Self-Selection and Liquidity Constraints in Different Migration Cost Regimes

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Abstract

As smuggling costs across the U.S.-Mexico border have increased, a shift has occurred in the types of migrants able to afford the costs. Potential unauthorized migrants often face a liquidity constraint such that they cannot borrow against their future earnings to pay the cost for clandestine entry. In this paper I model the decision to migrate with this liquidity constraint and the ability for U.S. social networks to alleviate these constraints. The model predicts (i) an increase in smuggling fees intensifies intermediate self-selection of migrants, (ii) an increase in US wages increases migration among higher ability types, and (iii) social networks enable lower ability types to migrate. The predictions of the model are tested by estimating migration behavior in low-cost and high-cost migration periods. In the high-cost period relative to the low-cost period, I find evidence of an intensification of intermediate self-selection. Moreover, social networks increase migration among low-income earners in the high-cost period. In the model calibrated using U.S.-Mexico data, I find the smuggling fees are an important component of who migrates.

JEL: F22, J31, J61.

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1 Introduction

The costs of unauthorized migration across the U.S. - Mexico border fall into two categories: explicit and implicit costs. The explicit costs of unauthorized migration consist of the fee required by the *coyotes* (people-smugglers) who assist the migrant in crossing the international border and secondarily of the cost of transportation to the border. The implicit costs of migration include the psychological burden of being away from home and the search costs associated with finding employment once the person arrives in the receiving country. While the implicit costs have been reduced by the formation of social networks in the United States (Espinosa and Massey, 1997, Orrenius 1999), the explicit costs have significantly increased in real terms coinciding with the intensification of border enforcement. (Gathmann, 2008)

Estimates of smuggling fees in Massey and Durand (2003) and Cornelius, Fitzgerald and Borger (2009) demonstrate more than a threefold increase in real terms in the last 15 years. These increased costs have changed the types of migrants and how migrants pay for these services. Rather than use personal savings that would take longer to accumulate or loans secured against their future earnings, which are not readily available, migrants have been using their social networks in the United States to alleviate this liquidity constraint. (Cornelius, 2001, Massey, Goldring and Durand, 1994)

This paper argues that potential migrants often cannot borrow in the current period against their future earnings in the United States to pay the cost for clandestine entry and therefore a standard self-selection migration model that calculates future earnings less the costs of migration misses the timing of smuggling costs payments. Chiquiar and Hanson (2005) motivate their empirical analysis with a simple model that calculates the threshold for migration when the potential migrant's earnings in their home country and the potential migrant's earnings in the host country less the migration costs are equated. However, by construction the costs are able to be paid out of the migrant's wages in the host country. This simplifying assumption does not contradict the fact that in practice migrants pay back relatives and friends for the cost of migration from US earnings.

This paper takes an alternative approach by requiring the migration costs to be paid in the period before US wages can be earned and modeling the social networks ability to alleviate the 'cash-in-advance' constraint. Orrenius and Zavodny (2005) and Stark and Taylor (1991) note this 'cash-in-advance' constraint binds the least-skilled potential migrants from migrating. However, these models fail to capture the additional migrants who use their social networks to pay the smuggling cost. The importance of social networks in the ability to pay migration costs is consistent with the findings of Mckenzie and Rapoport (2007a, 2007b) that migration networks change the propensity to migrate for different educational levels.

I model the decision of the household to migrate incorporating two fundamental relationships in the migration literature and specifying the liquidity constraint faced by potential migrants. First, in the seminal work, Sjaastad (1962) modeled the migrant's decision as a function of wages in the host country less the costs of migration and the foregone wages the migrant could have earned in his home country. [1] Similarly, this relationship determines who will migrate in my model and the model explicitly incorporates the period in which the costs are paid.

Second, the fundamental mechanism of my model – the transfer of ability types into foreign labor markets – assumes the inability of migrants to transfer skills one-for-one into host country labor markets. This is similar in concept to the seminal work of Borjas (1987) building on Roy (1951) using the intercountry differences in skill to model the self-selection of migrants that is dependent upon the variance of income between two countries. Borjas (1987) finds that since the income distribution is more unequal in Mexico than the United States, migrants are negatively selected from Mexico. The higher returns for lower ability types is consistent with the

[1] This model considers the impact of costs on unauthorized migrations, so the differentiation wages between legal and illegal migrants in Ethier (1986) is not necessary. However, the analysis in this paper could be augmented by generalizing the framework to all migrants with different cost structures specified.

functional form in my model that transfers native ability types. However, the finding of negative self-selection in Borjas (1987) would only be consistent with my model's predictions if potential migrants always had social networks to pay the smuggling fees in the period before the migrant could earn wages in the United States. Rather, the liquidity constraint is faced by more and more migrants as the smuggling costs have increased, restricting migration to middle ability types and intermediate self-selection. [2]

The framework set forth in this paper analyzes how migrants self-select with flexibilities in the model that can make the model more generalizable. However, by incorporating stylized facts that are characteristic of Mexico-to-U.S. unauthorized migration into the assumptions of the model, I find the model predicts many of the findings in the recent literature. I consider the range of ability types for who chooses to migrate in a constrained optimization model with a functional form that specifies how ability types transfer into foreign labor markets and a non-negative asset restriction on the household.[3] The transfer of ability types into foreign labor markets is a mechanism through which higher-income earners choose to remain in Mexico with the assumption that skills cannot transfer one-for-one into foreign labor markets. With a non-linear transferability of native ability types into foreign labor markets, the model predicts intermediate self-selection of migrants. The restriction of non-negative assets translates into an inability for the household to borrow against future earnings. The findings of intermediate self-selection of migrants is consistent with Chiquiar and Hanson (2005), Orrenius and Zavodny (2005) and McKenzie and Rapoport (2007a). [4]

[2]The dynamics of migration costs are considered in Carrington, Detragiache and Vishwanath (1996) where the costs decrease as social networks in the destination increase. However, by limiting my model to a two-period framework, migration patterns can be characterized without knowing how the social networks evolved over time.

[3]Ability types in this paper refer to some intrinsic talents of the household which is often correlated with educational attainment levels or earnings potential.

[4]This result is in contrast to the findings in Caponi (2006) of the highest and lowest educated persons tending to migrate and the findings in Borjas (1987) and Ibarraran and Lubotsky (2007) of negative self-selection.

The model has three primary predictions. First, an increase in smuggling fees intensifies intermediate self-selection by narrowing the range of ability-types that are able to migrate. Second, an increase in the U.S. wage, holding the U.S./Mexico wage ratio constant, increases migration among the higher ability types. Third, an increase in social networks in the United States increases migration among lower-ability types.

The narrowing of the range of ability-types that are able to migrate predicted in the model from increased smuggling costs has implications for the Mexican migrant-sending community. The increased cost of migration has allowed only those individuals with significant financial resources to migrate. Yet, the highest-income earners in Mexico are more reluctant to migrate because of better opportunities where they reside. This leaves only the middle-class of a community to migrate to the United States. Moreover, significant re-entry costs into the United States discourage undocumented migrants living in the United States from participating in circular migration – the frequent, temporary movements movements between localities in Mexico and the United States that for several generations was the dominant pattern in Mexico-to-U.S. migration. Without circular migration, the middle-class migrates and is less likely than previously to return to Mexico. This intensification of intermediate self-selection has the effect of increasing inequality in migrant-sending communities in Mexico.

The increase in migration rates of higher ability types predicted in the model as the wage in the United States increases is consistent with the assumption that higher ability types choose to not migrate because the wage they can earn in their home country is higher. As the wage increases, the more likely that net earnings in the United States would exceed their earnings in Mexico without migration. Finally, the prediction in the model that social networks are able to increase migration among lower ability types in consistent with the findings in Espinosa and Massey (1997), Orrenius (1999), Orrenius and Zavodny (2005), McKenzie and Rapoport (2007a).

However, McKenzie and Rapoport (2007a) find an additional effect of networks at the upper end of the schooling distribution, yet with a decrease in the average level of schooling. Social networks in this model are more specific and limited in how they assist future migrations, but future research could augment the current model with a characterization of how social networks assist the migrant in finding employment in the receiving country.

The structure of the paper is as follows: Section 2 models the household's decision to migrate, establish the lower- and upper-bound thresholds for migration and analyze the impact of cost, the wage ratio, and social network density on these thresholds. Section 3 motivates the different migration cost regimes with a description of the change in border enforcement policy over time and how that corresponded to an increase in smuggling fees. Section 4 will demonstrate that when the model is realistically calibrated to the US/Mexico data, the coyote fees are an important determinant of who can migrate. Section 5 tests the implications of the model by estimating the probability of migration in different migration costs regimes in communities with both low and high social network densities in the United States. Section 6 summarizes the findings.

2 Theoretical Model

2.1 Basic Setup

In a discrete-time two period framework, I propose a model with a household that faces a liquidity constraint such that smuggling fees are paid in the period before migrants receive US earnings and a function that transfers native ability into foreign labor market productivity.

There are four stylized facts of U.S./Mexico migration that should be incorporated into any model characterizing household behavior with respect to migration. First, the wage gap between the United States and Mexico should impact the decision to migrate. Hansen and Spilimbergo (1999) and Borger (2009) find that the inflows of migrants respond to the wage ratio. Second, there exists a range of income for households that are able to migrate. Intermediate selection has been evidenced in Chiquiar and Hanson (2005), Orrenius and Zavodny (2005), and McKenzie and Rapoport (2007a). Third, the costs of migration have increased as border enforcement in the United States has intensified, as illustrated hereafter in Section 3. Fourth, smuggling fees are paid before migrants receive any U.S. earnings and therefore most potential migrants face a liquidity constraint such that their U.S. earnings would exceed their costs and any foregone wages, but they do not have the resources to pay the costs of migration. Migrant networks in the U.S. provide the capital in advance to pay these costs.

The model consists of two countries, the United States and Mexico, divided by an international border, and two periods. Migration costs are exogenously determined by the government with its choice of border enforcement intensity. The household draws an ability level in the first period and decides the level of consumption, the saving of assets and whether they will migrate to the United States in the next period or not. If the household chooses to migrate, a share of the cost of migration is paid in the first period, where the share of the cost paid is a function of the size of the household's social network in the United States. The assets of the household must remain strictly non-negative. This restricts the household from borrowing the costs of migration and therefore its decision is subject to a liquidity constraint. However, the inability to borrow is relaxed if the household has social networks in the United States that allows it to pay only part of the cost in the first period. The incentive to migrate in the second period is determined by whether the household's consumption in the second period would be greater given that migration occurs. I assume that all agents are able to find employment in either location and the second period's wages are known with certainty.

2.2 Household Decision

The household maximizes its consumption, savings, and decide whether to migrate to the United States or not. The household faces the following two period well-behaved utility function with non-satiation and diminishing returns to consumption:

$$U(C_t) + \beta U(C_{t+1}) \tag{1}$$

where C_t is consumption in period t and β is the discount rate. The budget constraint for the household in period 1:

$$C_t + a_{t+1} + \Phi(1-\eta)\Psi_t = \alpha W_t^{mex} \tag{2}$$

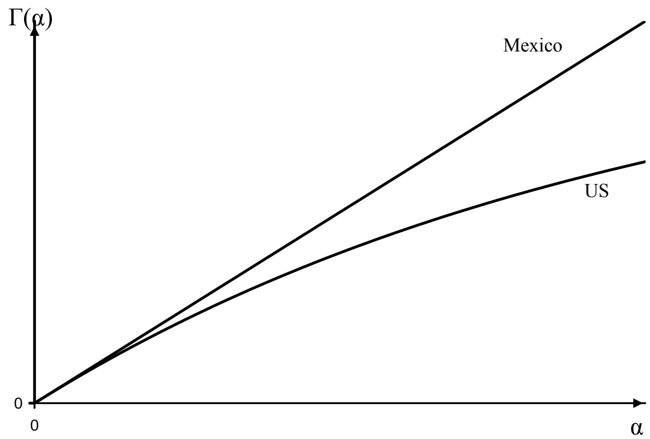
where a_t is the assets saved in period t, Φ is an indicator variable whether the person chooses to migrate or not with the variable equal to 1 if the person migrates from Mexico to the United States and equal to 0 if the person does not migrate. The parameter η is the fraction of the fee that can be borrowed and is assumed to be related to the size of the household's social network in the United States. Ψ_t is the cost of crossing the international border in the next period. W_t^{mex} is the wage earned in Mexico and α is the ability measure drawn by the household. During the second period, the budget constraint for the household:

$$C_{t+1} + \Phi\eta\Psi_t = (1+r)a_{t+1} + (1-\Phi)\alpha W_{t+1}^{mex} + \Phi\Gamma^u(\alpha)W_{t+1}^{us} \tag{3}$$

where r is the return on assets, W_{t+1}^{us} is the wage earned in the United States, and $\Gamma^u(.)$ is a function which transfers innate ability levels employment productivity levels in the United States.

The function $\Gamma^u(.)$ translates native ability levels into productivity in the United States' labor markets. The function is assumed to be continuous, everywhere differentiable, and an increasing function of ability-type with less than a one-for-one transfer from Mexico to the United States and with diminishing returns:

Figure 1: Productivity as a Function of Ability



Note: This graph characterizes the transferability of endowed ability into productivity in the workforce in the United States and Mexico. Ability draws for households in Mexico translate one-for-one to a productivity measure in Mexico whereas ability translates less than one-for-one into the United States' labor market.

$$\Gamma^{u'}(.) \leq 1 \qquad \Gamma^{u''}(.) < 0 \qquad \Gamma^{u}(0) = 0 \qquad \Gamma^{u'}(0) = 1 \tag{4}$$

The reason for the functional form assumed in equation 4 is there might exist language barriers or certification requirements that would prevent native ability levels from being transferred one-for-one to productivity into a foreign workforce. For example, migrants in the agricultural or construction sectors with relatively low ability levels could transfer their skills more readily to the United States than migrants with relatively high ability levels in the medical or legal sectors. Occupations in these sectors would require more education or re-accreditation to use their skills in the US labor market.[5]

[5] The non-linear restriction in the model is not necessary to predict intermediate self-selection since a linear transformation of less than one-for-one would discourage a range of high-income earners. However, the choice of a non-linear transfer of skills is more clear in the graphical depictions of the theoretical predictions.

The household maximizes utility in equation 1 with respect to the level of consumption in each period, the level of savings in the first period, whether or not to migrant and subject to the constraint in equation 2, equation 3, and the liquidity constraint $a_t \geq 0$.

The constrained optimization problem can be solved with a Lagrangian:

$$\begin{aligned} L = \; & U(C_t) + \beta U(C_{t+1}) \\ & + \lambda_t \Big(\alpha W_t^{mex} - C_t - a_{t+1} - \Phi(1-\eta)\Psi_t \Big) \\ & + \lambda_{t+1} \Big((1+r)a_{t+1} + (1-\Phi)\alpha W_{t+1}^{mex} + \Phi\Gamma^u(\alpha) W_{t+1}^{us} \\ & - C_{t+1} - \Phi\eta\Psi_t \Big) + \mu_{t+1} a_{t+1} \end{aligned} \tag{5}$$

The Kuhn-Tucker necessary conditions for an optimum are the following:

$$U'(C_t) - \lambda_t = 0 \tag{6}$$

$$\beta U'(C_{t+1}) - \lambda_{t+1} = 0 \tag{7}$$

$$\lambda_t - \lambda_{t+1}(1+r) = \mu_{t+1} \tag{8}$$

The complementary slackness conditions are:

$$\lambda_t \geq 0, \qquad \lambda_{t+1} \geq 0,$$

$$\mu_{t+1} \geq 0, \qquad a_{t+1}\mu_{t+1} = 0$$

Assets are completely consumed in the second period, so $a_{t+2} = 0$. If a household migrates, its consumption in the second period will be greater than its consumption in the first period and therefore μ_{t+1} will be positive and a_{t+1} will equal zero to satisfy the complementary slackness condition. $\lambda_t \geq \lambda_{t+1}(1+r)$ such that when μ_{t+1} is positive it is strictly greater than and when μ_{t+1} is zero it is equal.

An additional condition must be satisfied if the household chooses to migrate:

$$\lambda_{t+1}\left[\Gamma^u(\alpha)W^{us}_{t+1} - \alpha W^{mex}_{t+1} - \eta\Psi_t\right] \geq \lambda_t(1-\eta)\Psi_t \tag{9}$$

Combining equations 6, 7 and 9, a household's decision to migrate is a function of their net earnings in the United States and the cost of migration.

$$\frac{U'(C_{t+1})}{U'(C_t)}\left[\Gamma^u(\alpha)W^{us}_{t+1} - \alpha W^{mex}_{t+1} - \eta\Psi_t\right] \geq (1-\eta)\Psi_t \tag{10}$$

The net US earnings is defined as the wage earned in the United States less the wages the household would have otherwise earned in Mexico and any part of the fee that the household borrowed from its social networks in the first period to be able to migrate.

2.3 Implications of the Model

The following analysis will look at the decision of the household without considering the impact that migration has on wages in the United States. The model has five implications of migration.

2.3.1 Incentive to Migrate

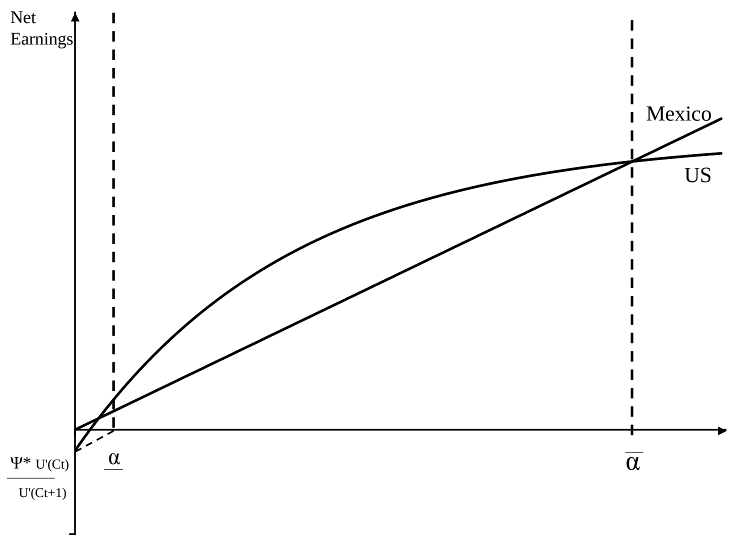
First, there exists an incentive to migrate to the United States given that for some level of ability, α^*, in equation 10, the discounted wages in the United States in the next period less the discounted foregone wages in Mexico and the remainder of the cost to be paid in the second period is equal to the cost required to be paid in the first period of crossing the border. For any $\alpha_i \geq \alpha^*$, the benefit of migrating will exceed the cost. This is the condition required for migration in the model and corresponds to the basic decision made by economic migrants.

2.3.2 Thresholds for Migration

Second, there is a lower-bound and an upper-bound thresholds for migration. A household in Mexico with a low ability draw would have an incentive to migrate to earn higher wages in the United States and would satisfy the condition previous described in section 2.2. However, there exists a lower-bound threshold for migration for ability levels less than or equal to $\underline{\alpha}$, where the earnings in Mexico are less than the cost of crossing the border.

$$\alpha W_t^{mex} < (1 - \eta)\Psi_t \tag{11}$$

Figure 2: Upper- and Lower-Bound Thresholds



Note: This graph depicts the upper-bound and lower-bound thresholds for migration, where the earnings in Mexico exceed the net earnings in the United States.

There also exists an upper-bound threshold for migration, such that the ability level in Mexico is high and corresponds to a relatively low productivity level in the United States. This would result in the earnings of the potential migrant in Mexico exceeding earnings in the United States less migration costs.

$$\left(\frac{W^{us}_{t+1}}{W^{mex}_{t+1}}\right)\Gamma^u(\alpha) - \alpha - \frac{\eta\Psi_t}{W^{mex}_{t+1}} \geq \frac{(1-\eta)\Psi_t}{W^{mex}_{t+1}}\frac{U'(C_t)}{U'(C_{t+1})} \tag{12}$$

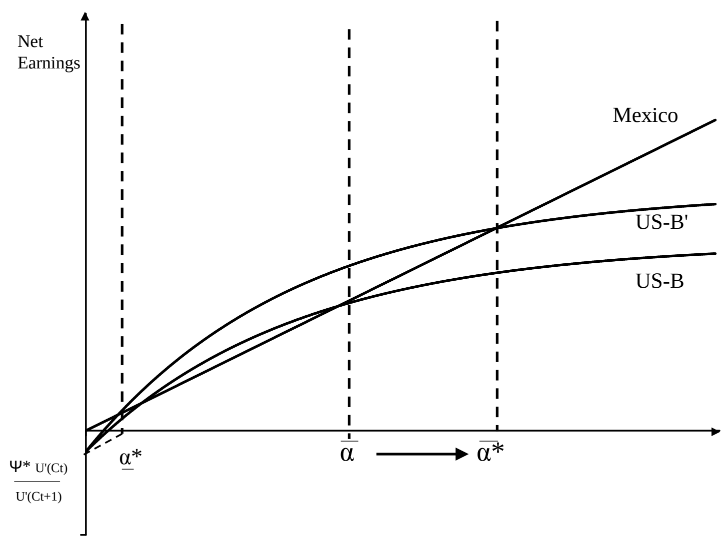
Figure 2 depicts the upper-bound threshold using equation 13. Equation 13 transforms equation 12 by normalizing the wage in Mexico to unity and setting the wage ratio between the United States and Mexico at some constant B. For the purposes of describing the thresholds, social networks are assumed to be zero so the individual is required to pay the entire cost in the first period. The upper-bound threshold is $\alpha = \overline{\alpha}$ such that the following equation is satisfied.

$$B * \Gamma^u(\overline{\alpha}) - \overline{\alpha} = \frac{\Psi_t}{W^{mex}_{t+1}}\frac{U'(C_t)}{U'(C_{t+1})} \tag{13}$$

For any α such that $\alpha \geq \overline{\alpha}$, equation 12 would be satisfied and the person would choose to stay in Mexico.

2.3.3 Wage Ratio and Migration

Figure 3: Impact of Increased US Wage on Migration



Note: This graph illustrates the effect on the upper-bound threshold of an increase in wage ratio, from B to B', increasing $\overline{\alpha}$ to $\overline{\alpha}^*$

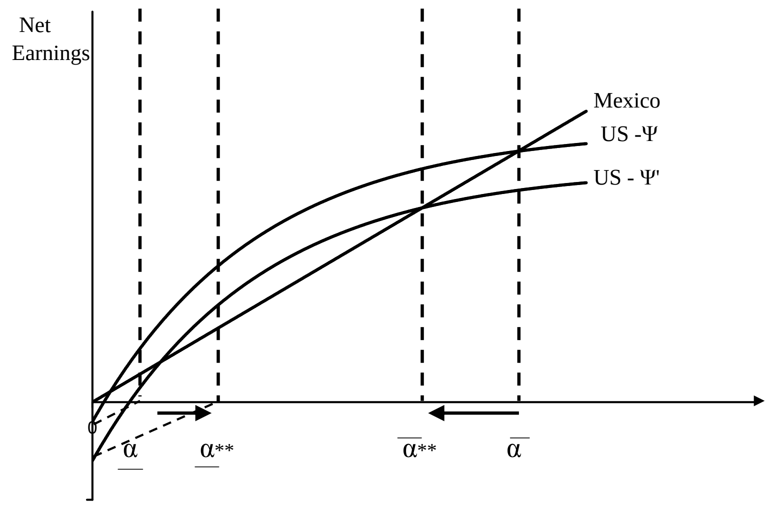
Third, an increase in the wage ratio between the United States and Mexico increases the number of households that migrate. Figure 3 demonstrates the effect of increasing the wage ratio from B to B' through an increase in the wage in the United States holding wages in Mexico constant. The incentive for migration increases and therefore the upper-bound constraint increases such that $\overline{\alpha}^* > \overline{\alpha}$. However, the constraint on the lower bound threshold still binds since the cost of migration is held constant. An increase in the wage ratio from B to B' has no impact on the lower-bound constraint, $\underline{\alpha}$. The implication of the model, that an increase in wage ratio corresponds to an increase in migration, is an important aspect of migration from Mexico to the United States. A migration population that is responsive to the wage ratio has been empirically demonstrated in the literature and would need to be a component of any theoretical model that characterizes the dynamics of economic migration.

2.3.4 Cost and Migration

The fourth implication of the model is that an increase in the cost of migration decreases the number of households that choose to migrate at the lower- and upper-bound thresholds. For a given wage ratio and ability level in equation 12, an increase in the cost of migration decreases migration for ability types around both the lower- and upper-bound thresholds.

The increase in migration costs increases the lower-bound threshold in equation 11, such that $\underline{\alpha'} > \underline{\alpha}$. Migration in a higher cost environment requires a higher ability type to have the earnings to pay the cost in the first period. Figure 4 exhibits the increase in the lower-bound threshold from an increase in cost. Note that lower-bound is not where the US net hourly earnings cross the Mexico hourly earnings. Rather, since the earnings to pay the cost of migration must be made in the first period, the cost is paid by Mexico earnings and therefore a parallel line from the negative cost is drawn. The interest rate is set at zero for the purposes of depicting the lower-bound.

Figure 4: Impact of Increased Cost on Migration



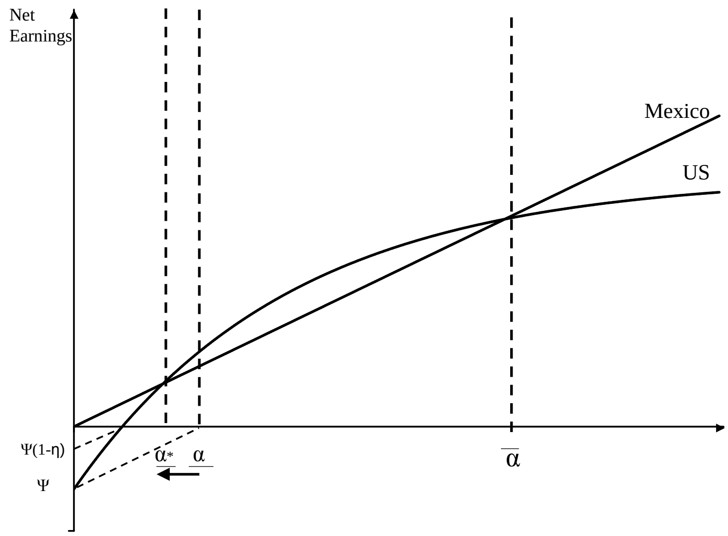
Note: The increase in the cost of migration constrains more low wage earners and reduces the incentive to migrate for more high wage earners. The increase in migration costs concentrates migration among middle wage earners.

The increase in cost decreases the upper-bound threshold in equation 12. For a given earnings level of a migrant, the increase in cost of migration reduces the net earnings from migration. Therefore, there exists an $\overline{\alpha}^{**} < \overline{\alpha}$ such that the condition in equation 12 is satisfied. Figure 4 illustrates the intensification of intermediate self-selection from increased costs of migration.

2.3.5 Social Networks and Migration

The final implication of the model is that an increase in social networks decreases the lower-bound. Although there are other benefits of social networks for the migrant, the fact that this model captures the ability of social networks to partially relax the liquidity constraint faced by potential migrants is an important dynamic in migration to the United States. In the model, greater social networks implies that it is less likely that equation 11 will bind for lower ability-types. Figure 5 illustrates the effect on the lower-bound.

Figure 5: Impact of Increased Social Networks on Migration



Note: This graph illustrates the effect on the lower-bound of an increase in social networks that allows the migrant to pay for part of the cost in the second period, decreasing $\underline{\alpha}$ to $\underline{\alpha}^*$. There is slight effect (not shown) on the upper-bound due to the benefit of paying part of the cost in the second period.

The figure abstracts from the benefit of paying part of the fee in the second period. The difference between the net earnings with an increase in social networks if the benefit of paying the fee in the second period is

$$\frac{\Psi_t}{W_t^{mex}}\left[1 - \frac{U'(C_t)}{U'(C_{t+1})}\right](\eta - \eta') \tag{14}$$

As the discount rate of future earnings (the second term in the brackets) approaches unity, the impact of paying the second period is zero. If the lender in the household's social network were assumed to charge an interest rate equal to the discount rate of the household, the net benefit would be the same for different levels of social networks.

3 Different Migration Cost Regimes

The last section showed qualitatively the impact of increased costs and social networks on the thresholds for migration. The following sections will describe the change in the costs of clandestine entry and the implications of different costs on the predictions of the model both numerically and empirically.

The cost of land-based migration across the Southwest border has changed over time. With the end of the *Bracero* program in the 1960s, a program that enabled guestworkers from Mexico to enter the United States to work, unauthorized crossings of the US/Mexico border became increasingly accompanied by *coyotes*. The cost of 'professionally assisted' clandestine crossings remained relatively stable in nominal terms and decreased in real terms from the 1970s to the early 1990s. However, with the intensification of border enforcement in the mid-1990s, smuggling fees increased in real terms.

3.1 Border Enforcement Intensity

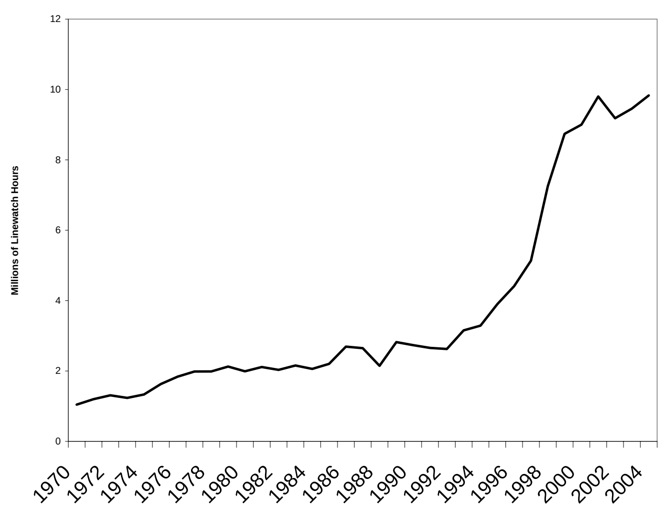
The intensity of border enforcement in the United States increased in 1993 with the implementation of Operation Hold-the-Line (El Paso sector) and continued with Operation Gatekeeper (San Diego sector) in late 1994. This shift in policy was followed by a significant expansion of the Border Patrol and a substantial increase in the number of hours agents patrolled the border ('linewatch hours'). Figure 6 illustrates the increase in linewatch hours over the previous four decades.

With the increase in border enforcement intensity in the United States had the effect of increasing the costs of migration through higher coyote fees. Gathmann (2008) finds the higher coyote fees are the result of both the enforcement effect, which increase the probability that the coyote himself might be apprehended, and the diversion effect, where border enforcement forced migrants to use more remote crossing locations. The later effect increases coyote fees to compensate the longer time required to 'cross' their clients and the greater physical risk to the coyote himself.

In addition to increased costs associated with apprehension effects and diversion effects, there is likely a gender composition effect. Women are considered more likely to use 'unconventional' methods for clandestine entry than their male counterparts, such as crossing through a legal port of entry with false or borrowed documents. Such modes of entry increase the fee charged by coyotes (Cornelius, Fitzgerald, and Borger, 2009). As the gender composition of unauthorized migration to the U.S. changed, so would its impact on the average coyote fee. However, to specify the different migration cost regimes, I will restrict the calculations to male migrants to control for any gender composition effect.

The smuggling fees are estimated using the Mexican Migration Project (MMP) dataset, a long-term research project now based at Princeton University that has surveyed large, geographically diverse, but not nationally representative set of migrant-sending communities in Mexico. The surveys are primarily conducted in Mexico which limits the more recent observations since many migrants have yet to return to

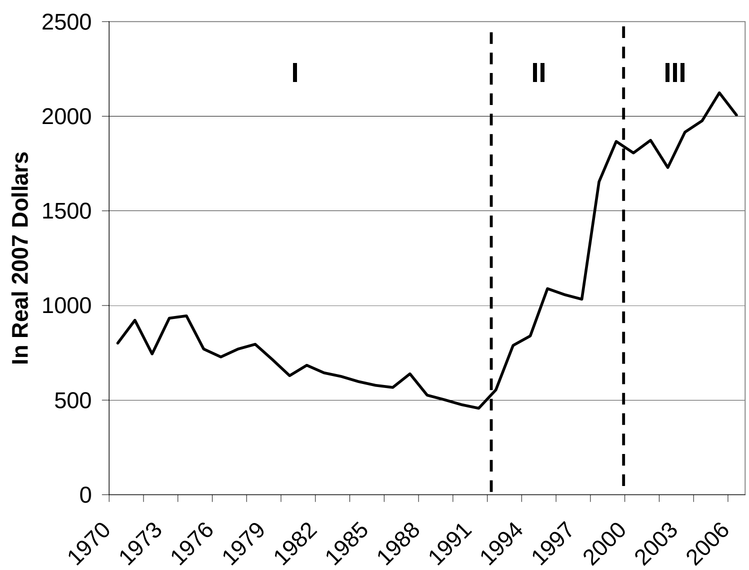
Figure 6: Linewatch Hours (1970-2004)



Note: Linewatch hours from 1970 to 2004 are the number of hours agents patrolled the border.

Mexico and therefore could participate in the survey. Figure 7 calculate the median real coyote fee reported by first-time undocumented male migrants over time. Note the coyote fees are reported in dollars since almost all of the transactions take place in dollars and the financing is often from relatives receiving US wages in dollars. The change in coyote fees and therefore the change in the cost of migration is dramatic over the the entire sample from 1970-2006. Period I represents a low-cost migration period from 1970-1992 with a median fee adjusted for inflation of US$629 (2007$) . Period II represents the growth period in migration costs between 1993-1998. Period III represents the high-cost migration period, with a median fee of US$1867 in 2007$. This paper will use these two contrasting migration-cost regimes (I and III) to test the impact of the intensification of border enforcement on self-selection in both the theoretical and empirical models.

Figure 7: Coyote Fees (1970-2006)



Note: The 'coyote' or smuggling fees are calculated from the Mexican Migration Project dataset (MMP118) and are average amounts paid in a given year by migrants entering clandestinely into the United States in 2007 dollars. Adjustments of the fees in real terms uses CPI inflation rates in the United States because coyotes are almost always paid in U.S. dollars and would raise rates to maintain their purchasing power in the United States.

Although understanding the underlying causes of the increase in smuggling costs over this period is important, for the purposes of this paper, the fact that smuggling costs experienced significant shifts provides the variability in costs necessary to understand how costs impacts the choice of migration. The response of potential migrants to increased costs is analyzed at the community level in the appendix. However, the empirical evidence at the community level only provides crude estimates of the impact of increased costs on who is able to migrate. The following section will numerically estimate from the theoretical model the thresholds for migration.

4 Numerical Analysis

I will show that in the model realistically calibrated to the US/Mexico data, higher smuggling fees have a larger impact on the lower-theshold in migrant-sending communities without strong social networks in the United States.

4.1 Estimation of Model with US/Mexico Data

The utility function is assumed to be log-utility with the household maximizing the follow problem:

$$ln(C_t) + \beta ln(C_{t+1})$$

subject to

$$C_t + a_{t+1} + \Phi(1-\eta)\Psi_t = \alpha W_t^{mex}$$

$$C_{t+1} + \Phi\eta\Psi_t = (1+r)a_t + (1-\Phi)\alpha W_{t+1}^{mex} + \Phi\Gamma^u(\alpha)W_{t+1}^{us}$$

$$a_{t+1} \geq 0$$

The functional forms for the ability transformation function for the United States is

$$\Gamma^u(\alpha) = 1 - e^{-\alpha}$$

which satisfies the conditions of the functional form of $\Gamma^u(.)$ in equation 4.

The first order conditions for the household:

$$\frac{1}{C_t} = \lambda_t \tag{15}$$

$$\frac{1}{C_{t+1}} = \lambda_{t+1} \tag{16}$$

$$1 - \frac{C_t}{C_{t+1}}(1+r) = \mu_{t+1} C_t \tag{17}$$

Conditions if choosing to migrate:

$$\Big(\frac{C_t}{C_{t+1}}\Big)\beta\Big[(1-e^{-\alpha})W^{us} - \alpha W^{mex} - \eta\Psi_t\Big] \geq$$
$$(1-\eta)\Psi_t$$

The first term is the ratio of consumption in the two periods by which the second period's consumption is discounted as in equation 10. This alleviates concerns about differences in standards of living between the two countries since consumption in the United States, C_{t+1} if the household migrates, will be much greater than C_t. The higher C_{t+1} implies the ratio will be smaller and consumption in the United States will be discounted by more than similar consumption levels in Mexico.

Solving for different levels of social networks combining the above condition with the budget constraints that determine consumption levels in the two periods:

$\eta = \mathbf{0}$

$$(\alpha W_t^{mex} - \Psi_t)\beta\Big[(1-e^{-\alpha})W^{us} - \alpha W^{mex}\Big] \geq$$
$$\Psi_t\Big[(1-e^{-\alpha})W^{us}\Big]$$

$\eta = \mathbf{1}$

$$\beta\Big[(1 - e^{-\alpha})W^{us} - \alpha W^{mex}\Big] \geq \Psi_t$$

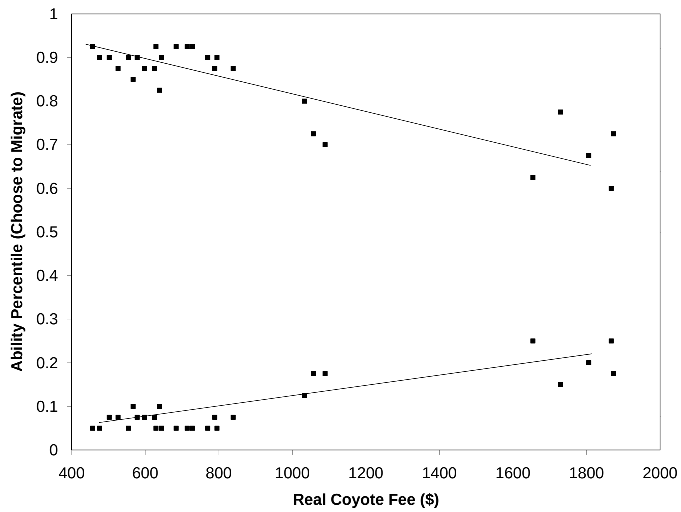
4.1.1 Impact of Increased Cost on Migration

The numerical estimation uses the above conditions to determine what levels of *alpha* would satisfy the conditions given wages in Mexico, a constant wage ratio between the U.S. and Mexico, and smuggling fees from 1976 to 2006. The impact of the increased cost of migration is evident in figure 8. This estimation uses the median coyote fee in real terms reported by migrants in the Mexican Migration Project survey as recorded in figure 7. The wage ratio between the United States and Mexico is held constant at 2.32, which is the average estimate for urban males age 35 with educational achievement levels between ninth and twelfth grade in Clemens, Montenegro and Pritchett (2008). The wage level is determined from wages in Mexico equal to earnings in the manufacturing sector as reported by the US Bureau of Labor Statistics Hourly Compensation of Production Workers in U.S. Dollars. The hourly wage uses a 2,080 hour work-year to calculate the yearly earnings where the average earnings are set for the median ability type worker.

Figure 8 is the impact on the thresholds for migration with networks such that the costs are paid in the second period. The increased cost reduces the upper-bound threshold and increases the lower bound threshold. The narrowest range of ability types were in 1998 and 2005 where the lower bound threshold was at the 25th percentile of ability levels and the upper-bound threshold was at the 63rd percentile of ability levels.

Table 1 estimates the thresholds for who is able to migrate. The category 'No Networks' reflects the cost being paid in the first period because the potential migrant is assumed to be without any networks in the United States. The category 'Networks' reflects the cost being paid in the second period because the potential migrant is assumed to have networks in the United States that will pay all the costs.

Figure 8: Impact of Increased Cost on Thresholds



Note: The increase in the cost of migration constrains more low wage earners and reduces the incentive to migrate for more high wage earners. With a constant wage ratio between the United States and Mexico, the increase in migration costs in the data reduces the upper-bound and lower-bound for migration.

Notice that the thresholds are narrower without networks than with networks, but the largest impact is for lower ability types in the years with high smuggling fees. The upper thresholds with networks is zero or slightly higher with than without networks. This is due to the fact that the utility of the household is higher in the first period when the household is earning wages in Mexico and therefore being able to pay the cost in the second period when their utility is relatively lower encourages higher ability types to migrate.[6] Observations for migrants without networks are absent from 1995 to the end of the sample because there does not exist an ability type such that the conditions for migration are satisfied at the given wages and smuggling fees. One reason for the non-existence of thresholds for migration without networks after 1995 is the significant drop is wages in Mexico from an hourly real wage in U.S. dollars of $2.54 in 1994 to $1.59 in 1995. This decease in wages

[6]These findings are consistent with the findings of McKenzie and Rapoport (2007a) of variation in self-selection due to the migrant networks.

combined with the increase in smuggling fees is such that for any range of ability types the household could not either accumulate the cash to pay the smuggling costs or its wages in Mexico would exceed its net earnings if the household migrated.

In the following section, the model is tested empirically to determine whether

Table 1: Ability Thresholds for Migration

Year	Fee	Networks		No Networks		Difference	
		Lower	Upper	Lower	Upper	Lower	Upper
1976	$728	0.050	0.925	0.125	0.925	-0.075	-0.0
1977	$770	0.050	0.900	0.175	0.900	-0.125	-0.0
1978	$795	0.050	0.900	0.175	0.900	-0.125	-0.0
1979	$714	0.050	0.925	0.150	0.900	-0.100	0.025
1980	$629	0.050	0.925	0.150	0.925	-0.100	-0.0
1981	$684	0.050	0.925	0.150	0.925	-0.100	-0.0
1982	$644	0.050	0.900	0.200	0.900	-0.150	-0.0
1983	$625	0.075	0.875	0.275	0.850	-0.200	0.025
1984	$598	0.075	0.875	0.225	0.875	-0.150	-0.0
1985	$578	0.075	0.900	0.225	0.875	-0.150	0.025
1986	$567	0.100	0.850	0.325	0.800	-0.225	0.050
1987	$639	0.100	0.825	0.375	0.750	-0.275	0.075
1988	$526	0.075	0.875	0.250	0.850	-0.175	0.025
1989	$502	0.075	0.900	0.200	0.875	-0.125	0.025
1990	$476	0.050	0.900	0.175	0.900	-0.125	-0.0
1991	$457	0.050	0.925	0.150	0.900	-0.100	0.025
1992	$554	0.050	0.900	0.175	0.900	-0.125	-0.0
1993	$789	0.075	0.875	0.250	0.850	-0.175	0.025
1994	$839	0.075	0.875	0.275	0.850	-0.200	0.025
1995	$1089	0.175	0.700	-	-	-	-
1996	$1057	0.175	0.725	-	-	-	-
1997	$1033	0.125	0.800	-	-	-	-
1998	$1654	0.250	0.625	-	-	-	-
1999	$1867	0.250	0.600	-	-	-	-
2000	$1806	0.200	0.675	-	-	-	-
2001	$1873	0.175	0.725	-	-	-	-
2002	$1729	0.150	0.775	-	-	-	-
2003	$1916	0.200	0.700	-	-	-	-
2004	$1976	0.225	0.650	-	-	-	-
2005	$2124	0.250	0.625	-	-	-	-
2006	$2006	0.225	0.650	-	-	-	-

Note: Smuggling fees are reported in 2007 dollars using U.S. CPI. Thresholds are defined as the lowest or highest ability type that would satisfy the conditions of migration. The network category is where all the fees are paid in the second period. The 'no network' category is where all the fees are paid in the first period. The dashes represent periods where no thresholds are established given the smuggling fees and wages.

these thresholds exist and whether the social network have been more critical to the ability to migrate in the period of high-cost migration.

5 Empirical Analysis

The intensity of border enforcement has been a policy choice of the United States government with different implications for the type of migrants that come, how long they stay, and the persons in the sending communities that remain. This paper has modeled the impact of cost dynamics on migration rates. The following section will estimate empirically whether different periods of migration costs change the estimates of who is able to migrate in order to confirm the model's implication on the economic profile of the migrant.

5.1 Data

The data to estimate the probability of migration are from the Mexican Migration Project (MMP). The survey is primarily conducted in Mexico and therefore provides information on migrants who return to their home communities after migrating. This biases the analysis to those less successful in their employment opportunities in the United States since they have decided to return home. The bias would most likely be in the direction of less skilled migrants. However, this particular bias would make it more difficult to find intermediate or positive self-selection of migrants, which is the hypothesis from the theoretical model. Despite its limitations, the survey provides extensive socio-economic data that will provide information on who is migrating over a longer period of time.

5.2 Methodology

The estimate uses the probability that the head of household migrates to the United States in the current year or in the previous two years. Although the income measures, as described hereafter, are estimated for the current period, the inclusion of the previous two years was required to capture return migrants who would otherwise not be reported in the primarily Mexico-based surveys. In contrast, Mckenzie and Rapoport (2007b) use a one year period. The reason is the amount of time migrants are currently staying in the United States on a given trip. As reported in the community level evidence in figure A2 of the appendix, the median length of stay has increased from 12 months during earlier periods to about 24 months currently. By extending the analysis to two years, it increases the likelihood that the survey will capture more return migrants in the later period when lengths of stays were extended. The drawback of the approach is that the level of assets of a household in the current period are most likely determined by the choice to migrate two period earlier. Therefore, the conclusions drawn from the analysis will highlight differences between similar income groups with different social networks rather than an explicit claim to the income level of households who choose to migrate.

The probability of migrating to the United States is a function of a household's income with higher income earners more able to pay the coyote fees to enter the United States clandestinely while the highest income earners wanting to remain in Mexico. This implies a inverse U-shaped impact of income on the probability to migrate. An additional factor in the probability of migrating is the density of social networks in the United States that reduces some of the implicit and explicit costs of migration. For example, some of the coyote fees could be paid or loaned by relatives living in the United States earning higher incomes. These factors that contribute to migration could differ between periods where coyote fees were relatively low and when the fees were significantly higher. The probability is estimated for the two subperiods by the following equation:

$$Prob_i = \alpha_i + \gamma_{1,i} ln(I) + \gamma_{2,i} ln(I)^2 + \gamma_{3,i}\delta + \gamma_{4,i}(ln(I) * \delta) \qquad (18)$$

where ln(I) is proxied for with the methodology in McKenzie (2005) using reported durable ownership described hereafter, δ is the instrumented density of social networks available to the migrant in the United States, and i = 1,2 based on whether the estimates are in the low-cost or high-cost period of migration. In order to calculate ln(I), I factorize the reported ownership of durable goods to characterize the consumption of non-durable goods in a period. McKenzie (2005) uses household surveys to demonstrate that this methodology provides a relatively good proximate of income distribution. For the purposes of this paper, the absolute levels of income are not as important as the relative distribution of income over a given group of communities. The MMP survey reports whether the household owns certain durable items. This data is factorized to weight the index and then the weight multiplies the indicator variable for whether the household owns a particular durable item to estimate ln(I). The density of social networks uses historical rates of migration of states in Mexico during the period 1954-1959 and 1924 as a proxy. This provides information on networks without the endogeneity of current networks in the United States. The data is divided into the two periods, 1982-1992, that represents low-cost period and 1998-2007, that represents the high-cost migration period. In addition, the sample is restricted to persons without the legal documentation to reside in the United States. Clustered standard errors are used for each community.

5.3 Results

Mckenzie and Rapoport (2007b) found an inverse U-shaped relationship between income and migration with an increase in social networks in the United States reducing the costs of migration. Using the expanded set of MMP data currently available, this paper finds the inverse U-shaped relationship between propensity to migrate and income in both periods. However, in the second period, the rate of migration has decreased and social networks become statistically significant with a positive coefficient.

The estimate for the impact of border enforcement on the probability of migration is in table 2. The results between the different migration lag variables does not affect the general findings. Social networks were statistically insignificant during the

1982-1992 period, whereas social networks were important in the later period. This would imply that income has an inverse-U relationship on the rate of migration, but the shape of the rate of migration changes for different densities of social networks in the United States.

Figure 9 illustrates the probability of migration for different levels of income at different densities of social networks. The earlier period between 1982 and 1992, migration rates were similar for the different levels of income and the different den-

Table 2: PROBABILITY OF MIGRATION, NETWORKS, AND BORDER ENFORCEMENT INTENSITY

Probability of head of household migrating in previous two years of survey year				
	(1a)	(1b)	(2a)	(2b)
	1982 – 1992	1998 – 2007	1982 – 1992	1998 – 2007
ln Income Index	**0.036*****	**0.033*****	**0.033****	**0.024*****
	(0.010)	(0.009)	(0.019)	(0.009)
ln Income Index^2	**−0.002*****	**−0.002*****	**−0.003*****	**−0.002*****
	(0.0008)	(0.0006)	(0.0008)	(0.0006)
Network Density	−0.025	**2.611****	0.716	**0.816*****
	(1.998)	(1.214)	(0.611)	(0.309)
$ln(Income) * Network$	−0.088	**−0.240***	−0.091	**−0.087****
	(0.218)	(0.137)	(0.074)	(0.035)
Constant	−0.049	**−0.096*****	−0.153	**−0.095****
	(0.050)	(0.032)	(0.103)	(0.031)
Migration Lag Variable	A	A	B	B
Observations	5752	9029	5752	9029
Number of Communities	29	60	29	60
Probability of Migrating				
Low Network (30^{th} Pctl)				
Low-Income	5.4%	1.6%	6.2%	3.4%
Middle-Income	7.9%	3.8%	8.9%	4.9%
High-Income	4.2%	0.5%	4.4%	1.5%
High Network (70^{th} Pctl)				
Low-Income	4.5%	5.6%	5.1%	7.6%
Middle-Income	6.3%	6.0%	7.5%	7.1%
High-Income	1.8%	0.5%	2.6%	1.1%

Note: Clustered standard errors in parentheses at the community level. *** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level. The total number of communities in the MMP data is 118. Migration lag variable A is the migration rate between 1955-1959 for the state in which the community resides and predicts the future rate of migration to the United States. Migration lag variable B is the migration rate in 1924 for the state in which the community resides.

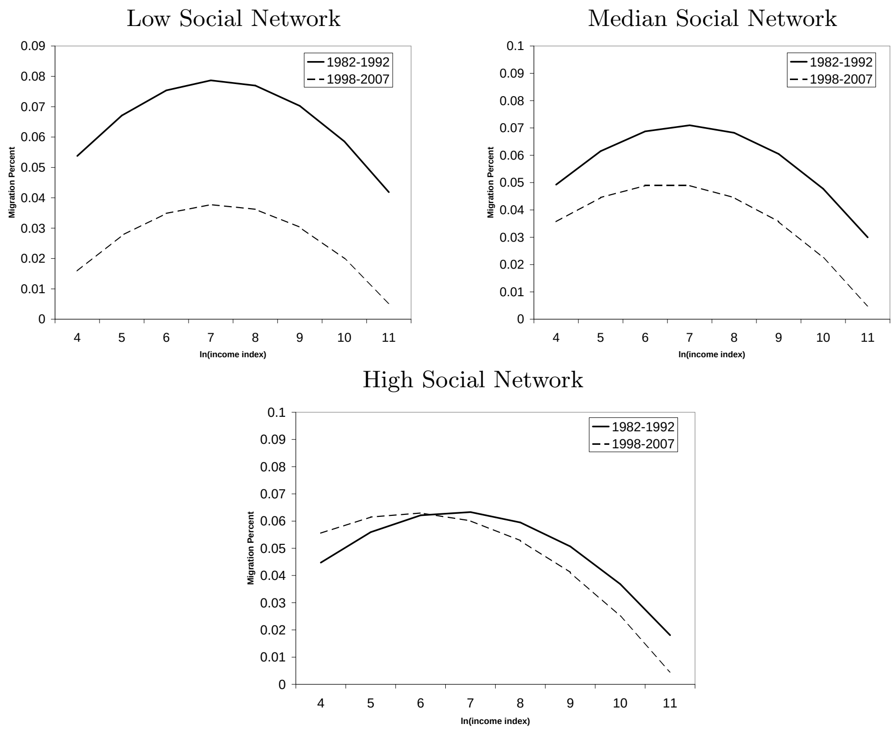


Figure 9: Probability of Migration in Differing Periods of Border Enforcement Intensity (1982-1992, 1998-2007)

Note: All panels: Estimated probability of migration during different periods of border enforcement intensity. Reported in the figures are the network densities at the 30th, 50th and 70th percentiles, as measured by the percent of migrants who went to the United States from their region in Mexico between 1951-1955. Solid line is the period 1982-1992 and the dashed line is the period 1998-2007.

sities of historical migration networks (30th, 50th and 70th percentiles reported). However, the period 1998-2007 was a period of higher cost of migration with the coyote fees more than three times the previous period. Networks were much more critical to the rate of migration in the later period with higher density of networks increasing the probability of migration for low income potential migrants. The opportunities for migration for communities with high rates of historical migration varied only slightly between periods.

6 Conclusion

This paper's model considers the impact of the liquidity constraint faced by potential unauthorized migrants when they evaluate their decision to migrate. The model's predictions were consistent with recent evidence in the literature of intermediate self-selection, an increase in US wages increases migration and social networks enable lower ability types to migrate. Moreover, the realistically calibrated model provides evidence that the increase in coyote fees has restricted who is able to migrate to the United States. The increase in coyote fees has constrained migration to the middle class of migrant-sending communities in Mexico.

This paper tested the model's predictions and found evidence of an intensification of intermediate self-selection in the high-cost period relative to the low-cost period and that communities with dense social networks observed an increase in migration among low-income earners in the high-cost period.

Social networks play an important role in reducing the cost of migration, as demonstrated. However, in addition to the assistance provided by family in the United States to pay the costs of migration, Espinosa and Massey (1997), Munshi (2003) have argued that networks reduce the cost of migration by providing assistance in finding employment. Although the primary mechanism through which this paper considers the dynamics of costs is the coyote fee and the liquidity constraint faced by the household with this cost, I leave to future research a secondary mechanism. This secondary mechanism would explicitly model differences in the probability of finding US employment based on the migrant's network density.

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A Appendix

A.1 Data

Data for linewatch hours were compiled originally by the U.S. Immigration and Naturalization Service and now are made available through the U.S. Customs and Border Protection. The data from 1963:7 to 2004:9 are available at http://irpshome.ucsd.edu/faculty /gohanson/data.htm on Gordon Hanson's webpage.

Wage data for the numerical analysis uses production workers in the manufacturing sector for 'maquiladora' firms available from the U.S. Bureau of Labor Statistics in U.S. dollars. These firms operate under duty-free import zones for the assembly and manufacture of goods. The benefit of using this data is its reliability relative to other sources of wages data from Mexico. However, not all potential migrants would have access to these employment opportunities and therefore may overestimate wages in Mexico. The wage ratio is allowed to remain constant the period of analysis. Further analysis could be done that varied the wage ratios between the United States and Mexico over this period.

A.2 Community Level Evidence

This appendix provides evidence of the change in migration patterns at the community level from the Mexican Migration Field Research and Training Program (MMFRP) survey data conducted by the Center for Comparative Immigration Studies at the University of California, San Diego. This section will describe the changes in the relative educational levels of migrants and the median length of time per stay by undocumented migrants.

I examined the migration histories of the entire migrant-age population of sending communities in *Jalisco*, *Yucatán*, and *Oaxaca* and their networks in the United States. This enabled me to assess the impact of higher coyote fees on who migrates and who remains in the community.

A.2.1 Community Data

A new data set from the Mexican Migration Field Research Project (MMFRP),[7] provides highly detailed migration histories from residents of communities in Mexico and their counterparts that have migrated to the United States. The MMFRP project has conducted five detailed surveys of migrants and potential migrants in *Tlacuitapa*, *Jalisco* (2005, 2007), *Tunkás*, *Yucatán* (2006, 2009), and *San Miguel Tlacotepec*, *Oaxaca* (2008). The surveys encompass nearly the entire migrant-age (15-65) population in each locality. The present analysis uses data from the *Tlacuitapa* (2007), *San Miguel Tlacotepec* (2008), and *Tunkás* (2009).

The data set has limitations. The lack of panel data on individual income and wealth makes it difficult to determine the effect of migration on inequality. However, the education profiles of nearly all of the migrating and non-migrating population of a community including community members living in the United States, provides information on the educational attainment of migrants relative to non-migrants over time.

A.2.2 Methodology

The annual changes in educational attainment of migrants who reside in the United States in a given year and their age cohort counterparts provide information on how migration patterns have changed as a result of border enforcement policies. Using similar age cohorts in each community as the measure of comparison is important because (i) the differences in attitudes about education over time can change, (ii) the returns to education can evolve, and (iii) policy and infrastructure changes such as the construction of schools can impact the level of schooling in a local area. Using

[7]MMFRP is an ongoing research project of the University of California-San Diego's Center for Comparative Immigration Studies

male-only cohorts to capture the historical primary pool of potential migrants, the difference in education of those who are in the United States in a given year from their age cohort in the community is estimated.

The cohort statistic considered for this analysis is calculated as the difference in the each person's educational attainment level from the cohort's average educational attainment level. Each participant of the survey reports an education attainment level which is averaged over the other potential male migrants that were born in the five-year increment around the birth year of the individual.

$$E_j = \frac{1}{J}\sum_{i=1}^{J} E_{i,j}$$

where E_j is the average education attainment level of cohort j and E_i is the attainment level of individual i with a birth year in cohort j. Then the difference in migration behavior over time can be estimated by differencing the average cohort attainment level of migrants in the United States relative to the entire cohort born in the sending community.

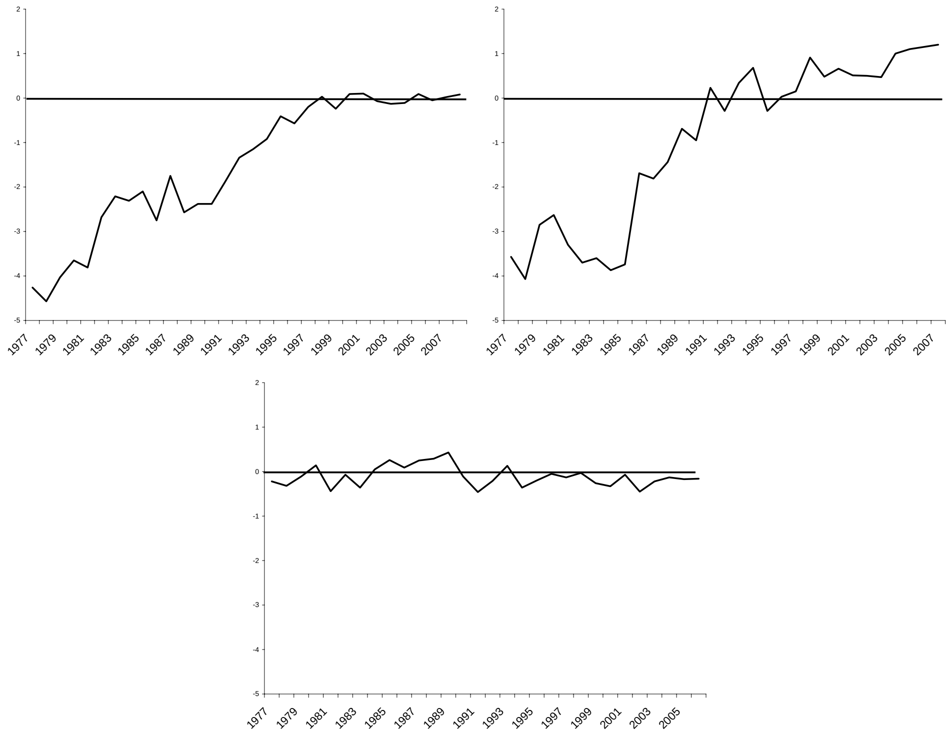
$$\hat{E}_t = \frac{1}{K}\sum_{i=1}^{K} E_{i,j} - E_j$$

where E_t is the difference in education attainment of migrants in the US in a given year t from their cohort in their home community, K is the number of migrants in the United States in a given year t, and c is the cohort of person i.

A.2.3 Educational Attainment of Migrants in US

Figure A1 reports the average deviation of respondent's educational attainment relative to their cohort for each of the respondent in the United States in a given year. In the communities of Tunkas (Top-Left panel) and San Miguel Tlacotopec (Top-Right panel), there has been a steady increase in educational attainment levels of male migrants in the United States relative to their home community. However,

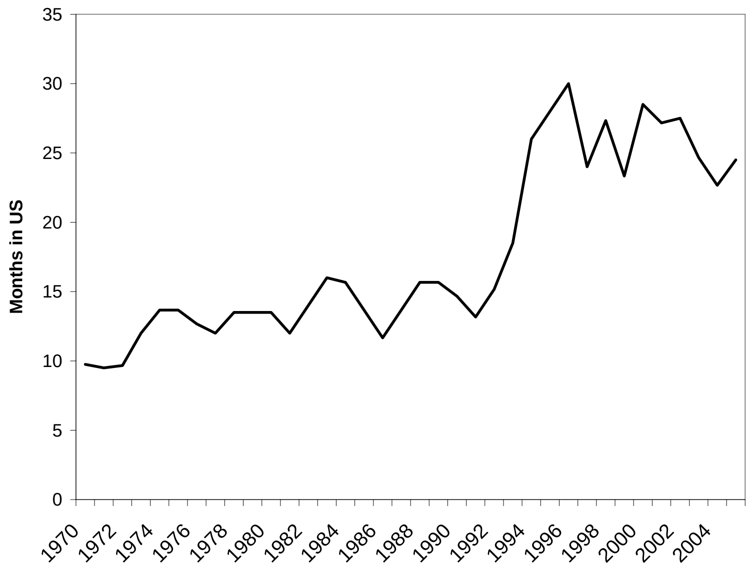
Figure A1: Difference of Education Level of Male Migrants from Cohorts



Note: All panels: Difference in the educational levels of undocumented migrants in the United States from their age cohorts in the community, 1977-2007. **Top-Left panel:** Difference in education of Tunkas male migrants. Tunkas is a relatively new migrant-sending community. **Top-Right panel:** Difference in education of San Miguel Tlacotopec male migrants. San Miguel Tlacotopec is a relatively new migrant-sending community. **Bottom panel:** Difference in education of Tlacuitapa male migrants. Tlacuitapa is a long-time migrant-sending community.

Tlacuitapa (Bottom panel) has remained constant throughout this period. One potential explanation for the difference between these communities is the migration trajectories. Tlacuitapa is a long-time migrant sending community with dense social networks in the United States whereas Tunkas and San Miguel Tlacotopec are relatively recent migrant-sending communities. Figure A1 provides additional strong evidence in support of the intensification of intermediate self-selection that modeled and tested heretofore.

Figure A2: MEDIAN TIME IN US PER STAY (1970-2005)



Note: The median time in the United States for undocumented migrants on a given stay in the United States calculated from the Mexican Migration Field Research Project (MMFRP). The data is estimated as a MA(3) to smooth out yearly fluctuations.

A.2.4 Length of Time per Stay

There is direct evidence that the patterns of migration have been altered by the increase in coyote fees. Figure A2 estimates the median length of time per stay reported by undocumented migrants in the MMFRP surveys from 1970 to 2005 with a 3-yr moving average to smooth fluctuations between years. During the 1970s and 1980s, the median length of stay was between 10 and 15 months. There is a spike in the data in 1994 when border enforcement intensified and the cost of coyotes increased. From 1994 to 2005, the average length of trip is between 25 and 30 months. There is some censorship of the data in the later part of the data since some migrants remain in the United States. However, by reporting the data only until 2005 for trips that have continued into 2009 and reporting the median values, the impact of the censorship is diminished.