Strategic Interactions and Dynamic Behavior in Migration in Rural Mexico[*]

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Abstract

Given the economic significance of migration and its relevance for policy, it is important to understand the factors that cause people to migrate. We add to the literature on the determinants of migration by examining strategic interactions and dynamic behavior in migration decisions using both reduced-form and structural econometric models. Using instrumental variables to address the endogeneity of neighbors' decisions, we first empirically examine whether strategic interactions in migration decisions actually take place in rural Mexico, whether the interactions depend on the size of the village, and whether there are nonlinearities in the strategic interactions. We then develop and estimate a structural econometric model of a dynamic game of intra-households migration decisions. The structural econometric model enables us to examine how natural factors, economic factors, institutions, government policies, and strategic interactions affect the migration decisions of households in rural Mexico. We use this model to simulate the effects of counterfactual policy scenarios, including those regarding schooling, land quality, climate, institutions, and government policy, on migration decisions and welfare.

JEL Codes: O15, O54

Keywords: migration, Mexico, strategic interactions, dynamic behavior, dynamic game

This draft: December 2016

[*]We thank Steve Boucher, Colin Carter, Tom Hertel, Erich Muehlegger, John Rust, Yaniv Stopnitzky, and Bruce Wydick for invaluable comments and discussions. We benefited from comments from seminar participants at the University of San Francisco; and conference participants at the Oxford Symposium on Population, Migration, and the Environment; the Agricultural and Applied Economics Association (AAEA) Annual Meeting; and the Gianinni Agricultural and Resource Economics Student Conference. We thank Gerardo Aragon, Diane Charlton, Katrina Jessoe, Rebecca Lessem, and Dale Manning for their help with the data. We are also indebted to Antonio Yunez-Naude and the staff of PRECESAM and of Desarrollo y Agricultura Sustentable for their invaluable assistance and data support. We received financial support from the University of California Institute for Mexico and the United States (UC MEXUS). Lin Lawell and Taylor are members of the Giannini Foundation of Agricultural Economics. All errors are our own.

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1 Introduction

According to estimates from the World Bank (2010a), around 3 percent of the world population lived in a country different from the one in which they were born. The US is the country with the highest immigrant population in the world, with more than 46 million people who were foreign born (United Nations, 2013), of which about 11 million are from Mexico (World Bank, 2010b). These trends are considerably changing demographic portraits, reshaping patterns of consumption, and altering the cultures of both sending and receiving countries.

The economic importance of migration from Mexico to the US is twofold. Since the mid-1980s, migration to the US has represented an employment opportunity for Mexicans during a period of economic instability and increasing inequality in Mexico. In addition, it has represented an important source of income via remittances, especially for rural households (Esquivel and Huerta-Pineda, 2007).[1] Remittances from the US to Mexico amount to 22.8 billion dollars per year, according to estimates from the World Bank (2012). According to recent calculations, an average of 2,115 dollars in remittances is sent by each of the nearly 11 million Mexicans living in the US, which represents up to 2 percent of the Mexican GDP (D'Vera et al., 2013). Some authors estimate that 13 percent of household total income and 16 percent of per capita income in Mexico come from migrant remittances (Taylor et al., 2008).[2]

With a border 3200 kilometers long, the largest migration flow between two countries, and a wage differential for low-skilled workers between the US and Mexico of 5 to 1 (Cornelious and Salehya, 2007), the US-Mexico migration relationship also imposes challenges to policy-makers of both countries. Beginning in 2000, Mexico moved away from its previous so-called 'no policy policy', and tried instead to pursue a more active policy to influence the US to agree to a workers program and to increase the number of visas issued for Mexicans, although

[1] Esquivel and Huerta-Pineda (2007) find that 3 percent of urban households and up to 10 percent of rural households in Mexico receive remittances.

[2] Castelhano et al. (2016) find that migrant remittances are not associated with increases in rural investment in agricultural production in Mexico, however.

its efforts got frustrated after the 9/11 attacks in September 2001. More recently, other domestic policies have included the programs Paisano and Tres Por Uno, which facilitate the temporary return during holidays of Mexicans legally living in the US and which match the contributions of migrant clubs for the construction of facilities with social impact in Mexican communities, respectively. On the US side, several reforms have been attempted to both open a path for legalization while increasing the expenditure to discourage illegal immigration, both of which affect mostly Mexicans. The most recent, the Deferred Action for Childhood Arrivals, gives access to work permits to individuals who entered the country before they were 16 years of age.

Given the economic significance of migration and its relevance for policy, it is important to understand the factors that cause people to migrate. We add to the literature on the determinants of migration by examining strategic interactions and dynamic behavior in migration decisions using both reduced-form and structural econometric models.

Migration decisions are dynamic because these decisions can be viewed as forms of investment, there is leeway over the timing of these decisions, and the payoffs from these decisions are uncertain; as a consequence, there may be an option value to waiting before making these decisions that makes these decisions dynamic rather than static. Migration decisions are also dynamic because households consider the future when making these decisions, basing them not only on the current state of economic factors, but also on the prospects of economic opportunities in other areas and the potential streams of net benefits (or payoffs) from migrating.

In addition to being dynamic, migration decisions are also strategic. We define 'strategic interactions' as arising whenever the migration decisions of other households in their village affect a household's payoffs from migration and therefore its decisions to have a member migrate. There are several reasons why a household's migration decisions may depend on the migration decisions of its neighbors, including migration networks and information externalities.

Using instrumental variables to address the endogeneity of neighbors' decisions, we first empirically examine whether strategic interactions in migration decisions actually take place in rural Mexico, whether the interactions depend on the size of the village, and whether there are nonlinearities in the strategic interactions.

Our results show that there is a significant and positive own-migration strategic effect. In our base case specification, an increase of 0.1 in the fraction of neighbors with migration to the US increases a household's probability of migration to the US by around 5.9 percentage points, while an increase of 0.1 in the fraction of neighbors with migration to other states in Mexico increases a household's probability of migration to other states in Mexico by around 6.3 percentage points. We also find that strategic interactions vary nonlinearly with village size.

We then develop and estimate a structural econometric model of a dynamic game of intra-households migration decisions. The structural econometric model enables us to examine how natural factors, economic factors, institutions, government policies, and strategic interactions affect the migration decisions of households in rural Mexico. We use this model to simulate the effects of counterfactual policy scenarios, including those regarding schooling, land quality, climate, institutions, and government policy, on migration decisions and welfare.

The balance of the paper proceeds as follows. We review the literature in Section 2. In Section 3 we discuss sources of strategic interactions in migration. Section 4 presents the reduced-form model that allows us to identify the strategic interactions. Section 5 describes the data. Section 6 presents the empirical results of our reduced-form model. Section 7 we describe our structural econometric model of a dynamic game. Section 8 presents the preliminary results of the structural econometric model. Section 9 concludes.

2 Literature Review

2.1 Determinants of Migration

The first strand of literature upon which our paper builds is the literature on determinants of migration. The new economics of labor migration posits the household as the relevant unit of analysis. Using the household as the relevant unit of analysis addresses several observed features of migration that are ignored by individualistic models, including the enormous flows of remittances and the existence of extended families which extend beyond national borders. Most applications of the new economics of labor migration assume that the preferences of the household can be represented by an aggregate utility function and that income is pooled and specified by the household budget constraint.

For example, Stark and Bloom (1985) assume that individuals with different preferences and income not only seek to maximize their utility but also act collectively to minimize risks and loosen constraints imposed by imperfections in credit, insurance, and labor markets. This kind of model assumes that there is an informal contract among members of a family in which members work as financial intermediaries in the form of migrants. The household acts collectively to pay the cost of migration by some of its members, and in turn migrants provide credit and liquidity (in form of remittances), and insurance (when the income of migrants is not correlated with the income generating activities of the household). In this setting, altruism is not a precondition for remittances and cooperation, but it reinforces the implicit contract among household members (Taylor and Martin, 2001). Garlick, Leibbrandt and Levinsohn (2016) provide a framework with which to analyze the economic impact of migration when individuals migrate and households pool income.

In the new economics of labor migration, individual characteristics and human capital variables are also very important because they influence not only the characteristics of the migrants but also the impacts that migration has on the productive activities of the remaining household. Migrants are not homogeneous nor are they a random sample from the population in the host country. Instead, individuals might be selected according to their characteristics and how these characteristics fit in the host country. Positive selection occurs when migrants have (expected) earnings above the mean in both the host and the source economy and negative selection when they would have expected income below the average in both locations. Borjas (1987) presents a variation of the Roy (1951) model which shows that, assuming constant costs, positive selection happens when the variance of the income in the host country is smaller than the variance in the source country, since then it would be as if the source country taxed highly skilled workers and insured less skilled workers. The opposite happens with negative selection.

The importance of migrant characteristics have been analyzed empirically with mixed results. Human capital theory à la Sjaastad (1962) suggests that migrants are younger than those who stay because younger migrants would capture the returns from migration over a longer time horizon. The role of education depends on the characteristics of the host and the source economy. Education is positively related to rural-urban migration but has a negative effect on international migration (Taylor, 1987). The reason is that education is not equally rewarded across different host economies. For example, agricultural work in the United States requires only low-skilled labor, so education has a negative effect on the selection of migrants for this type of work.

Changes in labor demand in the United States has modified the role of migrant characteristics in determining who migrates. Migrants from rural Mexico, once mainly poorly educated men, more recently have included female, married, and better educated individuals relative to the average rural Mexican population (Taylor and Martin, 2001). Borjas (2008) finds evidence that supports the negative selection of Puerto Rico emigrants to the United States, which is consistent with Borjas' (1987) model of negative selection of workers when the source economy has low mean wages and high inequality. On the other hand, Feliciano (2001), Chiquiar and Hanson (2005), Orrenius and Zavodny (2005), McKenzie and Rapoport (2010), Cuecuecha (2005), and Rubalcaba et al. (2008) find that the selection of

Mexican migrants occurs from the middle of the wage or education distribution. McKenzie and Rapoport (2007) show that migrants from regions with communities of moderate size in the United States are selected from the middle of the wealth distribution, while migrants from regions with bigger communities in the United States come from the bottom of the wealth distribution.

The financial costs of migration can be considerable relative to the income of the poorest households in Mexico.[3] Migration costs reflect in part the efforts of the host country to impede migration, which might explain why migration flows continue over time and why we do not observe enormous flows of migrants (Hanson, 2010). Migration costs for illegal crossing from Mexico to the United States are estimated to be 2,750 to 3,000 dollars (Mexican Migration Program, 2014). Estimates reported in Hanson (2010) suggest that the cost of the "coyote" increased by 37 percent between 1996-1998 and 2002-2004, mainly due to the increase of border enforcement due to the terrorist attacks of 9/11. Nevertheless, Gathmann (2008) estimates that even when the border enforcement expenditure for the Mexico-United States border almost quadrupled between 1986 and 2004, the increase in expenditure produced an increase the cost of the coyote of only 17 percent, with almost zero effect on coyote demand.

2.2 Reduced-form models of strategic interactions

In addition to the literature on migration, our paper also builds on the previous literature using reduced-form models of strategic interaction. We define 'strategic interactions' as arising whenever the actions of others affects the payoffs of a decision-maker and therefore the decision-maker's actions.

We build on the work of Lin (2009), who analyzes the strategic interactions among firms in offshore petroleum production. When individual petroleum-producing firms make their

[3]Data from the National Council for the Evaluation of the Social Policy in Mexico (CONEVAL) show that the average income of the poorest 20 per cent of rural Mexican households was only 456 dollars a year in 2012.

exploration decisions, positive information externalities and negative extraction externalities may lead them to interact strategically with their neighbors. If they do occur, strategic interactions in petroleum production would lead to a loss in both firm profit and government royalty revenue. Lin (2009) examines whether these inefficient strategic interactions take place on U.S. federal lands in the Gulf of Mexico. In particular, she analyzes whether a firm's exploration decisions depend on the decisions of firms owning neighboring tracts of land. To address the endogenity of neighbors' exploration decisions, she uses variables based on the timing of a neighbor's lease term as instruments for the neighbor's decision. The results suggest that strategic interactions do not actually take place, at least not in exploration, and therefore that the current parameters of the government offshore leasing policy do not lead to inefficient petroleum exploration.

Pfeiffer and Lin (2012) use a unique spatial data set of groundwater users in western Kansas to empirically measure the physical and behavioral effects of groundwater pumping by neighbors on a farmer's groundwater extraction. To address the simultaneity of neighbors's pumping, they use the neighbors' permitted water allocation as an instrument for their pumping.

Robalino and Pfaff (2012) estimate neighbor interactions in deforestation in Costa Rica. To address simultaneity and the presence of spatially correlated unobservables, they instrument for neighbors' deforestation using the slopes of neighbors' and neighbors' neighbors' parcels. They find that neighboring deforestation significantly raises the probability of deforestation. Policies for agricultural development or forest conservation in one area will affect deforestation rates in non-targeted neighboring areas. Similarly, Irwin and Bockstael (2002) investigate strategic interactions among neighbors in land use change using physical attributes of neighboring parcels as instruments to identify the effect of neighbors' behavior.

Morrison and Lin Lawell (2016) investigate the role of social influence in the commute to work. Using instruments to address the endogeneity of commute decisions and a dataset of U.S. military commuters on 100 military bases over the period 2006 to 2013, they show that workplace peers positively influence one anothers decisions to drive alone to work and carpool to work.

Topa and Zenou (2015) provide an overview of the research on neighborhoods and social networks and their role in shaping behavior and economic outcomes. They include discussion of empirical and theoretical analyses of the role of neighborhoods and social networks in crime, education, and labor-market outcomes.

Munshi (2003) identifies job networks among Mexican immigrants in the United States labor market. The network of each origin community in Mexico is measured by the proportion of the sampled individuals who are located at the destination (the US) in any year. He uses rainfall in the origin community as an instrument for the size of the network at the destination. Results show that the same individual is more likely to be employed and to hold a higher paying nonagricultural job when his network is exogenously higher.

2.3 Structural econometric models

In addition to the literature on migration and the literature on reduced-form models of strategic interactions, our paper also builds on previous literature using structural econometric models.

Structural econometric models have been applied in economics to answer important research questions. Our structural model also contributes to the burgeoning literature using structural models in development economics. While most of the dynamic structural econometric models in development economics model single-agent dynamic decision-making (see e.g., Todd and Wolpin, 2010; Duflo, Hanna and Ryan, 2012; Mahajan and Tarozzi, 2011), our structural models model a dynamic game between decision-makers, and thus allow for both dynamic and strategic decision-making.

Shenoy (2016) estimates the cost of migration and migration-related supply elasticity in Thailand using structural model of location choice. He finds that a migration costs from 0.3 to 1.1 times average annual earnings. He also finds that migration contributes 8.6

percentage points to local labor supply elasticity. We build on Shenoy's (2016) work by explicitly modeling the dynamic and strategic components of international migration.

To explain the large spatial wage disparities and low male migration in India, Munshi and Rosenzweig (2016) develop and estimate a structural econometric model of the trade-off between consumption smoothing, provided by caste-based rural insurance networks, and the income gains from migration. We build on Munshi and Rosenzweig's (2016) work by explicitly modeling the dynamics of international migration, by allowing for multiple channels of strategic interactions in addition to networks, and by applying our model to migration from rural Mexico.

The seminal work of Rust (1987) is the cornerstone of dynamic structural econometric models. Rust (1987) develops an econometric method for estimating single-agent dynamic discrete choice models. Hotz and Miller (1993) propose a two-stage algorithm.

Finding a single equilibrium is computationally costly even for problems with a simple structure. In more complex problems - as in the case of the dynamic game of migration, where many agents and decisions are involved -the computational burden is even more important. Bajari, Benkard and Levin (2007) propose a method for recovering the dynamic parameters of the payoff function without having to compute any single equilibrium. Their estimation builds on the algorithm of Hotz and Miller (1993) but allows for continuous and discrete choice variables, so their approach is more general and can be implemented in a broader array of research questions.

In a first stage, one estimates the parameters of the policy function, that is, one estimates the empirical relationship between the observed actions and the state variables. In this stage one also recovers the distribution of the state variables, which describes how these state variables evolve over time.

Forward simulation is used to estimate the value functions. The procedure consists of simulating many paths of play for each individual given distinct draws of the idiosyncratic shocks, and then averaging over the paths of play to get an estimate of the expected value function.

The second stage consists of estimating the parameters of the payoff function that are consistent with the observed behavior. This is done by appealing to the assumption of Markov Perfect Nash Equilibrium, so each observed decision is every agent's best response to the actions of the rest of the players. The estimation of the parameters in Bajari, Benkard and Levin (2007) is based on a minimum distance estimator, minimizing the deviations of the data from the equilibrium conditions.

The crucial mathematical assumption to be able to estimate the parameters in the payoff function is that the same equilibrium is played in every market, so in case of the existence of multiple equilibria, the same equilibrium is chosen always. We present further details of the estimation procedure below.

Morten (2016) develops and estimates a dynamic structural model of risk sharing with limited commitment frictions and endogenous temporary migration to understand the joint determination of migration and risk sharing in rural India. We build on Morten's (2016) work by allowing for multiple channels of strategic interactions in addition to risk sharing, and by applying our model to migration from rural Mexico.

Structural econometric models of dynamic behavior have been applied to bus engine replacement (Rust, 1987), nuclear power plant shutdown decisions (Rothwell and Rust, 1997), water management (Timmins, 2002), air conditioner purchase behavior (Rapson, 2014), and in labor economics in problems such as female labor supply, job search, and occupational choices (see Keane, Todd and Wolpin, 2011).

As many migrations are temporary (Dustmann and Gorlach, 2016), Kennan and Walker (2011) estimate a dynamic structural econometric model of optimal sequences of migration decisions in order to analyze the effects of expected income on individual migration decisions. They apply the model to interstate migration decisions within the United State. The model is estimated using panel data from the National Longitudinal Survey of Youth on white males with a high-school education. Their results suggest that the link between income and migration decisions is driven both by geographic differences in mean wages and by a tendency to move in search of a better locational match when the income realization in the current location is unfavorable.

Cook and Lin Lawell (2016) develop a dynamic structural econometric model of wind turbine owners' decisions about whether and when to add new turbines to a pre-existing stock, scrap an existing turbine, or replace old turbines with newer versions (i.e., upgrade). They apply the model to owner-level panel data for Denmark over the period 1980-2011 to estimate the underlying profit structure for wind producers and evaluate the impact of technology and government policy on wind industry development. Their structural econometric model explicitly takes into account the dynamics and interdependence of shutdown and upgrade decisions and generates parameter estimates with direct economic interpretations. Results from the model indicate that the growth and development of the Danish wind industry was primarily driven by government policies as opposed to technological improvements. The parameter estimates are used to simulate counterfactual policy scenarios in order to quantify the effectiveness of the Danish feed-in-tariff and replacement certificate programs. Results show that both of these policies significantly impacted the timing of shutdown and upgrade decisions made by turbine owners and accelerated the development of the wind industry in Denmark.

Carroll et al. (2016b) develop and estimate a dynamic structural econometric model of Verticillium wilt management for lettuce crops in Monterey County, California to determine the impact on welfare of decision-making by short-term versus long-term growers and to examine the intertemporal externalities between short-term growers. Our results affirm that fumigating with methyl bromide and planting broccoli are effective control options, and that they require long-term investments for future gain. However, renters are not rewarded for fumigating with methyl bromide or planting broccoli, even though these control methods benefit future renters, thus leading to an intertemporal externality between short-term growers. The long-term decision-making of long-term growers yields higher average welfare per grower-month and more use of the control options, likely due to differences in the incentives faced by owners versus renters, differences in the degree to which the intertemporal externality is internalized by owners versus renters, the severity of Verticillium wilt, the effectiveness of control options, rental contracts, and a longer planning horizon. Carroll et al. (2016a) analyze the externality between growers and seed companies by estimating the grower's benefits from and the spinach seed company's cost to testing and cleaning spinach seeds in order to reduce the level of microsclerotia.

Structural econometric models of dynamic games incorporate not only dynamic behavior but also strategic interactions as well. These models allow researchers to answer questions that cannot be addressed using static settings and that account for the effect of players decisions on other players' payoffs and state variables. Since the model we propose below is a dynamic game, here we briefly review some empirical applications of dynamic games in other fields of economics.

The structural econometric model of a dynamic game we use builds on a model developed by Pakes, Ostrovsky and Berry (2007), which has been applied to the multi-stage investment timing game in offshore petroleum production (Lin, 2013), to ethanol investment decisions (Thome and Lin Lawell, 2016), and to the decision to wear and use glasses (Ma, Lin Lawell and Rozelle, 2016); a model developed by Bajari et al. (2015) and applied to ethanol investment (Yi and Lin Lawell 2016a; Yi and Lin Lawell, 2016b); as well as on a model developed by Bajari, Benkard and Levin (2007), which has been applied to the cement industry (Ryan, 2012; Fowlie, Reguant and Ryan, 2016), and to the production decisions of ethanol producers (Yi, Lin Lawell and Thome, 2016).

Lin (2013) develops and estimates a structural model of the multi-stage investment timing game in offshore petroleum production. When individual petroleum-producing firms make their exploration and development investment timing decisions, positive information externalities and negative extraction externalities may lead them to interact strategically with their neighbors. If they do occur, strategic interactions in petroleum production would lead to a loss in both firm profit and government royalty revenue. The possibility of strategic interactions thus poses a concern to policy-makers and affects the optimal government policy. Lin (2013) examines whether these inefficient strategic interactions take place on U.S. federal lands in the Gulf of Mexico. In particular, she analyzes whether a firm's production decisions and profits depend on the decisions of firms owning neighboring tracts of land. The empirical approach is to estimate a structural econometric model of the firms' multi-stage investment timing game.

Ryan (2012) uses a dynamic game model to estimate the cost structure of the Portland's cement industry, which allows him to estimate the effects of changes in the regulatory environment coming from the 1990 amendments to the Clean Air Act of the United States. A typical cost-benefit analysis focuses only on the costs that existing firms would have to pay to comply with a new regulation. In contrast to such a static analysis, a dynamic games model allows him to evaluate the entry decisions of new players, which is determined mainly by the sunk costs. Ryan finds that the Clean Air Act Amendments increased the sunk costs of entry, which negatively affected potential entrants and partially benefited incumbents because of lower ex post competition.

Thome and Lin Lawell (2016) examine how economic factors, government policy and strategic interactions affect decisions about when and where to invest in building new ethanol plants. They model the decision to invest in ethanol plants using both reduced-form discrete response models and a structural model of a dynamic game. Yi and Lin Lawell (2016a,b) estimate a model of the investment timing game in ethanol plants worldwide that allows for the choice among different feedstocks.

Yi, Lin Lawell and Thome (2016) use a dynamic game model grounded on the theoretical models of Maskin and Tirole (1988) and Ericson and Pakes (1995) to analyze the effect of government subsidies and the Renewable Fuel Standard (RFS) on the US ethanol industry. Analyses that ignore the dynamic implications of these policies, including their effects on incumbent ethanol firms' investment, production, and exit decisions and on potential entrants' entry behavior, may generate incomplete estimates of the impact of the policies and misleading predictions of the future evolution of the fuel ethanol industry. Yi, Lin Lawell and Thome (2016) construct a dynamic model to recover the entire cost structure of the industry including the distributions of fixed entry costs and of exit scrap values. They use the estimated parameters to evaluate three different types of subsidy: a volumetric production subsidy, an investment subsidy, and an entry subsidy, each with and without the RFS. Results show that the RFS is a critically important policy for supporting the sustainability of corn-based fuel ethanol production, and that investment subsidies and entry subsidies are more effective than production subsidies.

Huang and Smith (2014) model the dynamics of a common-pool fisheries exploitation in North Carolina. They model daily fishing decisions as a dynamic game to quantify the inefficiency resulting from the common-pool resource exploitation. The common-pool exploitation produces two types of externalities: stock externalities (because the amount of harvest of each fisherman reduces the stock available for the rest of the fishermen and because they also alter the timing of fishing in a given season) and congestion externalities. They show that the usually proposed individually transferable quota only partially solves the inefficiency because it does not affect the timing of the exploitation within a season. They simulate a new theoretical daily limited entry policy and show that it yields to an outcome closer to the efficient allocation. Even if the theoretical grounds of the "tragedy of the commons" does not require an explicit dynamic setting, Huang and Smith (2014) argue that "the individual strategic and dynamic behavior is the mechanism that drives inefficient use of the commons."

3 Sources of Strategic Interactions

In this paper we contribute to the literature on the determinants of migration by examining whether strategic interactions are a determinant of migration decisions as well. We define 'strategic interactions' as arising whenever the migration decisions of other households in their village affect a household's payoffs from migration and therefore its decisions to have a member migrate.[4] There are several reasons why households make take into the account the actions of other households in their village when making their migration decisions.

The first source of strategic interactions are migration networks. Migration networks may affect migration decisions because they may reduce the financial, psychological, and/or informational costs of moving out of the community. Contacts in the source economy lower financial or information costs and reduce the utility loss from living and working away from home. The role of migration networks has been studied by Du, Park and Wang (2005) on China; Bauer and Gang (1998) on Egypt; Battisti, Peri and Romiti (2016) on Germany; and several others on Mexico, including Massey and Espinosa (1997) and Massey, Goldring and Durand (1994). These papers find a positive effect of migration networks on the probability of migration. In his analysis of job networks among Mexican immigrants in the U.S. labor market, Munshi (2003) finds that the same individual is more likely to be employed and to hold a higher paying nonagricultural job when his network is exogenously higher. Orrenius and Zavodny (2005) show that the probability of migrating for young males in Mexico increases when their father or siblings have already migrated. McKenzie and Rapoport (2010) find that the average schooling of migrants from Mexican communities with a larger presence in the United States is lower. Networks and the presence of relatives or friends in the host country are consistently found to be significant in studies such as those of Greenwood (1971) and Nelson (1976), among others.

Wahba and Zenou (2005) develop a theoretical model in which individuals are embedded within a network of social relationships. They show that, conditional on being employed, the probability of finding a job through social networks, relative to other search methods,

[4] We choose to use the term 'strategic interactions' instead of 'peer effects' for two main reasons. First, the term 'peer' often connotes an individual; in contrast; the decision-makers we examine are households rather than individuals. Second, a possible source of strategic interactions we allow for in our analysis is a competition effect, which is an effect that is potentially more accurately described as a 'strategic interaction' rather than a 'peer effect'. Nevertheless, our concept of 'strategic interactions' is very similar to that of 'peer effects'.

increases and is concave with the size of the network. The effects are stronger for the uneducated. There is however a critical size of the network above which this probability decreases. They then test empirically these theoretical findings for Egypt using the 1998 Labor Market Survey. The empirical evidence supports the predictions of their theoretical model.

A second source of strategic interactions are information externalities between households in the same village that may have a positive effect on migration decisions. When a household decides to send a migrant outside the village, other households in the village may benefit from learning information from their neighbor. This information may include information about the benefits and costs of migration, as well as information that enables a household to increase the benefits and reduce the costs of migration.

A third source of strategic interactions may be relative deprivation (Stark and Taylor, 1989; Stark and Taylor, 1991). Models of relative deprivation consider that a household's utility is a function of its relative position in the wealth distribution of all the households in the community. Individuals who migrate remain attached to their household and remit in order to improve the position of their household with respect the reference group. For this concept to be a valid motive for migration, the migrants must still consider their source country as their reference group, which is likely to happen when the source and the host countries are very different, so migrants do not choose the host country as a reference group. The relative deprivation motive also helps to explain why local migration is different from international migration because when a migrant moves within the same country it is more likely that she changes her relative group since it is easier to adapt in the host economy (where maybe the same language is spoken and the cultural differences are not as dramatic as in the case of international migration). Also, the relative deprivation concept would predict that those individuals from a household that is relatively deprived might decide to engage in international migration rather than domestic migration even though the former is more costly because by migrating locally her position in the most likely new reference group would be even worse than the position she would have if she did not migrate.

Taylor (1987) and Stark and Taylor (1989) empirically test the relative deprivation hypothesis controlling for the household relative position in the village's wealth distribution in Mexico. The results show that relative deprivation increases the probability of migration to the United States, but has no effect on internal migration, which supports the idea that when it is easy to change the reference group, migration might not occur if the position within the new reference group would be worse than the position in the original distribution.

Some behavioral explanations may add to our understanding of social comparisons and reference group formation that explain, for example, the relative deprivation hypothesis. McDonald et al. (2013) use a controlled experiment in which people play a modification of a three-player ultimatum game in which one of the players is given an exogenous amount of money that the other two consider as the reference "group". They show that differences in the wealth level of the reference player matters for the bargaining process in the game because it varies the level of payoff to which players might consider to be entitled.

A fourth source of strategic interactions is risk sharing. Chen, Szolnoki and Perc (2012) argue that migration can occur in a setting when individuals share collective risk. Each individual in a group decides her amount of contribution for a collective good. If the amount required for the transformation of the private good into the public good is not achieved, all the contributions are lost with a certain probability. They use computer simulations on a grid with randomly seeded "players" who follow simple behavior rules for learning and moving all over the grid. They analyze the emerging patterns after several simulations and find evidence for risk-driven migration, whereby individuals move to another location when the perceived risk of not attaining the amount needed for the public good is higher. Their simulations also show that migration might also promote cooperation, creating spatially diluted groups of "cooperators" who mantain the group from the invasion of free-riders ("defectors"). In a similar fashion, Cheng et al. (2011) use simulations to study the behavior that arises when migration is positively related to wealth. They use a grid to simulate an evolutionary prisoner's dilemma which determines the mobility of players across the grid according to simple behavioral rules. They show that migration might promote cooperation in the prisoner's dilemma game. Lin et al. (2011) use a grid and an evolutionary prisioner's dilemma game in which migration is determined by aspirations, defined as a threshold payoff level of a selected neighbor. Migration occurs with a certain probability if the aspired level of payoffs is greater than the own payoff. They show that aspirations also promote cooperation in the prisoner's dilemma game. Morten (2016) develops a dynamic model to understand the joint determination of migration and endogenous temporary migration in rural India, and finds that improving access to risk sharing reduces migration.

A fifth source of strategic interactions is a negative competition effect whereby the benefits of migrating to the US or within Mexico would be reduced if others from the same village also migrate to the US or within Mexico. We hypothesize that negative competition effects are less likely to explain strategic interactions in migration decisions to the US, however, since the labor market in the US is large relative to the number of migrants from a particular village. Our empirical analysis enables us to examine this hypothesis.

Owing to migration networks, information externalities, relative deprivation, risk sharing, and competition effects, households may take into account the migration decisions of neighboring households when making their migration decisions.

4 Reduced-Form Model

We estimate reduced-form models of a household's decision to have a member migrate to the US, and also of its decision to have a member migrate within Mexico. In particular, our dependent variable y_{ikt} is an indicator variable of whether household i has migration of type $k \in [USA, Mexico]$ at time t, which is equal to 1 for household i in year t if a household has a member who is a migrant to/within k in year t.

To analyze strategic interactions in migration, we analyze whether the fraction of neighbors who engage in migration to the US and the fraction of neighbors who engage in migration within Mexico affect a household's decision to have a member migrate to the US and/or a household's decision to have a member migrate within Mexico. In particular, we regress household i's decision y_{ikt} to engage in migration on the fraction s_{ikt} of the sampled households in the same village as household i, excluding i, that engage in migration of type k.

We estimate the following econometric model:

$$y_{ikt} = \alpha + \sum_k \beta_{sk} s_{ikt} + x_{it}'\beta_x + \mu_i + \tau_t + \varepsilon_{ikt}, \tag{1}$$

where the vector x_{it} includes covariates at the household, village, municipality, state, and national level as well as border crossing variables; μ_i is a village fixed effect; and τ_t is a year effect. We also run a set of specifications using a time trend instead of year effects.

The regressors at the household level in x_{it} include the number of males in the household, the age of the household head; the schooling of the household head; the maximum level of schooling achieved by any of the household members; the average level of schooling, measured as the number of years of education that have been completed, of household members 15 years old and above; a dummy if the household's first born was a male; the area of land owned by the household that is irrigated for agricultural purposes, interacted with village precipitation; the lagged fraction of household members working in the US; and the lagged fraction of household members working within Mexico.

The regressors at the municipality level in x_{it} include the number of schools in the basic system, the number of schools in the indigenous system, the number of cars, and the number of buses. The state-level variables in x_{it} include employment by sector. The national variables in x_{it} are aggregate variables that represent the broad state of the institutional and economic environment relevant for migration, including the average hourly wage, and wage by sector.

The border crossing variables in x_{it} includes variables that measure crime, deaths, and border enforcement at nearby border crossing points.

Measuring neighbors' effects is difficult owing to two sources of endogeneity. One source is the simultaneity of the strategic interaction: if household i is affected by its neighbor j, then household j is affected by its neighbor i. The other arises from spatially correlated unobservable variables (Manski, 1993; Manski, 1995; Brock and Durlauf, 2001; Conley and Topa, 2002; Glaeser, Sacerdote and Scheinkman, 1996; Moffitt, 2001; Lin, 2009; Robalino and Pfaff, 2012; Pfeiffer and Lin, 2012). It is therefore important to address these endogeneity problems in order to identify any strategic interactions.

To address the endogeneity of neighbors' migration decisions s_{ikt}, we use instruments for the fraction of neighbors that engage in migration that are correlated the neighbors' migration decisions but do not affect a household's own-migration decision except through their effect on the neighbors' migration decisions.[5]

One instrument we use for the fraction of neighbors that engage in migration is the neighbors' average number of males in the household, which we define as the average number of males in the household of other households in the same village as i, but not including i, at time t. The idea behind this instrument is that households that differ in the number of male members may have different strategies regarding migration and local work. The average number of males in the families of neighboring households j is a good instrument because it is likely to affect the migration decisions of neighboring households j, but it does not affect the decisions of household i except through its effect on the decisions of neighboring households j.

A second instrument we use for the fraction of neighbors that engage in migration is the fraction of neighbors whose first born is male, which we define as the fraction of other households in the village of i, not including i, at time t in which the first born was a male.

[5]Our use of instruments and two-stage least squares estimation also addresses the negative exclusion bias that affects OLS peer effect estimates even when there is randomized peer assignment (Caeyers and Fafchamps, 2016).

The intuition is similar to the previous instrument. Whether the first born was a male is exogenous. The fraction of neighboring households j in which the first born is a male is a good instrument because it is likely to affect the migration decisions of neighboring households j, but it does not affect the decisions of household i except through its effect on the decisions of neighboring households j.

A third instrument we use instrument we use for the fraction of neighbors that engage in migration is the neighbors' average household head schooling, which we define as the average of the household head schooling of other households in the village of i, but not including i, at time t. The intuition why this is a good instrument is that the average household head schooling of other households j may affect the productivity of other households j, the schooling and employment decisions of its members, and thus their likelihood to migrate, but it does not affect the decisions of household i except through its effect on the decisions of neighboring households j.

A fourth instrument we use for the fraction of neighbors that engage in migration is the fraction of neighbors whose household head is the most educated member of the household, which we define as the fraction of other households in the village of i, but not including i, at time t whose household head is the most educated member of the household. The intuition why this is a good instrument is that the fraction of neighbor households j in which the household head is the most educated member may affect the productivity of these households, the schooling and employment decisions of its members, and thus their likelihood to migrate, but it does not affect the decisions of household i except through its effect on the decisions of neighboring households j.

A fifth instrument we use for the fraction of neighbors that engage in migration is the neighbors' average household average schooling, which we define as the average of the mean household schooling of other households in the village of i, but not including i, at time t. This is a good instrument because the average schooling of neighbor households j may affect the productivity of these households and thus their likelihood to migrate, but does not affect the decisions of household i except through its effect on the decisions of neighboring households j.[6]

A sixth instrument we use for the fraction of neighbors that engage in migration is the neighbors' average irrigated area interacted with rain, which we define as the average irrigated land area interacted with rain of other households in the same village as i, but not including i, at time t. This is a good instrument since the average irrigated land area of neighbors j interacted with rain may affect the income generated by households j and thus their migration decisions, but does not affect the decisions of household i except through its effect on the decisions of neighboring households j.[7]

As we show in our results in Section 6, the first-stage F-statistic is greater than 10 in almost all specifications. To test the validity of our instruments, we also conduct an under-identification test, weak-instrument-robust inference tests, and a Sargan-Hansen test of over-identifying restrictions. In all our specifications, we reject under-identification. We also pass the Sargan-Hansen test of over-identifying restrictions in all specifications, since in each of these regressions we fail to reject the joint null hypothesis that the instruments are uncorrelated with the error term and that the excluded instruments are correctly excluded from the estimated equation.

One may worry that our instruments, which are based on characteristics of a household's neighbors, may be highly correlated with the same characteristics of the household itself. For example, if the number of males in a household does not vary much within a village, then the neighbors' average number of males in the household (one of our instruments) may be highly correlated with a household's own number of males in the household (one of our controls). However, as we show in our results in Section 6, there is variation within villages in the household characteristics on which the instruments are based so that the instruments

[6]The mean schooling in each household was constructed using the years of schooling of individuals over 15 years old.

[7]In their analysis of the effects of low skilled immigrants on the labor market outcomes of low skilled natives, Foged and Peri (2015) exploit the exogeneity of a Danish dispersal policy that distributed migrants from refugee counties to Denmark across municipalities to construct their instrument. Unfortunately, we do not have any similar exogenous policy in our context to exploit as an additional source of instruments.

are not too highly correlated with a household's own control variables; and moreover the correlations between the instruments and a household's own respective control variables are low. Thus, because the characteristics of a household are not perfectly collinear with the characteristics of its neighbors, the parameters in our endogenous effects model are identified (Manski, 1995).

To examine if the instruments are correlated with unobserved village factors that may affect migration decisions and therefore whether the exclusion restriction is satisfied, following a technique applied by Morrison and Lin Lawell (2016), we run a falsification test of the first-stage regression in which we use as dependent variables pseudo-endogenous variables rather than our actual endogenous variables. In particular, instead of the fraction of neighbors that engage in migration, we use the following pseudo-endogenous variable: the indicator variable y_{ikt} of whether household i has migration of type $k \in [USA, Mexico]$ at time t. If the exclusion restriction is satisfied and the instruments for the fraction of neighbors that engage in migration are not correlated with unobserved village factors that affect household migration decisions, then we would expect that our instruments – the neighbors' average number of males in household, the fraction of neighbors whose first born is male, the neighbors' average household head school, the fraction of neighbor households in which the household head is the most educated, neighbors' average household average schooling, and neighbors' average irrigated area interacted with rain – should not be strong predictors of whether household i engages in migration. In other words, if the exclusion restriction is satisfied, the characteristics of neighbors j that we use as instruments should not explain the migration decisions of household i. As we show in our results in Section 6, the characteristics of neighbors j that we use as instruments do not explain the migration decisions of household i. Thus, the instruments are not correlated with unobserved village factors that affect migration decisions and the exclusion restriction is satisfied.

5 Data

We use data from the National Survey of Rural Households in Mexico (ENHRUM) in its three rounds (2002, 2007 and 2010[8]). The survey is a nationally representative sample of Mexican rural households across 80 villages and includes information on the household characteristics such as productive assets and production decisions. It also includes retrospective employment information: individuals report their job history back to 1980. With this information, we construct an annual household-level panel data set that runs from 1990 to 2010[9] and that includes household composition variables such as household size, household head age, and number of males in the household. For each individual, we have information on whether they are working in the same village, in some other state within Mexico (internal migration), or in the United States.

The survey also includes information about the plots of land owned by each household, including slope (flat, inclined, or very inclined), quality (good, regular, or bad), irrigation status, and land area.[10] We reconstruct the information for the complete panel using the date at which each plot was acquired. Since a plot's slope and quality are unlikely to change over time (unless investments were taken to considerably change the characteristics of the plots, which we do not observe very often in the data), we interact the plot variables with a measure precipitation at the village level (Jessoe, Manning and Taylor, 2015) so the characteristics vary across households and along time. Rain data is available only for the subperiod of 1990 to 2007.

Because information on the slope and the quality of a household's plots of land is only available for the plots owned by the household, households that do now own any plots of land have missing observations for these two variables. We therefore also try estimating the

[8]The sample of 2010 is smaller than the sample of the two previous rounds because it was impossible to access some villages during that round due to violence and budget constraints.

[9]Since retrospective data from 1980 to 1989 included only some randomly selected individuals in each village who reported their work history, we begin our panel data set in 1990.

[10]We use information on plots of land which are owned by the household because our data set does not include comparable information on plots of land that are rented or borrowed.

models without using the plot-related slope and quality variables.

We use information from the National Statistics Institute (INEGI) to control for the urbanization and education infrastructure at the municipality level, including the number of basic schools and the number of indigenous schools. We also include the number of registered cars and buses. These data cover the period 1990 to 2010.

We also include aggregate variables that represent the broad state of the institutional and economic environment relevant for migration. We use data from the INEGI on the fraction of the labor force employed in each of the three productive sectors (primary, secondary, and tertiary[11]) at the state level, from 1995 to 2010. We use INEGI's National Survey of Employment and the methodology used in Campos-Vazquez, Hincapie and Rojas-Valdes (2012) to calculate the hourly wage at the national level from 1990 to 2010 in each of the three productive sectors and the average wage across all three sectors.

We use two sets of border crossing variables that measure the costs of migration. On the Mexican side, we use INEGI's data on crime to compute the homicide rate per 10,000 inhabitants at each of the 37 the Mexican border municipalities. On the United States' side, we use data from the Border Patrol that include the number of border patrol agents, apprehensions, and deaths of migrants at each of nine border sectors,[12] and match each border sector to its corresponding Mexican municipality.

We interact these border crossing variables (which are time-variant, but the same for all villages at a given point in time) with measures of distance from the villages to the border (which are time-invariant for each village, but vary for each village-border location pair).

We use a map from the International Boundary and Water Commission (2013) to obtain the location of the 26 crossing-points from Mexico to the United States. Using the Google Distance Matrix API, we obtain the shortest driving route from each of the 80 villages in

[11]The primary sector includes agriculture, livestock, forestry, hunting, and fisheries. The secondary includes the extraction industry and electricity, manufacturing, and construction. The tertiary sector includes commerce, restaurants and hotels, transportation, communication and storage, professional services, financial services, corporate services, social services, and government and international organizations.

[12]A "border sector"' is the term the Border Patrol uses to delineate regions along the border for their administrative purposes.

the sample to each of the 26 crossing-points, and match the corresponding municipality at which these crossing-points are located. This procedure allows us to categorize the border municipalities into those less than 1,000 kilometers from the village; and those between 1,000 and 2,000 kilometers from the village.

By interacting the distances to the border crossing points with the border crossing variables, we obtain the mean of each border crossing variable at each of the three closest crossing points, and the mean of each border crossing variable within the municipalities that are in each of the two distance categories defined above. We also compute the mean of each border crossing variable among all the border municipalities.

Figure 1 presents a map of the villages in our sample (denoted with a filled black circle) and the US-Mexico border crossing points (denoted with a red X).

Table 1 presents the summary statistics for the variables in our data set. Table 2 presents the within and between variation for the migration variables. 'Within' variation is the variation in the migration variable across years for a given village. 'Between' variation is the variation in the migration variable across villages for a given year.

6 Results of Reduced-Form Model

In this section we present the results of the reduced-form models we run to analyze the effects of strategic interactions on a household's decisions regarding migration. We run two sets of regressions: one for the decision to migrate to the US, and the other for the decision to migrate within Mexico. The strategic variables are the fraction of households in the same village as household i, excluding i, with migration to the US; and the fraction of households in the same village as i, excluding i, with migration within Mexico.

6.1 Validity of the instruments

Table 3 presents the results of our first-stage regressions.[13] The first stage F-statistic is greater than 10 in almost all specifications. To test the validity of our instruments, we also conduct an under-identification test, weak-instrument-robust inference tests, and a Sargan-Hansen test of over-identifying restrictions. In all our specifications, we reject under-identification. We also pass the Sargan-Hansen test of over-identifying restrictions in all specifications, since in each of these regressions we fail to reject the joint null hypothesis that the instruments are uncorrelated with the error term and that the excluded instruments are correctly excluded from the estimated equation.

One may worry that our instruments, which are based on characteristics of a household's neighbors, may be highly correlated with the same characteristics of the household itself. For example, if the number of males in a household does not vary much within a village, then the neighbors' average number of males in the household (one of our instruments) may be highly correlated with a household's own number of males in the household (one of our controls).

To address this concern and provide further evidence supporting the exclusion restriction, we examine the variation within villages in the values of household characteristics on which the instruments are based. For each village-year, we calculate the mean and standard deviation of the household characteristics on which the instruments are based across all households in that village-year. Panels A and B of Table 4 present summary statistics of the mean and standard deviation, respectively, over village-years of the household characteristics in each village-year. We then divide the mean standard deviation by the mean mean; the summary statistics for the ratio of the standard deviation over the mean over village-years are presented in Panel C of Table 4.

As seen in Panel C of Table 4, we find that the ratio of the mean standard deviation over

[13] The results of the first-stage regressions for all the US and within-Mexico migration specifications are available from the authors upon request.

the mean mean is non-zero for all of the covariates on which the instruments are based. For example, for irrigated area interacted with rain, the ratio of the mean (over village-years) of the standard deviation within a village-year, over the mean (over village-years) of the mean within a village-year is 2.46, which provides evidence that there is considerable variation in irrigated area interacted with rain within a village-year, and therefore that the neighbors' average irrigated area interacted with rain (one of our instruments) is not highly correlated with a household's own irrigated area interacted with rain (one of our controls). Thus, there is variation within villages in the household characteristics on which the instruments are based so that the instruments are not too highly correlated with a household's own respective control variables.

To provide further evidence that the instruments are not too highly correlated with a household's own respective control variables, we calculate the correlations between each instrument measuring neighbors' characteristics and its respective own household characteristic. As seen in Table 5, the correlations between the instruments and their corresponding own variables are low.

Thus, because the characteristics of a household are not perfectly collinear with the characteristics of its neighbors, the parameters in our endogenous effects model are identified (Manski, 1995).

To examine if the instruments are correlated with unobserved village factors that may affect migration decisions and therefore whether the exclusion restriction is satisfied, following a technique applied by Morrison and Lin Lawell (2016), we run a falsification test of the first-stage regression in which we use as dependent variables pseudo-endogenous variables rather than our actual endogenous variables. In particular, instead of the fraction of neighbors that engage in migration, we use the following pseudo-endogenous variable: the indicator variable y_{ikt} of whether household i has migration of type $k \in [USA, Mexico]$ at time t. If the exclusion restriction is satisfied and the instruments for the fraction of neighbors that engage in migration are not correlated with unobserved village factors that affect household migration decisions, then we would expect that our instruments – the neighbors' average number of males in household, the fraction of neighbors whose first born is male, the neighbors' average household head school, the fraction of neighbor households in which the household head is the most educated, neighbors' average household average schooling, and neighbors' average irrigated area interacted with rain – should not be strong predictors of whether household i engages in migration. In other words, if the exclusion restriction is satisfied, the characteristics of neighbors j that we use as instruments should not explain the migration decisions of household i.

We present the results of our falsification test of the first-stage regressions in Table 6. The first-stage F-statistics are all much lower than 10. The characteristics of neighbors j that we use as instruments therefore do not explain the migration decisions of household i. Thus, the instruments are not correlated with unobserved village factors that affect migration decisions and the exclusion restriction is satisfied.

6.2 Strategic Interactions

Tables 7 and 8 present the main results of our paper for migration to the US and migration within Mexico, respectively. For each specification in Tables 7 and 8, version 'a' of the specification includes year effects, while version 'b' uses a time trend instead. Specification 1a is our base case specification. Specification 2 excludes the plot-related variables (which are interacted with rain), so the sample size increases. Specification 3 is analogous to the base case but instead of using a variable for the household head schooling, we use a dummy for the household head being the household member with the most schooling.

According to the results for the US migration regressions in Table 7, there is a positive and significant own-migration strategic effect that is robust across specifications. In the base case specification 1a, an increase of 0.1 in the fraction of neighbors with migration to the US increases a household's probability of migration to the US by 5.86 percentage points. The result is robust across specifications; an increase of 0.1 in the fraction of neighbors with migration to the US increase a household's probability of migration to the US by 4.3 to 7.7 percentage points in the specifications that include year effects (1a, 2a, and 3a), and by 5.8 to 6.7 percentage points in the specifications that include a time trend instead (1b, 2b, and 3b). Additionally, the other-migration strategic effect is negative and significant at a 5% level in some specifications: there is some evidence that the fraction of neighbors with migration within Mexico has a negative effect on a household's probability of migration to the US.

Table 8 presents the results for the migration to other states within Mexico. Once again, there is a positive and significant own-migration strategic effect that is robust across specifications. In the base case specification 1a, an increase of 0.1 in the fraction of neighbors with migration to other states within Mexico increases a household's probability of migration to other states within Mexico by 6.33 percentage points. The result is robust across specifications; an increase of 0.1 in the fraction of neighbors with migration to other states within Mexico increases a household's probability of migration to other states in Mexico by 5.6 to 6.3 percentage points in the specifications that include year effects (1a, 2a, and 3a), and by 4.1 to 6.1 percentage points in the specifications that include a time trend instead (1b, 2b, and 3b). In contrast, the other-migration strategic effect is not significant at a 5% level: the fraction of neighbors with migration to the US has no significant effect on a household's probability of migration to other states within Mexico.

6.3 Other Determinants of Migration

Table 7 also presents the results of other characteristics that may explain migration to the US. The number of indigenous schools has a positive effect on migration to the US that is significant in some specifications.[14] The number of males in the household has a positive effect that is significant in all specifications, which is consistent with the previous literature

[14] In addition, the number of basic schools has a significant negative effect in specification 3a, but its coefficient is lower in magnitude than that of the significant positive coefficient on the number of indigenous schools.

on the determinants of migration, which finds that migrants from Mexico to the US are more likely to be male than female. The household head age has a significant positive effect in all specifications.

Household head schooling and whether the household head is the most educated both have a significant negative effect on the probability of migration to the US, which could provide evidence in favor of the negative selection hypothesis. Similarly, household average schooling has a negative effect that is significant in some specifications. However, the household's maximum level of schooling has a significant positive effect on the probability of migration to the US. Thus, while the household maximum schooling increases the probability of migration to the US, having the household head be the one with the most education in the household and having a high household average schooling decrease the probability of migration to US.

To control for persistence in migration, we include the lag of the fractions of household members migrating to the US and within Mexico, respectively, as regressors. The lagged fraction of household members migrating to the US has a significant positive effect on the probability of migration to the US. The lagged fraction of household members migrating to other states within Mexico has positive effect on the probability of migration to the US that is smaller in magnitude and significant in some specifications.

Table 8 also presents the results of other characteristics that may explain migration to other states within Mexico. The number of males in the household has a significant positive effect on migration to other states within Mexico. The age of the household head has a significant positive effect on the probability of migrating within Mexico. Whether the first born in the household is a male has a significant negative effect in some specifications.

Household head schooling and whether the household head is the most educated in household both have a significant negative effect on the probability of migrating within Mexico. Household maximum schooling has a significant positive effect in some specifications. Thus, while the household maximum schooling increases the probability of migration within Mexico, having the household head be the one with the most education in the household decreases the probability of migration within Mexico.

The lagged fraction of household members migrating within Mexico has a significant positive effect on the probability of migration within Mexico, which provides evidence for a high degree of persistence. In contrast, the lagged fraction of household members migrating to the US has no significant effect on the probability of migration within Mexico.

6.4 Robustness

We examine the robustness of our results by running alternative specifications that are variants of the base case specification 1a from Tables 7 and 8 for migration to the US and migration within Mexico, respectively. The results of our robustness checks are in Tables 9 and 10 for migration to the US and within Mexico, respectively. Specification 4 includes employment in the primary sector; and hourly wages in the primary, secondary, and tertiary sectors as additional regressors. Specifications 5-9 uses employment in the tertiary sector instead of employment in the primary sector, and the mean hourly wage instead of the hourly wages in the primary, secondary, and tertiary sectors. In addition, specifications 5-8 vary which measures of the border crossing variables are used. Specification 9 normalizes the municipality characteristics using the municipality population, and normalizes the border enforcement variables using the length of the border that each border municipality shares with the US.

The first stage F-statistic is greater than 10 in almost all specifications. In all the specifications of the corresponding first stage, we reject under-identification. We also pass the Sargan-Hansen test of over-identifying restrictions in all specifications, since in each of these regressions we fail to reject joint null hypothesis that the instruments are uncorrelated with the error term and that the excluded instruments are correctly excluded from the estimated equation.[15]

The main results from our base case specification are robust to changes in the wage, em-

[15]The results of the first-stage regressions for all the US and within-Mexico migration specifications are available from the authors upon request.

ployment, and border crossing variables. In the US migration results in Table 9, an increase in the fraction of neighbors with migrants to the US increases a household's probability of migration by 5.1 to 7.2 percentage points. In addition, the number of males in the household, the household head age, the maximum level of schooling in the household, the number of indigenous schools, the lagged fraction of household members with migration to the US, and the lagged fraction of household members with migration within Mexico have significant positive effects on the probability of having a migrant to the US. The fraction of neighbors with migration within Mexico, the number of basic schools, household head schooling, and household average schooling have significant negative effects on the probability of having a household member migrate to the US.

In Figure 2 we summarize our findings on the own-migration strategic effect for migration to the US across specifications 1a-3a of Table 7 and specifications 4-9 of Table 9.

Similarly, Table 10 shows that the main results from our base case specification for the Mexico migration analysis are robust to changes in the wage, employment, and border crossing variables as well. In the robustness checks, an increase in the fraction of neighbors with migrants within Mexico increases a household's probability of migration by 5.5 to 8.9 percentage points. The schooling of the household head has a negative effect on the probability of migration but the maximum level of any of the household members has a positive effect. The number of males in the household, the household head age, lagged fraction of household members with migration within Mexico, and the number of deaths at the closest border crossing point to the US have a significant positive effect on the probability of migration to other states within Mexico. The fraction of neighbors with migrants to the US, the lagged fraction of household members with migration to the US, and the average number of apprehensions at the closest border crossing point to the US has a significant negative effect on effect on the probability of migration to other states within Mexico in some specifications.

In Figure 3 we summarize the findings of our results on the own-migration strategic effect for migration within Mexico across specifications 1a-3a of Table 8 and specifications 4-9 of Table 10.

6.5 Results by Village Size

It is possible that differences in the sizes of the host economies might affect the extent of the strategic interactions. The reason is that the size of the village might affect how well the information is spread, how reliable the information is, the costs of information sharing, and possibly also the (perceived or actual) competition effect. Furthermore, the relationship between village size and the extent of the strategic interactions might not be linear or monotonically increasing.

A possible reason why the strategic interactions may vary non-linearly with village size is that the information externalities may vary with village size. The spread of information and information spillovers may be facilitated in small and medium-size communities, where people tend to know each other, and where actions of other households are easily inferred or observed. Strategic interactions may be less important in big communities where there may be less face-to-face interaction, which may decrease the value of the information.

Another possible explanation why the strategic interactions may vary non-linearly with village size is that competition effects may vary with village size. In small and medium-size villages, individuals may not perceive others to be competing with them for jobs in the United States. However, as the village size grows, individuals may perceive that a bigger pool of migrants might affect their chances of getting a job. We hypothesize that competition effects are less likely to explain strategic interactions in migration decisions to the US, however, since the labor market in the US is large relative to the number of migrants from a particular village.

To formally analyze the relationship between village size and the strategic effects, we interact the strategic variables with village size quartile dummies using the village size in 1990. We similarly interact the instruments with village size quartile dummies as well.

In all the specifications of the first-stage analysis by village size, we reject under-identification. We also pass the Sargan-Hansen test of over-identifying restrictions in all specifications, since in each of these regressions we fail to reject joint null hypothesis that the instruments are uncorrelated with the error term and that the excluded instruments are correctly excluded from the estimated equation.[16]

Table A.1 in the Appendix presents the results of the village size analysis for US migration. Specification 10a is analogous to the base case specification 1a of Table 7 whereas specification 11a is analogous to specification 2a of the same table. Specifications 10b and 11b use time trends instead of year effects. The results are robust and show a positive coefficient on the fraction of neighbors with migrants to the US for the first village size quartile (i.e., the small villages) that is only significant at a 10% level; a positive coefficient on the fraction of neighbors with migrants to the US that is significant at a 5% level for the second and third village size quartiles (i.e., the medium-size villages); and a negative coefficient on the fraction of neighbors with migrants to the US that is not significant on the fourth village size quartile (i.e., the large villages). The magnitude of the own-migration strategic effect in village size quartiles 2 and 3 are in line with those in Table 7. The own-migration strategic effect in village size quartile 1 (the small villages) is smaller in magnitude and only significant at a 10% level. Figure 4 presents a graphical summary of the results. For the other-migration strategic effect, we find that, in the third village size quartile, the fraction of neighbors with migration within Mexico has a significant negative effect on a household's decision to engage in migration to the US.

Table A.2 in the Appendix presents the same analysis for the migration within Mexico. The evidence for differences in the effects of the strategic variable is less robust in this case. There is a significant positive own-migration strategic effect in the first quartile (i.e., the small villages), but only in specifications 10a and 10b. There is a positive own-migration strategic effect in the third quartile, but it is only significant at a 10% level in all but

[16]The results of the first-stage regressions for all the US and within-Mexico migration specifications are available from the authors upon request.

specification 11b. Figure 5 summarizes the findings in Table A.2.

6.6 Nonlinearities in the Strategic Interaction

The previous analysis provides strong evidence that strategic considerations are important in shaping the probabilities that a household has migrants to the US and/or within Mexico. We also find that the strategic effects depend on village size. Another type of nonlinearity in the strategic interactions may also be present: the effect of the fraction of neighbor households with migration on a household's migration decision may be a nonlinear function of the fraction of neighbor households with migrants.

To formally test for nonlinearities in the strategic interaction in the most flexible way, we estimate a semiparametric partially linear IV model using Robinson's (1988) double residual estimator to semi-parametrically identify non-linearities in the own-migration strategic effect. We use a two-step procedure to account for the endogeneity of the strategic variables with a control function approach (Verardi, 2013). In the first stage, we fit two panel fixed effects models regressing the fraction of households with migrants to the US and within Mexico, respectively, on the same instruments and controls as we used in our base case specification 1a from Tables 7 and 8 respectively, and estimate the residuals. In the second stage, we run a semi-parametric estimation where the dependent variable is the migration dummy, controlling for the same controls as in our base case specification 1a, and adding the first-stage residuals as additional regressors. The controls, the residual estimated in the first stage, and village and year fixed effects are estimated parametrically, while the endogenous regressor – the fraction of households engaged in migration to the US (within Mexico) – is allowed to vary non-parametrically.

To examine any nonlinearities in the own-migration strategic effect for migration to the US, Figure 6 plots the partialled-out residual in the analysis of the decision to migrate to the US as a function of the fraction of neighbors with migration to the US. In general we seem to find a linear effect.

Similarly, to examine any nonlinearities in the own-migration strategic effect for migration within Mexico, Figure 7 plots the partialled-out residual in the analysis of the decision to migrate within Mexico as a function of the fraction of neighbors with migration to within Mexico. The relationship again seems to be linear.

We also run two additional alternative specifications of the semiparametric partially linear IV model. In one alternative specification, we run the semiparametric partially linear IV model without instrumenting for the other-migration strategic effect. In the other alternative specification, we run the semiparametric partially linear IV model without including the other-migration strategic effect as a regressor. Our results are robust across all specifications. Thus, our test for nonlinearities in the migration strategic effects do not reject the hypothesis that the strategic effects are linear in the fraction of neighbor households with migrants.

7 Structural Econometric Model

The migration decisions can be thought of as a dynamic game in which each household optimally decides how to allocate its members across distinct activities, taking into account for dynamic and strategic considerations about the future and about what neighbors are doing, respectively. The structural econometric model of a dynamic game we develop and estimate enables us to examine how natural factors, economic factors, institutions, government policies, and strategic interactions affect the migration decisions of households in rural Mexico. We use the estimated parameters from the structural econometric model to simulate the effects of counterfactual policy scenarios, including those regarding schooling, land quality, climate, institutions, and government policy, on migration decisions and welfare.

Migration decisions are dynamic because these decisions can be viewed as forms of investment, there is leeway over the timing of these decisions, and the payoffs from these decisions are uncertain; as a consequence, there may be an option value to waiting before making these decisions that makes these decisions dynamic rather than static. Migration decisions are also dynamic because households consider the future when making these decisions, basing them not only on the current state of economic factors, but also on the prospects of economic opportunities in other areas and the potential streams of net benefits (or payoffs) from migrating.

In addition to being dynamic, migration decisions are also strategic. We define 'strategic interactions' as arising whenever the migration decisions of other households in their village affect a household's payoffs from migration and therefore its decisions to have a member migrate. There are several reasons why a household's migration decisions may depend on the migration decisions of its neighbors, including migration networks and information externalities.

There are several advantages to using a dynamic structural econometric model. First, a dynamic structural model explicitly models the dynamics of migration decisions. Second, a dynamic structural model incorporates continuation values that explicitly model how expectations about future affect current decisions. Third, a structural econometric model of a dynamic game enables us to estimate structural parameters of the underlying dynamic game with direct economic interpretations. These structural parameters include parameters that measure the effects of state variables on household payoffs (utility) and the net effect of the strategic interactions. These parameters account for the continuation value. Fourth, the parameter estimates can be used to calculate welfare. Fifth, the parameter estimates can be used to simulate the effects of counterfactual scenarios on decisions and welfare.

7.1 Model

Assume that there are $i = 1, ..., N$ players and the planning horizon is discretized into an infinite number of periods $t = 1, ..., \infty$. The conditions of the economy (prices, regulation, environment) are summarized in a vector of state variables $\mathbf{s}_t \in S \subset \mathbb{R}^L$. At each period, each agent chooses an action from a discrete finite set $a_{it} \in A_i$, and all players choose their time-t actions a_{it} simultaneously, such that $\mathbf{a}_t = (a_{1t}, ..., a_{Nt}) \in A$ summarizes the actions played at t. At each period, each agent receives a idiosyncratic shock $\varepsilon_{it} \in E_i$ independent of other players' private shock (costs, health status, level of economic variables) with distribution $G_i(\cdot|\mathbf{s}_t)$ such that the collection of idiosyncratic shocks is $\varepsilon_t = (\varepsilon_{1t}, ..., \varepsilon_{Nt})$.

The per-period payoff function summarizes the costs and benefits from the participation in the game, such as fixed and variable costs, punishments, rewards, income, taxes, among many other, depending on the application. Thus, player's i per-period payoff function depends on the actions played by player i, the actions played by other players (denoted $-i$), the state of the economy $\mathbf{s}_t$, and its private shock. We denote the per-period payoff function as $\pi_i(\mathbf{a}_t, \mathbf{s}_t, \varepsilon_{it})$. The dynamic optimization problem of agent i at a given period $t = s$ is given by:

$$\max_{\{a_{it}\}} \quad E\left[\sum_{t=0}^{\infty} \beta^t \pi_i(\mathbf{a}_t, \mathbf{s}_t, \varepsilon_{it})|\mathbf{s}_t\right].$$

At each time t, each agent i makes his decisions in order to maximize the expected stream of future payoffs, without knowing what the future realizations of his idiosyncratic shocks and the state vector will be, and without knowing what other agents will play at time t.

The policy functions describe the behavior of agents as functions of other players' actions and the values of the state vector. For purposes of analyzing the behavior of agents in equilibrium, we follow Bajari, Benkard and Levin (2007) focusing on a particular type of policy functions, those consistent with pure strategy Markov perfect equlibria. A Markov strategy of player i is a function $\sigma_i : S \times E_i \to A_i$ that maps combinations of state-shocks into actions such that $\sigma : S \times E_1 \times ... \times E_N \to A$ is the profile of strategies, and where $E_i \subset \mathbb{R}^M$ is the support of G_i. For a realization of the state vector $\mathbf{s}$, the expected payoff of player i from playing strategy σ_i is:

$$V_i(\mathbf{s};\sigma) = E_\varepsilon \left[\pi_i(\sigma(\mathbf{s},\varepsilon),\mathbf{s},\varepsilon_i) + \beta \int V_i(\mathbf{s}';\sigma) dP(\mathbf{s}'|\sigma(\mathbf{s},\varepsilon),\mathbf{s})|\mathbf{s} \right].$$

This expression gives the expected payoff for player i when the state vector is realized at $\mathbf{s}$, before she receives the idiosyncratic shock. This payoff has two terms: the current payoff, which is a function of the set of strategies being played, the state vector, and the individual-specific shock; and the discounted stream of payoffs that the player expects given that state $\mathbf{s}$ was realized and the probabilities of ending up at state $\mathbf{s}'$ in the next period, which in turn depend on the profile of strategies, the set of idiosyncratic shocks, and the current state vector. The assumption of a Markov Nash Perfect Equilibrium means that for all players, states and strategies, each player set of decisions is the best response to the rest of the players decisions:

$$V_i(\mathbf{s};\sigma) \geq V_i(\mathbf{s};\sigma_i',\sigma_{-i}).$$

A structural econometric model specifies the relationship between the state variables and the policy functions, the way that states evolve over time, and the way the relevant variables enter in the payoff function of the agents that participate in the game.

7.2 The payoff function

We assume that the payoff function and the shocks distribution are indexed by a finite parameter vector θ, so the payoff function is given by $\pi_i(\mathbf{a},\mathbf{s},\varepsilon_;\theta)$ and the distribution of the private shock has density $G_i(\varepsilon_i|\mathbf{s};\theta)$. Our action variables include migrating to the US and migrating within Mexico. For the actions of neighbors, we include the fraction of neighbors with migration to the US and the fraction of neighbors with migration within Mexico. For state variables, we include the number of indigenous schools in the municipality, the number of males in the household, the household head age, a dummy variable for whether the first born of the household was a male, the household head schooling, the maximum level of schooling of any member of the household, the lag of the fraction of household members that worked in the US, the lag of the fraction of household members that worked in other state within Mexico, the average crime rate in border crossing municipalities that are within a radius of 1,000 kilometers from the village, and the average number of apprehensions in the border crossing municipalities that are within a radius of 1,000 kilometers from the village. We also include the squared terms of these state variables, and the interaction of each state variable, including the strategic variables, with the household's own action.

The payoff function is the per period payoff for each household. It is specific to each household since it includes household-specific state variables. We assume that the parameters are common to all households, but the values of the action variables and the state variables vary by household, as does the error term, so for each household the payoff is different.[17]

In our model, we do not assume the actions are mutually exclusive, so it is possible for household to engage in multiple actions at the same time. Households make decisions as to maximize their PDV of their entire stream of per period payoffs, so in each period, they face different trade-offs between the benefits and costs they can generate by migrating to a given location (US or within Mexico) versus those benefits and costs of migrating to a different location or not migrating at all. To see these tradeoffs from migration, we would compare the value function evaluated at different values of migration decisions. The tradeoffs depend on the parameters, the action variables, the state variables, and the shock.

The parameters θ to be estimated are the coefficients on the terms in the per-period payoff function, which include terms that are functions of action variables, strategic variables, demographic characteristics of the household, natural factors, economic factor, and government policies.

[17]We do not aggregate all households into a single utility function (although we do aggregate all members of the household into the households utility function), nor is the payoff function for an "average" household only. Instead, the payoff function is the per period payoff specific to each household.

7.3 Policy functions

The policy functions relate the state variables relevant for the decision of migration to the actions played by each household - engaging in migration to the US or within Mexico-. We want to study the effect of the strategic interaction in migration decisions. The actions a_i of each agent i are assumed to be functions of a set of state variables and private information:

$$a_i = \sigma_i(\mathbf{s}, \varepsilon_i; \sigma_{-i}). \tag{2}$$

Since the policy function for each player i depends on the policy functions for all other players, we solve for the policy functions by solving for a fixed point.

7.4 Transition densities

We estimate the value of next period's state variables relevant for the migration decision using flexible transition densities. Particularly, we use linear regressions that relate the current level of the state variables to their lags, and the lags of other related state variables.

At the national level, we regress the mean of wages in the primary, secondary, and tertiary sectors on the the lags of these three same variables. At the state level, we regress the employment shares in each sector on the lags of the three shares, and on the lags of the mean wages. At the municipality level, we regress the number of basic schools, the number of indigenous schools, and the number of students in the basic system on the lags of these same variables, and the lags of the employment levels in the three sectors.At the village level, we regress the average crime rate, the average numer of apprehensions, and the average number of border agents at the border crossing municipalities within 1,000 kilometers on their lags and the lag of the wage at the primary sector.

We also model the following transition desities at the household level: the number of males in the household, the number of males in the family,[18], the household size, a dummy

[18]We define a family as the household head, its spouse, and its chidlren.

indicator for whether the first born of the household was a male, the lag of the fraction of household members that worked in the US and in other state within Mexico, the household head schooling, the average schooling of the adults in the household, the maximum level of schooling of any household member, household's land slope and quality, and household's irrigated area. We model these transition densities by regressing these variables on their lags. The age of the head of the household evolves deterministically, so next period's age is today's age plus one.

7.5 Equilibrium conditions

Under the parameterization with θ the value function of player i is:

$$V_i(\mathbf{s};\sigma;\theta) = E\left[\sum_{t=0}^{\infty} \beta^t \pi_i(\sigma(\mathbf{s}_t, \varepsilon_t), \mathbf{s}_t, \varepsilon_{it}) | \mathbf{s}_0 = \mathbf{s}; \theta\right]$$

which gives the expected payoff over the distribution of the idiosyncratic shocks and states.

Bajari, Benkard and Levin show that the computational burden can be reduced if one assumes linearity in the payoff function. Particularly, they show that if $\pi_i(\mathbf{a}, \mathbf{s}, \varepsilon_i; \theta) = \Pi(\mathbf{a}, \mathbf{s}, \varepsilon_i) \cdot \theta$, then the value function can be written as:

$$V_i(\mathbf{s};\sigma;\theta) = E\left[\sum_{t=0}^{\infty} \beta^t \Pi_i(\sigma(\mathbf{s}_t, \varepsilon_t), \mathbf{s}_t, \varepsilon_{it}) | \mathbf{s}_0 = \mathbf{s}\right] \cdot \theta = \mathbf{W}_i(\mathbf{s};\sigma) \cdot \theta \tag{3}$$

Since $\mathbf{W}_i(\mathbf{s};\sigma)$ does not depend on θ, the forward looking simulation can be used to estimate each $\mathbf{W}_i$ once, and then obtain V_i for any value of θ. Bajari, Benkard and Levin argue that this assumption is valid in models of entry and exits with fixed costs.

7.6 Econometric Model

We follow Bajari, Benkard and Levin's algorithm to estimate $V_i(\mathbf{s};\sigma;\theta)$ using forward simulation.

Using the initial a initial set of state variables, we draw a private shock from $G_i(\cdot|\mathbf{s}_0,\theta)$ for each player. We ground on our reduced-form analysis of strategic interactions in migration to obtain the predicted action given the observed data and the expected share of neighbors with migration. Since the share of neighbors taking an action is not observed, we estimate the corresponding action using a fixed-point procedure.

We made our choice of the specification of the policy function based on our reduced-form analysis. For our structural model, we set those variables that turned out to be non-significant equal to zero.

We use the observed fraction of neighbors with migration in the data as an initial guess for the expected fraction of neighbors with migration. The predicted action allows us to compute the implied fraction of neighbors with migration predicted by the policy function, which will enter as the new guess. We repeat this process until the gradient of difference between the guess and the predicted fraction of neighbors with migration is below a certain threshold.

The coefficients of the transitions are used to obtain next period's state variables, which again allows us to compute the corresponding action using the fixed-point estimation described above. We repeat this for T periods.

7.6.1 Forward simulation

We use forward simulation to calculate the expected PDV of the entire stream of per-period payoffs by simulating $S = 100$ different paths of play of $T = 30$ periods length each using $D = 3$ different initial observed vectors of state variables. Our algorithm for the forward simulation for each initial observed vectors of state variables is as follows:

- Step 0: Starting at $t = 0$ with initial state variables.

- Step 1: Evaluate the policy functions using this period's state variables to determine this period's actions. Our methodological innovation is that we address the endogeneity of neighbors' decisions using a fixed point calculation, as described below.

- Step 2: Calculate this period's payoffs as a function of this period's state variables and actions.

- Step 3: Evaluate the transition densities using this period's state variables and action variables to determine next period's state variables.

- Repeat Steps 1-3 using next period's state variables.

We sum the discounted payoffs over the T periods and average over the S simulations to obtain the expected PDV of entire stream of payoffs

7.6.2 Fixed point algorithm

Our methodological innovation is that we address the endogeneity of neighbors' decisions using a fixed point calculation, as follows:

1. Estimate policy functions, based on the reduced-form analysis in equation 1.

2. Use the observed s_{ikt} in the data as the initial guess for the expected fraction of neighbors with migration.

3. Predict the actions using the policy function for the current guess.

4. Estimate the corresponding s_{ikt} for the predicted actions, which becomes the new guess.

5. Repeat 3. and 4. until the difference between the guess and the predicted fraction of neighbors with migration is below a certain threshold.

We estimate the parameter θ by imposing the restriction that the observed equilibrium is a Markov Perfect Nash Equilibrium. Then, the equilibrium condition $V_i(\mathbf{s}; \sigma_i, \sigma_{-i}; \theta) \geq$

$V_i(\mathbf{s}; \sigma_i', \sigma_i'\sigma_{-i}; \theta)$ yields a set of inequalities that are consistent with the assumed behavior. The goal of the estimation procedure is to find the value of θ that makes all the inequalities to hold at the same time. In practice, we will use an estimator that minimizes profitable deviations from the optimal strategy. Bajari, Benkard and Levin prove the asymptotic properties of this kind of estimator, which turns out to be consistent and asymptotically normal.

7.7 The optimization problem

Since we assume that the per period payoff function is linear in the parameters, we know we can write the value function of player i as in equation 3. We use forward looking simulation to compute $\mathbf{W}_i$, which is the present value of the discounted stream of expected payoffs. We estimate this expectation by simulating S different paths of play of T periods length each, using D different initial observed datasets. We add the discounted payoffs over the T periods, and then average over the S simulations to obtain the entries of $\mathbf{W}_i$.

The average of the discounted sum of payoffs over many simulated paths of play is $\hat{V}_i(\mathbf{s}; \sigma; \theta)$. Furthermore $\hat{V}_i(\mathbf{s}; \hat{\sigma}; \theta)$ is an estimate of the payoff function that results from playing the optimal strategy $\hat{\sigma}_i$, the best response to other players' actions $\hat{\sigma}_{-\mathbf{i}}$. Given our assumption of Markov perfect equilibria, the observed data is the best response of each agent to the observed states and expectations of the future. In order to estimate θ we compute alternative value functions $\hat{V}_i(\mathbf{s}; \sigma'; \theta)$ that result from perturbations to the policy function. We compute the corresponding actions that agents would have taken and simulate a whole set of S stories of length T, with D initial data sets. A deviation is profitable if the value of the discounted stream of payoffs under the perturbated policy is greater than under the optimal policy. We choose θ such that it minimizes the average profitable deviations.

8 Preliminary Results of Structural Econometric Model

In Table 11 we present the results of the policy functions that relate states to actions. Column (1) presents the state variables that affect the probability of a household of having migration to the US. Column (2) presents the results for a similar analysis but for migration within other states of Mexico. The implications of these results are detailed discussed in the reduced-form analysis above. We use the coefficients that are significant at a 10 percent level in our structural model to predict the actions played given the state variables. We embed this procedure in a fixed-point estimation so that we can study the effect of neighbors decisions on each household's decision to engage in migration either to the US or within Mexico.

In Tables 12 and 13 we present the results of the transition densities for the variables at the household, municipality, state, and national levels. This transition densities which describe the behavior of state variables over time. We regress the level of each variable on the lag of other relevant state variables. We use the coefficients that are significant at a 10 percent level to predict the value of next period's state variables, which affect the actions taken of each household in next period as well as the profit functions.

An advantage of our structural model is that the estimated parameters have direct economic interpretation Thus, it is possible to calculate the welfare associated with the observed and simulated data. We calculate the average welfare per household and the average welfare per household-year using the observed data and also using the simulated data.

Another advantage of our structural model is that we can use the estimated parameters to simulate the effects of counterfactual scenarios on decisions and on welfare. Counterfactual scenarios we will simulate include changes in precipitation, changes in land quality, changes in the availability of basic schools, changes in schooling, changes in the wages paid in the local market, and changes in other state variables that affect per-period payoffs. We will simulate the effect of the reallocation of criminal activity from some crossing municipalities to others on the probability of migration. We can simulate the effect of changes in the economic opportunities in Mexico, since theory predicts that an improve in such conditions would reduce the supply of migrants to the United States. We will also simulate changes in patterns of enforcement at the border, particularly, the reallocation of agents.

9 Conclusion

We contribute to the literature on the determinants of migration by examining whether strategic interactions matter for migration decisions. There are several reasons why a household's migration decisions may depend on the migration decisions of its neighbors, including migration networks and information externalities. Using instrumental variables to address the endogeneity of neighbors' decisions, we empirically examine whether strategic interactions in migration decisions actually take place in rural Mexico, whether the interactions depend on the size of the village, and whether there are nonlinearities in the strategic interactions.

Results of our reduced-form model show that there is a significant and positive own-migration strategic effect. In our base case specification, an increase of 0.1 in the fraction of neighbors with migration to the US increases a household's probability of migration to the US by around 5.9 percentage points, while an increase of 0.1 in the fraction of neighbors with migration to other states within Mexico increases a household's probability of migration to other states within Mexico by around 6.3 percentage points.

We study the relationship between the extent of the strategic interactions and village size, and find evidence that the strategic interactions vary by village size, likely because the information externalities vary with village size. For the case of migration to the United States, we find that strategic interactions occur in villages in village size quartiles 2 and 3 (the medium-size villages), while they are not significant at a 5% level in villages of village size quartiles 1 and 4. Thus, strategic interactions appear to be concave in village size, which is consistent with Wahba and Zenou (2005), who show that, conditional on being employed, the probability of finding a job through social networks, relative to other search methods, increases and is concave with the size of the network.

On the other hand, in the case of migration to other states within Mexico, results show that the strategic interactions take place in villages in village size quartile 1 (the smallest villages), and are only significant at a 10% level in village size quartile 3. These results, together with the differences in magnitudes of the estimated coefficients, imply that the strategic motivations behind international and domestic migration are different.

The results of our reduced-form model therefore suggest that strategic interactions among households in a village have an important role in household migration decisions that has been heretofore neglected in the literature.

Preliminary results of our structural econometric model of a dynamic game show that both dynamic behavior and strategic interactions arise in migration decisions.

Thurs, strategic interactions among households in a village have an important role in household migration decisions that has previously been neglected in the literature. Dynamic behavior is an important aspect of household migration decision-making as well.

Reduced-form models and structural econometric models each have their advantages and disadvantages, and it is often a good idea to tackle problems using both approaches.

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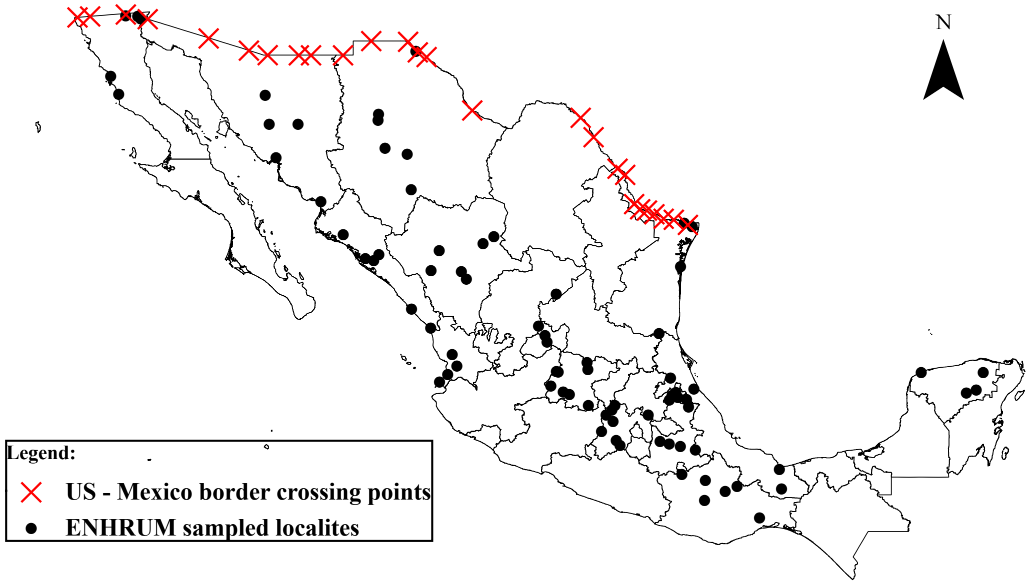

Figure 1: Location of sampled villages in the ENHRUM survey and the border crossing municipalities

Table 1: Summary statistics

Variable	Mean	Std.Dev.	Min	Max	# Obs
Household migration variables					
Household has a migrant to the US (dummy)	0.17	0.38	0	1	25761
Household has a migrant within Mexico (dummy)	0.2	0.4	0	1	25761
Neighbor migration variables					
Fraction of neighbors with migrants to US	0.17	0.21	0	1	25761
Fraction of neighbors with migrants to Mexico	0.2	0.17	0	0.89	25761
Household characteristics					
Number of household members	5.94	3.15	1	24	25761
Number of family members	5.48	2.83	1	17	25761
Number of children in household	2.17	1.86	0	12	25761
Number of children in family	1.82	1.85	0	11	25761
Number of males in household	2.93	1.84	0	17	25761
Number of males in family	2.74	1.72	0	12	25761
First born is a male (dummy)	0.5	0.5	0	1	25761
Household head age (years)	45.15	16.26	3	100	25725
Household head schooling (years)	4.75	3.84	0	23	25725
Household average schooling (years)	6.21	2.97	0	20.5	25554
Household maximum schooling (years)	8.99	3.84	0	23	25761
Household head is the most educated (dummy)	0.26	0.44	0	1	30313
Irrigated area (hectares)	0.22	3.38	0	426	21257
Plots' slope (1 = flat)	3.42	0.81	1	4	23836
Plots' quality (1 = good)	3.33	0.92	1	4	23811

Table 1: (continued)

Variable	Mean	Std.Dev.	Min	Max	# Obs
Municipality characteristics					
Number of basic schools	284.97	332.44	0	1762	22763
Number of indigenous schools	6.08	12.78	0	72	23313
Number of schools	238.87	301.17	0	1603	13107
Number of classrooms	1399.33	2236.64	0	12707	13322
Number of public libraries	20.09	34.74	0	327	11523
Number of labs	47.84	82.72	0	482	12987
Number of workshops	42.78	69.6	0	424	12987
Number of public libraries	4.92	5.69	0	28	19165
Number of students	42284.31	70057.57	0	372625	22763
Number of vehicles	44556.99	88624.85	0	502836	24220
Number of cars	29396.74	64269.9	0	383512	24220
Number of buses	371.1	841.11	0	5355	24220
Number of trucks	14203.43	23759.15	0	113819	24220
Number of motos	585.72	1685.87	0	18650	24220
Instruments					
Neighbors' average number of males in household	2.93	0.7	1.32	7.2	25761
Fraction of neighbors whose first born is male	0.5	0.13	0	1	25761
Neighbors' average household head schooling (years)	4.75	1.52	0.75	11.67	25725
Fraction of neighbors w/ household head the most educated	0.26	0.15	0	0.73	30313
Neighbors' average household average schooling (years)	6.07	1.61	1.81	12.17	25243
Neighbors' average irrigated area interacted with rain	77.44	281.02	0	4307.88	16735
State-level variables					
Employment in primary sector (% working population)	20.3	10.37	4.3	52	20635
Employment in secondary sector (% working population)	26.58	6.03	15.1	40.7	20635
Employment in tertiaty sector (% working population)	52.78	7.14	31.6	68.1	20635

Table 1: (continued)

Variable	Mean	Std.Dev.	Min	Max	# Obs
National variables					
Hourly wage in primary sector	29.48	5.3	21.91	39.45	30313
Hourly wage in secondary sector	31.77	3.4	24.9	35.98	30313
Hourly wage in tertiary sector	37.81	4.21	30.27	43.54	30313
Average hourly wage	35.97	3.34	29.61	41.44	33873
Border crossing variables					
Distance to the closest border crossing point (km)	847.4	474.1	7.0	2178.3	30352
Number of border crossing points					
... < 1000 km	6.3	5.4	0.0	17.0	30352
... 1000-2000 km	12.4	6.0	0.0	26.0	30352
Average crime rate (murders per 10,000 inhabitants)					
... in crossing municipalities < 1000 km	11.5	8.8	1.9	83.7	12166
... in crossing municipalities 1000-2000 km	12.2	7.4	2.9	52.3	16612
... along border municipalities	14.3	2.5	9.9	18.4	17554
... at the closest crossing point	8.7	6.6	0.0	38.2	17554
... at the second closest crossing point	13.8	26.3	0.0	217.4	17554
... at the third closest crossing point	9.6	19.2	0.0	144.2	17554
Average number of apprehensions					
... in crossing municipalities < 1000 km	139460.2	77498.3	44895.0	616346.0	21018
... in crossing municipalities 1000-2000 km	117863.6	52672.6	9964.9	359035.0	28716
... along border municipalities	148002.3	41312.4	74483.2	235178.7	30352
... at the closest crossing point	135340.4	99736.0	5536.0	616346.0	30352
... at the second closest crossing point	138760.5	99130.0	5536.0	616346.0	30352
... at the third closest crossing point	134691.0	107369.9	5288.0	616346.0	30352

Table 1: (continued)

Variable	Mean	Std.Dev.	Min	Max	# Obs
Average number of deaths					
... in crossing municipalities < 1000 km	48.4	29.8	11.0	219.0	11866
... in crossing municipalities 1000-2000 km	37.8	18.0	7.7	114.7	16444
... along border municipalities	52.1	18.8	20.9	79.4	17424
... at the closest crossing point	49.0	39.0	0.0	251.0	17424
... at the second closest crossing point	49.8	39.3	0.0	251.0	17424
... at the third closest crossing point	48.0	41.1	0.0	251.0	17424
Average number of agents					
... in crossing municipalities < 1000 km	1087.2	547.3	282.0	2806.0	17586
... in crossing municipalities 1000-2000 km	957.5	476.2	219.8	2403.3	24114
... along border municipalities	1055.3	502.0	361.1	2228.0	25504
... at the closest crossing point	1159.1	669.7	128.0	3353.0	25504
... at the second closest crossing point	1152.5	632.7	128.0	3353.0	25504
... at the third closest crossing point	1129.3	683.6	128.0	3353.0	25504

Table 2: Within and between variation of migration decisions

		Mean	Std. Dev.	Min	Max	# Obs
Household has a migrant to the US (dummy)						
	Overall	0.1746	0.3796	0.0000	1.0000	25,761
	Within		0.2254	-0.7778	1.1269	
	Between		0.3095	0.0000	1.0000	
Household has a migrant within Mexico (dummy)						
	Overall	0.2000	0.4000	0.0000	1.0000	25,761
	Within		0.2477	-0.7523	1.1524	
	Between		0.3197	0.0000	1.0000	

Notes: Within variation is the variation in the migration variable across years for a given village. Between variation is the variation in the migration variable across villages for a given year.

Table 3: First-stage regressions

	Dependent variable is fraction of neighbors with migration to/within:							
	(A)		(B)		(C)		(D)	
	US	Mexico	US	Mexico	US	Mexico	US	Mexico
Instruments:								
Neighbors' average number of males in household	0.1223***	0.0694***	0.1319***	0.0865***	0.1161***	0.0861***	0.1272***	0.0714***
	(0.0045)	(0.0062)	(0.0044)	(0.0062)	(0.0044)	(0.0064)	(0.0047)	(0.0064)
Fraction of neighbors whose first born is male	-0.0251	-0.1941***	-0.0429**	-0.2120***	-0.0090	-0.2177***	-0.0312*	-0.1963***
	(0.0167)	(0.0173)	(0.0173)	(0.0171)	(0.0169)	(0.0191)	(0.0162)	(0.0173)
Neighbors' average household head schooling	-0.0218***	0.0014			-0.0306***	0.0041	-0.0215***	0.0000
	(0.0022)	(0.0022)			(0.0025)	(0.0031)	(0.0022)	(0.0022)
Fraction of neighbors w/ household head the most educated			0.0191	0.0995***			0.0795***	0.0400*
			(0.0193)	(0.0202)			(0.0205)	(0.0229)
Neighbors' average household average schooling					0.0261***	-0.0121**		
					(0.0037)	(0.0049)		
Neighbors' average irrigated area interacted with rain	0.0000**	-0.0000***	0.0000*	-0.0000***	0.0000	-0.0000**	0.0000***	-0.0000***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Controls:								
Number of basic schools	0.0000	-0.0001***	-0.0000	-0.0001***	0.0000	-0.0001***	0.0000	-0.0001***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Number of indigenous schools	0.0074***	0.0080***	0.0061***	0.0083***	0.0054***	0.0089***	0.0077***	0.0081***
	(0.0010)	(0.0013)	(0.0010)	(0.0013)	(0.0011)	(0.0014)	(0.0010)	(0.0013)
Number of cars	-0.0000***	-0.0000	-0.0000***	-0.0000	-0.0000***	-0.0000	-0.0000***	-0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Number of buses	-0.0000***	-0.0000***	-0.0000	-0.0000***	-0.0000	-0.0000***	-0.0000***	-0.0000***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Number of males in household	0.0077***	0.0035***	0.0083***	0.0045***	0.0073***	0.0044***	0.0080***	0.0037***
	(0.0006)	(0.0006)	(0.0006)	(0.0006)	(0.0006)	(0.0006)	(0.0006)	(0.0006)
Household head age (years)	0.0001	-0.0001*	0.0000	-0.0002***	0.0000	-0.0001*	0.0001	-0.0002***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
First born is male (dummy)	-0.0032*	-0.0149***	-0.0047**	-0.0161***	-0.0020	-0.0163***	-0.0037*	-0.0151***
	(0.0019)	(0.0019)	(0.0019)	(0.0019)	(0.0019)	(0.0020)	(0.0019)	(0.0019)

Table 3: (continued)

	(A)		(B)		(C)		(D)	
Household head schooling (years)	-0.0004	0.0013***			-0.0009**	0.0014***		
	(0.0003)	(0.0004)			(0.0004)	(0.0004)		
Household head is the most educated (dummy)			0.0052**	0.0090***			0.0038*	0.0062***
			(0.0022)	(0.0023)			(0.0022)	(0.0024)
Household average schooling (years)	0.0002	-0.0022***	0.0009*	-0.0012**	0.0016**	-0.0030***	-0.0003	-0.0012**
	(0.0006)	(0.0007)	(0.0005)	(0.0005)	(0.0006)	(0.0007)	(0.0005)	(0.0006)
Household maximum schooling (years)	-0.0013***	0.0008*	-0.0013***	0.0008*	-0.0012***	0.0008*	-0.0012***	0.0008*
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Lag fraction of household members working in US	-0.0895***	-0.0042	-0.0913***	-0.0077	-0.0875***	-0.0041	-0.0900***	-0.0072
	(0.0101)	(0.0071)	(0.0100)	(0.0070)	(0.0100)	(0.0070)	(0.0101)	(0.0071)
Lag fraction of household members working within Mexico	-0.0057	-0.1026***	-0.0090	-0.1022***	-0.0063	-0.1007***	-0.0051	-0.1035***
	(0.0072)	(0.0079)	(0.0073)	(0.0080)	(0.0073)	(0.0081)	(0.0072)	(0.0079)
Irrigated area interacted with rain	0.0000***	-0.0000	0.0000***	-0.0000	0.0000***	-0.0000	0.0000***	-0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Average hourly wage (pesos)	-0.0189***	-0.0106*	0.0022***	0.0029***	0.0021***	0.0027***	-0.0212***	-0.0119*
	(0.0069)	(0.0061)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0069)	(0.0061)
Average crime rate (murders per 10,000 inhabitants)								
... in crossing municipalities < 1000 km	-0.0004***	-0.0007***	-0.0003***	-0.0006***	-0.0002**	-0.0006***	-0.0004***	-0.0007***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
... along border municipalities	0.0059***	-0.0010	0.0016***	0.0005**	0.0014***	0.0004	0.0067***	-0.0006
	(0.0012)	(0.0010)	(0.0003)	(0.0002)	(0.0003)	(0.0002)	(0.0012)	(0.0010)
Average number of apprehensions								
... in crossing municipalities < 1000 km	0.0000	0.0000***	0.0000	0.0000***	0.0000	0.0000***	0.0000	0.0000***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
... along border municipalities	-0.0000***	-0.0000***	0.0000***	-0.0000***	0.0000***	-0.0000***	-0.0000***	-0.0000***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Year			0.0048***	0.0081***	0.0031***	0.0078***		
			(0.0006)	(0.0006)	(0.0006)	(0.0007)		
Village fixed effects	Y	Y	Y	Y	Y	Y	Y	Y

Table 3: (continued)

	(A)		(B)		(C)		(D)	
Year effects	Y	Y	N	N	N	N	Y	Y
First-stage F-statistic	62.2421	48.9869	36.7310	37.5253	41.1986	35.5245	45.4990	35.9942
Underidentification, Kleibergen p-value	0.0000		0.0000		0.0000		0.0000	
Weak instrument-robust inference, Anderson F p-value	0.0013		0.0012		0.0068		0.0041	
Weak instrument-robust inference, Anderson Chi p-value	0.0012		0.0012		0.0066		0.0039	
Overidentification, J p-value	0.3649		0.1556		0.3366		0.1371	
p-value (Pr>F)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
# observations	6323		6323		6323		6323	

Notes: Standard errors in parentheses. Significance codes: * p<0.1, ** p<0.05, *** p<0.01.

Table 4: Village-year means and standard deviations analysis

	N	Mean (A.1)	S.D.	Min	Max	
	A: Village-year mean					
Number of males in household	1575	2.9742	0.7115	1.3636	6.5	
First born is male (dummy)	1575	0.511	0.1361	0	0.9286	
Household head schooling	1575	4.7973	1.5731	1.2	10.25	
Household head is the most educated (dummy)	1575	0.2504	0.1431	0	0.6957	
Household average schooling (years)	1575	6.1355	1.6512	2.2462	11.5026	
Irrigated area interacted with rain	1223	68.2133	253.0473	0	4068.552	
	B: Village-year S.D.					
	N	Mean (B.1)	S.D.	Min	Max	
Number of males in household	1575	1.6806	0.5033	0.5774	3.5019	
First born is male (dummy)	1575	0.4971	0.034	0	0.5477	
Household head schooling	1575	3.5127	1.0612	0.9003	7.3655	
Household head is the most educated (dummy)	1575	0.404	0.115	0	0.5164	
Household average schooling (years)	1575	2.6435	0.7219	0.6655	5.3905	
Irrigated area interacted with rain	1215	167.892	607.1104	0	7987.343	
	C: Ratio B/A					Ratio B.1/A.1
	N	Mean	S.D.	Min	Max	
Number of males in household	1575	0.5682	0.1278	0.2309	1.0042	0.5651
First born is male (dummy)	1574	1.0501	0.2976	0.2878	2.1082	0.9728
Household head schooling	1575	0.775	0.2417	0.2715	1.7873	0.7322
Household head is the most educated (dummy)	1510	2.0163	0.8737	0.6763	4.6904	1.6134
Household average schooling (years)	1575	0.4515	0.1387	0.0911	1.2056	0.4309
Irrigated area interacted with rain	184	2.9044	0.938	0.9327	4.6904	2.4613

Table 5: Correlations of instruments and own variables

	Correlation of own variable with corresponding instrument
Number of males in household	0.2252
First born is male (dummy)	0.0239
Household head schooling	0.2456
Household head is the most educated (dummy)	0.1831
Household average schooling (years)	0.4167
Irrigated area interacted with rain	0.2388

Table 6: Falsification test of the first-stage analysis

	From the analysis of migration to US:				*From the analysis of migration within Mexico:*			
	Dependent variable is fraction of neighbors with migration to/within:							
	(A)		(B)		(C)		(D)	
	US	Mexico	US	Mexico	US	Mexico	US	Mexico
Instruments:								
Neighbors' average number of males in household	Y	Y	Y	Y	Y	Y	Y	Y
Fraction of neighbors whose first born is male	Y	Y	Y	Y	Y	Y	Y	Y
Neighbors' average household head schooling	Y	Y			Y	Y	Y	Y
Fraction of neighbors w/ household head the most educated			Y	Y			Y	Y
Neighbors' average household average schooling					Y	Y		
Neighbors' average irrigated area interacted with rain	Y	Y	Y	Y	Y	Y	Y	Y
Village fixed effects	Y		Y		Y	Y	Y	Y
Time specification	Year effects		Time trend		Time trend		Year effects	
First-stage F-statistic	5.7233	4.2579	4.4611	4.6438	3.7057	3.7180	4.0263	3.6366
# observations	6323		6323		6323		6323	

Table 7: IV results for migration to the US

	Dependent variable is probability of migration to the U.S.					
	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)
Fraction of neighbors with migration to US	0.5862***	0.6232***	0.4315**	0.5765***	0.7718***	0.6723***
	(0.1687)	(0.1914)	(0.1954)	(0.1682)	(0.2073)	(0.2182)
Fraction of neighbors with migration within Mexico	-0.4766*	-0.5045*	-0.2845	-0.4583**	-0.6784**	-0.5098*
	(0.2644)	(0.2637)	(0.2283)	(0.1926)	(0.3077)	(0.2764)
Number of basic schools	-0.0002	-0.0001	0.0000	-0.0000	-0.0002*	-0.0001
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Number of indigenous schools	0.0090**	0.0089**	0.0011	0.0011	0.0097**	0.0087**
	(0.0042)	(0.0041)	(0.0022)	(0.0022)	(0.0043)	(0.0041)
Number of cars	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Number of buses	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Number of males in household	0.0203***	0.0203***	0.0311***	0.0310***	0.0195***	0.0197***
	(0.0028)	(0.0028)	(0.0020)	(0.0020)	(0.0028)	(0.0028)
Household head age (years)	0.0007**	0.0007**	0.0012***	0.0012***	0.0008***	0.0008***
	(0.0003)	(0.0003)	(0.0002)	(0.0002)	(0.0003)	(0.0003)
First born is male (dummy)	0.0019	0.0020	0.0024	0.0024	0.0016	0.0024
	(0.0074)	(0.0074)	(0.0055)	(0.0055)	(0.0075)	(0.0074)
Household head schooling (years)	-0.0043***	-0.0043***	-0.0033***	-0.0033***		
	(0.0013)	(0.0013)	(0.0010)	(0.0010)		
Household head is the most educated (dummy)					-0.0263***	-0.0263***
					(0.0080)	(0.0079)
Household average schooling (years)	-0.0041	-0.0042	0.0023	0.0022	-0.0074***	-0.0071***
	(0.0026)	(0.0026)	(0.0020)	(0.0020)	(0.0024)	(0.0024)
Household maximum schooling (years)	0.0088***	0.0088***	0.0046***	0.0047***	0.0085***	0.0082***
	(0.0017)	(0.0017)	(0.0013)	(0.0013)	(0.0019)	(0.0019)
Lag fraction of household members working in US	2.0739***	2.0764***	1.8971***	1.9037***	2.0972***	2.0877***
	(0.0802)	(0.0807)	(0.0456)	(0.0454)	(0.0811)	(0.0813)
Lag fraction of household members working within Mexico	0.0826**	0.0799*	0.0432*	0.0311	0.0674	0.0830**
	(0.0420)	(0.0413)	(0.0260)	(0.0249)	(0.0451)	(0.0418)

Table 7: (continued)

	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)
Irrigated area interacted with rain	-0.0000	-0.0000			-0.0000	-0.0000
	(0.0000)	(0.0000)			(0.0000)	(0.0000)
Average hourly wage (pesos)	-0.0070	0.0011	-0.5369**	0.0007	-0.0060	0.0010
	(0.0232)	(0.0015)	(0.2211)	(0.0011)	(0.0238)	(0.0015)
Average crime rate (murders per 10,000 inhabitants)						
... in crossing municipalities < 1000 km	-0.0007*	-0.0007*	0.0002	0.0004	-0.0008*	-0.0007*
	(0.0004)	(0.0004)	(0.0003)	(0.0003)	(0.0004)	(0.0004)
... along border municipalities	0.0010	0.0001	-0.0282**	-0.0000	0.0002	0.0001
	(0.0042)	(0.0010)	(0.0119)	(0.0003)	(0.0043)	(0.0010)
Average number of apprehensions						
... in crossing municipalities < 1000 km	0.0000	0.0000	0.0000	0.0000*	0.0000**	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
... along border municipalities	-0.0000	-0.0000	-0.0000**	0.0000	-0.0000	-0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Year		-0.0003		-0.0021		-0.0011
		(0.0016)		(0.0014)		(0.0017)
Village fixed effects	Y	Y	Y	Y	Y	Y
Year effects	Y	N	Y	N	Y	N
p-value (Pr>F)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
adjusted R-squared	0.3633	0.3601	0.4341	0.4200	0.3411	0.3560
# observations	6323	6323	11871	11871	6323	6323

Notes: Standard errors in parentheses. Significance codes: * p<0.1, ** p<0.05, *** p<0.01.

Table 8: IV results for migration within Mexico

	Dependent variable is probability of migration within Mexico					
	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)
Fraction of neighbors with migration to US	-0.1061	-0.1616	-0.1133	-0.0364	-0.0505	-0.1534
	(0.1525)	(0.1651)	(0.1888)	(0.1653)	(0.1666)	(0.1865)
Fraction of neighbors with migration within Mexico	0.6334**	0.6024**	0.5617***	0.4063**	0.5802**	0.6057**
	(0.2521)	(0.2347)	(0.2163)	(0.1838)	(0.2628)	(0.2480)
Number of basic schools	-0.0001	-0.0001	-0.0000	-0.0000	-0.0001	-0.0001
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Number of indigenous schools	-0.0059	-0.0056	-0.0004	-0.0003	-0.0058	-0.0057
	(0.0044)	(0.0042)	(0.0021)	(0.0021)	(0.0044)	(0.0042)
Number of cars	0.0000	-0.0000	-0.0000	-0.0000	0.0000	-0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Number of buses	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Number of males in household	0.0255***	0.0257***	0.0253***	0.0252***	0.0247***	0.0249***
	(0.0027)	(0.0027)	(0.0018)	(0.0018)	(0.0027)	(0.0027)
Household head age (years)	0.0018***	0.0018***	0.0017***	0.0017***	0.0019***	0.0019***
	(0.0003)	(0.0003)	(0.0002)	(0.0002)	(0.0003)	(0.0003)
First born is male (dummy)	-0.0137*	-0.0139**	0.0035	0.0032	-0.0134*	-0.0134*
	(0.0071)	(0.0071)	(0.0053)	(0.0053)	(0.0071)	(0.0071)
Household head schooling (years)	-0.0047***	-0.0046***	-0.0025**	-0.0025**		
	(0.0013)	(0.0013)	(0.0011)	(0.0011)		
Household head is the most educated (dummy)					-0.0355***	-0.0351***
					(0.0075)	(0.0075)
Household average schooling (years)	0.0028	0.0028	0.0008	0.0007	0.0001	0.0003
	(0.0027)	(0.0027)	(0.0020)	(0.0020)	(0.0022)	(0.0022)
Household maximum schooling (years)	0.0031*	0.0030	0.0065***	0.0065***	0.0020	0.0018
	(0.0018)	(0.0018)	(0.0013)	(0.0013)	(0.0019)	(0.0019)
Lag fraction of household members working in US	-0.0015	-0.0084	-0.0169	-0.0134	0.0104	-0.0008
	(0.0303)	(0.0307)	(0.0216)	(0.0206)	(0.0307)	(0.0315)
Lag fraction of household members working within Mexico	2.2062***	2.2010***	2.0798***	2.0678***	2.2039***	2.2037***
	(0.0863)	(0.0858)	(0.0525)	(0.0516)	(0.0857)	(0.0855)

Table 8: (continued)

	(1a)	(1b)	(2a)	(2b)	(3a)	(3b)
Irrigated area interacted with rain	0.0000	0.0000			0.0000	0.0000
	(0.0000)	(0.0000)			(0.0000)	(0.0000)
Average hourly wage (pesos)	0.0162	0.0009	-0.3906	0.0005	0.0171	0.0008
	(0.0224)	(0.0015)	(0.2581)	(0.0010)	(0.0222)	(0.0015)
Average crime rate (murders per 10,000 inhabitants)						
... in crossing municipalities < 1000 km	0.0000	-0.0002	-0.0002	0.0000	0.0000	-0.0002
	(0.0004)	(0.0004)	(0.0003)	(0.0003)	(0.0004)	(0.0004)
... along border municipalities	-0.0017	0.0000	-0.0208	-0.0001	-0.0020	-0.0000
	(0.0039)	(0.0010)	(0.0140)	(0.0003)	(0.0039)	(0.0010)
Average number of apprehensions						
... in crossing municipalities < 1000 km	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
... along border municipalities	0.0000	0.0000	-0.0000	0.0000	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Year		-0.0021		-0.0028*		-0.0026
		(0.0017)		(0.0014)		(0.0017)
Village fixed effects	Y	Y	Y	Y	Y	Y
Year effects	Y	N	Y	N	Y	N
p-value (Pr>F)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
adjusted R-squared	0.4579	0.4599	0.4667	0.4774	0.4626	0.4603
# observations	6323	6323	11871	11871	6323	6323

Notes: Standard errors in parentheses. Significance codes: * p<0.1, ** p<0.05, *** p<0.01.

Table 9: Robustness of IV results of migration to the US

	Dependent variable is probability of migration to the U.S.					
	(4)	(5)	(6)	(7)	(8)	(9)
Fraction of neighbors with migration to US	0.6403**	0.7189***	0.6327**	0.6321**	0.6376**	0.5082***
	(0.2519)	(0.2713)	(0.2483)	(0.2532)	(0.2562)	(0.1611)
Fraction of neighbors with migration within Mexico	-0.3849	-0.5966*	-0.3828	-0.3751	-0.5217*	-0.3546
	(0.2881)	(0.3153)	(0.2890)	(0.2857)	(0.3170)	(0.2505)
Number of basic schools	-0.0003	-0.0004**	-0.0003	-0.0003	-0.0003*	
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	
Number of indigenous schools	0.0073	0.0082	0.0090*	0.0073	0.0083	
	(0.0054)	(0.0060)	(0.0054)	(0.0054)	(0.0051)	
Number of basic schools (normalized)						-0.0001
						(0.0002)
Number of indigenous schools (normalized)						0.0071**
						(0.0036)
Number of cars	0.0000	0.0000	0.0000	0.0000	0.0000	
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	
Number of buses	0.0000	-0.0000	-0.0000	0.0000	-0.0000	
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	
Number of cars (normalized)						0.0000
						(0.0000)
Number of buses (normalized)						0.0000
						(0.0001)
Number of males in household	0.0208***	0.0261***	0.0207***	0.0207***	0.0261***	0.0204***
	(0.0033)	(0.0029)	(0.0033)	(0.0033)	(0.0029)	(0.0028)
Household head age (years)	0.0005	0.0009***	0.0005	0.0005	0.0009***	0.0007**
	(0.0004)	(0.0003)	(0.0004)	(0.0004)	(0.0003)	(0.0003)
First born is male (dummy)	0.0030	-0.0095	0.0034	0.0031	-0.0093	0.0022
	(0.0090)	(0.0076)	(0.0089)	(0.0089)	(0.0076)	(0.0074)
Household head schooling (years)	-0.0035**	-0.0034**	-0.0035**	-0.0035**	-0.0033**	-0.0044***
	(0.0015)	(0.0014)	(0.0015)	(0.0015)	(0.0014)	(0.0013)

Table 9: (continued)

	(4)	(5)	(6)	(7)	(8)	(9)
Household average schooling (years)	-0.0064**	-0.0029	-0.0064**	-0.0064**	-0.0030	-0.0038
	(0.0033)	(0.0029)	(0.0033)	(0.0033)	(0.0029)	(0.0025)
Household maximum schooling (years)	0.0094***	0.0074***	0.0095***	0.0094***	0.0074***	0.0086***
	(0.0021)	(0.0019)	(0.0021)	(0.0021)	(0.0018)	(0.0017)
Lag fraction of household members working in US	2.1919***	2.1141***	2.1899***	2.1910***	2.1058***	2.0668***
	(0.0934)	(0.0784)	(0.0932)	(0.0934)	(0.0778)	(0.0797)
Lag fraction of household members working within Mexico	0.1163**	0.0151	0.1172**	0.1172**	0.0243	0.0965**
	(0.0502)	(0.0504)	(0.0498)	(0.0499)	(0.0505)	(0.0400)
Irrigated area interacted with rain	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000	-0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Employment in primary sector (% working population)	0.0004					
	(0.0026)					
Employment in tertiary sector (% working population)		0.0004	-0.0007	-0.0003	0.0011	
		(0.0022)	(0.0024)	(0.0025)	(0.0022)	
Average hourly wage (pesos)		-0.0425	-0.0270	-0.0009	-0.0344	-0.0010
		(0.0431)	(0.0462)	(0.0185)	(0.0418)	(0.0432)
Hourly wage in primary sector (pesos)	0.0056					
	(0.0111)					
Hourly wage in secondary sector (pesos)	0.0226					
	(0.0461)					
Hourly wage in tertiary sector (pesos)	-0.0191					
	(0.0474)					
Average crime rate (murders per 10,000 inhabitants)						
... in crossing municipalities $<$ 1000 km	-0.0005		-0.0006	-0.0005		-0.0006
	(0.0006)		(0.0005)	(0.0006)		(0.0004)
... in crossing municipalities 1000-2000 km	0.0005			0.0004		
	(0.0009)			(0.0009)		
... along border municipalities				0.0001		

Table 9: (continued)

	(4)	(5)	(6)	(7)	(8)	(9)
				(0.0024)		
... at the closest crossing point		-0.0003				
		(0.0009)				
... at the second closest crossing point		-0.0002*				
		(0.0001)				
... at the third closest crossing point		-0.0002				
		(0.0002)				
Average number of apprehensions						
... in crossing municipalities < 1000 km	-0.0000		-0.0000	-0.0000		
	(0.0000)		(0.0000)	(0.0000)		
... in crossing municipalities 1000-2000 km	-0.0000			0.0000		
	(0.0000)			(0.0000)		
... along border municipalities				-0.0000		
				(0.0000)		
... at the closest crossing point		0.0000				
		(0.0000)				
... at the second closest crossing point		0.0000				
		(0.0000)				
... at the third closest crossing point		-0.0000				
		(0.0000)				
... in crossing municipalities < 1000 km (normalized)						0.0000
						(0.0000)
Average number of deaths						
... in crossing municipalities < 1000 km	-0.0000		-0.0001	-0.0000		
	(0.0003)		(0.0003)	(0.0003)		
... in crossing municipalities 1000-2000 km	0.0002			0.0002		
	(0.0006)			(0.0006)		

Table 9: (continued)

	(4)	(5)	(6)	(7)	(8)	(9)
... along border municipalities				0.0003		
				(0.0013)		
... at the closest crossing point		-0.0006				
		(0.0004)				
... at the second closest crossing point		-0.0005				
		(0.0005)				
... at the third closest crossing point		0.0010*				
		(0.0005)				
Average number of agents						
... in crossing municipalities < 1000 km	-0.0000		0.0000	-0.0000		
	(0.0001)		(0.0001)	(0.0001)		
... in crossing municipalities 1000-2000 km	-0.0001			-0.0001		
	(0.0001)			(0.0001)		
... along border municipalities				0.0001		
				(0.0002)		
... at the closest crossing point		0.0000				
		(0.0001)				
... at the second closest crossing point		-0.0000				
		(0.0001)				
... at the third closest crossing point		0.0001				
		(0.0001)				
Village fixed effects	Y	Y	Y	Y	Y	Y
Year effects	Y	Y	Y	Y	Y	Y
p-value (Pr>F)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
adjusted R-squared	0.3517	0.3469	0.3525	0.3526	0.3562	0.3719
# observations	4487	6234	4487	4487	6234	6323

Table 9: (continued)

	(4)	(5)	(6)	(7)	(8)	(9)

Notes: Standard errors in parentheses. Significance codes: * p<0.1, ** p<0.05, *** p<0.01.

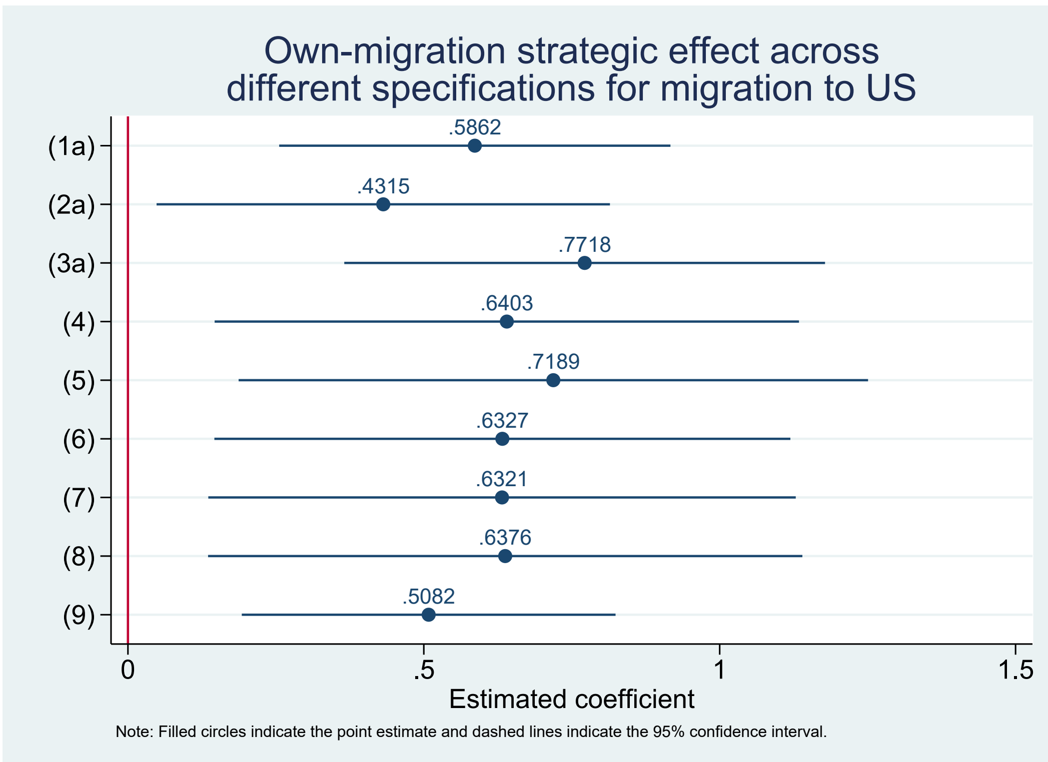

Figure 2: Summary of strategic interaction results for migration to US from specifications 1a-3a (Table 7) and from 4-9 (Table 9).

Table 10: Robustness of IV results of migration within Mexico

	Dependent variable is probability of migration within Mexico					
	(4)	(5)	(6)	(7)	(8)	(9)
Fraction of neighbors with migration to US	-0.2896	-0.4968**	-0.2878	-0.2890	-0.4569*	-0.0656
	(0.2496)	(0.2530)	(0.2461)	(0.2500)	(0.2348)	(0.1469)
Fraction of neighbors with migration within Mexico	0.7183**	0.8893***	0.7292**	0.7207**	0.8469***	0.5470**
	(0.2887)	(0.3004)	(0.2868)	(0.2852)	(0.2998)	(0.2375)
Number of basic schools	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001	
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	
Number of indigenous schools	0.0018	-0.0029	-0.0000	0.0014	-0.0029	
	(0.0060)	(0.0074)	(0.0063)	(0.0061)	(0.0061)	
Number of basic schools (normalized)						-0.0003
						(0.0002)
Number of indigenous schools (normalized)						0.0028
						(0.0046)
Number of cars	0.0000	0.0000	0.0000	0.0000	0.0000	
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	
Number of buses	0.0000	0.0000	0.0000	0.0000	0.0000	
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	
Number of cars(normalized)						-0.0000
						(0.0000)
Number of buses(normalized)						-0.0000
						(0.0000)
Number of males in household	0.0259***	0.0289***	0.0260***	0.0259***	0.0289***	0.0255***
	(0.0034)	(0.0029)	(0.0034)	(0.0034)	(0.0028)	(0.0027)
Household head age (years)	0.0019***	0.0021***	0.0019***	0.0019***	0.0021***	0.0018***
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0003)
First born is male (dummy)	-0.0067	-0.0143*	-0.0069	-0.0068	-0.0147*	-0.0140**
	(0.0091)	(0.0083)	(0.0092)	(0.0091)	(0.0083)	(0.0071)
Household head schooling (years)	-0.0050***	-0.0046***	-0.0051***	-0.0050***	-0.0047***	-0.0047***
	(0.0016)	(0.0016)	(0.0016)	(0.0016)	(0.0015)	(0.0013)

Table 10: (continued)

	(4)	(5)	(6)	(7)	(8)	(9)
Household average schooling (years)	0.0038	-0.0011	0.0039	0.0038	-0.0009	0.0026
	(0.0035)	(0.0033)	(0.0035)	(0.0035)	(0.0032)	(0.0027)
Household maximum schooling (years)	0.0042*	0.0075***	0.0041*	0.0042*	0.0074***	0.0031*
	(0.0023)	(0.0022)	(0.0023)	(0.0023)	(0.0022)	(0.0018)
Lag fraction of household members working in US	-0.0636	-0.0800*	-0.0627	-0.0634	-0.0763*	0.0017
	(0.0467)	(0.0422)	(0.0464)	(0.0468)	(0.0412)	(0.0301)
Lag fraction of household members working within Mexico	2.1941***	2.2208***	2.1945***	2.1947***	2.2154***	2.1960***
	(0.1100)	(0.0867)	(0.1097)	(0.1099)	(0.0867)	(0.0856)
Irrigated area interacted with rain	0.0000	-0.0000	0.0000	0.0000	-0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Employment in primary sector (% working population)	-0.0016					
	(0.0027)					
Employment in tertiary sector (% working population)		0.0005	0.0007	0.0001	0.0002	
		(0.0020)	(0.0022)	(0.0023)	(0.0021)	
Average hourly wage (pesos)		-0.0235	-0.0399	0.0089	-0.0360	-0.0305
		(0.0436)	(0.0460)	(0.0184)	(0.0447)	(0.0392)
Hourly wage in primary sector (pesos)	-0.0111					
	(0.0121)					
Hourly wage in secondary sector (pesos)	-0.0507					
	(0.0523)					
Hourly wage in tertiary sector (pesos)	0.0456					
	(0.0523)					
Average crime rate (murders per 10,000 inhabitants)						
... in crossing municipalities < 1000 km	0.0002		0.0001	0.0002		0.0000
	(0.0006)		(0.0005)	(0.0006)		(0.0004)
... in crossing municipalities 1000-2000 km	0.0002			0.0002		
	(0.0010)			(0.0010)		
... along border municipalities				-0.0014		

Table 10: (continued)

	(4)	(5)	(6)	(7)	(8)	(9)
				(0.0026)		
... at the closest crossing point		-0.0006				
		(0.0009)				
... at the second closest crossing point		0.0000				
		(0.0001)				
... at the third closest crossing point		0.0003				
		(0.0002)				
Average number of apprehensions						
... in crossing municipalities < 1000 km	0.0000		-0.0000	0.0000		
	(0.0000)		(0.0000)	(0.0000)		
... in crossing municipalities 1000-2000 km	0.0000			0.0000		
	(0.0000)			(0.0000)		
... along border municipalities				0.0000		
				(0.0000)		
... at the closest crossing point		-0.0000003*				
		(0.0000002)				
... at the second closest crossing point		0.0000				
		(0.0000)				
... at the third closest crossing point		-0.0000				
		(0.0000)				
... in crossing municipalities < 1000 km (normalized)						0.0000
						(0.0000)
Average number of deaths						
... in crossing municipalities < 1000 km	-0.0003		-0.0002	-0.0003		
	(0.0004)		(0.0004)	(0.0004)		
... in crossing municipalities 1000-2000 km	-0.0004			-0.0005		
	(0.0007)			(0.0007)		

Table 10: (continued)

	(4)	(5)	(6)	(7)	(8)	(9)
... along border municipalities				0.0005		
				(0.0014)		
... at the closest crossing point		0.0009**				
		(0.0004)				
... at the second closest crossing point		-0.0003				
		(0.0004)				
... at the third closest crossing point		-0.0005				
		(0.0005)				
Average number of agents						
... in crossing municipalities < 1000 km	0.0000		-0.0000	0.0000		
	(0.0001)		(0.0001)	(0.0001)		
... in crossing municipalities 1000-2000 km	0.0001			0.0001		
	(0.0001)			(0.0001)		
... along border municipalities				-0.0002		
				(0.0002)		
... at the closest crossing point		-0.0000				
		(0.0001)				
... at the second closest crossing point		0.0000				
		(0.0001)				
... at the third closest crossing point		-0.0000				
		(0.0001)				
Village fixed effects	Y	Y	Y	Y	Y	Y
Year effects	Y	Y	Y	Y	Y	Y
p-value (Pr>F)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
adjusted R-squared	0.4218	0.4158	0.4208	0.4216	0.4205	0.4642
# observations	4487	6234	4487	4487	6234	6323

Table 10: (continued)

	(4)	(5)	(6)	(7)	(8)	(9)

Notes: Standard errors in parentheses. Significance codes: * p<0.1, ** p<0.05, *** p<0.01.

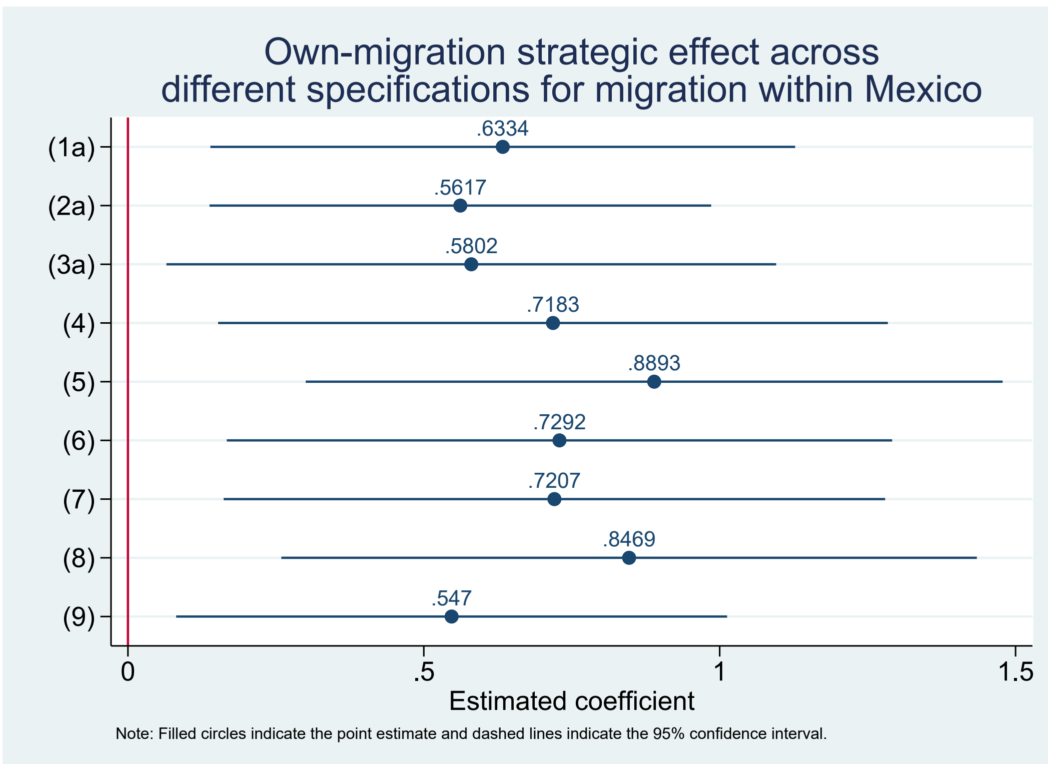

Figure 3: Summary of strategic interaction results for migration within Mexico from specifications 1a-3a (Table 8) and from 4-9 (Table 10).

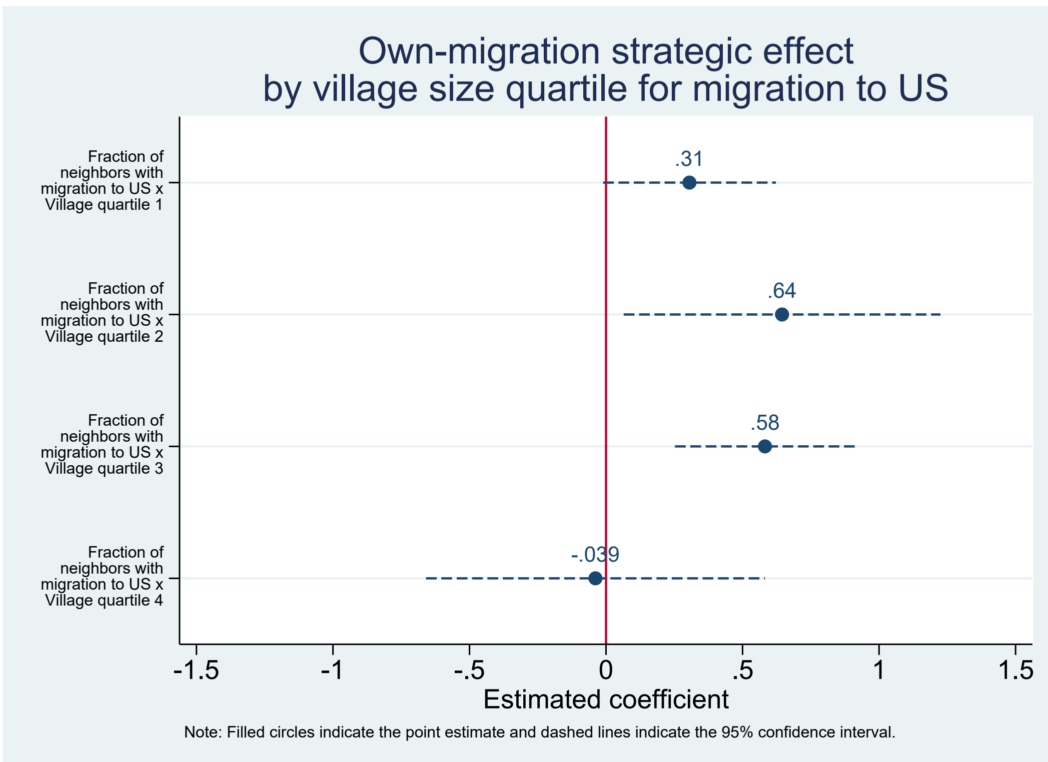

Figure 4: Strategic interactions in migration to US by village size

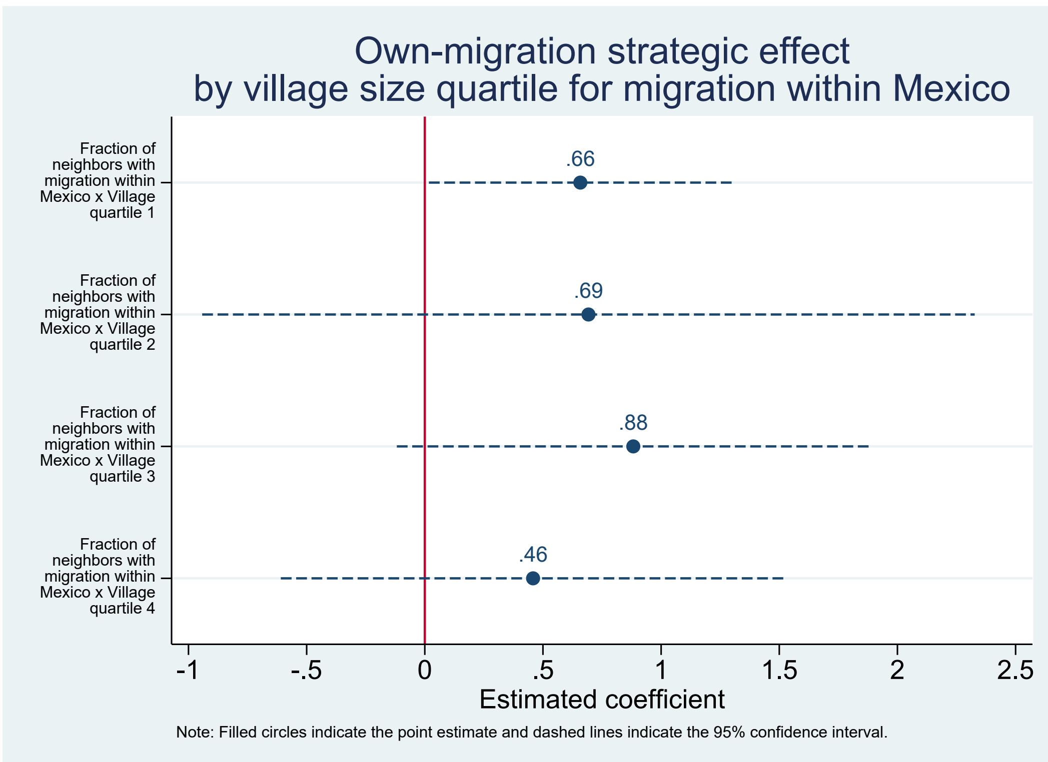

Figure 5: Strategic interactions in migration within Mexico by village size.

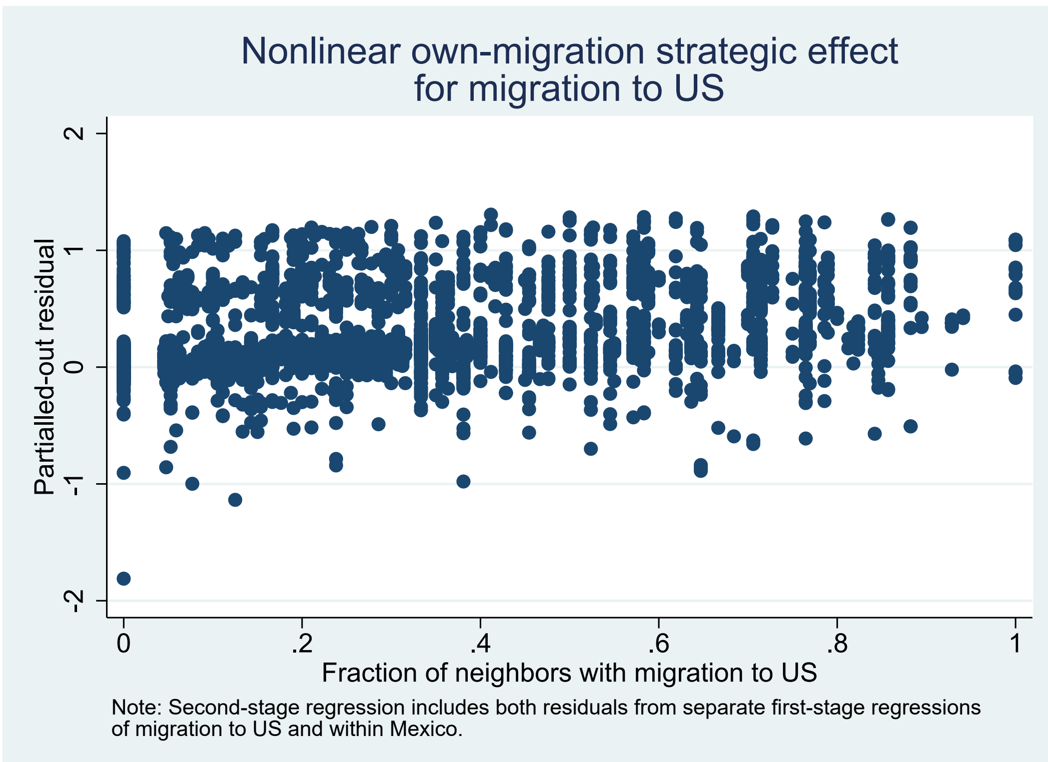

Figure 6: Non-linearities in the strategic interactions for migration to US.

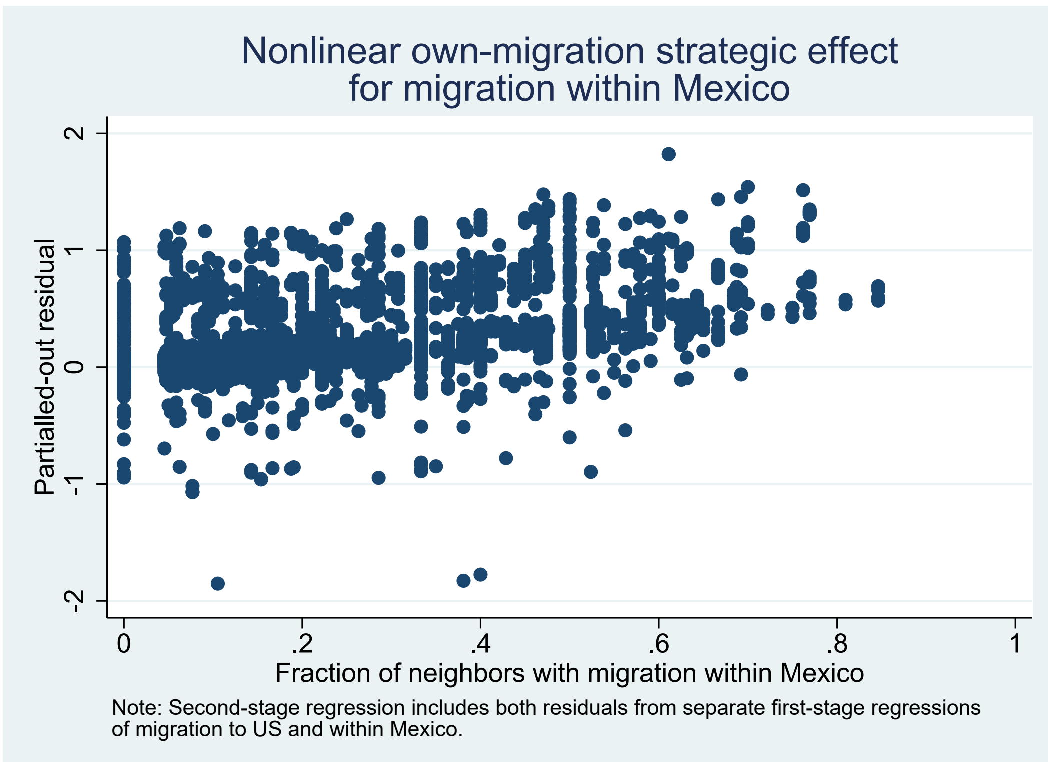

Figure 7: Non-linearities in the strategic interactions for migration within Mexico.

Table 11: Policy functions

	Dependent variable is probability of migration	
	to the US	*within Mexico*
	(1)	(2)
Fraction of neighbors with migration to US	0.6232***	-0.1616
	(0.1907)	(0.1645)
Fraction of neighbors with migration within Mexico	-0.5045*	0.6024***
	(0.2627)	(0.2338)
Number of basic schools	-0.0001	-0.0001
	(0.0001)	(0.0001)
Number of indigenous schools	0.0089**	-0.0056
	(0.0041)	(0.0042)
Number of cars	0.0000	-0.0000
	(0.0000)	(0.0000)
Number of buses	-0.0000	0.0000
	(0.0000)	(0.0000)
Number of males in household	0.0203***	0.0257***
	(0.0028)	(0.0027)
Household head age (years)	0.0007**	0.0018***
	(0.0003)	(0.0003)
First born is male (dummy)	0.0020	-0.0139**
	(0.0074)	(0.0071)
Household head schooling (years)	-0.0043***	-0.0046***
	(0.0013)	(0.0013)
Household average schooling (years)	-0.0042	0.0028
	(0.0026)	(0.0027)
Household maximum schooling (years)	0.0088***	0.0030
	(0.0017)	(0.0018)
Lag fraction of household members working in US	2.0764***	-0.0084
	(0.0805)	(0.0305)
Lag fraction of household members working within Mexico	0.0799*	2.2010***
	(0.0412)	(0.0855)
Irrigated area interacted with rain	-0.0000	0.0000
	(0.0000)	(0.0000)
Average crime rate (murders per 10,000 inhabitants)		
... in crossing municipalities < 1000 km	-0.0007*	-0.0002
	(0.0004)	(0.0004)
... along border municipalities	0.0001	0.0000
	(0.0010)	(0.0010)
Average number of apprehensions		
... in crossing municipalities < 1000 km	0.0000*	0.0000
	(0.0000)	(0.0000)
... along border municipalities	-0.0000	0.0000
	(0.0000)	(0.0000)

Table 11: (continued)

	(1)	(2)
Average hourly wage (pesos)	0.0011	0.0009
	(0.0015)	(0.0015)
Year	-0.0003	-0.0021
	(0.0016)	(0.0016)
Village fixed effects	Y	Y
p-value (Pr->F)	0	0
adjusted R-squared	0.644	0.618
# observations	6323	6323

Notes: Standard errors in parentheses. Significance codes: * p<0.05, ** p<0.01, *** p<0.001.

Table 12: Transition densities at the household level

Independent variables are the lag of:	*Dependent variables are:* Number of males in household (1)	Number of males in family (2)	Household size (3)	First born is (dummy) (4)	Lag of fraction of household member with migration to US (5)	Lag of fraction of household members with migration within Mexico (6)	Household head schooling (years) (7)	Household average schooling (years) (8)	Household maximum schooling (years) (9)	Household's land slope interacted with rain (10)	Household's land quality interacted with rain (11)	Household's irrigated area interacted with rain (12)
Number of males in household	X	X	X	X	X	X	X	X	X	X	X	X
Number of males in family	X	X	X	X	X	X	X	X	X	X	X	X
First born is male (dummy)	X	X	X	X	X	X	X	X	X	X	X	X
Household head age (years)	X	X	X	X	X	X	X	X	X	X	X	X
Household size (members)	X	X	X	X	X	X	X	X	X	X	X	X
Household head schooling (years)	X	X	X	X	X	X	X	X	X	X	X	X
Household average schooling (years)	X	X	X	X	X	X	X	X	X	X	X	X
Household maximum schooling (years)	X	X	X	X	X	X	X	X	X	X	X	X
Lag of fraction of household members working in US	X	X	X	X	X	X	X	X	X			
Lag of fraction of household members members working within Mexico	X	X	X	X	X	X	X	X	X			
Fraction of households with migration to US	X	X	X	X	X	X	X	X	X	X	X	X
Fraction of households with migration within Mexico	X	X	X	X	X	X	X	X	X	X	X	X
Own household migration to US (dummy)	X	X	X	X	X	X	X	X	X	X	X	X
Own household migration within Mexico (dummy)	X	X	X	X	X	X	X	X	X	X	X	X
Number of basic schools							X	X	X			
Number of indigenous schools							X	X	X			

Table 12: (continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Household's land slope interacted with rain							X	X	X	X	X	X
Household's land quality interacted with rain							X	X	X	X	X	X
Household's irrigated area interacted with rain							X	X	X	X	X	X
Constant	X	X	X	X	X	X	X	X	X	X	X	X

Table 13: Transition densities at the village, municipality, state, and national level

Independent variables are the lag of:	*Dependent variables are:* Avg. crime rate (a), (c) (13)	Avg. numer of apprehensions (c) (14)	Avg. number of agents (c) (15)	Number of basic schools (16)	Number of indigenous schools (17)	Number of students in basic system (18)	Employment in primary sector (b) (19)	Employment in secondary sector (b) (20)	Employment in tertiary sector (b) (21)	Avg. hourly wage in primary sector (pesos) (22)	Avg. hourly wage in secondary sector (pesos) (23)	Avg. hourly wage in tertiary sector (pesos) (24)
Number of basic schools				X	X	X						
Number of indigenous schools				X	X	X						
Number of students in basic system				X	X	X						
Employment in primary sector (b)				X	X	X	X	X	X			
Employment in secondary sector (b)				X	X	X	X	X	X			
Employment in tertiary sector (b)				X	X	X	X	X	X			
Avg. hourly wage in primary sector (pesos)	X	X	X				X	X	X	X	X	X
Avg. hourly wage in secondary sector (pesos)							X	X	X	X	X	X
Avg. hourly wage in tertiary sector (pesos)							X	X	X	X	X	X
Avg. crime rate (a) (c)	X	X	X									
Avg. number of apprehensions (a)	X	X	X									
Avg. number of agents (a)	X	X	X									
Constant	X	X	X	X	X	X	X	X	X	X	X	X

Notes: (a) in crossing municipalities < 1,000 kilometers; (b) % of working population; (c) murders per 10,000 inhabitants.

Appendix A

Table A.1: IV results of migration to the US by village size

	Dependent variable is probability of migration to the U.S.			
	(10a)	(10b)	(11a)	(11b)
Fraction of neighbors with migration to US x Village quartile 1	0.3057*	0.2949*	0.3083*	0.2971*
	(0.1614)	(0.1629)	(0.1617)	(0.1631)
Fraction of neighbors with migration to US x Village quartile 2	0.6448**	0.6671**	0.6646**	0.6797**
	(0.2959)	(0.2874)	(0.2952)	(0.2871)
Fraction of neighbors with migration to US x Village quartile 3	0.5822***	0.5714***	0.5702***	0.5578***
	(0.1683)	(0.1671)	(0.1668)	(0.1654)
Fraction of neighbors with migration to US x Village quartile 4	-0.0387	-0.0610	-0.0315	-0.0560
	(0.3167)	(0.3052)	(0.3168)	(0.3052)
Fraction of neighbors with migration within Mexico x Village quartile 1	-0.1657	-0.1352	-0.1466	-0.1273
	(0.2202)	(0.1983)	(0.2198)	(0.1985)
Fraction of neighbors with migration within Mexico x Village quartile 2	-0.3936	-0.4268	-0.4064	-0.4382
	(0.3704)	(0.3693)	(0.3696)	(0.3686)
Fraction of neighbors with migration within Mexico x Village quartile 3	-0.7298**	-0.7153**	-0.6937**	-0.6786*
	(0.3543)	(0.3535)	(0.3504)	(0.3497)
Fraction of neighbors with migration within Mexico x Village quartile 4	-0.0569	-0.0387	-0.0561	-0.0419
	(0.2723)	(0.2598)	(0.2721)	(0.2599)
Village population	0.0000	0.0000	0.0000	0.0000
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Number of basic schools	-0.0002*	-0.0002*	-0.0002*	-0.0002*
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Number of indigenous schools	0.0065	0.0061	0.0067	0.0063
	(0.0052)	(0.0050)	(0.0052)	(0.0050)
Number of cars	0.0000	0.0000	0.0000	0.0000*
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Number of buses	-0.0000	-0.0000	-0.0000	-0.0000

Table A.1: (continued)

	(10a)	(10b)	(11a)	(11b)
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Number of males in household	0.0234***	0.0234***	0.0234***	0.0234***
	(0.0028)	(0.0028)	(0.0028)	(0.0028)
Household head age (years)	0.0004	0.0004	0.0004	0.0004
	(0.0003)	(0.0003)	(0.0003)	(0.0003)
First born is male (dummy)	-0.0027	-0.0026	-0.0024	-0.0024
	(0.0075)	(0.0075)	(0.0075)	(0.0075)
Household head schooling (years)	-0.0053***	-0.0053***	-0.0052***	-0.0052***
	(0.0013)	(0.0013)	(0.0013)	(0.0013)
Household average schooling (years)	-0.0012	-0.0011	-0.0010	-0.0010
	(0.0025)	(0.0024)	(0.0025)	(0.0024)
Household maximum schooling (years)	0.0073***	0.0073***	0.0071***	0.0071***
	(0.0017)	(0.0017)	(0.0017)	(0.0017)
Lag fraction of household members working in US	2.0478***	2.0461***	2.0506***	2.0486***
	(0.0787)	(0.0785)	(0.0786)	(0.0784)
Lag fraction of household members working within Mexico	0.1011***	0.1014***	0.1013***	0.1013***
	(0.0357)	(0.0354)	(0.0356)	(0.0353)
Irrigated area interacted with rain	-0.0000	-0.0000		
	(0.0000)	(0.0000)		
Average hourly wage (pesos)	-0.0192	0.0003	-0.0196	0.0004
	(0.0236)	(0.0015)	(0.0236)	(0.0015)
Average crime rate (murders per 10,000 inhabitants)				
... in crossing municipalities < 1000 km	-0.0007*	-0.0006	-0.0007*	-0.0006
	(0.0004)	(0.0004)	(0.0004)	(0.0004)
... along border municipalities	0.0026	0.0005	0.0028	0.0005
	(0.0041)	(0.0010)	(0.0041)	(0.0010)
Average number of apprehensions				

Table A.1: (continued)

	(10a)	(10b)	(11a)	(11b)
... in crossing municipalities < 1000 km	0.0000	0.0000	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
... along border municipalities	-0.0000	-0.0000	-0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Year		0.0005		0.0003
		(0.0016)		(0.0016)
Village fixed effects	Y	Y	Y	Y
Year effects	Y	N	Y	N
p-value (Pr>F)	0.0000	0.0000	0.0000	0.0000
adjusted R-squared	0.3839	0.3848	0.3839	0.3849
# observations	6062	6062	6062	6062

Notes: Standard errors in parentheses. Significance codes: * p<0.1, ** p<0.05, *** p<0.01.

Table A.2: IV results of migration within Mexico by village size

	Dependent variable is probability of migration within Mexico			
	(10a)	(10b)	(11a)	(11b)
Fraction of neighbors with migration to US x Village quartile 1	0.1222	0.1318	-0.1949	-0.1602
	(0.2386)	(0.2454)	(0.3879)	(0.4369)
Fraction of neighbors with migration to US x Village quartile 2	-0.5809	-0.5903	-0.3316	-0.5062
	(0.6560)	(0.6282)	(0.3996)	(0.4279)
Fraction of neighbors with migration to US x Village quartile 3	-0.0236	-0.0350	-0.6388	-0.8024
	(0.1889)	(0.1909)	(0.4465)	(0.4980)
Fraction of neighbors with migration to US x Village quartile 4	-0.1548	-0.1426	-0.0912	0.0112
	(0.5123)	(0.5085)	(0.4350)	(0.3985)
Fraction of neighbors with migration within Mexico x Village quartile 1	0.6582**	0.5719**	0.2880	0.2240
	(0.3270)	(0.2907)	(0.2393)	(0.2394)
Fraction of neighbors with migration within Mexico x Village quartile 2	0.6925	0.6442	0.6339	0.8942
	(0.8340)	(0.8108)	(0.7217)	(0.7778)
Fraction of neighbors with migration within Mexico x Village quartile 3	0.8822*	0.8817*	2.2146*	2.6170**
	(0.5105)	(0.5091)	(1.1448)	(1.2587)
Fraction of neighbors with migration within Mexico x Village quartile 4	0.4581	0.4236	0.2670	0.1693
	(0.5447)	(0.5457)	(0.2207)	(0.2053)
Village population	0.0000	0.0000	0.0001	0.0001
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Number of basic schools	-0.0001	-0.0001	-0.0001	-0.0001
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Number of indigenous schools	-0.0032	-0.0035	0.0016	0.0025
	(0.0078)	(0.0075)	(0.0030)	(0.0032)
Number of cars	0.0000	0.0000	-0.0000	-0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Number of buses	0.0000	0.0000	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Number of males in household	0.0251***	0.0252***	0.0258***	0.0258***

Table A.2: (continued)

	(10a)	(10b)	(11a)	(11b)
	(0.0028)	(0.0028)	(0.0020)	(0.0021)
Household head age (years)	0.0018***	0.0018***	0.0017***	0.0017***
	(0.0003)	(0.0003)	(0.0002)	(0.0002)
First born is male (dummy)	-0.0126*	-0.0127*	0.0033	0.0036
	(0.0073)	(0.0073)	(0.0058)	(0.0059)
Household head schooling (years)	-0.0044***	-0.0043***	-0.0024**	-0.0024**
	(0.0014)	(0.0014)	(0.0012)	(0.0012)
Household average schooling (years)	0.0017	0.0016	0.0015	0.0018
	(0.0027)	(0.0027)	(0.0022)	(0.0023)
Household maximum schooling (years)	0.0038**	0.0038**	0.0064***	0.0063***
	(0.0019)	(0.0019)	(0.0015)	(0.0015)
Lag fraction of household members working in US	-0.0034	-0.0045	-0.0258	-0.0302
	(0.0338)	(0.0334)	(0.0230)	(0.0239)
Lag fraction of household members working within Mexico	2.2039***	2.1991***	2.0919***	2.1003***
	(0.0881)	(0.0873)	(0.0581)	(0.0602)
Irrigated area interacted with rain	0.0000	0.0000		
	(0.0000)	(0.0000)		
Average hourly wage (pesos)	0.0213	0.0014	-0.3440	0.0003
	(0.0245)	(0.0017)	(0.3033)	(0.0011)
Average crime rate (murders per 10,000 inhabitants)				
... in crossing municipalities < 1000 km	-0.0001	-0.0003	0.0003	0.0004
	(0.0004)	(0.0004)	(0.0003)	(0.0003)
... along border municipalities	-0.0032	-0.0004	-0.0193	-0.0004
	(0.0042)	(0.0011)	(0.0163)	(0.0004)
Average number of apprehensions				
... in crossing municipalities < 1000 km	0.0000	0.0000	-0.0000	-0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
... along border municipalities	0.0000	0.0000	-0.0000	0.0000

Table A.2: (continued)

	(10a)	(10b)	(11a)	(11b)
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Year		-0.0022		-0.0007
		(0.0020)		(0.0015)
Village fixed effects	Y	Y	Y	Y
Year effects	Y	N	Y	N
p-value (Pr>F)	0.0000	0.0000	0.0000	0.0000
adjusted R-squared	0.4544	0.4575	0.4184	0.3950
# observations	6062	6062	11412	11412

Notes: Standard errors in parentheses. Significance codes: * p<0.1, ** p<0.05, *** p<0.01.