

# Labor Migration as Price Arbitrage: Theory and Evidence from Mexican Workers in the US\*

Hyejin Ku

Florida State University

April 15, 2008

## Abstract

This paper analyzes the labor migration that arises due to geographic real price differences. A migrant's consumption mix is optimized across borders via remittances. To the extent that the real price level is lower in the source country, migration is triggered by a lower cut-off wage in the host country. Empirical results show that as the purchasing power of the US dollar in Mexico goes up, a skilled Mexican worker is more likely to migrate to the US and a Mexican migrant in the US is more likely to be working in a low-paying job. (JEL: F22, O12, O24)

## 1 Introduction

A well-known empirical regularity in economics is that for a wide range of goods the prices are not equalized across markets and purchasing power parity (PPP) is far from holding true, at least in the short-run (see Kenneth Rogoff, 1996; Penelopi K. Goldberg and Michael M. Knetter, 1997; Alan Taylor and Mark Taylor, 2004, for a review). Moreover, the way that national price levels deviate from PPP is such that the real price levels or costs of living in poor countries tend to be lower than in rich ones (Bela Balassa, 1964; Paul A. Samuelson, 1964). As of 2008, the same basket

---

\*I wish to thank Kaushik Basu, Steve Coate, Stefan Klöpper, and Asaf Zussman for their guidance and support throughout this project; Nancy Chau, Gary Fields, Gordon Hanson, Heinrich Hock, George Jakobson, Hillel Rapoport, Holger Seebens, Emma Stephens, Henry Wan, Homa Zarghamee, and participants at the Advanced Graduate Workshop on Poverty, Development and Globalization, University of Manchester; the Development Workshop and NEUDC at Cornell University; the PEGNet Conference at GTZ-Berlin; the SCID/UNDP Conference on Mexican Migration at Stanford University, for helpful suggestions and comments. Please direct any comments or suggestions to hku@fsu.edu.

of goods and services, including rent, costs 120.2 in London, 82.4 in Frankfurt, 55.9 in Prague, 49.1 in Mexico City, and 43.3 in Manila, when the price level of New York is normalized to 100 (Union Bank of Switzerland, 2008). This implies that a US dollar, if converted to pesos at the market exchange rate and spent in Mexico City, can buy twice as much as what it affords in New York City.

This paper investigates, in the context of Mexico-US migration, the differences in real prices or costs of living between countries as the forces driving international migration and guiding the patterns of employment for migrant workers. Specifically, it argues that to the extent that the real price level in the source country is lower than that in the host country and that migrants spend their income in the source country, migration is triggered by a lower cut-off wage in the host country than otherwise. This in turn implies a larger migration flow and the deterioration of the observed labor market outcomes of migrants as the real price gap widens.

To illustrate the argument above, consider a Mexican worker who lives with his spouse and a child in Mexico. Assume that the real price levels in Mexico and the US are such that the dollar price of a Big Mac in Mexico is half of that in the US. Fix the real wages for the worker's skill level at one Big Mac per hour in both Mexico and the US. Therefore, there is no economic incentive to pursue migration in the conventional sense of *wage arbitrage*. However, the US-Mexico real price differences do provide opportunities for *price arbitrage*. Suppose that in Mexico the household income, namely one Big Mac, is split between the worker and his dependents. If the worker migrates to the US, he still consumes half of his US wage—that is, half a Big Mac—for himself. The rest is sent back to Mexico in the form of remittances. Because the dollars that formerly could buy only half a Big Mac in the US can purchase a whole Big Mac in Mexico, the migrant's spouse and child can now eat a whole Big Mac. Essentially, the household's consumption of Big Macs jumps from one to one and a half, and no individual member is consuming less than before. Since this improvement in the household utility is made under a zero real wage premium, we can infer that to the extent that the purchasing power of the dollar is higher in Mexico, a US wage lower than one Big Mac may trigger the Mexican worker to migrate to the US.<sup>1</sup>

---

<sup>1</sup>Although I confine my analysis to Mexico-US migration of workers, another example of migration as price arbitrage can be found in the retirement of American senior citizens to places such as Mexico, Costa Rica, and Panama. Due to the low costs of living in those countries, the retirees can afford better standards of living, especially housing and services that are labor intensive, than what they would have enjoyed by staying in the US with a fixed retirement income (The New York Times, 2005). Since the retirees' migration decision does not interfere with their labor market decision, this could be viewed as a cleaner example of price arbitrage than the case of Mexican workers

By making a case for migration as price arbitrage, this paper contributes to the literature in several important ways. First, it identifies labor migration and subsequent optimization of consumption mix across borders as a strategy to achieve price arbitrage in non-tradable goods. Economists have long understood that some key mechanisms, such as international trade, result in price arbitrage in tradable goods. In contrast, price arbitrage in non-tradable goods has so far been considered to be limited, by definition. This paper points out that when the costs of moving goods and services around are prohibitively high, consumers (or their delegates) can themselves cross borders to take advantage of the arbitrage opportunities generated by the real price gap between markets.

Second, this paper suggests that the pressure for migration is higher than what is predicted by existing theories alone to the extent that asymmetric purchasing power of currencies is prevalent empirically. There is a vast literature on the forces driving migration between Mexico and the US and in other settings. Maximization of expected net earnings by isolated individuals is the most well-known (Larry A. Sjaastad, 1962; Michael P. Todaro, 1969; John R. Harris and Michael P. Todaro, 1976; Michael J. Greenwood, 1985; Gordon H. Hanson and Antonio Spilimbergo, 1999). A more nuanced view of migration is that it is the outcome of the collective decisions made by family members to overcome a variety of market failures (see Oded Stark, 1991 for a review). A prominent example is the risk diversification through migration among family members (Mark R. Rosenzweig and Stark, 1989). Since price arbitrage can operate independently from these other factors, deviation of real exchange rates from PPP suggests a larger migration flow than what is predicted by standard theory. This in turn implies, for example, that migration flow from Mexico to the US would be lower if the Mexican peso achieved PPP with the US dollar *ceteris paribus*.

Third, it provides a new explanation as to why immigrants from low income countries earn lower wages than natives or fellow immigrants from other countries. Many studies have previously sought to understand this phenomenon and typically the explanation is found in the self-selection of immigrants on quality (Andrew D. Roy 1951; George J. Borjas, 1987; Stephen J. Trejo, 1997; Daniel Chiquiar and Gordon H. Hanson, 2005) or transportability of imported skills (Barry Chiswick, 1978; George J. Borjas, 1994; Robert J. Lalonde and Robert H. Topel, 1997; Rachel M. Friedberg, 2000; Zvi Eckstein and Yoram Weiss, 2004). This paper argues that even after controlling for the skill levels of migrants, the real price difference between the host and source countries can in itself influence a migrant worker's labor market outcome in the host country by altering his reservation

---

in the US.

wage. Pointing out that a macro-level phenomenon, namely the deviation of the real exchange rate from PPP, can influence the occupational outcomes of migrant workers in a way that is not predicted by standard theory is one of the main innovations of this paper.

This paper starts by building a micro-founded model of migration with remittances in the context of Mexico-US migration. The model follows the framework of John R. Harris and Michael P. Todaro (1970) and many variants of it (see Gary S. Fields, 2005 for a survey) in that there are high-paying and low-paying sectors in the destination and a prospective migrant assesses his occupational outcomes in a probabilistic manner. My major point of departure from the Harris and Todaro (1970) model is that I incorporate the empirically-observed discrepancy between the market real exchange rate and PPP, allowing for the possibility of a real price gap between the source and destination countries.

There is a continuum of households in Mexico, in which each consists of a worker who can potentially migrate to the US and a dependent who is sedentary. Each household seeks to maximize the joint utility of the worker and the dependent. Households are heterogeneous on one dimension: the intrahousehold allocation of income between the worker and the dependent. If the worker stays in Mexico, he earns a base wage and shares his income with the dependent. If he migrates, he remotely supports the dependent by sending remittances. Once in the US, he encounters a random job offer which can be either in the high-paying (non-agricultural) sector, or in the low-paying (agricultural) sector. If offered a high-paying job, a migrant always accepts it. In contrast, if offered a low-paying job, a migrant accepts it only if (i) the US dollar has sufficiently greater purchasing power relative to the peso, and (ii) the migrant's household spends a sufficiently large fraction of its income in Mexico. In the case that he rejects the low-paying job, the migrant returns to Mexico and works for the base wage in Mexico.

The key predictions of my theoretical model are as follows: To the extent that the purchasing power of the dollar is higher relative to the peso, (a) the level of Mexico-US migration goes up; (b) a larger fraction of Mexican immigrants are employed in the low-paying sector; and (c) a migrant who spends a larger share of his income in Mexico is more likely than others to be working in the low-paying sector in the US.

I link these predictions to the actual behavior of Mexican workers during the period of 1968-1996. The data come from the Mexican Migration Project (MMP), a survey commonly used in the literature, which documents US-bound migration and labor market experiences of Mexican

workers.<sup>2</sup> The MMP is a recall-based panel dataset at the individual level, and the sample includes migrants, many of whom are undocumented, as well as non-migrants. Following the strategy in Kaivan Munshi (2003), I measure a migrant's labor market outcome in the US by his occupation (agricultural vs. non-agricultural) since the MMP does not provide information on wages at the person-year level.

My empirical analysis examines the relationship between the US-Mexico real exchange rate (RER) and the migration and occupational outcomes of Mexican workers. I exploit the family situation of individual workers in a person-year, in particular, the marital status and the existence of children under the age of 18, while controlling for the individual fixed effects. The underlying assumption is that the workers who have dependents in Mexico will be more likely to evaluate a US wage in terms of its purchasing power in Mexico than those who do not have any dependents in Mexico. For identification, I make the assumption that Mexican workers systematically change neither their marital status nor the number of children as a response to the change in RER in each person-year.

The main empirical findings lend support to the theory. Specifically, I find that as the purchasing power of the US dollar in Mexico goes up, a skilled Mexican worker is more likely to be located in the US as opposed to Mexico and a Mexican migrant in the US is more likely to be working in a low-paying job than otherwise.

## 2 Relation to the Literature

Despite its potential importance in explaining the patterns of migration and the labor market behavior of migrant workers, the issue of a geographic real price differential has attracted scant attention. Hanson and Spilimbergo (1999) is a macro-level empirical study to which this paper is related. In studying the illegal immigration of Mexican workers, they find that a US wage, expressed in its purchasing power in Mexico, is positively associated with the level of apprehension, a proxy for the illegal attempts at migration. While consistent with the theory of this paper, their results do not separately identify the effect of the US-Mexico real price gap and that of the US wage (in dollars). In contrast, I try here to identify the effect of the US-Mexico real price difference without convolution of other factors, utilizing micro-level data. In a separate study, Douglas S. Massey and

---

<sup>2</sup>See Douglas S. Massey et al. (1994); Jorge Durand et al. (1996); Kaivan Munshi (2003); Pia M. Orrenius and Madeline Zavodny (2005); and David McKenzie and Hillel Rapoport (2007) for details of the survey.

Kristin E. Espinosa (1997) find that high rates of Mexican inflation and the devaluation of pesos reduce the likelihood of an initial undocumented trip to the US. However, since the two explanatory variables change the real exchange rate in the opposite directions, interpretation of their results is ambiguous insofar as price arbitrage is concerned.

The issue of price arbitrage is also addressed in earlier theoretical studies. In a life-cycle model under fixed wages and prices, Slobodan Djajic (1989) shows that a guest worker's decision to migrate depends on both the real and nominal wage differentials while a permanent migrant is primarily interested in the real wage differential. This is because a guest worker is able to choose the country in which to spend her labor income independently of where she earns it. In a similar framework, Christian Dustmann (1995, 1997, and 2003) demonstrates that a high purchasing power of the host country currency in the migrant's home economy might hasten the return migration of an existing migrant.<sup>3</sup> My major point of departure from these studies is that I examine the effects of price arbitrage on the occupational outcomes of migrants in the host country as well as the migration decision itself. In addition, this paper provides empirical evidence supporting the logic of price arbitrage in migration. It is worthwhile to mention here that the "return" in my static model is the ensuing event upon rejection of the low-paying job in the US, not the return migration in the sense of the optimal migration duration in dynamic models.<sup>4</sup> Empirically, this paper evaluates a migration outcome in terms of the location (Mexico vs. the US) of an individual in each year rather than the action of moving from Mexico to the US or the other way around. Essentially, what is measured is the average effects of price arbitrage on new migration (Djajic, 1989) and the return migration of existing migrants (Dustmann, 1995, 1997, and 2003). I am not aware of any previous work that relates the real price difference between host and source countries to the labor market outcome of a migrant worker in the host country.

---

<sup>3</sup>Also see Stark et al. (1997) on this.

<sup>4</sup>I employ a static model to demonstrate the effects of price arbitrage on the migration and labor market outcomes of workers in the simplest possible way. In contrast, at issue in the other studies mentioned above is not the price arbitrage per se; consumption or savings behavior of temporary migrants is the focus. Hence, a life-cycle model is more appropriate in those studies.

### 3 The Model

#### 3.1 Preferences

There are a continuum of households of mass 1 in Mexico. Households are indexed by  $\alpha$ , which ranges over  $[0, 1]$ . Each household consists of a worker (1) and a dependent who does not have any earnings (2). The household is assumed to maximize the family utility function,  $U(C_1, C_2)$ , in the sense of the unitary model (Gary S. Becker, 1981). The unitary model of the household encompasses several different models of family structure in which a family in aggregate behaves as if it is maximizing a family utility function.<sup>5 6</sup> Alternatively, we may think of  $U(C_1, C_2)$  as the individual utility function of the worker or potential migrant who cares about her partner's consumption for altruistic reasons.<sup>7</sup> The worker can potentially migrate to the US but the dependent is sedentary. If the worker stays in Mexico, he shares his income with his dependent. If he migrates to the US, he remotely supports the dependent by sending remittances. Each household seeks to maximize the household utility function, which can be represented as follows:<sup>8</sup>

$$U_\alpha = \begin{cases} \sigma C_1^{1-\alpha} C_2^\alpha & \text{if 1 stays in Mexico} \\ \sigma C_1^{1-\alpha} C_2^\alpha - \theta & \text{if 1 migrates to the US} \end{cases}$$

$C_1$  and  $C_2$  refer to the consumption level of the worker and the dependent, respectively. Households differ on one dimension: the weights assigned to the consumption of the worker and the dependent. Without loss of generality, let  $\alpha$  indicate each household's preference weight on  $C_2$ . The utility that a household derives from a pecuniary benefit, consumption, remains the same regardless of the worker's location. However, when the worker is away from home, he feels a psychic cost of  $\theta$ . The psychic cost can be negative, meaning there can be a psychic pleasure in being in the

---

<sup>5</sup>See Theodore C. Bergstrom (1995) for a survey of theories of the family including the unitary approach.

<sup>6</sup>If the household is modeled more realistically with the balance of power varying between the partners as in Martin Browning et al. (1994), this could lead to interesting possibilities. In particular, if we follow the approach in Kaushik Basu (2006) where a decision variable of a household can in turn affect the balance of power that guides the process of decision making, multiplicity of migration equilibria may be predicted: initial bargaining power in the household influences whether a worker would migrate or not, but at the same time the wages that she earns at home and abroad can have different levels of impact on how much say she will get within the household. This idea may be explored in a separate paper. To focus on the issues addressed in this paper, the household will be assumed to behave as in the unitary model.

<sup>7</sup>Hillel Rapoport and Frederic Docquier (2006) provide an extensive review of the motivations for intrahousehold transfers in the context of migrants' remittances.

<sup>8</sup>Alternatively, we can treat the household utility as the individual utility of the worker with varying degrees of altruism towards his dependent. From a purely analytical standpoint, the two approaches are identical.

US. A migrant has to experience migration to observe his  $\theta$ . Hence,  $\theta$  is ex ante uncertain and is the realization of a random variable uniformly distributed on  $[-c, c]$  with  $c > 0$ . I normalize the utility function by multiplying  $\sigma \equiv 1/\alpha^\alpha(1-\alpha)^{1-\alpha}$  to the pecuniary component of it. This makes the indirect utility of different households comparable while maintaining the heterogeneity in the intrahousehold allocation of resources between households.

To migrate from Mexico to the US, the worker has to incur a one-time “transportation cost” of  $\tau > 0$  in terms of utility. This represents various pecuniary and non-pecuniary costs involved in crossing the Mexico-US border.<sup>9</sup>

Once a migrant arrives in the US and his psychic cost is revealed, he decides whether to accept a given job offer or not. When the utility loss from a high psychic cost dominates the net gain in wages, a migrant may decide to return to Mexico immediately. For simplicity, I assume that it is costless to cross the border from the US side.

### 3.2 Technology

Let  $W$  and  $W^*$  denote the nominal wages in Mexico and the US, respectively. Next, denote by  $p$  (pesos) and  $p^*$  (dollars) the price levels in Mexico and the US, respectively. In Mexico, a price-taking firm produces  $X$  units of output, employing  $n$  units of labor, according to the following technology<sup>10</sup>:

$$X = \beta n, \beta > 0$$

In the US, there are two sectors where Mexican laborers can be employed: the high-paying sector (H) and the low-paying sector (L). Again, for simplicity, let us assume that there is only one price-taking firm in each sector. They produce output  $X_H$  and  $X_L$ , respectively, and employ  $n_H$  and  $n_L$  units of labor. The production technology in each sector is as follows:

$$\begin{aligned} X_L &= \beta n_L, \beta > 0 \\ X_H &= f_H(n_H), f'_H > 0; f''_H < 0 \end{aligned}$$

For simplicity, I assume the productivity in the US low-paying sector is equal to that of Mexico. This is to elucidate the case of migration as price arbitrage: if there are Mexican workers who

---

<sup>9</sup>For legal migration, the worker has to make a visit to the US embassy, pay the application fees, fill out forms, etc. For undocumented migrants, the fees paid to smugglers, or “coyotes,” and the risk of apprehension are a substantial part of the “transportation costs” (Hanson and Spilimbergo, 1999).

<sup>10</sup>Alternatively, we could assume the existence of many firms, but dealing with a single firm is innocuous as long as it is modeled as a price-taker.

prefer working in the US low-paying sector to working in Mexico, even in the absence of a real wage premium from migration, then the story of arbitrage will become clearer. I simplify the technology in Mexico and the US low-paying sector to a linear production function. In this way, I can retain the same analytical outcomes that result when diminishing marginal return on labor is assumed in all three sectors, while making the algebra much simple. In what follows, we will ignore the labor market outcomes of natives from the US, as our focus is on Mexican workers.<sup>11</sup> For a similar reason, I abstract away from the issue of unemployment in this model. Since the total endowment of labor in Mexico is fixed at unity,

$$n + n_H + n_L = 1; \quad n, n_H, n_L \geq 0. \quad (1)$$

All three firms are assumed to produce the same good or service. The price charged for the product is  $p$  pesos in Mexico and  $p^*$  dollars in the US. In Mexico, profit-maximization of firms and free entry imply that only at the following wage is the zero-profit condition met, with firms hiring as many workers as are supplied:<sup>12</sup>

$$\beta = \frac{W}{p} \equiv w. \quad (2)$$

In the US, the wage  $W^*$  can have two different values depending on sectors. Let  $W_H$  denote the wage in the formal sector and  $W_L$  that of the informal sector. The profit maximization of each firm implies

$$f'_H(n_H) = \frac{W_H}{p^*} \equiv w_H$$

and

$$\beta = \frac{W_L}{p^*} \equiv w_L. \quad (3)$$

The wage in the low-paying sector ensures that there are positive numbers of active firms and that they absorb as many workers as are supplied. If the high- and low-paying sectors coexist in the

---

<sup>11</sup>We can either treat natives as being employed in a sector where immigrant workers cannot be hired or assume that they are embedded in the production functions above. The important assumption is that US natives do not move between the high-paying and low-paying sectors that we are discussing here.

<sup>12</sup>A competitive Mexican firm maximizes

$$\begin{aligned} \pi(n) &= pf(n) - Wn \\ &= (p\beta - W)n. \end{aligned}$$

If  $\beta < \frac{W}{p}$ , no firm will operate in the market. If  $\beta \geq \frac{W}{p}$ , new entry of firms will continue and the wage will eventually settle at the level specified in (2).

market,  $w_H$  and  $w_L$  will be equalized in equilibrium. However, the wage in the high-paying sector has an institutional lower bound at  $\bar{W}$ :

$$W_H \geq \bar{W}$$

There is no such restriction in the low-paying sector. It is assumed that the minimum wage  $\bar{W}$  is above the wage that would prevail if wages were flexible, which ensures  $\bar{W} \geq W_L$ . This means there would always be an excess supply of labor in the high-paying sector were it to pay a wage greater than or equal to  $\bar{W}$ . Thus competition will drive down  $W_H$  and it will eventually settle at  $\bar{W}$ . Hence the profit maximizing condition for the high-paying sector can now be written as<sup>13</sup>

$$f'_H(n_H) = \frac{\bar{W}}{p^*} \equiv \bar{w}. \quad (4)$$

Essentially, the demand for labor in the high-paying sector,  $n_H$ , is fixed.

### 3.3 Real Exchange Rate between Mexico and the US

The market exchange rate is such that a dollar exchanges with  $e$  pesos. Despite the assumption that all three sectors produce the same good or service, I do not impose the condition that  $p$  and  $p^*$  are on par when converted to a single currency using the market exchange rate. If the products are non-tradable, for instance,  $p$  and  $p^*$  are determined in the respective domestic markets, whereas the peso-dollar nominal exchange rate  $e$  is determined in the foreign exchange market or is set by the central bank at an arbitrary level. Overall, the real exchange rate,  $ep^*/p \equiv Q$ , may or may not be equal to unity as PPP would predict.<sup>14</sup> Incorporating the empirically-observed discrepancy between the market exchange rate and PPP is the key point of departure from the literature, where a price parity between regions is typically assumed in most models.<sup>15</sup> If PPP holds,  $Q = 1$ . If the US dollar has extra purchasing power when spent in Mexico, then  $Q > 1$ . If it is cheaper to live in

---

<sup>13</sup>See Basu (2003, pp.167) for more precise formulation of profit-maximizing behavior of firms under a “wage rigidity axiom.”

<sup>14</sup>In the extreme case, different prices may be charged for an identical good sold in the same location. Marcus Asplund and Richard Friberg (2001), using data from Scandinavian duty-free stores, show that the catalog prices expressed in Swedish and Finnish currencies do not equalize when they are converted to a single currency based on the market exchange rate. They attribute this to the rigidities in nominal prices in contrast to the volatility of nominal exchange rates.

<sup>15</sup>In the case of rural-urban migration, the nominal exchange rate  $e$  will be set to unity. Even in that case, a price gap between the urban and rural areas may persist as long as  $p$  and  $p^*$  are different from each other, which is totally possible even within one country.

the US, then  $Q < 1$ . I will assume that  $Q \geq 1$  since Mexico is a country where the real price level is relatively low.

### 3.4 The Migration Problem

Each household seeks to maximize its utility by potentially sending a worker to the US. Ex ante, a Mexican worker does not know which job offer he will encounter if he migrates to the US. Thus,  $w^*$  is a random draw from  $\{w_L, \bar{w}\}$ . Mexican workers believe that with probability  $\mu$  they will be offered a job in the high-paying sector, and with  $1 - \mu$  in the low-paying sector. The timing of the model is as follows: (i) workers in Mexico decide whether to migrate to the US or not; (ii) for those who arrive in the US, the psychic cost  $\theta$  is revealed and a US wage  $w^*$  is offered; (iii) migrants decide whether to accept the job offer (and stay in the US) or return to Mexico.

#### 3.4.1 Location-specific Utility Maximization

In Mexico, a household  $\alpha$  maximizes  $U_\alpha = \sigma C_1^{1-\alpha} C_2^\alpha$  subject to the budget constraint  $C_1 + C_2 \leq w$ . The solution to this problem is  $C_1 = (1 - \alpha)w$  and  $C_2 = \alpha w$ . Hence, the maximized value of utility in Mexico, which I denote by  $U_\alpha^{MX}$ , equals  $w$ . If the worker migrates to the US, the household maximizes  $U_\alpha = \sigma C_1^{1-\alpha} C_2^\alpha - \theta$  with location-specific price indices in the budget constraints, since  $C_2$ , the consumption for the dependent, must be purchased in Mexico. Therefore, the appropriate constraints become:

$$\begin{aligned} C_1 + R &\leq w^*, \\ C_2 &\leq QR, \end{aligned}$$

where  $R$  is the remittances (expressed in terms of the US real wage) sent back to Mexico. The migrant spends part of his wage,  $w^*$ , on own consumption in the US and sends the rest to his dependent in Mexico. The real exchange rate,  $Q$ , determines how  $R$  is translated into the level of consumption in Mexico. The maximized value of utility in the event of migration is  $U_\alpha^{US,L} = Q^\alpha w_L - \theta$  if the migrant works for the low-paying sector and  $U_\alpha^{US,H} = Q^\alpha \bar{w} - \theta$  if in the high-paying sector.<sup>16</sup>

---

<sup>16</sup>The solution vector is  $(C_1, C_2, R) = ((1 - \alpha)w^*, \alpha w^* Q, \alpha w^*)$ , where  $w^* \in \{w_L, \bar{w}\}$  depending on sectors.

### 3.4.2 Behavior of Migrants in the US

Assume that the wage in the US high-paying sector is so attractive that every migrant accepts it if offered, even if the highest psychic cost  $\theta$  is realized. Formally, this can be stated as  $\bar{w} > c + w$ .<sup>17</sup> Next, define  $\hat{\theta}(\alpha)$  to be the cut-off psychic cost which makes a migrant from household  $\alpha$  indifferent between accepting a job offer in the US low-paying sector and returning to Mexico. Formally,  $\hat{\theta}(\alpha)$  is defined by

$$\hat{\theta}(\alpha) = Q^\alpha w_L - w. \quad (5)$$

The migrant, when offered the low-paying job, will accept it and stay in the US only if  $\theta < \hat{\theta}(\alpha)$ ; otherwise he will return to Mexico. The idea is that unlike in the case of the high-paying job, the low-paying job in the US makes a migrant's stay in the US worthwhile only if the psychic costs he feels abroad are sufficiently low. Note that the cut-off psychic cost is worker-specific, as the  $\alpha$  differs between households; hence the notation  $\hat{\theta}(\alpha)$ .

For a migrant  $\alpha$  who just arrived in the US, there are three possible states that can be realized. I characterize each state by the pair  $(\theta, w^*)$ :

State	Decision	Utility
$(\theta, \bar{w})$	stay	$Q^\alpha \bar{w} - \theta$
$(\theta < \hat{\theta}(\alpha), w_L)$	stay	$Q^\alpha w_L - \theta$
$(\theta \geq \hat{\theta}(\alpha), w_L)$	return to Mexico	$w$

Let  $\rho(\alpha)$  denote the probability that migrant  $\alpha$  stays in the US conditional upon being offered a job in the low-paying sector. Recalling that  $\mu$  is the ex ante belief about a good wage draw, the ex ante probability of each of the three states above is  $\mu; \rho(\alpha)(1 - \mu); (1 - \rho(\alpha))(1 - \mu)$  respectively.

Denote the total number of migrants by  $m$ . At equilibrium, I require that the ex ante belief about  $w^*$  be consistent with the actual probability. Therefore, the probability of being offered a job in the formal sector is

$$\mu = \Pr(w^* = \bar{w}) = \frac{n_H}{m}.$$

---

<sup>17</sup>A migrant from household  $\alpha$  will accept the job offer and stay in the US if

$$Q^\alpha \bar{w} - \theta > w.$$

Recall that  $\theta \in [-c, c]$ . If the above condition is satisfied for  $\theta = c$  at  $Q = 1$ , then it will be satisfied for all  $\alpha \in [0, 1]$  as long as  $Q \geq 1$ .

Next, recalling that  $\theta$  is a random draw from a uniform distribution over  $[-c, c]$ , we can write<sup>18</sup>

$$\begin{aligned}\rho(\alpha) &= \Pr(\theta < \widehat{\theta}(\alpha) | w^* = w_L) \\ &= \left(\frac{1}{2} + \frac{\widehat{\theta}(\alpha)}{2c}\right),\end{aligned}\tag{6}$$

since the wage draw and the realization of a psychic cost are independent.

### 3.4.3 Migration Decision in Mexico

The worker from household  $\alpha$  will migrate to the US only if the gain in expected utility net of the transportation costs is positive:

$$E_{\theta, w^*}[U_\alpha^{US}] - \tau \geq U_\alpha^{MX}$$

Plugging in the values for  $U_\alpha^{US}$  and  $U_\alpha^{MX}$  with appropriate weights, we can express the above condition as follows:

$$\begin{aligned}\mu E_\theta[Q^\alpha \bar{w} - \theta] + \rho(\alpha)(1 - \mu)E_\theta[Q^\alpha \bar{w} - \theta | \theta < \widehat{\theta}(\alpha)] \\ + (1 - \rho(\alpha))(1 - \mu)w - \tau - w \geq 0\end{aligned}\tag{7}$$

Let  $\widehat{\alpha}$  define the Mexican worker (or equivalently, the household he belongs to) who is indifferent between migrating and not migrating; with  $\widehat{\alpha}$ , the condition above holds with equality. Notice that the households which allocate a larger share of household income to Mexico have a greater incentive to opt for migration than others. Therefore, the workers from households with  $\alpha \geq \widehat{\alpha}$  migrate to the US and those from households  $\alpha < \widehat{\alpha}$  stay in Mexico. Then, the total level of US-bound migration,  $m$ , is

$$m = 1 - \widehat{\alpha}.\tag{8}$$

Since (7) holds with equality at  $\alpha = \widehat{\alpha}$  (or  $1 - m$ ), the level of migration,  $m$ , is determined in the following equation, which I name the ‘‘Indifference’’ condition:

$$\left(1 - \frac{n_H}{m}\right)\left(\frac{w_L^2}{4c}\right)(Q^{1-m})^2 + \left\{\frac{n_H}{m}\bar{w} - \left(1 - \frac{n_H}{m}\right)\left(\frac{w_L}{2c}\right)(w - c)\right\}Q^{1-m} + \left(1 - \frac{n_H}{m}\right)\frac{(w + c)^2}{4c} - w - \tau = 0\tag{9}$$

Finally, for the the migrants who are already in the US and are deciding whether to accept a job offer or return to Mexico, the strategies they adopt should lead to the actual labor market

<sup>18</sup>The parameters of the model are such that  $\widehat{\theta}(\alpha) \in [-c, c]$  for all  $\alpha$ 's as long as  $Q$  is not too large. If  $\widehat{\theta}(\alpha) < -c$ , then  $\Pr(\theta < \widehat{\theta}(\alpha)) = 0$ . If  $\widehat{\theta}(\alpha) > c$ , then  $\Pr(\theta < \widehat{\theta}(\alpha)) = 1$ .

equilibrium. Out of  $m$  total migrants,  $n_H$  lucky ones are offered a job in the high-paying sector and they accept it with certainty. There are  $m - n_H$  migrants who are offered a job in the low-paying sector. Among these, only  $n_L$  migrants will accept the job offer and stay in the US, while the rest will return to Mexico. For a migrant from household  $\alpha$ , the probability that he stays in the US even for the low-paying job is given by (6). We require that the individual-specific decision rule regarding the state of a bad wage draw, when averaged over all the migrants ( $\alpha \geq \hat{\alpha}$ ), be consistent with the actual labor market equilibrium. Formally, this can be stated as

$$\frac{n_L}{m - n_H} = \int_{\hat{\alpha}}^1 \rho(\alpha) \left( \frac{1}{1 - \hat{\alpha}} \right) d\alpha.$$

Using (5) and (6), we can express it in the following equation, which I call the ‘‘Consistency’’ condition:

$$\frac{n_L}{m - n_H} - \frac{1}{2} + \frac{w}{2c} - \frac{w_L}{2c} \left( \frac{Q - Q^{1-m}}{m \ln Q} \right) = 0. \quad (10)$$

### 3.5 Equilibrium

An equilibrium of this model consists of a level of migration,  $m$ , and a total employment of Mexican workers in the US low-paying sector,  $n_L$ , that simultaneously satisfy the ‘‘Indifference’’ and ‘‘Consistency’’ conditions that are provided in (9) and (10), respectively.

## 4 Some Theoretical Results

In this section I first characterize the conditions under which an equilibrium of the migration model exists. I then derive the implications of an exogenous change in the US-Mexico real exchange rate  $Q$  on the average migration and labor market outcomes of Mexican workers at large. Next, I compare the migration and labor market outcomes of workers from different households. Specifically, I examine whether a worker from a household which allocates a larger share of its income to the dependent can exhibit different migration and labor market behavior than others in equilibrium.

### 4.1 Preliminaries

Consider the following three assumptions:

**A1:**  $\tau > \frac{(\beta - c)^2}{4c}$ .

This assumption states that the transportation cost for migrating to the US is non-negligible. It ensures that the ‘‘Indifference’’ condition in (9), which can be viewed as a quadratic equation

in  $Q^{1-m}$ , has two real roots, one positive and one negative. Since  $Q^{1-m} > 0$  for all  $Q > 0$  and  $m \in [0, 1]$ , we can rule out the case of the negative root. This condition essentially plays the role of ruling out multiple equilibria.

**A2:**  $c \leq \beta$ .

This assumption says that the highest psychic cost involved in migration is still smaller in magnitude than either the Mexican wage or the US wage in the low-paying sector.

**A3:**  $\bar{w} \in [\frac{\beta^2 + (\beta+c)^2}{4c(\beta+c)}, \omega]$  where  $\omega \equiv f'(\eta)$  with  $\eta$  such that

$$\frac{Q - Q^{1-\eta}}{\eta \ln Q} = 1 + \frac{c}{\beta}.$$

This assumption sets the lower and upper bounds for the exogenously-fixed US wage in the high-paying sector,  $\bar{w}$ . All the theoretical results from here on will be derived assuming that A1, A2, and A3 are satisfied.

**Proposition 1** *A migration equilibrium,  $(m, n_L)$ , exists and it is unique.*

**Proof.** A vector  $(m, n_L)$  that satisfies the “Indifference (*I*)” and “Consistency (*C*)” conditions is an equilibrium of this model. The equilibrium can be represented diagrammatically in the  $(m, n_L)$ -space. Consider Figure 1. The horizontal axis represents the space of  $m$ . The vertical axis represents the space of  $n_L$ . The domain of this model is the lower right triangle bound from above by the dashed line in Figure 1 because  $n_L \leq m - n_H$ , and  $m \in [n_H, 1]$  for an exogenously fixed  $n_H$ . Then, we can depict the (*I*) and (*C*) conditions in the figure. The (*I*) condition corresponds to a vertical line in the diagram, as, in accordance with (9), the (*I*) condition does not depend in any way on  $n_L$ . The (*C*) condition corresponds to an upward sloping curve that passes through the origin in the diagram. To see this, rearrange the terms in the (*C*) condition in (10) and solve for  $n_L$ :

$$n_L = (m - n_H) \left\{ \frac{1}{2} - \frac{w}{2c} + \frac{w_L}{2c} \left( \frac{Q - Q^{1-m}}{m \ln Q} \right) \right\}. \quad (11)$$

From this expression, we can derive

$$\frac{\partial n_L}{\partial m} = \frac{n_H}{m} \left( \frac{w_L}{2c} \right) \left\{ \left( \frac{Q - Q^{1-m}}{m \ln Q} \right) - Q^{1-m} \right\} + \left( \frac{Q^{1-m} w_L - w + c}{2c} \right). \quad (12)$$

Since  $\left( \frac{Q - Q^{1-m}}{m \ln Q} \right) - Q^{1-m} \geq 0$  for all  $Q \geq 1$ , the first term on the right hand side is non-negative. In the second term,  $Q^{1-m} w_L - w$  is nothing but  $\hat{\theta}(\hat{\alpha})$  (see (5) and (8)). Since  $\hat{\theta}(\hat{\alpha}) \in [-c, c]$ , the second term on the right hand side is non-negative. This establishes  $\frac{\partial n_L}{\partial m} \geq 0$ . The (*I*) and (*C*) curves necessarily intersect because  $\frac{\partial n_L}{\partial m}$  is finite for all  $m \in [0, 1]$ . For this intersection to occur in the

domain, we require  $n_L \leq m - n_H$ . A3 guarantees this inequality. Therefore, an equilibrium exists. In addition, the monotonicity in the  $(I)$  and  $(C)$  curves ensures that the equilibrium is unique. ■

## 4.2 US-Mexico Real Price Gap and the Behavioral Responses of Mexican Workers

**Proposition 2** *The total level of Mexico-US migration,  $m$ , rises as the US-Mexico real exchange rate ( $Q$ ), or purchasing power of the US dollar in Mexico, goes up.*

**Proof.** Consider Figure 2. Suppose the economy currently lies at point  $a$  where the  $(I_1)$  and  $(C_1)$  curves intersect. We can show that as  $Q$  rises, the  $(I_1)$  curve shifts to the right and the  $(C_1)$  curve rotates to the left, yielding  $(I_2)$  and  $(C_2)$  curves as the new equilibrium conditions. At the new equilibrium point  $b$ ,  $m$  and  $n_L$  are both higher than in the old equilibrium  $a$ . See Appendix for a formal proof. ■

When the US-Mexico real exchange rate rises, each dollar of remittances will translate into a higher Mexican consumption than before. Intuitively, those workers who were formerly on the verge of migrating, but did not, will now join the pool of migrants. In terms of the cut-off  $\hat{\alpha}$ , this can be interpreted as follows: the households which allocate a large share of their income to the dependents, i.e. the households with a relatively high  $\alpha$ , always derive a higher utility from a given US wage than do others. Therefore, workers from these households are always more likely than other workers to pursue migration. When the real exchange rate rises, the cut-off  $\hat{\alpha}$  becomes smaller, meaning that even households with a relatively small  $\alpha$  come to find migration worthwhile.

**Proposition 3** *The ratio of the low-paying sector to total US employment of Mexican workers rises as the US-Mexico real price gap widens.*

**Proof.** To show  $\partial(n_L/(n_L + n_H))/\partial Q > 0$ , it is sufficient to show  $\frac{\partial n_L}{\partial Q} > 0$ , as  $n_H$  only depends on  $\bar{w}$ , which is exogenously fixed. That  $\frac{\partial n_L}{\partial Q} > 0$  is already shown in the proof above. See Appendix for a formal proof. ■

Proposition 3 has much to do with the probability that a migrant will stay in the US even for a low-paying job. As a unit of the US wage becomes more attractive than before, a migrant who would have returned to Mexico in the event that he drew a bad wage and a high psychic cost now finds it worthwhile to stay in the US even for a low-paying job.

Next, I explore the relationship between household types and their behavioral responses to the US-Mexico real price gap. Household type is completely characterized by the index  $\alpha$ , which indicates in what proportion a worker shares his income with his dependents.

**Proposition 4** *Consider  $\alpha_j$  and  $\alpha_k$  such that  $\alpha_j > \hat{\alpha}$  and  $\alpha_k > \hat{\alpha}$ . If  $\alpha_j < \alpha_k$ , then as  $Q$  goes up the probability that worker  $\alpha_k$  is employed in the informal sector becomes higher relative to the probability that worker  $\alpha_j$  is employed in the informal sector.*

**Proof.** See Appendix. ■

It is intuitive that a Mexican migrant who spends most of his income in Mexico will be more *willing* to work for a lower wage in the US than a migrant who spends most of his income in the US. This is because the former will tend to evaluate a US wage on the basis of its purchasing power in Mexico. However, whether the former will *actually* receive a lower wage in response to the exchange rate shock should not be quite as obvious – he can always hide his reservation wage from employers and claim the fair market wage. Heterogeneity in employment outcomes among workers may be generated in models of equilibrium unemployment (Harris and Todaro, 1970, Carl Shapiro and Joseph E. Stiglitz, 1984). However, in those models workers are randomly assigned to either the high-paying jobs or the unemployment pool, and there exists no correlation between the reservation and actual wages of workers. In contrast, my model is able to establish the link between worker types (hence their reservation wages) and their labor market outcomes in equilibrium, as Proposition 4 shows. This is achieved by introducing the outside option of return migration to Mexico in the model.

## 5 Data

### 5.1 Characteristics of Mexican Workers

Information on the migration experiences of Mexican workers is based on the Mexican Migration Project (MMP) dataset.<sup>19</sup> The MMP started in 1982, and each year during the winter months (when seasonal migrants are home) around 200 randomly selected households are surveyed in each community chosen for the survey. The MMP is an ongoing project; I use the MMP107 database, which contains information on 107 communities. Each community is surveyed only once but the

---

<sup>19</sup>The MMP is a collaborative research project based in Princeton University and the University of Guadalajara, and the dataset is publicly available (<http://mmp.opr.princeton.edu/>).

heads of household are asked their entire life retrospective migration histories. For my analysis, I use only the information that relies on a recall length of 15 years or fewer, assuming that people can reasonably recall events that occurred up to 15 years before. For instance, if a head of household was interviewed in 1995, I use his information pertaining to the periods between 1980 and 1995, but discard his information for the years prior to 1980.<sup>20</sup>

The data provided in the MMP allow the construction of panel data at the head-of-household level, where the unit of observation is a person-year. The information that the MMP provides for each person-year is rather sparse: we observe a person’s demographic status, location of residence, and occupation, but not wages. In contrast, the MMP reports more detailed information, such as remittances and wages, on the most recent migration spell of each person (see Table A1 for the summary statistics for this subset of the panel dataset). Therefore, based on the detailed information from the last migration episodes, we can establish a link between occupation and wages in the US. Following the strategy in Munshi (2003), I classify occupations in the US into two categories: agricultural and non-agricultural. As Table A2 shows, even after controlling for various human capital characteristics of the migrants, as well as year, destination MSA, and origin community fixed effects, agricultural jobs in the US are lower-paying than non-agricultural jobs in terms of both hourly wage and annual income. Therefore, we will henceforth treat occupations in the agricultural sector as low-paying (L) and those in the non-agricultural sector as high-paying (H) in the ensuing panel regression analyses.

My sample is restricted to individuals that are between the ages of 18 and 64. I confine my analysis to the male heads of household since that represents the predominant household configuration in Mexico. The summary statistics for the main dataset are provided in Table 1. The first column includes all the person-years in the sample, and the next three columns pertain to the person-years in which the respondent was in the US. “New migrants” refer to individuals who freshly arrived in the US in the given person-year, and “established migrants” refer to those who arrived in the US in any prior year. As we see in the first column of Table 1, about eight percent of all person-years are spent in the US among members of the sample. Migrants tend to be younger than the general population and are, by and large, undocumented. Also, the average educational attainment of Mexican workers is low (under 6 years of education).

In a recent review, Hanson (2006) concludes that the MMP sample is by design reasonably

---

<sup>20</sup>See Megan Beckett et al. (2001); James P. Smith and Duncan Thomas (2003) for measurement error in retrospective data.

representative of seasonal migrants in communities with traditionally high migration flows but not of the general population. Therefore, the conclusions derived from these data should be applied to seasonal migrants who return to Mexico with high frequency. However, that is precisely the population to which the theory developed in section 3 is most applicable.

## 5.2 Real Exchange Rates

The US-Mexico real price difference, or the real exchange rate (RER), is

$$Q = \frac{ep^*}{p},$$

where  $e$  is the market nominal exchange rate measured in pesos per dollar and  $p$  and  $p^*$  are the nominal price indices in Mexico and the US, respectively. The peso-dollar market exchange rate  $e$ , and the PPP conversion factor  $p/p^*$  are obtained from the Penn World Table (PWT). Then,  $Q$  is constructed by dividing the nominal exchange rate by the PPP conversion factor.<sup>21</sup>

Figure 3 shows the US-Mexico real exchange rate  $Q$ , between 1968 and 1996. The mean real exchange rate is around 2 with a standard deviation of 0.4, meaning that the US dollar, when spent in Mexico, has on average twice as much purchasing power in real terms than when spent in the US. Despite the large fluctuations in the real exchange rate, it never falls below 1, i.e. the purchasing power of the peso relative to the dollar is always lower. This is consistent with the Balassa-Samuelson hypothesis in that real price levels tend to be lower in poorer countries in general.

## 5.3 Macroeconomic and Policy Controls

In some of the specifications, I use macroeconomic and policy controls. The variables include the real GDP data obtained from the Penn World Table, US unemployment data from the Bureau of Labor Statistics, and Mexican urban unemployment rate (available only for 1973-1996) from the National Institute of Statistics, Geography and Informatics of Mexico (INEGI). Dummy variables indicating whether the Immigration Reform and Control Act (IRCA) of 1986 and Immigration Act of 1990 are effective are constructed following the coding scheme of Hanson and Spilimbergo (1999).

---

<sup>21</sup>The PWT reports PPP conversion factors that are based on GDP, consumption, government spending, and investment, respectively. I use the one based on consumption to proxy as closely as possible the real exchange rates that would matter most for Mexican migrant workers.

## 6 Empirical Strategy

Identification is based on the interaction between the individual's family structure and variation in the US-Mexico real exchange rate over time. In particular, I use information on marital status and the existence of children under the age of 18 for all person-years. The underlying assumption is that the workers who have dependents in Mexico will be more likely to evaluate a US wage in terms of its purchasing power in Mexico, and thus be more strongly motivated by the price arbitrage opportunities, than others. In the theoretical model, households differ on one dimension, namely  $\alpha$ , and the only role that the parameter  $\alpha$  plays is to determine what fraction of the worker's income would be spent in Mexico as opposed to the US in the event of migration. Here, individuals with more dependents in Mexico correspond to "high  $\alpha$ " types in the theoretical model and those without are regarded as having low values of  $\alpha$ .

It might seem more straightforward to measure  $\alpha$  based on the actual remittances behavior of individuals and compare the outcomes of interest between individuals with different values of  $\alpha$ . However, such an approach is neither feasible nor practical. First of all, the MMP dataset does not contain information on remittances behavior for all migration spells. Information on remittances is available only for the most recent migration episodes of individuals who have ever migrated to the US. Second, even if information on remittances were available for all the migrants, the  $\alpha$  for person-years who are not in migration would have to be determined by other measures since remittances are irrelevant for non-migrants. Lastly, remittances themselves may be endogenous to the real exchange rate. A recent empirical study by Dean Yang (2008) shows that a change in the exchange rate between the host and source countries indeed alters the remittances behavior of Filipino migrants abroad.

Due to the methodological concerns associated with remittances data, I proxy for  $\alpha$  based on an individual's family structure, which is predetermined with respect to the Mexico-US real price differences: Mexican workers cannot systematically change their marital status or the number of children in each person-year as a response to the high frequency variation in the US-Mexico real exchange rate.

In light of the previous discussion, it is worthwhile to establish the correlation between family structure and remittances in order to assess whether the former is, in fact, an adequate proxy for  $\alpha$ .

## 6.1 Is Family Structure a Good Proxy for Cross-border Resource Allocation Patterns?

Using data on the last migration spell of workers, I classify the migrants into four groups depending on their family status: unmarried with no children under 18 (group 0); married without children (group 1, denoted by  $D^1$ ); unmarried with children (group 2;  $D^2$ ); and married with children (group 3;  $D^3$ ). Then, using the remittances behavior of group 0 as a benchmark, I test if groups 1, 2, and 3 behave differently than the base group. Specifically, I conduct a regression analysis using the following specification:

$$R_{it} = c_0 + \beta_1 D_{it}^1 + \beta_2 D_{it}^2 + \beta_3 D_{it}^3 + X_{it}\lambda + \varepsilon_{it}, \quad (13)$$

where  $i$  corresponds to the person and  $t$  to the year. The variable  $R_{it}$  indicates whether a person sent any remittances back to Mexico. The explanatory variables include a constant ( $c_0$ ), variables  $D^1$ ,  $D^2$ , and  $D^3$  that indicate the family status of the migrant as defined above, and a vector of individual-specific controls ( $X_{it}$ ). The coefficients of interest are therefore  $\beta_1$ ,  $\beta_2$ , and  $\beta_3$ . The individual-level control variables consist of the following: log of hourly wage or log of annual income, age, a quadratic in educational attainment, English proficiency (0 to 4), and US document status (legal/illegal). Depending on specifications, I also include the community of origin, year, and destination MSA fixed effects. I estimate (13) using OLS, clustering the standard errors at the origin community-level.

The results are presented in Table 2. The coefficients from column (3) indicate that, compared to an unmarried migrant without children, a migrant who is married with children is 10.2 percentage points more likely to send remittances. This corresponds to 12.8 percent of the mean (see Panel B of Table A1). However, remittances behavior of migrants in groups 1 and 2 does not differ in a statistically significant way from the baseline group. Similar results are obtained when we replace the hourly wage with annual income (see column (6)).<sup>22</sup>

Although remittances may not be the only way that a migrant in the US engages in consumption activities in Mexico, it is reassuring to see that migrants in group 3 behave differently than the baseline group in a way that is consistent with the assumption underlying my identification strategy. Since we do not find any difference between the remittance patterns of the baseline group and the people in group 1 or 2, the ensuing analysis will focus mostly on the difference between group 3

---

<sup>22</sup>I also estimate equation (13) using probit models and the results are virtually identical to those from OLS regressions.

and the baseline group. From here on, individuals who are married with children (group 3) will be treated as “high  $\alpha$ ” types and those who are unmarried without children (group 0) as having low values of  $\alpha$  from the theory.

## 6.2 US-Mexico Real Price Gap and the Behavioral Responses by Mexican Workers

To see if the price arbitrage effect in migration is actually at play, I consider two testable implications of the theoretical model. As the US dollar gains more purchasing power in Mexico (a rise in  $Q$ ), Mexican workers with high values of  $\alpha$  should be (i) more likely to migrate and (ii) more likely to work in the low-paying (agricultural) sector in the US than their low  $\alpha$  counterparts.

Consider the following regression:

$$y_{it} = c_0 + \phi_i + \xi_t + \sum_{k=1}^3 \beta_k D_{it}^k + \sum_{k=1}^3 \gamma_k (D_{it}^k \times Q_t) + \sum_{k=1}^3 (D_{it}^k \times Z_t) \delta_k + X_{it} \lambda + \varepsilon_{it}. \quad (14)$$

The variable  $y_{it}$  may represent either the migration status of individual  $i$  in year  $t$ , or the labor market outcome of a temporary migrant to the US, depending on the specification. The regressors include a constant ( $c_0$ ), the time-invariant individual characteristics ( $\phi_i$ ), and the time fixed effects ( $\xi_t$ ), among others. Note that  $\xi_t$  will absorb all effects of real exchange rate (RER) fluctuations or policy changes that are common to high- and low- $\alpha$  types. Identification thus comes from the differential effect of RER fluctuations across types.

As in (13), the dummy variables  $D^1$ ,  $D^2$ , and  $D^3$  indicate the family status of each person-year: married without young children ( $D^1$ ); unmarried with children ( $D^2$ ); and married with children ( $D^3$ ). The omitted category is unmarried individuals without children under the age of 18. The variable  $Q_t$  denotes the US-Mexico real exchange rate in year  $t$ . The vector  $Z_t$  includes macroeconomic and policy controls that may differentially influence individuals, but which may be correlated with  $Q_t$ . Finally, the vector  $X_{it}$  is the time-varying individual-specific controls that include the ownership of land, property, or business, and the US document status in the event of migration.

The coefficient of main interest is  $\gamma_3$  which shows the additional response to  $Q_t$  by individuals who are married with children (high  $\alpha$  types) over and above the response by the benchmark group of individuals who are unmarried without children (low  $\alpha$  types).

### 6.2.1 Concurrent vs. Lagged Price Levels

A natural question that arises in the empirical implementation of (14) is whether it is the concurrent or lagged real exchange rate that Mexican workers in a given year respond to. For example, the large implementation costs might result in a lag in acting on migration decisions, while job adjustment of migrants within the US might occur more rapidly. To deal with this issue, I start by running a variant of (14) which includes the lagged values of  $Q$  as well as the concurrent one. Consider the following regression:

$$\begin{aligned}
 y_{it} = & c_0 + \phi_i + \xi_t + \sum_{k=1}^3 \beta_k D_{it}^k + \sum_{k=1}^3 \gamma_k (D_{it}^k \times Q_t) \\
 & + \sum_{k=1}^3 \delta_k (D_{it}^k \times Q_{t-1}) + \sum_{k=1}^3 \lambda_k (D_{it}^k \times Q_{t-2}) + \sum_{k=1}^3 \mu_k (D_{it}^k \times Q_{t-3}) + \varepsilon_{it},
 \end{aligned} \tag{15}$$

where  $Q_{t-1}$ ,  $Q_{t-2}$ , and  $Q_{t-3}$  denote the US-Mexico real exchange rate lagged by one, two, and three years, respectively. The main coefficients of interest here are  $\gamma_3$ ,  $\delta_3$ ,  $\lambda_3$ , and  $\mu_3$ . Once the relevant lag size is determined, the main analysis will be based on equation (14) where  $Q_t$  is replaced by a lagged value as appropriate.<sup>23</sup>

## 7 Empirical Results

### 7.1 Migration Status

The migration outcome is measured such that  $y_{it}$  is 1 if the worker is located in the US in that person-year, and 0 if the worker is located in Mexico. The estimates of equation (15) are provided in Table 3. Columns (1) through (4) are based on all the person-years in the sample. Regardless of the lag size in  $Q$ , we do not find any discernable difference between the migration behavior of workers who are married with children and those who are unmarried without children. Next, I try to split the sample by skill level. I define “skilled” as having educational attainment greater than 6 years and “unskilled” as having educational attainment of 6 years or fewer. The idea is that skilled and unskilled workers may have different levels of access to information or migration opportunities when price arbitrage opportunities arise. Thus, their migration patterns in response to the change in real prices may differ. Columns (7) and (8) show that among skilled workers, there is statistically

---

<sup>23</sup>For lagged  $Q$  to affect contemporaneous behavior, real exchange rate shock must exhibit some degree of persistence. However, note that clustering at the individual level non-parametrically adjusts standard errors for arbitrary patterns of autocorrelation.

significant difference between the migration patterns of the baseline group (unmarried without children) and workers who are married with children. It turns out that the migration decisions of workers depend on the previous year's real exchange rate, not the concurrent one. This makes sense insofar as migration decision requires time to implement. For example, prospective migrants must obtain a US visa in case of legal migration and seek help from smugglers in case of illegal migration, etc. These administrative and pecuniary costs involved in migration might contribute to the delayed response to given change in the real exchange rate. The coefficients in column (8) show that as the US-Mexico real exchange rate deviates from PPP by one standard deviation (0.4) from the mean (2), a worker who is married with minor dependents becomes about 1.2 percentage points more likely to be in the US in the following year than a worker who is unmarried without children. This effect measures only the differential response to the price arbitrage opportunity by the former over and above the response by the latter. To the extent that the baseline group also reacts to price arbitrage opportunities, the overall effects will be larger. As columns (9) through (12) show, we do not find any effect among unskilled workers. Again, this does not mean that the baseline group does not react to the real price differences. Rather, it indicates that there is no difference between the migration responses of high and low  $\alpha$ 's within unskilled workers. In the analysis that follows, I examine the case of skilled workers in more detail.

## 7.2 Migration Behavior of Skilled Workers

Based on the sample of skilled workers, I estimate equation (14) where  $Q_t$  is now replaced with  $Q_{t-1}$ . The estimates are presented in Panel A of Table 4. Column (1) is the baseline regression. Columns (2) through (4) present specifications where various macroeconomic and policy variables are controlled for. As before, the workers who are married with children are more responsive to the real exchange rate compared to the baseline group. Without the  $Q$ 's from other periods, the coefficient  $\gamma_3$  is estimated to be smaller than before but it is still statistically significant at the conventional level. In column (5), I add additional individual-level controls (ownership of land, property, and business) and obtain identical results. Specifically, the coefficient indicates that as the purchasing power of the US dollar in Mexico deviates by one standard deviation (0.4) from the mean of two, skilled Mexican workers who are married with children are 0.72 percentage points more likely to be in the US as opposed to Mexico compared to the baseline group. It is interesting in that individuals who are otherwise less likely to migrate, if anything, tend to respond *more* to the US-Mexico real price difference in particular. This is as predicted by the price arbitrage story

of migration. Column (6) reports the estimates when the sample is restricted to workers aged 18-49 years old who are more likely to be active in the labor market as opposed to those aged 18-64 years old. The results remain virtually the same. Column (7) presents the results when I discard observations from the survey year and the year just prior to that. This is to address potential bias arising from the absence of certain migrants at the time the survey was taking place in Mexico. The point estimate of  $\gamma_3$  is statistically not distinguishable from that in the full sample.

So far, I have used the level of real exchange rate  $Q_{t-1}$  in the regressions. As a specification check, I repeat the analysis above using log of  $Q_{t-1}$  instead. The results are presented in Panel B of Table 4. Again, the estimates of  $\gamma_3$  are robust to the inclusion of macroeconomic and policy controls, time-varying characteristics of individuals, and sample restrictions. Based on the point estimate in column (5), as the purchasing power of the US dollar in Mexico goes up by one standard deviation, the high  $\alpha$ 's are 0.78 percent more likely to be in the US relative to the baseline group. Overall, the estimated effects are quite consistent with those in Panel A.

### 7.3 Occupational Outcomes in the US

Next, I examine the effects of the US-Mexico real price gap on the occupational outcomes of Mexican migrants in the US. For this analysis, I only consider individuals who are currently employed.<sup>24</sup> The occupational outcome  $y_{it}$  is measured as 1 if the person-year is employed in a high-paying (non-agricultural) job and 0 if he is in a low-paying (agricultural) job.

I start by estimating equation (15) for all the person-years. I then examine the cases of new migrants and established migrants separately in light of earlier studies documenting the evolution of migrants' labor market outcomes with tenure in the host country (see Eckstein and Weiss, 2004, for example). The results are provided in Table 5. As we see in columns (1) through (4), although being married with children is positively associated with the likelihood of employment in the high-paying sector, there is no differential response in this group to the US-Mexico real price gap over and above that of the baseline group. However, in the sample of new migrants, we do find effects that are consistent with the price arbitrage theory. According to column (8), as the purchasing power of the US dollar in Mexico goes up by one standard deviation (0.4), migrants who are married and have minor dependents are 3.8 percent more likely to be employed in the low-paying (agricultural) sector. Also, unlike the case of the decision to migrate, the labor market response is to the concurrent real exchange rate rather than to a lagged value. This makes sense insofar as

---

<sup>24</sup>Unemployment rate is less than 1 percent.

migration decisions require time to implement whereas labor market decisions can be immediate. In contrast to the case of new migrants, for established migrants we do not find any difference across worker types in terms of their response to the real exchange rate. This is consistent with the idea that the sorting of new migrants across occupations is noisier than that of established migrants who have had more time to match with employers.

#### 7.4 Labor Market for Freshly Arrived Migrants

To examine the case of new migrants further, I estimate equation (14) using the sample of individuals who are in their first year of migration in the US. The results are presented in Panel A of Table 6. Column (1) shows the estimates for the baseline regression. The estimates show that being married with children has, if anything, a direct positive effect of 17.8 percentage points on the likelihood of employment in a high-paying job. In contrast, as the purchasing power of the US dollar in Mexico rises by one standard deviation (0.4), workers of this type are 3.16 percent more likely to be working in the low-paying sector than those who are unmarried without children. This result clearly demonstrates the argument of migration as price arbitrage: if the workers were to evaluate all of their US income by its purchasing power in the US, why should they ever respond to the dollar's purchasing power in Mexico?

To make sure that what we are capturing here is the differential response of migrants with high values of  $\alpha$  (married with children) to the real exchange rate, not other macro-level shocks, I try to control for the interaction between worker types and the macroeconomic and policy controls. The results are robust when I include the strictness of US immigration policies (column (2)), real GDPs in Mexico and the US (column (3)), and unemployment rates in both countries (column (4)). The results are also robust to the inclusion of individual-level controls such as the US document status of workers (column (5)), and the ownership of land, property, and business (column (6)). The point estimate in column (6) indicates that one standard deviation rise (0.4) in the Mexican purchasing power of the US dollar makes Mexican migrants who are married with children 2.84 percentage points more likely to be working in the low-paying, agricultural sector in the US than the baseline group. When I restrict the sample to workers between 18 and 49 years of age, the point estimate of  $\gamma_3$  goes up slightly, intensifying the price arbitrage effect (column (7)). Column (8) shows the estimates when I discard observations from the survey year and the year before. Again, the results are robust to this sample restriction.

Repeating the specification check from above, I estimate equation (14) by replacing  $Q_t$  with the

logarithm of  $Q_t$ . The results are similar to those from the level specification, and the magnitude of effects is slightly larger. Column (6) reads that as the US-Mexico real exchange rate goes up by one standard deviation (0.4) from the mean (2), Mexican migrants who are married with children are 3.8 percent more likely to be working in the low-paying sector compared to those who are unmarried and without minor dependents.

## 7.5 Discussion

The main empirical findings can be summarized as follows: as the purchasing power of the US dollar in Mexico goes up, (a) skilled Mexican workers who are married with children under the age of 18 (and are thus more likely to evaluate a US wage based on its purchasing power in Mexico) are more likely to be in the US relative to singles without children; and (b) Mexican migrants who are married with children are more likely to be working in the low-paying agricultural sector than those who are unmarried and without children. This second effect is found only among new migrants, not established ones who have experienced the US labor market for longer than one year.

My empirical analysis relied on the existence of additional response to price arbitrage opportunities by workers who are predicted to respond more to them over and above the response made by the baseline group. To the extent that the baseline group also reacts to price arbitrage opportunities, the average response of all workers may be larger although estimating such effect was not the purpose of my empirical exercise. Rather, I tried to document evidence for migration as price arbitrage as predicted by the theory.

An empirical issue is whether the real exchange rate that I use in this analysis is the most sensible one. The answer will depend on how relevant the basket of goods that the Penn World Table uses is to the households of Mexican migrant workers. As Angus Deaton (2006) points out, the PPP exchange rates are not constructed for the purpose of measuring poverty, so there is no guarantee that they will accurately convert the living standards of poor people from one country to another. For instance, the basket of goods that the poor face may have far fewer imported goods than the basket of a typical household. Moreover, the price levels will differ across regions within the same country and even across households within a community. Ideally, I would have liked to use the US-Mexico real exchange rate, which is household- or region-specific. However, even disregarding the case of Mexico, CPIs that are comparable across cities do not exist in the US.<sup>25</sup> To the extent that the real exchange rate that I used here is a proxy for the US-Mexico price

---

<sup>25</sup>The US Bureau of Labor Statistics provides CPIs for major US cities, but they are comparable only across time

differences felt by Mexican workers, this study will serve as a useful benchmark for future research on this issue.

## 8 Conclusion

This paper theoretically and empirically demonstrated price arbitrage as the force driving US-Mexico migration, and the patterns of employment of Mexican workers in the US. A higher purchasing power of the US dollar in Mexico has been shown to lead to increased Mexico-US migration, and the deterioration of the occupational outcome of a Mexican migrant worker in the US, *ceteris paribus*. Real price or cost-of-living differences between regions, especially between rich and poor regions, are a well-known phenomenon. This paper showed migration and subsequent optimization of consumption mix across borders as a strategy employed in order to take advantage of the persistent real price gap between regions. To the extent that the real price differences are large relative to the costs of migration, the analytical framework presented in this paper could be applied to other pairs of countries or regions such as East-West migration within Europe or rural-urban migration in China.

## References

- [1] Asplund, Marcus and Richard Friberg (2001). “The Law of One Price in Scandinavian Duty-Free Stores,” *American Economic Review*, 91(4): 1072-1083.
- [2] Balassa, Bela (1964). “The Purchasing Power Parity Doctrine: A Reappraisal,” *Journal of Political Economy*, 72(6):584-96.
- [3] Basu, Kaushik (2003). *Analytical Development Economics: The Less Developed Economy Revisited*, MIT Press.
- [4] Basu, Kaushik (2006). “Gender and Say: A Model of Household Behavior with Endogenously-determined Balance of Power,” *Economic Journal*, 116(511): 558-580.
- [5] Beckett, Megan, Julie Da Vanzo, Narayan Sastry, Constantijn Panis, and Christine Peterson (2001). “The Quality of Retrospective Data: An Examination of Long-Term Recall in a Developing Country,” *Journal of Human Resources*, 36(3): 593-625.

---

within cities, not across cities at a point in time.

- [6] Bergstrom, Theodore C. (1997). "A Survey of Theories of the Family," in *Handbook of Population Economics*, edited by Mark R. Rosenzweig and Oded Stark, North-Holland.
- [7] Borjas, George J. (1987). "Self-Selection and the Earnings of Immigrants," *American Economic Review*, 77(4): 531-553.
- [8] Borjas, George J. (1994). "The Economics of Immigration," *Journal of Economic Literature*, 32: 1667-1717.
- [9] Browning, Martin, Francois Bourguignon, Pierre-Andre Chiappori, and Valerie Lechene (1994). "Income and Outcomes: A Structural Model of Intrahousehold Allocation," *Journal of Political Economy*, 102(6): 1067-96.
- [10] Chiquiar, Daniel and Gordon H. Hanson (2005). "International Migration, Self-Selection, and the Distribution of Wages: Evidence from Mexico and the United States," *Journal of Political Economy*, 113(2): 239-281.
- [11] Chiswick, Barry (1978). "The Effect of Americanization on the Earnings of Foreign-Born Men," *Journal of Political Economy*, 86: 897-922.
- [12] Deaton, Angus (2006). "Measuring Poverty," in *Understanding Poverty*, edited by Abhijit Banerjee, Roland Benabou, and Dilip Mookerjee, Oxford University Press.
- [13] Djajic, Slobodan (1989). "Migrants in a Guest-worker System," *Journal of Development Economics*, 31: 327-339.
- [14] Durand, Jorge, William Kandel, Emilio Parrado and Douglas S. Massey (1996). "International Migration and Development in Mexican Communities," *Demography*, 33(2): 249-264.
- [15] Dustmann, Christian (1995). "Savings Behavior of Return Migrants: A Life-cycle Analysis," *Zeitschrift fur Wirtschafts- und Sozialwissenschaften*, 115: 511-533.
- [16] Dustmann, Christian (1997). "Return Migration, Uncertainty and Precautionary Savings," *Journal of Development Economics*, 52: 295-316.
- [17] Dustmann, Christian (2003). "Return Migration, Wage Differentials, and the Optimal Migration Duration," *European Economic Review*, 47: 353-369.

- [18] Eckstein, Zvi and Yoram Weiss (2004). “On the Wage Growth of Immigrants: Israel 1990-2000,” *Journal of the European Economic Association*, 2(4): 665-695.
- [19] Fields, Gary S. (2005). “A Guide to Multi-Sector Labor Market Models,” working paper, Cornell University.
- [20] Friedberg, Rachel M. (2000). “You Can’t Take It with You? Immigrant Assimilation and the Portability of Human Capital,” *Journal of Labor Economics*, 18(2): 221-251.
- [21] Goldberg, Penelopi K. and Michael M. Knetter (1997). “Goods Prices and Exchange Rates: What Have We Learned?,” *Journal of Economic Literature*, 35(3): 1243-72.
- [22] Greenwood, Michael J. (1985). “Human Migration: Theory, Models, and Empirical Studies,” *Journal of Regional Science*, 25(4): 521-45.
- [23] Hanson, Gordon H. (2006). “Illegal Migration from Mexico to the United States,” *Journal of Economic Literature*, 44: 869-924.
- [24] Hanson, Gordon H., and Antonio Spilimbergo (1999). “Illegal Immigration, Border Enforcement, and Relative Wages: Evidence from Apprehensions at the U.S.-Mexico Border,” *American Economic Review*, 89(5), 1337-1357.
- [25] Harris, John R. and Michael P. Todaro (1970). “Migration, Unemployment and Development: A Two-Sector Analysis,” *American Economic Review*, 60: 126–142.
- [26] Lalonde, Robert J. and Robert H. Topel (1997). “Economic Impact of International Migration and the Economic Performance of Migrants,” in *Handbook of Population and Family Economics*, edited by Mark R. Rosenzweig and Oded Stark, North-Holland.
- [27] Massey, Douglas S., L. Goldring, and Jorge Durand (1994). “Continuities in Transnational Migration: An Analysis of Nineteen Mexican Communities,” *American Journal of Sociology*, 99(6): 1492-1533.
- [28] Massey, Douglas S. and Kristin E. Espinosa (1997). “What’s Driving Mexico-U.S. Migration? A Theoretical, Empirical, and Policy Analysis,” *American Journal of Sociology*, 102(4): 939-999.

- [29] McKenzie, David and Hillel Rapoport (2007). "Network Effects and the Dynamics of Migration and Inequality: Theory and Evidence from Mexico," *Journal of Development Economics*, 84: 1-24.
- [30] Munshi, Kaivan (2003). "Networks in the Modern Economy: Mexican Migrants in the U.S. Labor Market," *Quarterly Journal of Economics*, 118(2):549-99.
- [31] New York Times (2005). "More American Retirees Seek Havens Abroad," by Hillary Chura, *The New York Times*, July 30, 2005.
- [32] Orrenius, Pia M., and Madeline Zavodny (2005). "Self-selection among Undocumented Immigrants from Mexico," *Journal of Development Economics*, 78:215-240.
- [33] Rapoport Hillel and Frederic Docquier (2006). "The Economics of Migrants' Remittances," in *Handbook on the Economics of Reciprocity, Giving and Altruism, Volume 2: Applications*, edited by Serge-Christophe Kolm and Jean Mercier Ythier, Elsevier-North Holland.
- [34] Rogoff, Kenneth (1996). "The Purchasing Power Parity Puzzle," *Journal of Economic Literature*, 34(2): 647-668.
- [35] Rosenzweig, Mark R. and Oded Stark (1989). "Consumption Smoothing, Migration, and Marriage: Evidence from Rural India," *Journal of Political Economy*, 97(4): 905-926.
- [36] Roy, A.D. (1951). "Some Thoughts on the Distribution of Earnings," *Oxford Economic Papers*, New Series, 3(2): 135-146.
- [37] Samuleson, Paul A. (1964). "Theoretical Notes on Trade Problems," *Review of Economics and Statistics*, 46(2):145-54.
- [38] Shapiro, Carl, and Joseph E. Stiglitz (1984). "Equilibrium Unemployment as a Worker Discipline Device," *American Economic Review*, 74(3): 433-444.
- [39] Sjaastad, Larry A. (1962). The Costs and Returns of Human Migration, *Journal of Political Economy*, 70(5): 80-93.
- [40] Smith, James P. and Duncan Thomas (2003). "Remembrances and Things Past: Test-Retest Reliability of Retrospective Migration Histories," *Jouranal of the Royal Statistical Society*, 166(1): 23-49.

- [41] Stark, Oded (1991). *The Migration of Labor*, Cambridge, Blackwell.
- [42] Stark, Oded, Christian Helmenstein, and Yury Yegorov (1997). “Migrants’ Savings, Purchasing Power Parity, and the Optimal Duration of Migration,” *International Tax and Public Finance*, 4: 307-324.
- [43] Taylor, Alan and Mark Taylor (2004). “The Purchasing Power Parity Debate,” *Journal of Economic Perspectives*, 18(4): 135-158.
- [44] Todaro, Michael P. (1969). “A Model of Labor Migration and Urban Unemployment in Less Developed Countries,” *American Economic Review*, 59(1): 138-148.
- [45] Trejo, Stephen J. (1997). “Why Do Mexican Americans Earn Low Wages?,” *Journal of Political Economy*, 105(6): 1235-1268.
- [46] Union Bank of Switzerland (2008). *Prices and Earnings: A Comparison of Purchasing Power around the Globe*, UBS.
- [47] Yang, Dean (2008). “International Migration, Remittances, and Household Investment: Evidence from Philippine Migrants’ Exchange Rate Shocks,” *Economic Journal*, 118: 591-630.

## 9 Appendix

### 9.1 Proof of Proposition 2 and Proposition 3

Consider the “Indifference ( $I$ )” condition given in (9). It pins down the total level of migration  $m$  in equilibrium. Denote the equilibrium  $m$  by  $\eta(Q)$ . Next, denote the left hand side of the ( $I$ ) condition by  $g$ . Taking partial derivatives of (9) with respect to  $Q$ ,

$$\frac{\partial g}{\partial m} \frac{\partial \eta(Q)}{\partial Q} + \frac{\partial g}{\partial Q} = 0. \quad (16)$$

Know

$$\frac{\partial g}{\partial Q} = (1-m)Q^{-m} \left\{ \frac{n_H}{m} \bar{w} + \left(1 - \frac{n_H}{m}\right) \frac{w_L}{2c} (\hat{\theta}(\hat{\alpha}) + c) \right\} \geq 0,$$

because  $\hat{\theta}(\hat{\alpha}) \in [-c, c]$ . Next,

$$\begin{aligned} \frac{\partial g}{\partial m} &= \frac{n_H}{m} \left[ \frac{1}{4cm} \{ (Q^{1-m} w_L)^2 + (w+c)^2 \} - Q^{1-m} \bar{w} \{ \ln Q + \frac{1}{m} (w+c) \} \right] \\ &\quad - \left(1 - \frac{n_H}{m}\right) \left(\frac{1}{2c}\right) (Q^{1-m} w_L) (\ln Q) (\hat{\theta}(\hat{\alpha}) + c), \end{aligned}$$

Know that the second term  $-(1 - \frac{n_H}{m})(\frac{1}{2c})(Q^{1-m} w_L)(\ln Q)(\hat{\theta}(\hat{\alpha}) + c) < 0$ , again using  $\hat{\theta}(\hat{\alpha}) \in [-c, c]$ .

A3 is a sufficient condition for

$$\frac{1}{4cm} \{ (Q^{1-m} w_L)^2 + (w+c)^2 \} - Q^{1-m} \bar{w} \{ \ln Q + \frac{1}{m} (w+c) \} \leq 0,$$

which in turn implies  $\frac{\partial g}{\partial m} < 0$ . Solving (16) for  $\frac{\partial \eta(Q)}{\partial Q}$  and using  $\frac{\partial g}{\partial Q} \geq 0$  and  $\frac{\partial g}{\partial m} < 0$ , we can derive

$$\frac{\partial \eta(Q)}{\partial Q} = -\frac{\partial g}{\partial Q} \left( \frac{\partial g}{\partial m} \right)^{-1} \geq 0.$$

This means that the total equilibrium migration level  $m$  rises as  $Q$  goes up. Diagrammatically, this means the ( $I$ ) curve shifts to the right when  $Q$  goes up. This is illustrated in Figure 2.

Next, consider equation (11), which is an alternative representation of the “Consistency ( $C$ )” condition provided in (10). Taking total derivatives of (11), we obtain

$$\begin{aligned} dn_L &= \left[ \frac{n_H}{m} \frac{w_L}{2c} \left\{ \left( \frac{Q - Q^{1-m}}{m \ln Q} \right) - Q^{1-m} \right\} + \frac{1}{2c} (\hat{\theta} + c) \right] dm \\ &\quad + \left\{ \left(1 - \frac{n_H}{m}\right) \frac{w_L}{2c} \frac{1}{(\ln Q)^2} \left[ \{1 - (1-m)Q^{-m}\} \ln Q - (1 - Q^{-m}) \right] \right\} dQ \end{aligned} \quad (17)$$

For a fixed  $n_L$ , i.e. when  $dn_L = 0$ ,

$$\begin{aligned} \left. \frac{dm}{dQ} \right|_{n_L} &= - \left\{ \left(1 - \frac{n_H}{m}\right) \frac{w_L}{2c} \frac{1}{(\ln Q)^2} \left[ \{1 - (1-m)Q^{-m}\} \ln Q - (1 - Q^{-m}) \right] \right\} \\ &\quad \times \left[ \frac{n_H}{m} \frac{w_L}{2c} \left\{ \left( \frac{Q - Q^{1-m}}{m \ln Q} \right) - Q^{1-m} \right\} + \frac{1}{2c} (\hat{\theta} + c) \right]^{-1}. \end{aligned}$$

Know that

$$(1 - \frac{n_H}{m}) \frac{w_L}{2c} \frac{1}{(\ln Q)^2} [\{1 - (1 - m)Q^{-m}\} \ln Q - (1 - Q^{-m})] \geq 0$$

and

$$[\frac{n_H}{m} \frac{w_L}{2c} \{(\frac{Q - Q^{1-m}}{m \ln Q}) - Q^{1-m}\} + \frac{1}{2c}(\hat{\theta} + c)] \geq 0.$$

Therefore,

$$\left. \frac{dm}{dQ} \right|_{n_L} \leq 0 \quad (18)$$

The condition (18) means that the (*I*) curve is such that for a fixed  $n_L$ ,  $m$  decreases as  $Q$  rises. As I illustrate in Figure 2, the (*I*) curve rotates counterclockwise as  $Q$  rises. The combination of the rightward shift of the (*I*) curve and the counterclockwise rotation of the (*C*) curve together imply that in the new equilibrium with a higher  $Q$ , both  $m$  and  $n_L$  will be larger than before. ■

## 9.2 Proof of Proposition 4

Since both workers have  $\alpha > \hat{\alpha}$ , they both try out migration to the US though ex post; they may or may not stay there depending on the wage offer and the psychic costs. Consider

$$\begin{aligned} & \phi(\alpha_k, \alpha_j) \\ \equiv & \Pr(\alpha_k \text{ in the low-paying sector} | \alpha_k \text{ stays in the US}) \\ & - \Pr(\alpha_j \text{ in the low-paying sector} | \alpha_j \text{ stays in the US}) \\ = & \frac{\rho(\alpha_k)(1 - \mu)}{\mu + \rho(\alpha_k)(1 - \mu)} - \frac{\rho(\alpha_j)(1 - \mu)}{\mu + \rho(\alpha_j)(1 - \mu)}, \end{aligned}$$

where  $\rho(\alpha)$  is defined by (6). Showing that  $\partial\phi(\alpha_k, \alpha_j)/\partial Q > 0$  is equivalent to showing

$$\frac{\partial\{\rho(\alpha_k) - \rho(\alpha_j)\}}{\partial Q} > 0,$$

which is certainly true because

$$\frac{\partial\{\rho(\alpha_k) - \rho(\alpha_j)\}}{\partial Q} = \frac{\partial(Q^{\alpha_k} - Q^{\alpha_j})(w_L/2c)}{\partial Q} = \frac{w_L}{2c}(\alpha_k Q^{\alpha_k-1} - \alpha_j Q^{\alpha_j-1}) > 0,$$

for  $\alpha_j < \alpha_k$ . ■

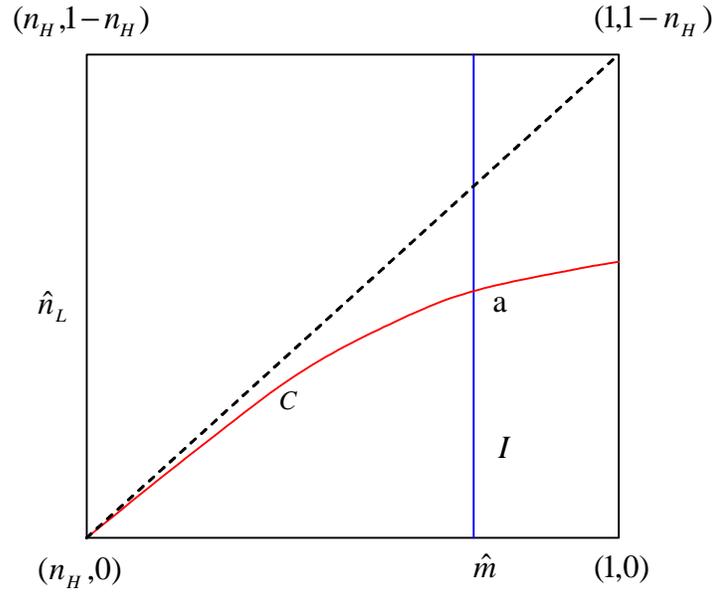


Figure 1: Migration and Labor Market Equilibrium

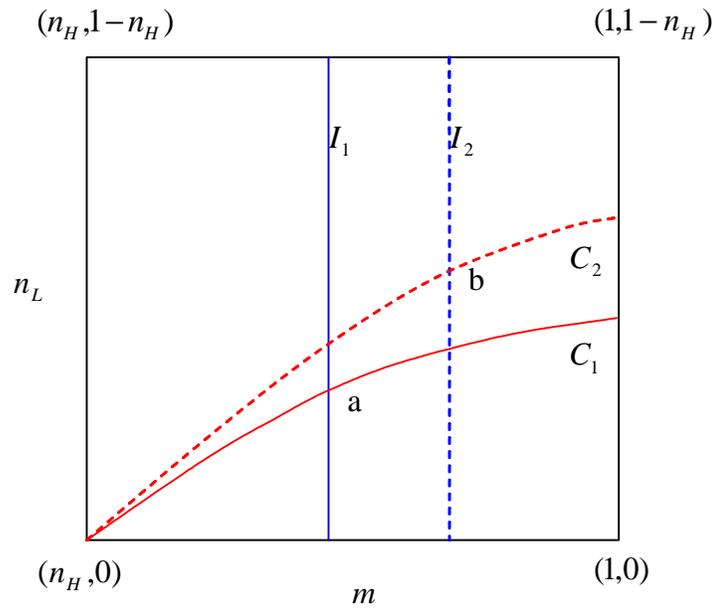


Figure 2: Comparative Statics



Figure 3: US-Mexico Real Exchange Rate 1968-1996 (Source: Penn World Table)

Table A1: Mexican Migrants on Their Most Recent Trip to the US

<b>Panel A: Characteristics of Migrants</b>	
Age	39.43 (9.97)
Education	5.61 (3.93)
English proficiency (0-4)	1.15 (1.31)
Undocumented	0.70 (0.46)
Married	0.80 (0.40)
Have minors	0.79 (0.41)
Hourly wage (current \$)	5.35 (5.11)
Annual income (current \$)	7670.64 (10794.52)
Hours worked per week	46.58 (14.40)
Months worked per week	7.25 (3.65)
Agricultural job	0.33 (0.47)
<b>Panel B: Incidence and Magnitude of Remittances</b>	
Remit (1 if sent any remittances)	0.80 (0.40)
Monthly remittances if remit (current \$)	322.21 (293.95)
Obs	1620
<b>Panel C: Purpose of remittances (%)</b>	
Health expenses	0.51
Food and maintenance	0.23
Construction or repair of house	0.10
Debt payment	0.06
Purchase of consumer goods	0.05
Savings	0.02
Purchase of house or lot	0.01
Other	0.03
Obs	1112

Standard deviations are in parentheses.

Table A2: Wages for Agricultural and Non-agricultural Jobs in the US

	Dependent variables:	
	Log Hourly wage	Log Annual Income
	(1)	(2)
Agricultural job	-0.173*** (0.060)	-0.286*** (0.103)
Age	-0.003 (0.011)	-0.019 (0.020)
Education	0.040** (0.017)	0.072*** (0.025)
Education-sq	-0.003** (0.001)	-0.006*** (0.002)
English	0.068*** (0.017)	0.191*** (0.029)
Undocumented	-0.093** (0.041)	-0.157** (0.076)
Year fixed effects	Yes	Yes
Origin community fixed effects	Yes	Yes
Destination MSA fixed effects	Yes	Yes
Observations	1620	1620
R-squared	0.434	0.385

Robust standard errors clustered at the year\*origin community\*destination MSA level are in parentheses.

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 1: Characteristics of Mexican Workers

	All Workers	Migrant Workers		
		All Migrants	New Migrants	Established Migrants
Migration status	0.082 (0.274)			
Undocumented		0.583 (0.493)	0.652 (0.476)	0.495 (0.500)
Unemployed	0.006 (0.080)	0.007 (0.085)	0.009 (0.096)	0.005 (0.069)
Agricultural job	0.340 (0.474)	0.395 (0.489)	0.493 (0.500)	0.269 (0.444)
Age	38.089 (12.100)	34.722 (11.060)	33.798 (10.456)	35.913 (11.686)
Education	5.631 (4.515)	5.218 (3.507)	4.909 (3.350)	5.616 (3.660)
Married	0.790 (0.407)	0.786 (0.410)	0.815 (0.389)	0.749 (0.434)
Have children under 18 years of age	0.777 (0.416)	0.751 (0.433)	0.774 (0.418)	0.721 (0.449)
Land ownership	0.196 (0.497)	0.233 (0.558)	0.292 (0.618)	0.157 (0.458)
Property ownership	0.615 (0.569)	0.623 (0.619)	0.634 (0.612)	0.608 (0.628)
Business ownership	0.179 (0.419)	0.096 (0.328)	0.111 (0.345)	0.076 (0.303)
Obs	162932	13373	7529	5844

Standard deviations are in parentheses.

Each observation is a person-year.

Migration status=1 if in the US; 0 otherwise.

New migrants refer to the migrants who arrived in the US in the person-year.

Established migrants refer to the migrants who arrived in the US in any year prior to the person-year.

Table 2: Remittances Behavior by Family Status

	Dependent variable: Remittances					
	(1)	(2)	(3)	(4)	(5)	(6)
Married with no children	0.011 (0.061)	-0.016 (0.065)	-0.014 (0.065)	0.013 (0.060)	-0.014 (0.063)	-0.015 (0.063)
Unmarried with children	0.093* (0.055)	0.062 (0.057)	0.064 (0.062)	0.104** (0.051)	0.073 (0.054)	0.074 (0.059)
Married with children	0.138*** (0.036)	0.103*** (0.039)	0.102** (0.041)	0.148*** (0.037)	0.114*** (0.039)	0.113*** (0.041)
Log hourly wage	0.043** (0.018)	0.031 (0.020)	0.028 (0.021)			
Log annual income				0.064*** (0.013)	0.062*** (0.013)	0.064*** (0.012)
Age	0.000 (0.001)	0.002 (0.001)	0.002 (0.001)	0.000 (0.001)	0.002 (0.001)	0.002 (0.001)
Education	0.002 (0.007)	0.004 (0.007)	0.005 (0.007)	-0.001 (0.007)	0.001 (0.007)	0.001 (0.007)
Education-squared	-0.001*** (0.000)	-0.001*** (0.000)	-0.001*** (0.000)	-0.001** (0.000)	-0.001** (0.000)	-0.001** (0.000)
English proficiency	0.013 (0.010)	0.013 (0.010)	0.011 (0.010)	0.003 (0.010)	0.003 (0.010)	0.000 (0.010)
Undocumented	0.044* (0.023)	0.069*** (0.026)	0.064** (0.026)	0.051** (0.022)	0.077*** (0.025)	0.071*** (0.025)
Origin community fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year-fixed effects	No	Yes	Yes	No	Yes	Yes
Destination MSA fixed effects	No	No	Yes	No	No	No
Observations	1620	1620	1620	1620	1620	1620
R-squared	0.166	0.186	0.230	0.192	0.212	0.256

Robust standard errors clustered at the community-level are in parentheses.

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Remittances=1 if sent any remittances; 0 otherwise.

Table 3: US-Mexico Real Price Gap and Migration Status of Mexican Workers

	Dependent variable: Migration Status											
	All workers				Skilled workers				Unskilled workers			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Married with children (D3)	0.002 (0.005)	0.002 (0.017)	-0.007 (0.023)	-0.134 (0.126)	0.002 (0.006)	0.014 (0.025)	-0.012 (0.033)	-0.234 (0.222)	0.005 (0.007)	-0.015 (0.024)	-0.013 (0.032)	-0.089 (0.159)
Q*D3		0.006 (0.007)	0.003 (0.007)	0.001 (0.008)		0.002 (0.010)	-0.010 (0.010)	-0.009 (0.011)		0.014 (0.010)	0.016 (0.010)	0.013 (0.011)
Q1*D3		-0.004 (0.007)	0.002 (0.010)	0.005 (0.010)		0.005 (0.010)	0.028** (0.014)	0.030** (0.014)		-0.013 (0.011)	-0.017 (0.015)	-0.015 (0.014)
Q2*D3		0.005 (0.007)	0.002 (0.008)	0.001 (0.009)		-0.002 (0.010)	-0.012 (0.011)	-0.008 (0.012)		0.009 (0.011)	0.011 (0.011)	0.007 (0.012)
Q3*D3		-0.006 (0.006)	-0.002 (0.008)	0.001 (0.008)		-0.011 (0.009)	0.005 (0.011)	0.007 (0.011)		-0.000 (0.009)	-0.003 (0.011)	-0.003 (0.011)
Control variables*(D1, D2, D3):												
IRCA and Immigration Act 1990	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
Log GDP per capita Mexico and US	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes
Observations	162932	162932	162932	162932	46261	46261	46261	46261	116671	116671	116671	116671
R-squared	0.625	0.625	0.625	0.625	0.610	0.610	0.610	0.610	0.628	0.629	0.629	0.629

Robust standard errors clustered at the individual-level are in parentheses.

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Migration status=1 if in the US; 0 otherwise.

Q1, Q2, and Q3 denote the US-Mexico real exchange rate lagged by one, two, and three years, respectively.

D1 - married without children; D2 - unmarried with children

All regressions include D1, D2, and (D1, D2)\*(Q, Q1, Q2, Q3).

Table 4: US-Mexico Real Price Gap and Migration Status of Skilled Workers

	Dependent variable: Migration Status						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Level specification							
Married with children (D3)	-0.003 (0.017)	-0.019 (0.019)	-0.198 (0.226)	-0.200 (0.254)	-0.200 (0.252)	-0.210 (0.263)	-0.157 (0.261)
Q1*D3	0.002 (0.007)	0.014 (0.009)	0.019** (0.009)	0.018* (0.010)	0.018* (0.010)	0.018* (0.010)	0.022** (0.010)
R-squared	0.610	0.610	0.610	0.610	0.612	0.609	0.628
Panel B: Log specification							
Married with children (D3)	-0.002 (0.013)	-0.010 (0.015)	-0.167 (0.222)	-0.170 (0.253)	-0.171 (0.251)	-0.181 (0.262)	-0.123 (0.260)
Log(Q1)*D3	0.005 (0.016)	0.027 (0.020)	0.042** (0.020)	0.040 (0.021)	0.039* (0.021)	0.039* (0.022)	0.047** (0.022)
R-squared	0.610	0.610	0.610	0.610	0.612	0.609	0.628
Control variables*(D1, D2, D3):							
IRCA and Immigration Act 1990	No	Yes	Yes	Yes	Yes	Yes	Yes
Log GDP per capita Mexico and US	No	No	Yes	Yes	Yes	Yes	Yes
Unemployment Mexico and US	No	No	No	Yes	Yes	Yes	Yes
Time-varying individual characteristics:							
Land, property, and business ownership	No	No	No	No	Yes	Yes	Yes
Observations	46261	46261	46261	46115	46115	43217	42522

Robust standard errors clustered at the individual-level are in parentheses.

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Migration status=1 if in the US; 0 otherwise.

Q1 denotes the US-Mexico real exchange rate lagged by one year.

D1 - married without children; D2 - unmarried with children

Panel A: All regressions include D1, D2, and (D1, D2)\*Q1.

Panel B: All regressions include D1, D2, and (D1, D2)\*Log(Q1).

Column (6): restrict sample to individuals with 49 years old or younger.

Column (7): discard the survey year and the previous year from the sample.

Table 5: US-Mexico Real Price Gap and Occupational Outcomes of Migrant Workers

	Dependent variable: Occupational Outcome in the US											
	All migrants				New migrants				Established migrants			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Married with children (D3)	0.012 (0.018)	0.070 (0.076)	0.071 (0.087)	0.997** (0.483)	0.014 (0.024)	0.164 (0.107)	0.162 (0.140)	1.088 (0.822)	0.018 (0.025)	0.066 (0.095)	0.078 (0.103)	0.528 (0.584)
Q*D3		-0.039 (0.025)	-0.048* (0.025)	-0.027 (0.027)		-0.103** (0.049)	-0.112** (0.053)	-0.094* (0.054)		-0.003 (0.033)	-0.009 (0.026)	0.005 (0.030)
Q1*D3		0.029 (0.027)	0.041 (0.033)	0.023 (0.034)		0.052 (0.054)	0.065 (0.076)	0.030 (0.078)		0.004 (0.032)	0.011 (0.034)	0.003 (0.036)
Q2*D3		-0.031 (0.027)	-0.039 (0.029)	-0.023 (0.034)		-0.081 (0.059)	-0.090 (0.068)	-0.086 (0.074)		0.014 (0.032)	0.008 (0.032)	0.024 (0.038)
Q3*D3		0.014 (0.026)	0.021 (0.028)	0.015 (0.028)		0.062 (0.046)	0.071 (0.065)	0.045 (0.067)		-0.039 (0.033)	-0.036 (0.032)	-0.034 (0.032)
Control variables*(D1, D2, D3):												
IRCA and Immigration Act 1990	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
Log GDP per capita Mexico and US	No	No	No	Yes	No	No	No	Yes	No	No	No	Yes
Observations	13275	13275	13275	13275	7459	7459	7459	7459	5816	5816	5816	5816
R-squared	0.887	0.888	0.888	0.888	0.878	0.878	0.878	0.879	0.933	0.933	0.933	0.933

Robust standard errors clustered at the individual-level are in parentheses.

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Occupational outcome=1 if employed in a high-paying (non-agricultural) job; 0 otherwise.

Q1, Q2, and Q3 denote the US-Mexico real exchange rate lagged by one, two, and three years, respectively.

D1 - married without children; D2 - unmarried with children

All regressions include D1, D2, and (D1, D2)\*(Q, Q1, Q2, Q3).

Table 6: US-Mexico Real Price Gap and Occupational Outcomes of New Migrants

	Dependent variable: Occupational Outcome in the US							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Level specification								
Married with children (D3)	0.178** (0.081)	0.186** (0.087)	1.419* (0.738)	1.455 (1.132)	1.449 (1.131)	1.452 (1.133)	1.345 (1.176)	1.107 (1.194)
Q*D3	-0.079** (0.036)	-0.084** (0.039)	-0.068* (0.037)	-0.070* (0.040)	-0.071* (0.040)	-0.071* (0.040)	-0.077* (0.041)	-0.077* (0.043)
R-squared	0.878	0.878	0.879	0.879	0.879	0.879	0.876	0.895
Panel B: Log specification								
Married with children (D3)	0.139** (0.062)	0.146** (0.067)	1.305* (0.736)	1.089 (1.161)	1.082 (1.159)	1.083 (1.161)	0.958 (1.206)	0.724 (1.223)
Log(Q)*D3	-0.177** (0.076)	-0.189** (0.084)	-0.163** (0.081)	-0.191** (0.090)	-0.192** (0.090)	-0.192** (0.089)	-0.207** (0.092)	-0.209** (0.096)
R-squared	0.878	0.878	0.879	0.879	0.879	0.879	0.876	0.895
Control variables*(D1, D2, D3):								
IRCA and Immigration Act 1990	No	Yes						
Log GDP per capita Mexico and US	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Unemployment Mexico and US	No	No	No	Yes	Yes	Yes	Yes	Yes
Time-varying individual characteristics:								
Undocumented	No	No	No	No	Yes	Yes	Yes	Yes
Land, property, and business ownership	No	No	No	No	No	Yes	Yes	Yes
Observations	7459	7459	7459	7391	7391	7391	6682	6490

Robust standard errors clustered at the individual-level are in parentheses.

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Occupational outcome=1 if employed in a high-paying (non-agricultural) job; 0 otherwise.

D1 - married without children; D2 - unmarried with children

Panel A: All regressions include D1, D2, and (D1, D2)\*Q.

Panel B: All regressions include D1, D2, and (D1, D2)\*Log(Q).

Column (7): restrict sample to individuals with 49 years old or younger.

Column (8): discard the survey year and the previous year from the sample.