national level, the specification is useful for seeing whether there is any correlation between emigration and relative labor supply in aggregate data.

In Table 2, there is a strong positive correlation between the size of a Mexican birth cohort (relative to the number of U.S. high school dropouts in that cohort) and the emigration rate for the cohort. Our dependent variable is expressed as a share and the explanatory variables are in logs, so our parameter estimates give the decadal labor supply elasticity of net migration. In column (1), which is based on OLS, a 10% increase in the relative size of a Mexican cohort is associated with an increase in the decadal emigration rate of 0.3 percentage points, with the effect precisely estimated. Consistent with theory, larger Mexican birth cohorts have higher emigration rates. Initial relative per capita GDP in Mexico is negatively correlated with emigration, also as predicted by theory. State-level changes in per capita GDP enter with a negative sign, as predicted by theory, but are imprecisely estimated. Column (2) gives instrumental variable estimates, where we control for measurement error or endogeneity in the U.S. supply of low-skilled labor by instrumenting for the ratio of Mexican birth cohort size to U.S. high school dropouts with the ratio of Mexican birth cohort size to U.S. birth cohort size. The IV estimates are twice as large as the OLS estimates and are precisely estimated.[19] Columns (3) and (4) break out cohorts by gender, revealing that the effects of cohort size on emigration are larger for men than for women, a result we discuss below.

Next, we turn to the main results for the sample of three-year birth cohorts using individual Mexican state birth cohorts as the unit of analysis. Given small cohorts are measured with less precision, estimates using state-level census data are noisy, making net emigration heteroskedastic. To address measurement error, we use robust standard

[19] These results suggest that in OLS regressions inconsistency is due more to measurement error in the supply of low-skilled U.S. native labor (which would tend to bias coefficient estimates on relative cohort size toward zero) than to the endogeneity of U.S. labor supply to shocks to Mexican migration (which would tend to introduce positive bias in the coefficient on relative cohort size).

errors clustered at the level of birth states and trim the 2.5% tails of net-emigration flows.

The first column of Table 3 controls for birth-state fixed effects only. Mexico has a long history of regional differences in income levels, income growth, and population growth (Chiquiar, 2005). Birth-state fixed effects remove these and related sources of state-level heterogeneity from the regression. Labor supply continues to work in the manner theory predicts: increases in Mexico's cohort size (relative to the U.S.) drive emigration up. The correlation between emigration and initial GDP remains negative and precisely estimated. In column (2) of Table 3, we introduce controls for gender, census year, and 10-year birth cohorts.[20] Census year fixed effects remove the effect of changes in border enforcement by U.S. immigration authorities, such as those introduced by the Immigration Reform and Control Act in the late 1980s and the expansion in U.S. border fortifications in the 1990s (Hanson, 2006), provided the impact of these changes is experienced in a common way across cohorts in our study (those aged 16-50). Birth-year fixed effects control for the size of the average Mexican birth cohort, cohort-specific effects of U.S. enforcement policies, and other unexplained differences in migration propensities between earlier and later-born cohorts.[21]

These additional controls amplify the effect of labor supply on emigration but drive the effect of initial per capita GDP to zero. Given the lack of substantial cross-state, cross-time variation in Mexican GDP per capita (Chiquiar, 2005), census-year and birth-year fixed effects appear to remove most of the explanatory power of the initial

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[20] Since a full set of birth-year fixed effects would eliminate all variation in U.S. labor supply, we limit the controls to dummies for 10-year birth groups. In unreported results, we find that relative cohort size remains positively and significantly correlated with emigration, even with the full set of birth-year dummies in the regression. In this specification, the effect of cohort size on emigration is identified entirely on variation in population growth across Mexican states.

[21] Based on theoretical results reported in an appendix, birth-year fixed effects also control for cohort-specific pressures to migrate internally.

level of development. We do not interpret these results as evidence that labor demand is unimportant, but rather that even conditioning on initial average income there is a powerful independent channel through which labor supply drives emigration.

In column (3), we move from OLS to IV, following a similar strategy of instrumentation as in Table 2. The IV estimates for labor supply are again larger. A 10% increase in the base size of a Mexican cohort results in a 1.3% increase in out-migration per decade over the working years of that cohort. Columns (4) and (5) indicate that the impact of labor supply on emigration is roughly twice as large for men as for women. The migration decisions of men appear to be more responsive to labor-market conditions upon entry into the labor force, perhaps reflecting the tendency of families to invest in the migration of fathers and sons over mothers and daughters. Later results suggest that over time, migration rates for women increase, allowing them to catch up (consistent with the similar long run migration rates for men and women seen in Figure 2).

Based on the results in Table 3, the correlation between initial labor supply and emigration appears to be robustly positive. The coefficient estimates in column (3) imply that moving a Mexican state from the 25th to the 75th percentile of relative labor supply would raise the decennial emigration rate by 25 percentage points, against a mean emigration rate of 7%.[22]

4.3 Network Effects and Migration Dynamics

So far, we have constrained the estimated elasticities to be constant across regions of Mexico. Pre-existing migration networks could affect the emigration elasticity, σ^*, in equation (19), by making regions with stronger networks more sensitive to changes in

[22] To perform this calculation, we express state cohort sizes as deviations from each state's mean over the sample period and take the 25th and 75th percentiles of the distribution of these within-state deviations.

labor-market conditions. We capture the strength of pre-existing migration networks either by the state emigration rate in 1924 or the distance of a state to the railroad that ran down Mexico's spine in 1910, which U.S. labor contractors initially used to locate potential Mexican workers (Cardoso, 1980).[23]

The first two columns of Table 4 show results in which we interact relative cohort size with pre-existing migration networks (all regressions in Table 4 are based on IV estimation).[24] In column (1), the interaction term is positive, indicating that Mexican states with a longer history of emigration are more responsive to variation in cohort size. There is a similar result in column (2), where the interaction term is negative, implying that states closer to the migration railroad respond more strongly to relative cohort size. In unreported results, we found no precisely estimated interaction effect between migration networks and initial relative per capita GDP.

The interaction between cohort size and pre-existing migration patterns captures intergenerational migration networks. Father and uncles may relay their experiences to sons and nephews (and daughters and nieces), helping create regional persistence in migration patterns. Munshi (2003), Orrenius and Zavodny (2005) and McKenzie and Rapoport (2007) also provide evidence that networks (either within families or communities) lower the cost of emigrating from Mexico.

By their nature, intergenerational networks change slowly over time. Equation (11) allows for intra-generational networks, which produce a dynamic migration response

[23] Consistent with a large literature on the subject, we find that distance to the U.S. border is not a good proxy for the strength of migration networks, whereas distance to the railroad is.

[24] As in previous regressions, the high school dropout cohort size ratio is instrumented using the entire US native born population cohort size ratio. Each column in Table 4 interacts the HS dropout ratio with an exogenous variable, and in each case we instrument for this using the interaction of the native population ratio with the same exogenous variable.

to initial labor-market conditions. The shock caused to initial migration will have effects that are dampened as a cohort ages if labor demand is relatively inelastic (η<<0), such that $\theta < 0$, or that are amplified as a cohort ages if network effects from migration are strong (γ>>0), in which case $\theta > 0$. The dynamic labor-supply elasticity, θ, can be estimated by interacting initial labor-market conditions with the number of years since a cohort entered the labor force, assumed to be the current cohort age minus sixteen.[25]

The third column of Table 4 shows these interactions estimated on the full sample of birth cohorts. For shocks to relative labor supply, the pooled results indicate an interaction effect which is in the same direction as the marginal effect, but insignificant. The labor demand interaction, on the other hand, is in the opposite direction from the uninteracted effect and strongly significant. This suggests that the depression of migration caused by a positive GDP shock at age 16 is transitory, and over subsequent decades migrants compensate by leaving these states in larger numbers.

Columns (4)-(6) repeat this exercise, dividing the sample according to the strength of pre-existing migration networks. These disaggregated results display intriguing heterogeneity in the dynamic response to labor supply. In states with the strongest history of migration (top tercile) the interaction effect is negative, suggesting that the dampening response of wages to migration is dominant. States with intermediate levels of historical migration display a strongly positive interaction between labor supply and years since turning 16, indicating that migration accelerates over time. In states with

[25] The analysis in Table 4 is the place that our theory tells us that internal Mexican migration will play a role. However, birth-year fixed effects remove the mean impact of Mexican cohort size from the data. The remaining effects of aggregate Mexican cohort size are difficult to identify because each state cohort size is independently included, and so the sum across states introduces a complicated form of differencing into the data. We therefore omit aggregate Mexican cohort size from the analysis shown.

non-existent networks (bottom tercile), the dynamic interaction is insignificant. Taken together, these results suggest that the networks created by labor supply-driven migration are self-reinforcing over time only if those networks are *new*; states in which those networks were already extant show a dampening, rather than an acceleration, over time. Where historical migration networks are weakest, the migration networks initiated by labor supply shocks may be too small to create new, self-reinforcing flows.

4.4 Robustness Checks

Estimates of net migration are noisy, especially for smaller states in the sample. We implement robustness checks to examine the extent to which measurement error may be affecting the estimation. A particular concern is raised by the fact that the base cohort size appears in the numerator and denominator of the dependent variable as well as in log form as an independent variable. It might be the case that we are picking up a spurious correlation arising from the fact that the base cohort size is observed with error and a function of this measure error is then regressed on itself. Fortunately, we have a simple way to modulate the degree of measurement error present in the data, which is to aggregate over larger or smaller cohorts than the three-year birth-year groups used so far in the analysis. As we calculate base cohort sizes and net migration rates on one-year (five-year) cohorts we should increase (decrease) the measurement error, which allows us to gauge the extent to which this matters for our results.

In Table 5, we re-create the fixed effect regression presented in column (3) of Table 3, using one-year, three-year, or five-year birth cohorts. As we move from less aggregated to more aggregated cohorts, the magnitude of the coefficient on relative cohort size *increases*, which is the exactly opposite pattern we would expect if measurement error were responsible for our results. Also, the precision of the coefficient estimates increases as we move to more aggregated cohorts, despite the fact that the three-year cohort sample has 60% fewer observations than the one-year sample and the five-year sample has 80% fewer observations. The clear implication from this exercise is that rather than measurement error driving our results through spurious correlation, it may understate the strength of the relationships due to attenuation bias.

The use of five-year cohorts in Table 5 helps address another issue, related to the fact that our specification assumes that possibilities for labor substitution between younger and older cohorts can be subsumed into state, census-year, and birth-year fixed effects. As we expand the size of a birth cohort, we allow for more flexible patterns of labor substitution, though at the cost of reducing the sample size. Another way to address the issue of labor substitutability is to include the size of adjacent cohorts in the estimation directly. In unreported results, we added as regressors the log size of the previous and following state birth cohorts, each expressed relative to the size of the cohort pertaining to an observation. This addition leaves our qualitative results on the impact of relative labor supply on emigration unchanged.

Another issue has to do with omitted variables that could be related to state population growth. Because changes in the timing of the demographic transition are not randomly assigned, we may be concerned that some third factor exists which is driving both changes in cohort size and the decision to migrate out of Mexico. In this case the correlations we measure between Mexican cohort size and net migration would be biased. Perhaps the most obvious underlying source of heterogeneity in Mexico during this period is differences in the timing of industrialization. In 1970, 12% of Mexican GDP derived from agriculture, but by 2000 this number had fallen to 5%. While early industrializing states, such as the Federal District and the state of Mexico, saw little change in their agricultural share, other states saw a sharp decline. In unreported results, we examine whether the movement out of agriculture may have mutually driven population growth and migration during the period of our study by including the share of state GDP that comes from agriculture to the specification in column (3) of Table 3. Our results on relative labor supply are unchanged, suggesting they are not being driven by unobserved heterogeneity in the timing of industrialization across Mexican states.

4.5 The Final Stock of Migration and Possible Future Trends

All of our results so far have followed the theoretical model in analyzing the flow of migration over time. We summarize our empirical section by presenting results on the impact of labor supply and demand shifts on the *stock* of migrants, meaning the total share of a cohort that has migrated out at by the time they reach age 50. In order to measure these long-term effects we must observe the cohort prior to migration age and then be able to follow them until they reach the end of their migration years. We therefore restrict this analysis to cohorts aged between 40 and 50 which were first observed in the data younger than age 15. This group of 843 cohorts gives us the ability to measure the impact of labor supply shocks on the long-term net stock of migrants. We include as demand controls the GDP ratio when these cohorts turned 16 as well as the most recent change in state per capita GDP that they had experienced.

In this regression (shown in Table 6), he coefficient estimate of 0.37 for relative labor supply indicates that for every three 'extra' Mexican nationals (relative to the number of U.S. natives) born in a given state one of them will eventually migrate to the

U.S. Different from the results on migration flows in Table 5, the effects of labor supply shocks are somewhat larger for women than for men. The most likely explanation for this is reverse migration; while men have a higher propensity to migrate at younger ages they are also more likely to return to Mexico later in life, and hence the use of older cohorts enhances the apparent sensitivity of women to labor-supply shocks.

One way of understanding long-term emigration magnitudes is to simulate total out-migration using the parameter estimates from Table 3. We use the marginal effect from column 3, which gives a decadal coefficient of 0.144 on the log base cohort size. From here we can calculate the aggregate base cohort size for each birthyear for the country as a whole, and multiply the log of this quantity times the marginal effect and the number of decades over which they are observed. Of the 37.5 million Mexicans born between 1960 and 1980, this method suggests that just over 2.2 million emigrated as a result of labor supply growth. Using independent estimates that the stock of Mexican immigrants in the U.S. increased by 5.2 million during the years 1977-1997 (that is, the years after these cohorts had turned 16), this implies that 42% of total migration can be explained by labor supply growth in these 21 cohorts. This figure is likely to be an under-estimate both because it uses only a subset of cohorts to form the numerator of the fraction, and because it ignores the subsequent network-driven migration caused by these individuals. Hence, labor supply growth in Mexico alone can account for one third of the total migration from that country to the U.S. over the past quarter century.

Going forward in time, growth in Mexico's labor supply relative to the U.S. is likely to slow substantially. With Mexican fertility rates having fallen from 7 in 1960 to 2.5 in 2000, labor supply shocks are likely to become a much less significant push factor in Mexican labor outflows. Given the substantial role of labor supply in Mexican emigration to date, this is an important development.

To examine the implications of Mexico's slowdown in population growth for migration, we use the regression results to forecast future emigration rates by birth cohort. First, we sum the data by Mexican state and gender to arrive at aggregate labor supply in Mexico (and in the U.S.) for each year, from which we calculate the log labor supply ratio, with Mexico in the numerator. In order to construct the forecast of this log labor supply ratio, we ran an Arima model that included a first-order autoregressive and a first-order moving average component as well as a linear and quadratic time trend. Using the Arima model, we then projected relative labor supply from 2000 through 2020. The net migration rates across age for each cohort were then predicted using the parameter estimates from column (3) of Table 4, which gives us the dynamic effects of cohort size estimated using the entire Mexican population. Figure 4 plots the resulting net emigration rates by decade from 1960-2020, expressed relative to the 1940 cohort (i.e., subtracting values for 1940 from each cohort). This exercise is equivalent to forecasting changes in emigration due to labor supply, holding labor demand, enforcement policies, and other factors constant. By expressing emigration relative to a base cohort, we isolate changes in past and future emigration that the empirical results suggest are associated with changes in relative labor supply.

In Figure 4, labor-supply-induced emigration *falls* for cohorts born between1940 to 1960, owing to the large increase in U.S. population associated with the baby boom. From 1960 to 1980, relative labor supply growth in Mexico leads to a dramatic surge in emigration. But this surge peaks for the 1980 birth cohort, which would have begun to enter the labor market in the late 1990s. Emigration rates fall for all subsequent cohorts, as population growth in Mexico begins to decline to U.S. levels. By the time the 2020 birth cohort comes of age, emigration rates would have returned to levels equal to those of the 1940 birth cohort. Holding labor demand and enforcement policies constant, it would appear that emigration from Mexico is peaking today and that labor-supply-driven pressures for labor outflows will weaken in subsequent decades. Of course, shocks to labor demand or U.S. immigration policy could produce much larger or much smaller emigration rates, depending on their realizations. Also, while the forecast in Figure 4 controls for intra-generational migration networks, it does not control for dynamic changes in intergenerational networks, which fall outside our framework.

5. Discussion

The surge in labor flows from Mexico to the U.S. over the last 25 years has made international migration the subject of intense policy debate in the two countries. Mexico accounts for fully one-third of post 1980 U.S. immigration and the U.S. is now the country of residence for nearly one-fifth of young working-age Mexican males. Despite the magnitude of these labor movements, there is little academic research that attempts to account for the scale of Mexican emigration.

Our approach is to examine the contribution of labor-supply shocks to the labor exodus from Mexico by exploiting variation across Mexican states in the evolution of population growth. Larger birth cohorts in Mexico have higher rates of emigration, consistent with positive labor supply shocks contributing to outmigration. Differential growth in labor supply between Mexico and the U.S. over 1960-1984 can account for one third of observed Mexican migration to the U.S. over 1977-2000.

Looking ahead, population growth in Mexico has decreased dramatically. Indeed, the 1970 to 2000 decline in fertility in Mexico is one of the fastest ever recorded. Will slowing population growth contribute to slower increases in emigration rates in the future? Absent network effects (and holding labor demand constant), the answer would appear to be yes. The direct effects of differential labor supply growth should already be dwindling. The sharp increase which started in 1960 came to an end in 1980, and so cohorts coming of migration age today are not experiencing the shocks which those only a decade ago faced. The mechanical migration pressures caused by population growth are now pressing on Mexico's *southern* border, because neighboring Central American countries have not undergone the rapid demographic transition seen in Mexico

However, emigration from Mexico shows evidence of network effects. Emigration is more responsive to Mexico-U.S. differences in labor supply in states that have stronger historical migration networks, and the response of emigration to initial labor-supply differences appears to accelerate over time in a manner consistent with early migrants encouraging later migrants to move abroad. Networks effects could make the impact of differential Mexico-U.S. labor-supply growth over the 1960-1980 period long lived, as the current generation of migrants eases migration for later generations. In this event, emigration from Mexico may continue to accelerate for some time, even as population growth in the two countries continues to converge.

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Appendix: Allowing for Internal Migration and Labor Demand Shocks

Here, we introduce internal migration within Mexico into the theoretical model from section 2. The motivation is to allow low-wage Mexican states to shed labor to other Mexican states and the U.S. and to allow high-wage Mexican states to take in labor from poorer states and send labor abroad. The persistence in earnings differentials across states in Mexico suggests internal migration works slowly to equilibrate wages (Chiquiar, 2005), consistent with internal labor mobility being costly.

Let the wage for group *i* in state *s* be given by

(A1) $$\ln w_{sit} = \ln X_{sit} + \eta \ln L_{si0} + \eta m_{sit},$$

where L_{si0} is the pre-migration state population and $m_{sit}=M_{sit}/L_{si0}$ is the fraction of the population that has left the state on net at time *t* (due to either internal or external migration). Individuals in state *s* may migrate within Mexico, in which case they earn the national average wage given by (4), or they may emigrate to the U.S., in which case they earn the wage given by (6). There are adjustment costs to moving labor either between states in Mexico or between a Mexican state and the U.S. Following similar logic as in (9), the external migration rate (from the state to the U.S.) for group *i* in state *s* at time *t* is

(A2) $$v^*_{sit} = \sigma^* \left(\ln w^*_{i,t-1} - \ln w_{si,t-1} + \gamma \sum_{r=1}^{t-1} v_{sir} - C \right),$$

where we again allow for network effects in emigration and assume these are specific to individual states in Mexico. The group *i* rate of internal migration (out of state *s* to another state in Mexico) is given by

(A3) $$v_{sit} = \sigma \left(\ln w_{i,t-1} - \ln w_{si,t-1} \right),$$

where for simplicity we assume there are no network effects for internal migration and we normalize the disamenity associated with internal migration to zero.

To solve the model, we combine (4), (6), (A2) and (A3), derive the internal and external migration rates in period 1, and proceed iteratively to later periods.[26] Define the pre-migration effective wage difference between the U.S. and Mexican state *s* as,

(A4) $$\omega^*_{si0} = \ln w^*_{i0} - \ln w_{si0} - C = \ln \frac{X^*_{i0}}{X_{si0}} + \eta \ln \frac{L^*_{i0}}{L_{si0}} - C,$$

and the pre-migration wage difference between Mexico overall and state *s* as,

(A5) $$\omega_{si0} = \ln w_{i0} - \ln w_{si0} = \ln \frac{X_{i0}}{X_{si0}} + \eta \ln \frac{L_{i0}}{L_{si0}}.$$

[26] With internal migration, the solution to the model is complicated by the fact that the rate of wage convergence across Mexican states may differ from that between Mexico and the U.S., which introduces a series of second-order terms into the expressions for internal and external migration rates. We derive migration rates ignoring these second-order terms, which makes our solution an approximation.

The resulting approximate solution (see note 24) for the migration rate to the U.S. for group *i* in state *s* at time *t* is,

(A6) $$v^*_{sit} = \omega^*_{si0}\sigma^*\left(1+\sigma^*\left[\gamma+\eta\left(1+\tau\lambda\right)\right]\right)^{t-1} + \omega_{si0}\sigma\left(\left[1+\sigma^*\eta\right]^{t-1} - 1\right),$$

for which we adopt the following linearization (as in (11)),

(A7) $$v^*_{it} = \omega^*_{i0}\sigma^* + \omega^*_{i0}\left(t-1\right)\left(\sigma^*\right)^2\left[\gamma+\eta\left(1+\tau\lambda\right)\right] + \omega_{si0}(t-1)\sigma\sigma^*\eta\,.$$

The factors driving state emigration to the U.S. are similar to the national case in (11): the weaker is a Mexican state's labor demand or the larger is its labor supply (relative to the U.S.) the higher will be the state emigration rate, as captured by the first two terms on the right of (A7).[27] The third term on the right of (A7) captures how internal migration within Mexico modifies labor flows abroad. If state *s* has a pre-migration wage that is below the national average, such that $\omega_{si0} > 0$, then internal migration dampens emigration to the U.S. (owing to the fact that $(t-1)\sigma\sigma^*\eta < 0$). This occurs because relative to the case in which all state labor outflows were to the U.S. some external migration is diverted to internal migration.

Finally, we allow for labor demand to change over time, such that X_{sit}, X_{it}, and X^*_{it} are no longer constant. Define

$$x^*_{sit} = \ln\frac{X^*_{it}}{X_{sit}} - \ln\frac{X^*_{i0}}{X_{si0}}, \quad x_{sit} = \ln\frac{X_{it}}{X_{sit}} - \ln\frac{X_{i0}}{X_{si0}},$$

which are, respectively, the growth in U.S. and Mexican national labor demands relative to state *s* between the pre-migration period 0 and time *t*.[28] The solution to the migration rate to the U.S. for group *i* in state *s* at time *t* now becomes,

(A8) $$v^*_{it} = \omega^*_{i0}\sigma^* + \omega^*_{i0}\left(t-1\right)\left(\sigma^*\right)^2\left[\gamma+\eta\left(1+\tau\lambda\right)\right] + \omega_{si0}(t-1)\sigma\sigma^*\eta + \sum_{r=1}^{t-1}\theta^*_r x^*_{sir} + \sum_{r=1}^{t-1}\theta_r x_{sir}\,.$$

Allowing for labor-demand shocks introduces a series of distributed lag terms into the expression for the emigration rate. It is straightforward to show that θ^*_r (θ_r) is positive (negative) and that the magnitude of the coefficients decrease in *r* (such that labor-demand shocks further back in time have larger effects on current emigration).

[27] We ignore institutional responses by Mexican states to labor outflows. If educational opportunities in a state are unresponsive to cohort size (as shown for the U.S. by Bound and Turner, 2006), then a further reason why positive labor supply shocks in a Mexican state may contribute to out-migration is that individuals are crowded out of local opportunities to continue their schooling and move elsewhere to do so.

[28] Since we assume that individuals re-optimize their migration decisions in each period and we ignore fixed migration costs, we do not need to address expectations about future labor-demand shocks.

Figure 1

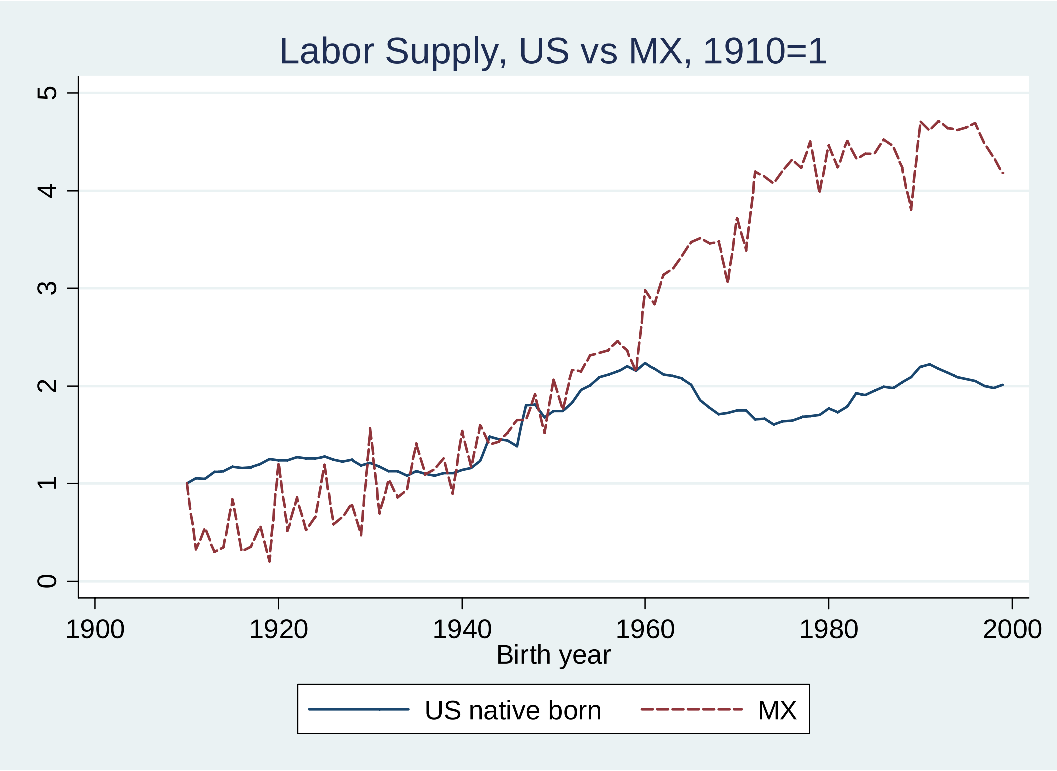

Figure 2

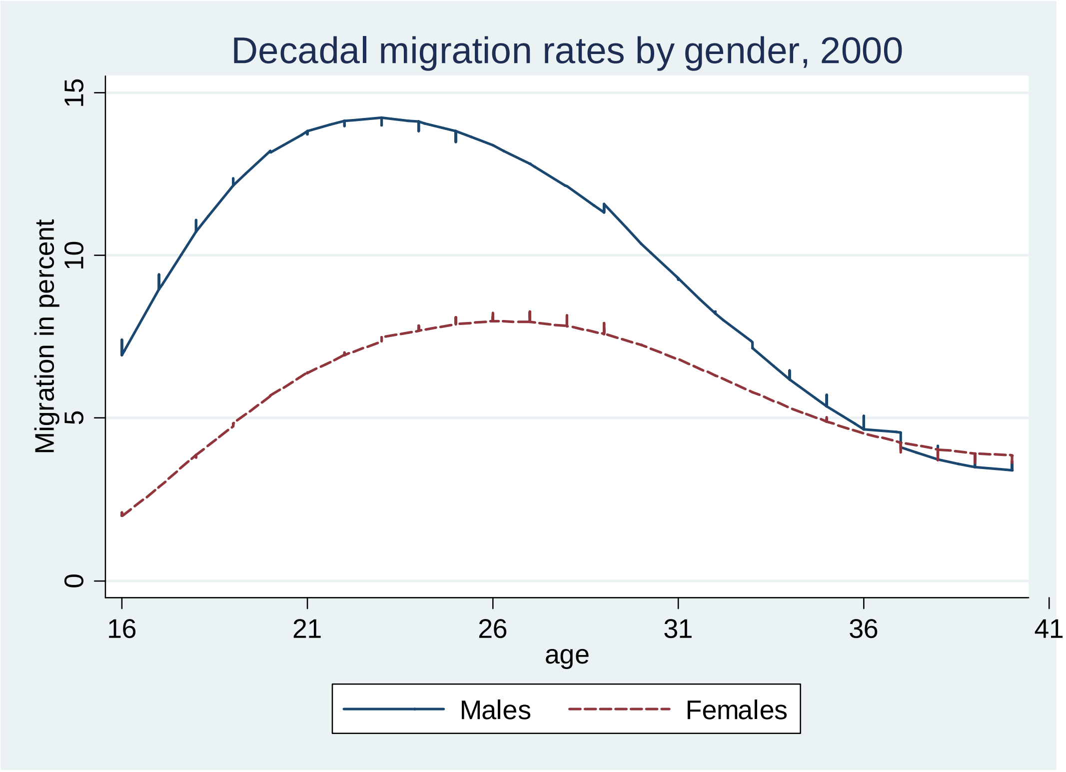

Figure 3

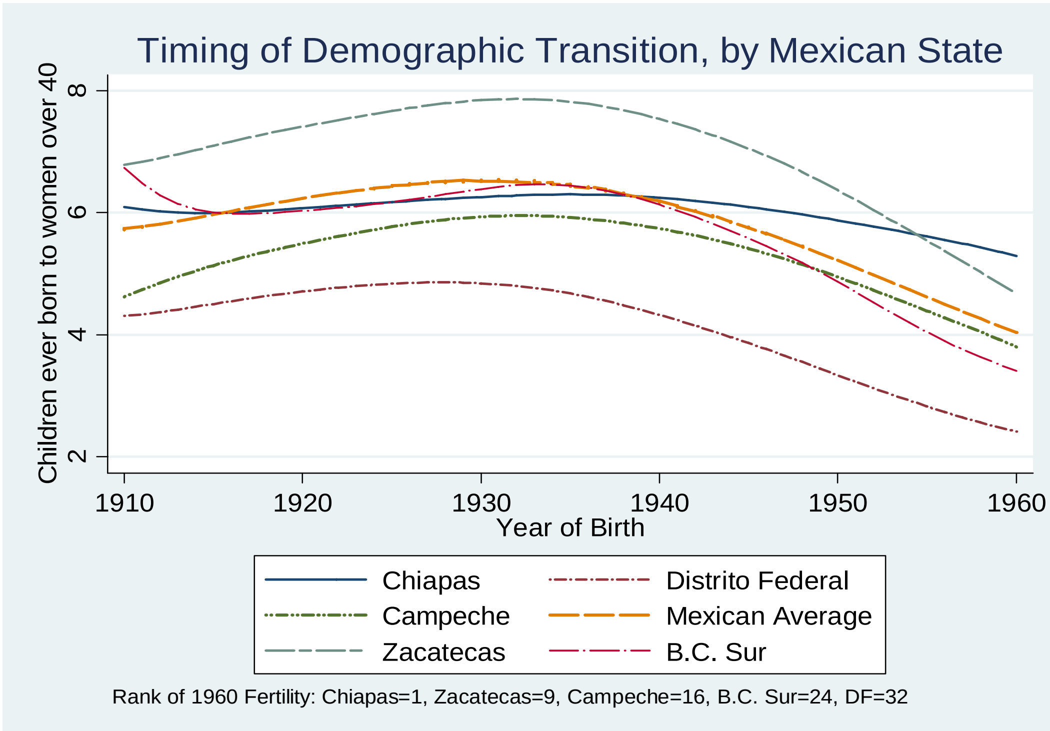

Figure 4: Future Emigration and the Slowdown in Mexican Population Growth

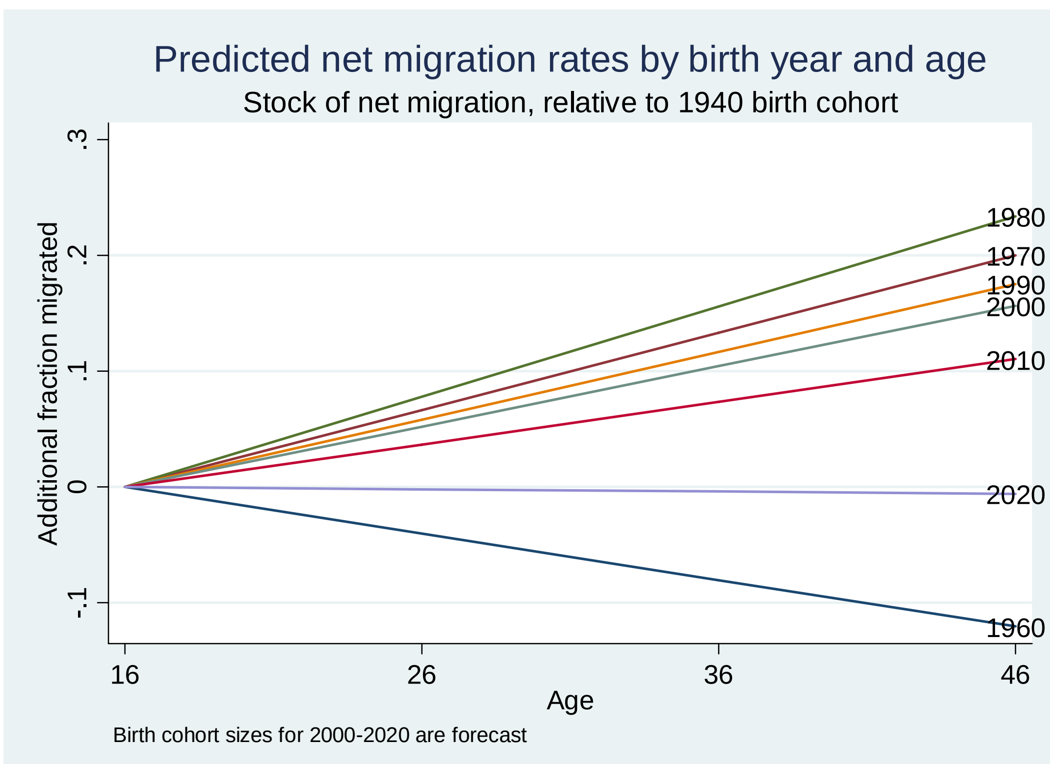

Table 1: Population and GDP (PPP) in Mexico and the U.S.

	Mexico		US			Ratio, MX/US		
Year	GDP per capita	Size of Birth Cohort	GDP per capita	Size of Birth Cohort	No. of high school dropouts	GDP per capita	Size of Birth Cohorts	MX Birth Cohort / US HS dropouts
1920		584,776		2,281,441	1,115,098		0.26	0.52
1930		753,616		2,223,977	884,869		0.34	0.85
1940	4,498	743,566	8,820	2,097,851	605,711	0.51	0.35	1.23
1950	5,385	1,002,387	12,009	3,209,845	408,878	0.45	0.31	2.45
1960	6,138	1,438,300	13,840	4,107,562	381,367	0.44	0.35	3.77
1970	8,341	1,792,770	18,391	3,221,446	350,870	0.45	0.56	5.11
1980	11,976	2,153,340	22,666	3,250,323	431,330	0.53	0.66	4.99
1990	12,594	2,273,444	28,429	4,041,951		0.44	0.56	
2000	15,279	2,018,483	34,759	3,703,392		0.44	0.55	

GDP in both countries is measured in 2000 US dollars.

Table 2: Baseline Results for Net Migration, National Birth Cohorts

	(1)	(2)	(3) Men Only	(4) Women Only
Dep. variable: decadal change in net migration rate	OLS	IV	IV	IV
log (MX cohort size/US HS dropouts)	0.030	0.071	0.147	0.017
	(2.24)*	(4.12)**	(5.09)**	(0.83)
log (MX GDP/US GDP) at age 16	-0.219	-0.263	-0.359	-0.193
	(3.32)**	(3.94)**	(3.74)**	(2.25)*
10-yr change log(MX GDP/US GDP)	-0.055	-0.146	-0.054	-0.127
	(0.27)	(0.71)	(0.16)	(0.48)
Time trend	0.001	-0.002	-0.005	0.001
	(0.24)	(1.51)	(2.34)*	(0.53)
Female cohort dummy	-0.039	-0.045		
	(3.62)**	(4.08)**		
Observations	166	166	83	83
R-squared	0.17	0.13		0.15

Mexican cohort size is fixed at its initial value; the number of native US high school dropouts is contemporaneous. The analysis is performed using one-year birth cohorts. GDP refers to GDP per capita. In IV regressions, log (MX birth cohort size/ US birth cohort size) is used as an instrument for log (MX birth cohort size/US HS dropouts).

T statistics in parentheses, * significant at 5%; ** significant at 1%.

Table 3: Baseline Results for Net Migration, State Birth Cohorts

	(1)	(2)	(3)	(4)	(4)
		All Cohorts		**Men Only**	**Women Only**
Dependent variable: decadal change in net migration rate	OLS	OLS	IV	IV	IV
log (MX State cohort size/US HS dropouts)	0.0359	0.049	0.1443	0.1876	0.1053
	(12.17)**	(4.49)**	(12.99)**	(11.51)**	(7.54)**
log (MX State GDP/US GDP) at age 16	-0.0788	-0.0307	-0.0217	-0.0261	-0.0168
	(6.23)**	(2.38)*	(1.46)	(1.13)	(1.01)
10-yr change log(MX State GDP/US GDP)	-0.0148	0.0031	-0.0179	-0.0297	-0.0028
	(0.63)	(0.12)	(0.62)	(0.59)	(0.09)
Observations	2258	2258	2258	1124	1134
R-squared	0.19	0.29	0.23	0.25	0.31
Fixed Effects Used:	State	State, census yr, Sex, 10yr birth cohort	State, census yr, Sex, 10yr birth cohort	State, census yr, Sex, 10yr birth cohort	State, census yr, Sex, 10yr birth cohort

Mexican state cohort size is fixed at its initial value; the number of native US high school dropouts is contemporaneous. The analysis is performed using three-year birth cohorts. GDP refers to GDP per capita. In IV regressions, log (MX state birth cohort size/ US birth cohort size) is used as an instrument for log (MX state birth cohort size/US HS dropouts).

T statistics in parentheses, * significant at 5%; ** significant at 1%.

Regressions in all tables use robust SEs clustered at the cohort level and are weighted by birth cohort size.

Table 4: Migration Dynamics and Network Effects

	Interaction Effects		Dynamic Effects			
Mexican States:	**All**	**All**	**All**	**By Terciles of 1924 migration**		
Dep. variable: decadal change in net migration rate				Top Tercile (highest migration)	Middle Tercile	Bottom Tercile (lowest migration)
log (MX State cohort size/US HS dropouts)	0.151	0.158	0.205	0.249	0.248	0.270
	(13.85)**	(13.76)**	(11.30)**	(7.55)**	(7.90)**	(7.67)**
log (MX State GDP/US GDP) at age 16	-0.022	-0.033	-0.043	-0.060	-0.009	-0.032
	(1.48)	(2.86)**	(3.06)**	(2.70)**	(0.22)	(1.96)
10-yr change log(MX State GDP/US GDP)	-0.004	-0.050	-0.065	-0.129	-0.110	-0.009
	(0.15)	(2.27)*	(2.63)**	(2.88)**	(2.35)*	(0.33)
log cohort size ratio * 1924 migration rate	18.001					
	(3.19)**					
log cohort size ratio * Distance to train		-0.0001				
		(4.85)**				
log cohort size ratio * Years since 16			0.001	-0.001	0.003	-0.001
			(1.92)	(2.01)*	(5.42)**	(1.17)
log GDP ratio (at 16) * Years since 16			0.004	0.005	0.001	0.004
			(5.53)**	(4.48)**	(1.37)	(3.27)**
Years since 16 (demeaned)			0.012	0.014	0.016	0.012
			(4.13)**	(3.16)**	(3.07)**	(2.27)*
(Years since 16)^2			-0.0001	-0.0002	-0.0001	0.00001
			(1.24)	(2.89)**	(0.65)	(0.07)
Observations	2258	2187	2258	837	642	779
R-squared	0.21	0.2	0.2	0.09	0.31	0.01

All regressions include Mexico state, census year, gender, and 10-year birth year fixed effects. All regressions are based on instrumental variables, using three-year birth cohorts; see text for discussion of instruments.

T statistics in parentheses, * significant at 5%; ** significant at 1%.

Regressions in all tables use robust standard errors clustered at the cohort level and are weighted by birth cohort size.

Table 5: Alternative Specifications and Samples for Net Migration

Unit of Aggregation:	1-year cohorts	2+3-year cohorts	5-year cohorts
log (MX State cohort size/US HS dropouts)	0.069	0.144	0.202
	(9.50)**	(12.99)**	(11.32)**
log (MX State GDP/US GDP) at age 16	-0.032	-0.022	0.007
	(2.88)**	(1.46)	(0.38)
10-yr change log(MX State GDP/US GDP)	-0.011	-0.018	-0.042
	(0.55)	(0.62)	(1.56)
Observations	5545	2258	1173
R-squared	0.18	0.23	0.34

All regressions include Mexico state, census year, gender, and 10-year birth year fixed effects, and are based on instrumental variables, using log (MX state cohort size/ US native total) as an instrument for log (MX state cohort size/US HS dropouts).
T statistics in parentheses, * significant at 5%; ** significant at 1%.
Regressions in all tables use robust standard errors clustered at the cohort level and are weighted by birth cohort size.

Table 6: The Final Stock of Net Emigrants

Dependent variable: s*tock* of net migration	All cohorts aged 40-50	Men aged 40-50	Women aged 40-50
log (MX State cohort size/US HS dropouts)	0.372	0.261	0.451
	(7.54)**	(4.14)**	(6.23)**
log (MX State GDP/US GDP) at age 16	0.134	0.08568	0.171
	(2.10)*	(1.00)	(1.88)
10-yr change log(MX State GDP/US GDP)	-0.021	0.014	-0.051
	(0.35)	(0.18)	(0.59)
Observations	840	413	427
R-squared	0.43	0.38	0.44

All regressions are based on one-year birth cohorts, include Mexico state, census year, and 10-year birth year fixed effects, and are based on instrumental variables, using log (MX state cohort size/ US native total) as an instrument for log (MX state cohort size/US HS dropouts).

T statistics in parentheses, * significant at 5%; ** significant at 1%.

Regressions in all tables use robust standard errors clustered at the cohort level and are weighted by birth cohort size.