What Do Networks Do? The Role of Networks on Migration and "Coyote" Use

Sarah Dolfin
Mathematica Policy Research, Inc.

Garance Genicot
Georgetown University

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Abstract

While a large literature has established that more migration experience among family and community networks tends to encourage migration, there is little research investigating the mechanism by which networks exert such effects. This paper aims to determine the relative importance of three potential benefits provided by networks: information on border crossing, information on jobs, and credit. We develop empirical tests of these network effects based on a simple model of migration that allows individuals to choose between migrating alone or with the help of a border smuggler. Using a unique dataset of undocumented Mexican migrants to the United States, we find that larger family networks encourage both migration and coyote use, consistent with the job information hypothesis. Community networks also appear to provide job information as larger networks increase the likelihood of migration. The finding that family (but not community) networks have a smaller impact for asset holders indicates that at least some of the benefit the family network provides is a source of credit.

Address all correspondence to sdolfin@mathematica-mpr.com and ggenicot@georgetown.edu.
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1 Introduction

Social networks are now widely recognized to be very influential in migration decisions. A large literature has established that more extensive friend and family networks of previous migrants encourage migration (Gottlieb 1987, Grossman 1989, Church and King 1993, Massey and Espinosa 1997, Orrenius 1999, Zahniser 1999, Davis and Winters 2001, Winters et al. 2001, Munshi 2003, and Colussi 2004). Yet there has been little research investigating the mechanism by which networks exert such effects. Migrant networks can facilitate migration in different ways: through providing information on the migration process itself, such as crossing the border; through providing information on destinations and jobs, and aiding integration after arrival; and through helping financing the cost of migration. Assessing the relative importance of these roles is crucial to our understanding of migration and to the design of immigration policies.

This paper aims to distinguish between these three channels through which family and community migration networks provide assistance to their members. To do this, we take advantage of a unique dataset of Mexican migrants to the U.S. called the Mexican Migration Project (MMP). This data is well-suited to our analysis in several ways. First, Mexico represents the largest source of immigration to the United States. Of the 32.5 million foreign-born respondents surveyed in the March 2002 CPS, 9.8 million (30 percent) were from Mexico. Moreover, estimates suggest that Mexicans make up about 57% of undocumented immigrants, or about 5.3 million (Passel 2004). Hence, the data effectively covers a large part of the population of interest. Second, it includes detailed, dated information on the migration experiences of respondents and their families, as well as on their asset holdings, which we use to construct a retrospective panel of respondents' migration histories. Finally, the data contains information on illegal border crossing and the use of border smugglers, known as "coyotes," to help migrants enter the country. This information is critical for accurately capturing the realities of migration. Previous research indicates that around 80 percent of all newly arrived immigrants from Mexico are undocumented (Passel 2004), and contemporary news accounts have helped to publicize the widespread presence of border smugglers. This picture finds support in our data: among the sample of Mexican migrants studied here, 73% first migrated illegally, and of these, 74% hired a coyote to help them navigate the crossing. To make our analysis realistic, we focus on illegal migration, and model the migration decision as a choice to migrate with a coyote, without a coyote, or not at all.

We derive a simple model to illustrate the different channels through which networks may affect migration decisions. Information about the migration process and border crossing may substitute for coyote services so that migrants are better able to travel alone. In contrast, information about jobs increases the benefits of migration and encourages coyote use. To the extent that networks substitute for personal wealth in providing a source of credit, their effects on migration and coyote use should be greatest among migrants with low asset holdings. We can assess the importance of these different types of network effects by testing these predictions empirically. Our results indicate that family networks encourage both migration and coyote use, suggesting that migration networks provide their members with information on jobs at the destination. However, the finding that family networks have a smaller impact for asset holders indicates that at least some of the benefit the network provides is a source of credit. Community networks also encourage migration, consistent with the jobs hypothesis, but do not appear to offer credit.

The rest of the paper is organized as follows. Section 2 reviews related literature. Section 3 presents a model of migration and derives the predictions that we will test. Section 4 describes our empirical approach, and Section 5 presents the results of the analysis. Section 6 concludes.

2 Existing literature

Research has found that networks play a critical role in determining migration patterns. Networks tend to increase the likelihood of migration (Gottlieb 1987, Grossman 1989, Church and King 1993, Orrenius 1999, Davis and Winters 2001, Massey and Espinosa 1997, Zahniser 1999 and Winters et al. 2001)[1] and tend to attract migrating members to the same geographic area (Bartel 1989, Dunlevy 1991, and Jaeger 2000). However, much remains to be learned about the functioning of migrant networks. In particular, little is known about the actual mechanism by which networks affect the migration decisions of their members. As discussed earlier, migrant networks could affect migration decisions through different channels that fall into one of three categories. First, migrant networks can provide various types of *information* regarding modes of crossing and living conditions at the destination. Second, they can provide information that helps migrants to *find work* and assimilate into society at the destination. Third, migrant networks can function as a source of *credit*, providing potential migrants with the funds needed to cover the cost of migration.

[1] In contrast, Taylor (1986) finds that the presence of immediate kin of the household head in another Mexican state is only weakly associated with the odds of internal migration. Instead, networks of U.S. migrants more strongly affected migration to the United States.

Recent work provides support for the role of networks in finding jobs at their destinations. Using Mexican rainfall as an instrument for the size of migrants' U.S. networks, Munshi (2003) finds that larger networks substantially improve Mexican immigrants' likelihood of employment in the U.S. Colussi (2004) estimates the same network effect structurally. In addition, work by Mckenzie and Rapoport (2004) at a macroeconomic level offers results that are suggestive of a network credit effect. Using historic state-level migration rates and U.S. labor market conditions as instruments for migration, they present empirical evidence for an inverse U-shaped relationship between immigration and inequality in Mexican communities. Such a pattern is consistent with the hypothesis of migrant networks helping current migrants to finance the cost of migration. While these studies shed light on particular network functions, we are not aware of other research that specifically aims to distinguish between them.

A related line of research considers the effect of migrant networks on the use of "coyotes" or migrant smugglers. Several studies find that a more extensive network encourages coyote use (Donato, Durand and Massey 1992, Singer and Massey 1997, Gathmann 2004, Ibarraran and Lubotsky 2005). Various characteristics of the network besides size have been found to matter as well. The type of relationship between network members has been shown to be important. Singer and Massey (1997) find that networks comprised of parents or community members increase the likelihood of coyote use. While they do not find that sibling networks have the same effect, Donato, Durand and Massey (1992) do. Other evidence indicates that the amount of time spent in the U.S. by network members, or network "experience," affects migration. Gathmann (2004) finds that longer U.S. experience of the network reduces the probability of a migrant using a coyote to cross the border.

In this paper, we use a simple model's predictions about the different effects a migrant network would have on a member's migration decision and coyote use depending on its role. The primary contribution of this paper is to test for the three possible effects of networks. In addition, we address three important limitations in the literature described above.

First, we incorporate the choice to hire a coyote into the migration decision in a realistic way. Studies of migrants' decisions that include the possibility of hiring a coyote typically examine coyote use conditional on illegal migration, while these decisions may actually be made jointly. An individual's choice about whether or not to migrate may depend on the availability of a reliable and affordable coyote. To address this shortcoming, we analyze the migration decision as a choice between migrating without a coyote (alone), migrating with a coyote, and not migrating at all. This strategy allows us to draw more nuanced inferences about the effects of various factors on the migration decision from our estimates. While studies of coyote use estimate the overall effect of a given factor on coyote use among those who migrate illegally, we distinguish between the part of the effect actually due to the factor's influence on the migration decision and the part representing its additional effect on coyote use.

Second, most studies of migration decisions rely on cross-sectional analyses.[2] This is a limitation because potential endogeneity makes it difficult to give a causal interpretation to the network effect. For instance, the observation that an individual behaves similarly to other individuals in his network may reflect not the impact

[2]Donato, Durand, and Massey (1992) is an exception. They use longitudinal data on migrants (from an earlier round of the MMP data used here) to estimate a logit model of the probability of using a coyote.

of their behavior on his choice, but rather the correlation of preferences among network members. Networks may form because similar individuals choose to join together; in the case of family networks, a genetic component of similar preferences may be inherited.[3] We examine retrospective longitudinal data, which allows us to isolate the effects of changes in an individual's network or assets over time on his subsequent migration decisions. This approach represents an improvement that allows us to more confidently interpret network effects. However, it is important to recognize that limitations remain. There still may be a dynamic endogeneity effect if *changes* in an individual's network are not exogenous. As an example, an individual considering migration may encourage other network members to migrate while he makes his decision. Our analysis cannot control for this type of behavior or dynamic unobserved heterogeneity, so some caveats to interpretation remain.

Finally, we include a role for wealth in influencing migration decisions. In a world where individuals are likely to be credit-constrained, a measure of wealth is essential to the understanding of migration decisions, as the next Section makes clear.

[3] Manski (1993) distinguishes endogenous network effects from exogenous effects, where exogenous characteristics of the group are associated with individual behavior, and correlated effects, where behavior or individuals in a group may be similar due to their having similar characteristics (p. 532–533).

3 The Effects of Migrant Networks

In order to empirically distinguish between three hypothesized functions of the migration network — crossing information, job information, and credit[4] — we develop a simple model of migration. This allows us to clarify the roles played by networks and assets in migration decisions, and to derive testable predictions about their effects.

Consider a population of individuals indexed by i. Individuals have three possible migration options indexed by $j \in \{n, c, a\}$ and characterized by a probability of success in crossing p_j and a cost q_j. The symbol n stands for not migrating ($p_n = 0, q_n = 0$); a for migrating illegally alone ($p_a > 0, q_a > 0$); and c for migrating illegally with a coyote ($p_c > p_a, q_c > q_a$). Assume also that $\frac{q_a}{p_a} < \frac{q_c}{p_c}$ so that the probability of success relative to cost is higher when crossing with a coyote than when crossing alone. Individuals have additively separable utility functions defined over consumption with utility indicators u_i that are increasing, weakly concave, and exhibit diminishing absolute risk aversion.

Let w_i^{us} be the U.S. wage for individual i, w_i^{mx} his Mexican wage, and $\Delta w_i = w_i^{us} - w_i^{mx} > 0$ his monetary gain from migrating. Assume there are no credit markets. Consider the decision for an individual i who has not yet migrated and whose total cash-in-hand is A_i: he chooses a migration option j in order to

$$Max_{j\in\{n,c,a\}}\{V_{i,j}(A_i) \equiv p_j u_i(w_i^{us} + A_i - q_j) + (1 - p_j)u_i(w_i^{mx} + A_i - q_j)\} \quad (1)$$

[4]One might imagine that another potential function of the network is to provide information on reliable coyotes. However, this is unlikely to be the case; as Kossoudji (1992, p. 163) writes, "[E]ven though knowledge of a particular coyote may filter back to the home community, he usually has moved on to another location or another line of work by the time migrants are able to utilize their knowledge."

subject to $q_j \leq A_i$.

Clearly, a higher U.S. wage increases the likelihood of migration. Moreover, the higher the U.S. wage, w_i^{us}, the more attractive using a coyote is as compared to crossing alone, since $p_c u_i'(w_i^{us} + A_i - q_c) > p_a u_i'(w_i^{us} + A_i - q_a)$. In contrast, the effect of the Mexican wage on the likelihood of migration is ambiguous. On one hand, it increases the payoff to staying in Mexico, but on the other hand it reduces the risk associated with migration.[5] Similarly, an increase in w_i^{mx} could increase or decrease the relative attractiveness of crossing alone versus crossing with a coyote, depending on whether $(1-p_c)u_i'(w_i^{mx} + A_i - q_c) <$ (or $>$)$(1-p_a)u_i'(w_i^{mx} + A_i - q_a)$.

For risk neutral individuals, what matters is the expected monetary gain of migration. The higher Δw_i, the more likely individual i is to migrate. Moreover, there are two cutoff levels of gain $0 < \Delta_1 < \Delta_2$ such that if $\Delta w_i < \Delta_1$, he does not migrate; if $\Delta w_i \in [\Delta_1, \Delta_2]$, he migrates alone; and if $\Delta w_i \geq \Delta_2$ he migrates with a coyote. The more risk averse an individual, the less he would want to migrate, but the more he would prefer using a coyote than not.[6] If it were not for the credit constraint, risk averse individuals with higher cash-in-hand would prefer to migrate alone, as risk aversion is decreasing.

In the absence of credit markets, individuals are defined as credit constrained if migration either alone or with a coyote would maximize their utility, but they are prevented from making these choices because the costs exceed their cash-in-hand.

[5]For instance, consider individual i with constant relative risk aversion utility $u(x) = \frac{1}{1-\rho}x^{1-\rho}$. If i was indifferent between not migrating or migrating using method $j \in \{c, a\}$, an increase in w_i^{mx} would increase her likelihood of migrating if $[\frac{1}{(1-p)^{1/\rho}} - 1](1-p)(w_i^{mx} + A_i - q_j)^{1-\rho} > p(w_i^{us} + A_i - q_j)^{1-\rho}$.

[6]For instance, using a CRRA utility indicator $u(x) = \frac{1}{1-\rho}x^{1-\rho}$, a higher risk aversion ρ reduces i's incentive to migrate but increases the attractiveness of c over a.

That is, either $V_{i,a}(A_i) = max\{V_{i,j}(A_i)\}$ but $A_i < q_a$, or $V_{i,c}(A_i) = max\{V_{i,j}(A_i)\}$ but $A_i < q_c$.

Now consider how a network would affect the migration decision. First, better information on crossing increases p_a, the probability of successfully crossing alone, thereby increasing overall migration and reducing the likelihood of coyote use.[7] Second, help finding a job and assimilating in the U.S. increases the benefit of migration through w_i^{us}, thereby increasing migration and making the use of a coyote more attractive than crossing alone. Third, credit alleviates credit constraints, thereby increasing both migration and coyote use.

Hence, the model predicts that migrant networks should have an overall positive effect on the likelihood of migration. The effect of networks on coyote use may be negative if the effect of crossing information dominates or positive if the job and credit effects dominate. For individuals with low levels of cash-in-hand, the credit effect has a positive impact on migration and coyote use. Our empirical analysis will test these predictions in order to determine the specific ways in which networks affect migration and coyote use. We will estimate models of the migration and coyote use decisions and test whether the coefficients on the network measures are positive or negative, in accordance with the predictions. The credit effects of networks can be tested through examination of the coefficient on the interaction of network measures with asset measures.

[7] Or similarly, increases p_a and $\frac{p_a}{p_c}$.

4 Empirical Approach

4.1 Data

The data we use in our analysis comes from the Mexican Migration Project (MMP), a collaborative research project based at Princeton University and the University of Guadalajara. The MMP survey data contains a wealth of information on the demographic characteristics of Mexican households, as well as a unique battery of questions on legal and illegal migration experiences of individuals in the household and on a variety of household assets. This survey began in 1982 and has continued to collect data on migration between the United States and Mexico in nearly every year since 1987. Our study uses the most recently released data, MMP93, which offers a representative sample of households from 93 communities in 17 states in Mexico.[8] Figure 1 presents a map of these community locations. Between two and five communities (towns or cities) in each state are covered each year, and roughly 200 households in each community are interviewed.[9]

Our sample includes household heads who have and have not yet made a migration to the U.S.[10] We focus on household heads, as these are the only household members who report information on coyote use. We consider only first trips to the

[8]The surveys are fielded each year between November and February, the off-season for agricultural work and a time when many migrants return to Mexico. While this data is representative of the states included, it is not nationally representative. A subset of the data, composed of migrants interviewed in the U.S. using "snowball" sampling procedures, is omitted from our analysis as it is not a representative sample.

[9]More information on the Mexican Migration Project and the data are available at http://mmp.opr.princeton.edu. See also Massey and Zeteno (1999) for a detailed description.

[10]We use the terms migration, trip, and crossing interchangeably throughout to refer to an individual's spell of migration.

U.S. since the determinants of subsequent trips are likely to be different, and in particular, are likely depend on characteristics of the first trip. We do not count as migrants the 126 individuals who entered the U.S. as tourists (and did not work during their stay).

While individuals in the MMP report U.S. trips as early as 1906, our analysis restricts attention to those trips from 1968 to 2000. This allows us to avoid potential complications associated with differing migration policies; in particular, the end of the second Bracero Program. This program involved a series of agreements between Mexico and the United States under which some 4.6 million Mexicans were admitted as temporary agricultural workers on U.S. farms between 1942 and 1964.[11] It has been argued that the surge in illegal immigration observed in the late 1960s resulted from the ending of the program (Orrenius 2001).

Due to the very small number of legal migrants in our sample, we have chosen to exclude them from our analysis. While the full MMP sample contains a total of 1,321 legal migrants, most of them (70%) are Bracero workers. Restricting our sample to trips made from 1968 to 2000 leaves only 237 legal migrants. Preliminary work showed that including them does not qualitatively change our results.

While the surveys represent cross-sections, their retrospective questions on migration and assets allow the construction of a longitudinal panel of data for the sampled individuals. A disadvantage of the retrospective nature of this data is the possibility of recall bias. However, there are at least two reasons why the data used here may be relatively unlikely to suffer from this problem. First, since the first trip is a relatively significant event, individuals may find it easier to recall

[11]Some of our national-level data series begin in 1968, so this is the earliest year after the Bracero Program that we can examine.

than subsequent trips. Second, the ordering of events may be more accurate than specific dates of events, and it is the ordering which is most critical to our analysis.

Variables to be used in analysis include standard demographic characteristics as well as national-level measures of border enforcement, wages, and unemployment. The most critical, however, are measures of migration, networks, and assets. The following sections describe their construction in detail.

Migration measures

The MMP migration survey includes two sets of questions about household heads' travels to the U.S. One set asks about the individual's first U.S. trip, including the type of documentation used, and the other asks about illegal crossings, including any use of coyotes. The responses to these questions are used to create variables pertaining to migration. We define the migration year as the earlier of the dates of the first U.S. trip (except for tourists) and the first illegal crossing. Migrants are deemed illegal if they report that their first U.S. trip was an undocumented migration or only reported an illegal crossing (4,107 individuals), if they cross with a tourist visa and subsequently accept work (253 individuals), if they report using a coyote on their first U.S. trip despite not reporting an illegal crossing (48 individuals), or if they report an illegal crossing prior to their first U.S. trip (36 individuals).

An indicator of coyote use is constructed based on whether an illegal migrant reports using a coyote. For convenience, we say that those not using a coyote migrated "alone," although this does not necessarily mean that they did not travel with other migrants. We defined the 253 individuals who crossed the border as tourists at their first migration but subsequently took up work as having migrated alone, since presumably their tourist visas made it unnecessary to hire a coyote to enter the country. Finally, note that coyote use status is missing for illegal migrants who reported that their first illegal crossing followed their first undocumented migration. We drop the 182 illegal migrants who do not report any coyote information.

Network measures

We define two sets of network measures to capture features of both family and community networks. The first set reflects characteristics of the family network. Each individual reports the date of first migration of both parents and up to twelve siblings. Using this information, we generate a measure of family network size, recording the number of nuclear family members who have made a trip to the U.S. prior to each year. The second set of measures captures characteristics of the community network. Using the person-level data, we construct measures of the absolute number and proportion of surveyed individuals from each community who have made a trip to the U.S. prior to each year. These measures proxy for the size and density of the community network.[12]

[12] In addition, we create two supplementary sets of family network variables. These indicate how recently the trips took place, recording the years of the earliest and most recent trips among all nuclear family members prior to each year. Information from recent trips may be most valuable, though early trips may have generated remittances that allowed the household to invest in capital. Early trips may also contribute to a family culture of, or preference for, migration. We think of these measures as capturing the age and recency of the family network, following Orrenius (1999). However, these factors proved to have little effect on migration decisions (see Appendix Table 1).

Asset measures

Dated information on household assets includes information on land, property, and business holdings. The survey reports the dates of acquisition and sale, if applicable.[13] For each year, we construct an indicator for whether the individual held any assets. As the next section will show, only a small proportion of migrants hold any assets. Hence, in most of our analysis, we will restrict attention to whether an individual holds any assets or not.[14]

4.2 Descriptive statistics

Table 1 presents descriptive statistics for the entire sample of $16,053$ Mexican household heads. These statistics summarize the migration, demographic, national, asset, and network characteristics that will be used in our analysis. The three columns of the table present means for the subgroups of non-migrants, those migrating alone, and those migrating with a coyote. Of all the household heads in our sample, 23% migrated illegally (with 20% migrating between 1968 and 2000). Among the illegal migrants, 74% used a coyote and 26% migrated alone. The $2,173$ household heads not included in Table 1 are either legal immigrants ($1,321$ heads) or have missing variables. Recall that most of these legal migrants are in fact Bracero workers. Indeed, when we restrict our sample to individuals who have not migrated prior to 1968, there is a total of only 607 missing.

[13]Assets for which acquisition and sale dates are not reported include livestock, vehicles, and household appliances.

[14]We also constructed a set of dummy variables to indicate the type of asset held: land, property, or business. As results using the three separate dummies tended to be insignificant (see Appendix Table 2), our analysis focuses on the single asset-holding indicator.

The summary statistics reveal several differences between migrants who cross alone and with coyotes. Those crossing with coyotes have larger sized family and community networks (1 and 120 versus 0.7 and 86) and a greater likelihood of holding any assets. They also tend to be younger, more educated, and more recent migrants. This simple comparison suggests that networks and assets are associated with a greater likelihood of coyote use.

Not surprisingly, migrants also differ from nonmigrants. Migrants are more likely to be younger married males, in smaller households, with less education. The difference in education between migrants and non-migrants could reflect the greater relative gains of migration for the less educated. Differences in national characteristics, including Mexican and U.S. wages, border linewatch hours,[15] and the exchange rate, between migration types simply reflect differences in the year of migration.

4.3 Estimation Methodology

We model the migration decision empirically with a duration model. Individuals are assumed to choose one of three options each year: migrate alone, migrate with a coyote, or don't migrate at all. The model specifies the duration from birth until the first U.S. migration as a function of covariates that include network characteristics, asset holding, and their interactions, as well as national and individual characteristics. The appeal of the approach lies in its close conceptual link to the hypothesized theoretical process. In order to compare distinct effects of covariates on the decisions to migrate alone or with a coyote, we use a competing risks model

[15]This is a measure of the total number of manhours spent by U.S. staff in patrolling the border.

in which an individual exits a spell of "non-migration" in one of these two ways.

The specific method we use follows Lunn and McNeil (1995). Their approach involves data augmentation by duplicating the data for each exit or failure type k. Using the pooled data, one estimates Cox's proportional hazard regression stratified by type of failure.[16] Here, $k = 1$ denotes migration alone while $k = 2$ denotes migration with a coyote. This does not impose any restrictions on the relationship between the baseline hazard functions for each failure type, λ_{10} and λ_{20}.[17] Separate coefficients for each failure type are allowed by including interactions of covariates $x_i(t)$ with a failure-type dummy $\delta_i = I(k = 2)_i$; the coefficients on the interactions may be tested to determine whether there is a differential effect of the covariate on the decision to migrate with a coyote rather than without. Thus, the hazard function takes the form

$$\lambda_{ki}(t) = \lambda_{k0}(t) exp\left(b_1' x_i(t) + b_2' \delta_i x_i(t)\right)$$

for all $t \geq 0$ and $k = 1, 2$. The partial likelihood function is

$$\prod_{t_i,\ \delta_i=0} \left(\frac{exp\ (b_1' x_i)}{\sum_{R_i} exp\ (b_1' x_i)} \right) \prod_{t_i,\ \delta_i=1} \left(\frac{exp\ (b_1' x_i + b_2' \delta_i x_i)}{\sum_{R_i} exp\ (b_1' x_i + b_2' \delta_i x_i)} \right)$$

The covariance matrix of the coefficient estimates is adjusted in order to allow for the correlation of failure types within individuals.[18]

[16] The proportional hazard specification assumes that the proportional effect of a covariate on the conditional probability of failure does not depend on duration; see the original Cox (1972) and the survey by Kiefer (1988).

[17] An alternative method they describe assumes a constant ratio of the hazard functions.

[18] An alternative approach is to model the relationship between failure times as a random effect or "frailty," but this involves making assumptions about the distribution of the random effect term.

We include a variety of covariates to explain the time until migration. In addition to time-invariant individual demographic characteristics such as year of birth, gender, and education, we include a set of typical economic and enforcement controls. Wages in the source and destination countries, the exchange rate, and U.S. unemployment affect the expected benefits from migration, while the number of annual manhours spent on U.S. border patrol affects the likelihood of a successful illegal crossing for both migrants and coyotes. Most importantly, measures of the size of the family network and the density of the community network, an asset holding indicator, and their interactions will allow us to test the model's predictions about the network's function.[19]

It is important to point out at least two limitations of this simple approach. One is the weakness of our asset measures as proxies for wealth. These crude measures exhibit little variation and may not accurately reflect differences in wealth, biasing our estimates towards zero. A second limitation is that we ignore coyote prices in order to avoid the selection issue created by the fact that only those who use coyotes report prices, at the cost of greater precision. Future work would do well to address this issue that has not yet been treated in the literature. Another reason to omit coyote prices is because they are endogenous to coyote demand, so their estimated effect is uninformative. This issue has also received little attention.[20]

[19] Results using the size of the community network were qualitatively similar.

[20] An exception is Orrenius (1999), who instruments for coyote prices in a different context using border enforcement hours. As Gathmann (2004) points out, however, this instrument will be invalid if border enforcement responds to coyote demand and supply (pp. 3-4). Instead, she instruments coyote prices with the severity of coyote punishment (prison sentences and fines), since these are supply shifters that are exogenous to demand. The collection of such data for the period we study to pursue a similar strategy is beyond the scope of this paper.

5 Results

The model is estimated on the panel data set we construct for years 1968 to 2000. The panel includes 13,275 household heads observed for up to 32 years. Table 2 presents the results of three specifications involving various sets of covariates representing demographic, economic, enforcement, network sizes and asset variables. For the community network, we use the network density as a measure of network size, but using the absolute size would not affect the results.[21] The simple specification in Panel 1 allows only network densities, asset, and interaction variables to have separate effects on migration with or without a coyote. That in Panel 2 allows all variables to have separate effects on each type of migration. The specification in Panel 3 modifies that in Panel 1 by additionally including a set of community dummy variables, as well as distinct effects for the demographic variables.[22] The advantage of including the community dummies is that they will control for all the unobserved, time-invariant community-level factors that affect a migrant's decisions.

In Panels 1 to 3, the first column of marginal effects ("Migrating Alone") should be interpreted as the effect of each variable on the likelihood of migrating alone in a given year given that one has not yet migrated. The second column of marginal effects ("Additional Effect with Coyote Use") reports the additional effect of each variable on the likelihood of migrating with a coyote. Our primary interest is in the effects of the network and asset measures.[23]

[21] The network density is the proportion of surveyed individuals from the community who have made a trip to the U.S. prior to that year.

[22] We do not include separate effects for all explanatory variables in this specification for computational feasibility.

[23] The inclusion of legal migrants does not not have a qualitative effect on our results.

Table 2 indicates that family networks have large and significant effects on the likelihood of migrating, especially migrating with a coyote. Under the specifications in Panels 1–3, in the absence of assets, one additional family member having migrated significantly increases the likelihood of migrating alone by between 25% and 31%, and significantly increases the likelihood of migrating with a coyote by between 35 and 37%. This is consistent with a job information effect of family networks discussed in Section 3 but not with a crossing information effect, since that would tend to reduce the likelihood of coyote use.[24]

Results on community networks are somewhat different. Panels 1 and 2 show that an additional 1% of the community having migrated significantly increases the probability of migrating by 5 or 6 percent. In the simplest specification in Panel 1, an increase in the community network has an even larger impact on coyote use, increasing the likelihood of migrating a coyote by about 7 percent (an additional 1.6 percent). These findings suggest that community networks, like family networks, provide members with job information. However, after controlling for community fixed effects in the specification in Panel 3, we see that community networks actually have a strong *negative* effect on migration and in particular on migrating alone, contrary to the model's predictions. In other words, conditional on the average number of migrants from an individual's community, the migration of additional community members has a negative impact on the individual's migration, suggesting a slowdown in a community's migration flow over time.

These results are consistent with the "S-shaped" effect of migrant networks found by Colussi (2004). Such a pattern could be explained by a rising wage in the

[24]As illustrated in Appendix Table 1, the age and recency of the family network have little impact on migration decisions.

sending communities following migration, as he suggests, or to remittances from migrants that improve living conditions in the originating communities (Massey and Parrado 1994). In these cases, we would also expect the relative attractiveness of the U.S. to decrease after a few waves of migration. These explanations are consistent with the evidence found by Mckenzie and Rapoport (2004) that many MMP communities have already reached relatively high level of migration.

Asset ownership *per se* does not affect the hazard of migrating alone. It has a positive but only weakly significant effect on the likelihood of migrating with a coyote.[25] However, when interacted with family networks, we see a significant negative effect on the probability of migration in all specifications. Having any assets reduces the effect of the family network on migration by between 7% and 9%. This supports the hypothesis that individuals are credit constrained and that families provide credit to individuals. No such substitution effect is present for community networks, however, indicating that, overall, acquaintances are a less important source of credit. While the additional effect of the interaction on coyote use is also negative, it is not significant. This finding suggests that credit is only relevant for the decision of whether or not to migrate, and thus that the expense of a coyote adds only marginally to the expense of migrating at all.

Effects of Other Factors

The effects of individual demographic characteristics, economic, and enforcement variables are also of interest.

Not surprisingly, females heads of household are much less likely to migrate than males, and even less likely to use coyotes. There are several potential explanations.

[25]Appendix Table 2 decomposes the effect of different assets and shows that land ownership is the most important asset in determining migration and coyote use decisions.

Female headed households may tend to be poorer which suggest that they should be less likely both to migrate and to use a coyote. Females may have a comparative advantage at crossing the border alone as INS agents tend to apprehend mainly males (see Donato and Patterson 2004). As female migration is also driven by family reunification, and because their economic gains from migration may be lower, the model presented in Section 3 would predict that females are more likely to migrate alone. Finally, women may avoid coyotes due to fear of potential abuse.

Education decreases the likelihood of migration. This could be due to better employment options available in Mexico to those with more education. Moreover, education decreases the likelihood of coyote use even more, suggesting that being educated increases one's comparative advantage of crossing alone. Younger individuals are also more likely to migrate, and even more likely to use a coyote. However, this could potentially reflect a supply effect as the number of coyotes has been increasing steadily over time.

The U.S. wage has a positive impact on migration and especially on coyote use. This is consistent with the model in Section 3: higher U.S. wages increase coyote use, as the greater the gain from migration, the greater the willingness to pay to increase the probability of a successful migration. Mexican wages in Panels 1 and 3 have a weakly significant but *positive* effect on the likelihood of migrating. Panel 2 shows that this effect is driven by a positive effect on the likelihood of migrating with a coyote; Mexican wages actually have a negative and insignificant effect on migrating alone. As seen in Section 3, these effects are consistent with the migration decision of rational individuals as long as they exhibit some risk aversion. Note that it could also reflect the effect of credit constraints.[26]

[26]One may also question whether the Mexican manufacturing wage is a good measure of the

As expected, higher U.S. unemployment tends to discourage migration. However, it has no effect on the mode of migration, as Panel 2 shows. The fact that some coyotes do provide jobs may offset the negative effect on coyote use that would be expected from a decrease in economic opportunities. Results also indicate a weakly significant and negative effect of the exchange rate on migration. We observe in Panel 2 that the exchange rate affects only those migrants using a coyote. The reason could be that many coyotes charge prices in dollars, so that a rising exchange rate makes them more expensive (see Massey and Espinosa 1997).

Finally, border patrol linewatch hours are not significant in any of the specifications. This may not be surprising, as linewatch hours may have several effects on coyote supply and demand. To the extent that longer hours proxy for high enforcement, this should tend to discourage migration. For a migrant, using a coyote might may become relatively more secure, but coyotes may be less inclined to make the trip since penalties are targeted at them. Finally, higher enforcement might be a response to more illegal migration; this endogeneity could bias the estimate upward (towards zero).

6 Conclusions

This paper advances our understanding of the effects of networks on migration decisions by investigating the channels through which networks influence the choices to migrate illegally and to hire a coyote for the crossing. Networks may provide

economic opportunities of the mainly agricultural population that we examine. However, we found that average Mexican rainfall has an insignificant effect on migration, contrary to what we might expect if rainfall relates to the supply of agricultural crops and hence agricultural prices and wages.

three different services: information about border crossing, information about jobs at the destination, or credit to finance the trip. Using a simple model of migration, we derive theoretical predictions of the effects of these different services on migration and coyote use, and test them using data on a sample of illegal Mexican migrants who entered the U.S. between 1968 and 2000.

Results indicate that larger family networks tend to increase the likelihood of migration. The family network has an even larger positive effect on coyote use. According to the theoretical model, this pattern suggests that the family network helps prospective migrants find jobs at their destination, rather than providing information that helps them to navigate the crossing. Larger community networks, in contrast, have small and mixed impacts on migration and coyote use, implying that the community network plays a smaller role in an individual's migration decisions.

Another area of interest is whether assets affect migrants' coyote use by making it possible for them to afford this expense. The results show that assets in general have little effect on migration. In contrast, the negative effects of network and asset interactions on migrating alone indicate that family networks, though not community networks, provide credit as well as job information to migrants. This credit provision, however, does not appear to affect coyote use.

This study presents evidence that migrant networks provide multiple benefits to their members, and highlights the importance of distinguishing between these types of services. In particular, our findings suggest that the credit role of networks should not be neglected.

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Figure 1: MMP map (source http://mmp.opr.princeton.edu)

Table 1: Summary Statistics by Migration Status

	Non-Migrant			Mig. Alone			Mig. with Coyote		
Variable	**Mean**	**Std. Dev.**	**N**	**Mean**	**Std. Dev.**	**N**	**Mean**	**Std. Dev.**	**N**
Female	0.184	0.387	10233	0.039	0.195	937	0.039	0.195	2710
Married	0.786	0.41	10227	0.923	0.266	937	0.925	0.263	2709
Age	47.788	15.508	10223	46.181	14.611	937	39.514	11.819	2710
Education	5.886	4.815	10221	4.954	3.955	935	5.328	3.451	2708
Household size	4.741	2.409	10232	5.023	2.425	937	5.092	2.308	2710
Year of 1st migration				1972.253	14.89	937	1980.06	10.962	2710
Age at 1st migration				24.191	8.528	937	25.177	8.925	2710
Any assets †				0.229	0.421	937	0.278	0.448	2710
Any assets * Comm network †				0.379	0.485	937	0.51	0.5	2710
Family network †				0.698	1.176	937	1.013	1.379	2710
Community network †				86.305	80.201	748	120.612	102.267	2539
Any community network †				0.068	0.056	748	0.094	0.068	2539
Border patrol hours †				2583.919	1167.528	685	2952.843	1556.399	2502
Mexican average wage †				1.588	0.553	662	1.541	0.585	2488
U.S. average Wage †				10.726	0.515	662	10.647	0.53	2488
Exchange rate †				0.955	1.913	662	1.339	2.305	2488

† At the year of first migration.

Table 2: Competing risk model of migration.

	(1)							
	Migrating Alone				Additional Effect with Coyote Use			
	dF/dx	Std. Err.	z	P>|z|	dF/dx	Std. Err.	z	P>|z|
Individual Characteristics								
Year Born	0.0245	0.0071	3.4500	0.0010				
Female	-1.2638	0.0922	-13.7100	0.0000				
Education	-0.0767	0.0044	-17.4000	0.0000				
Economic Variables								
Mexican Wage	0.0777	0.0413	1.8800	0.0600				
US Wage	0.3464	0.0676	5.1300	0.0000				
Mexican Rainfall	-0.0003	0.0003	-1.2400	0.2140				
US unemployment	-0.0222	0.0174	-1.2800	0.2020				
Exchange Rate	-0.0572	0.0259	-2.2100	0.0270				
Enforcement								
Border Patrol Hrs	0.1243	0.1074	1.1600	0.2470				
Network Variables								
Family Network	0.3059	0.0280	10.9300	0.0000	0.0555	0.0307	1.8100	0.0710
Community Network	5.4013	0.4764	11.3400	0.0000	1.6454	0.4862	3.3800	0.0010
Assets and Interactions								
Any asset	-0.0328	0.0738	-0.4400	0.6570	0.1374	0.0893	1.5400	0.1240
Asset*Family Network	-0.0938	0.0350	-2.6800	0.0070	-0.0318	0.0412	-0.7700	0.4400
Asset*Commty Network	-0.3987	0.5825	-0.6800	0.4940	0.2508	0.6706	0.3700	0.7080
Community Dummies	No							
Log likelihood	-25,752.43							
Wald chi2	1674.32							
N	13275							

Table 2: Continued.

	(2)							
	Migrating Alone				Additional Effect with Coyote Use			
	dF/dx	Std. Err.	z	P>|z|	dF/dx	Std. Err.	z	P>|z|
Individual Characteristics								
Year Born	-0.0216	0.0116	-1.8700	0.0620	0.0778	0.0148	5.2500	0.0000
Female	-1.0336	0.1330	-7.7700	0.0000	-0.3852	0.1762	-2.1900	0.0290
Education	-0.0269	0.0066	-4.0700	0.0000	-0.0805	0.0081	-9.9300	0.0000
Economic Variables								
Mexican Wage	-0.0629	0.0715	-0.8800	0.3800	0.2194	0.0884	2.4800	0.0130
US Wage	0.1133	0.1091	1.0400	0.2990	0.4222	0.1406	3.0000	0.0030
Mexican Rainfall	-0.0001	0.0005	-0.2100	0.8320	-0.0004	0.0006	-0.6500	0.5140
US unemployment	-0.0294	0.0292	-1.0100	0.3140	0.0185	0.0366	0.5000	0.6140
Exchange Rate	-0.0038	0.0424	-0.0900	0.9290	-0.0821	0.0536	-1.5300	0.1250
Enforcement								
Border Patrol Hrs	0.0516	0.1871	0.2800	0.7830	0.0815	0.2304	0.3500	0.7240
Network Variables								
Family Network	0.2867	0.0278	10.3200	0.0000	0.0861	0.0310	2.7800	0.0050
Community Network	6.3554	0.5077	12.5200	0.0000	0.1888	0.5589	0.3400	0.7350
Assets and Interactions								
Any asset	0.0073	0.0730	0.1000	0.9200	0.0774	0.0895	0.8600	0.3870
Asset*Family Network	-0.0902	0.0346	-2.6000	0.0090	-0.0375	0.0411	-0.9100	0.3620
Asset*Commty Network	-0.7068	0.5623	-1.2600	0.2090	0.7289	0.6625	1.1000	0.2710
Communtiy Dummies	No							
Log likelihood	-25,693.88							
Wald chi2	1,787.72							
N	13275							

Table 2: Continued.

	(3)							
	Migrating Alone				Additional Effect with Coyote Use			
	dF/dx	Std. Err.	z	P>|z|	dF/dx	Std. Err.	z	P>|z|
Individual Characteristics								
Year Born	0.0845	0.0099	8.5700	0.0000	0.0315	0.0058	5.4600	0.0000
Female	-0.9441	0.1342	-7.0400	0.0000	-0.3837	0.1763	-2.1800	0.0300
Education	-0.0018	0.0068	-0.2700	0.7900	-0.0817	0.0080	-10.1800	0.0000
Economic Variables								
Mexican Wage	0.0879	0.0411	2.1400	0.0320				
US Wage	0.2636	0.0681	3.8700	0.0000				
Mexican Rainfall	-0.0003	0.0003	-1.2700	0.2020				
US unemployment	-0.0339	0.0174	-1.9400	0.0520				
Exchange Rate	-0.0559	0.0261	-2.1400	0.0320				
Enforcement								
Border Patrol Hrs	0.0103	0.1069	0.1000	0.9230				
Network Variables								
Family Network	0.2544	0.0285	8.9300	0.0000	0.0858	0.0325	2.6400	0.0080
Community Network	-6.5973	0.9324	-7.0800	0.0000	1.4153	0.7558	1.8700	0.0610
Assets and Interactions								
Any asset	-0.0597	0.0868	-0.6900	0.4920	0.1170	0.1063	1.1000	0.2710
Asset*Family Network	-0.0748	0.0355	-2.1000	0.0350	-0.0347	0.0428	-0.8100	0.4170
Asset*Commty Network	-0.4698	0.7774	-0.6000	0.5460	0.2373	0.9426	0.2500	0.8010
Communtiy Dummies	Yes							
Log likelihood	-25,183.69							
Wald chi2	2,904.09							
N	13275							

Appendix Table 1: Networks.

	Migrating Alone				Additional Effect with Coyote Use			
	dF/dx	Std. Err.	z	P>|z|	dF/dx	Std. Err.	z	P>|z|
Individual Characteristics								
Year Born	-0.0212	0.0116	-1.8300	0.0670	0.0779	0.0148	5.2500	0.0000
Female	-1.0351	0.1330	-7.7800	0.0000	-0.3884	0.1764	-2.2000	0.0280
Education	-0.0272	0.0066	-4.1100	0.0000	-0.0795	0.0082	-9.7200	0.0000
Economic Variables								
Mexican Wage	-0.0626	0.0715	-0.8800	0.3810	0.2225	0.0884	2.5200	0.0120
US Wage	0.1137	0.1092	1.0400	0.2980	0.4229	0.1406	3.0100	0.0030
Mexican Rainfall	-0.0001	0.0005	-0.2100	0.8300	-0.0004	0.0006	-0.6600	0.5110
US unemployment	-0.0293	0.0292	-1.0000	0.3160	0.0190	0.0366	0.5200	0.6040
Exchange Rate	-0.0052	0.0424	-0.1200	0.9020	-0.0816	0.0536	-1.5200	0.1280
Enforcement								
Border Patrol Hrs	0.0529	0.1870	0.2800	0.7770	0.0772	0.2306	0.3300	0.7380
Network Variables								
Family Network	0.2824	0.0368	7.6800	0.0000	0.0874	0.0414	2.1100	0.0350
Years since earliest fam net	-0.0008	0.0066	-0.1200	0.9080	-0.0058	0.0079	-0.7300	0.4640
Years since latest fam net trip	0.0060	0.0074	0.8100	0.4190	0.0157	0.0092	1.7100	0.0870
Community Network	6.2525	0.5153	12.1300	0.0000	0.1946	0.5802	0.3400	0.7370
Assets and Interactions								
Any asset	-0.0150	0.0725	-0.2100	0.8360	0.1071	0.0889	1.2000	0.2280
Asset*Family Network	-0.0690	0.0515	-1.3400	0.1800	-0.0464	0.0618	-0.7500	0.4530
Asset*Years since earliest	-0.0060	0.0094	-0.6400	0.5250	0.0066	0.0111	0.5900	0.5550
Asset*Years since latest	0.0034	0.0099	0.3500	0.7280	-0.0149	0.0119	-1.2500	0.2120
Asset*Commty Network	-0.5208	0.7308	-0.7100	0.4760	1.0588	0.8573	1.2400	0.2170
Log likelihood	-25,677.31							
Wald chi2	1,690.10							
N	13,275.00							

Appendix Table 2: Assets.

	Migrating Alone				Additional Effect with Coyote Use			
	dF/dx	Std. Err.	z	P>|z|	dF/dx	Std. Err.	z	P>|z|
Individual Characteristics								
Year Born	-0.0236	0.0121	-1.9500	0.0510	0.0798	0.0154	5.1700	0.0000
Female	-1.0737	0.1424	-7.5400	0.0000	-0.3271	0.1851	-1.7700	0.0770
Education	-0.0276	0.0070	-3.9600	0.0000	-0.0773	0.0084	-9.1800	0.0000
Economic Variables								
Mexican Wage	-0.1113	0.0754	-1.4800	0.1400	0.2837	0.0926	3.0600	0.0020
US Wage	0.0968	0.1148	0.8400	0.3990	0.4530	0.1468	3.0900	0.0020
Mexican Rainfall	-0.0001	0.0005	-0.1000	0.9170	-0.0004	0.0006	-0.6700	0.5000
US unemployment	-0.0226	0.0306	-0.7400	0.4600	0.0239	0.0381	0.6300	0.5320
Exchange Rate	0.0202	0.0440	0.4600	0.6460	-0.0840	0.0557	-1.5100	0.1310
Enforcement								
Border Patrol Hrs	-0.0080	0.1865	-0.0400	0.9660	0.1043	0.2301	0.4500	0.6500
Network Variables								
Family Network	0.2972	0.0294	10.1100	0.0000	0.0697	0.0324	2.1500	0.0310
Community Network	6.0644	0.5459	11.1100	0.0000	0.3508	0.5925	0.5900	0.5540
Assets and Interactions								
Any land	-0.0452	0.1692	-0.2700	0.7890	0.3894	0.2021	1.9300	0.0540
Any land*Family Network	-0.1917	0.1046	-1.8300	0.0670	-0.0215	0.1155	-0.1900	0.8520
Any land*Commty Network	0.0771	1.3679	0.0600	0.9550	0.3099	1.6456	0.1900	0.8510
Any property	0.0377	0.1047	0.3600	0.7190	-0.0796	0.1304	-0.6100	0.5420
Any prop*Family Network	-0.0421	0.0483	-0.8700	0.3840	-0.0602	0.0593	-1.0200	0.3100
Any prop*Commty Network	0.1873	0.8526	0.2200	0.8260	0.4673	1.0190	0.4600	0.6470
Any business	0.0997	0.1949	0.5100	0.6090	-0.1217	0.2406	-0.5100	0.6130
Any bus*Family Network	-0.2060	0.1161	-1.7700	0.0760	0.1211	0.1362	0.8900	0.3740
Any bus*Commty Network	-4.0468	1.9623	-2.0600	0.0390	1.6911	2.3773	0.7100	0.4770
Log likelihood	-14,884.68							
Wald chi2	1014.43							
N	12062							