Capital and Labor Mobility in Mexico: Implications for Wages, Employment, Child Labor and Manufacturing Production

by

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(Under the direction of Scott E. Atkinson)

Abstract

My dissertation is comprised of three essays that examine the implications of capital and labor mobility for wages, employment, child labor and manufacturing production in Mexico. The first essay examines the effect of Mexican interstate immigration and international return migration of labor and foreign capital on wages and employment in the *maquiladora* industry in Mexico. I consider these issues by first computing cost and demand functions for Mexican skilled and unskilled labor in the Textile *maquiladora* industry in 20 Mexican states for 1998-2001. The same analysis is performed for the Food, Beverage and Tobacco industry comprised of 10 Mexican states. In both industries the results suggest that the demand for skilled relative to unskilled workers is wage elastic and that foreign direct investment is more beneficial to skilled workers and increases their relative wages and demand. Separately, using the Mexican Census 2000 I estimate the effect of migration on the equilibrium wage and employment of each labor type in the six divisions of the manufacturing industry. The results show that interstate immigration and international return migration have positive effects on wages. A combination of these two models allows calculation of the effects of labor and capital migration on the demand for each factor and changes in factor shares. My findings suggest that wages and employment in the *maquiladora* industry are insensitive to inflows of migrants.

The second essay examines whether remittances provide a substitute away from child labor toward greater investments in education in Mexico. Furthermore, what role do financial constraints play in influencing school attendance? A number of dimensions of my essay are unique for the case of Mexico. First, no other study examines the impact of remittances on child labor and schooling for Mexico. Second, with a multinominal logit model I determine what role financial constraints play in school abandonment of children, allowing for the distinction between the role of income and remittances in influencing school attendance in children 5-17 years of age. Issues of endogeneity are addressed by estimation of a set of bivariate probit models determining schooling, remittances and child labor. Using data from the Mexican Census 2000, I find that remittances decrease the probability of school abandonment, increase school attainment and reduce child labor.

In the third essay the performance of *maquiladora* textile industry is examined in nineteen Mexican states for the period 1998-2004 to determine whether the industry has been adversely affected by China's entrance into the World Trade Organization. No empirical study exists that I know of which analyzes the productivity of the manufacturing industry in Mexico. Therefore, the objective of this paper is to fill this gap by estimating the industry's productivity change, technical change and efficiency change from 1998-2004. First, economic efficiency and productivity growth are estimated utilizing an input distance function, which is dual to the cost function. A translog distance function is employed as a flexible representation of the true underlying distance function to compute technical, productivity and efficiency changes. Finally, I compute technical efficiencies for nineteen Mexican states, defined as the additional increase in output that they could obtain from a given level of input, if they were operating on the technological frontier. According to my analysis, the average annual productive change is 9.74%. The average annual technical change is 13.49%. The average annual rate of growth in efficiency change is -3.75%. These results suggest that, on average, positive technical change outweighs negative efficiency change. My findings indicate

that the *maquiladora* industry remains productive during the period when it faces increased competition from China.

Index words: Mexican Migration, Foreign Direct Investment, *Maquiladora* Industry, Wages, Employment, Productivity Growth

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Dedication

To my parents, my sisters Grizal and Brenda, my favorite brother Alex and my silly niece Clara.

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Chapter 1

Introduction

The purpose of this paper is to study the impact of capital and labor mobility on employment, wages, child labor and productivity in a Mexican industry that predominantly employs migrants in transit to the U.S. The outflow of migrants from Mexico to the U.S. and their impact on the U.S. labor market is an area of research which has received much attention. However, little research has been conducted on the issue of labor mobility within Mexico, which occurs prior to migration abroad. Interstate migration in Mexico can have adverse effects on border cities, urban areas, and labor markets that predominantly hire these migrant workers. The manufacturing industry, also known as the *maquiladora* industry, is an industry that employs migrants in transit to the U.S. Analogous to the literature on U.S. immigration, I examine the effect of Mexican interstate immigration and international return migration of labor on wages and employment in the *maquiladora* industry. The industry is also affected by capital mobility, that is, foreign direct investment into Mexico from abroad. Capital mobility in this industry can adversely affect the relative wage inequality between the workers employed in this industry, comprised of skilled and unskilled workers. and have dire consequences for migration. Increased wage inequality in this industry can lead interstate migrants to continue their migration process abroad to the U.S. Therefore, in addition to analyzing the effect of Mexican interstate immigration and international return migration of labor, I also analyze the impact of foreign capital mobility on wages and employment in the *maquiladora* industry.

These issues are considered by computation of cost and demand functions for Mexican skilled and unskilled labor in the Textile *maquiladora* industry in 20 Mexican states for

1998-2001. The same analysis is performed for the Food, Beverage and Tobacco industry comprised of 10 Mexican states. In both industries I find that the demand for skilled workers relative to unskilled is wage elastic and that foreign direct investment is beneficial to skilled workers and increases their relative wages and demand.

Separately, using the Mexican Census 2000 I estimate the effect of migration on the equilibrium wage and employment of each labor type in the six divisions of the manufacturing industry. I find that interstate immigration and international return migration have a positive effect on wages. A combination of these two models allows calculation of the effects of labor and capital migration on the demand for each factor and on changes in factor shares. I find that wages and employment in the *maquiladora* industry are insensitive to inflows of migrants.

Another form of capital mobility that affects labor markets in Mexico is the money sent back by migrants from the U.S. that is, remittances. Remittance studies have examined the impact on various development indicators such as schooling, consumption of non-durable goods, and the labor supply of men and women. However, no study has examined the impact of remittances on the labor supply of child, that is child labor. The second essay examines whether remittances provide a substitute away from child labor toward greater investments in education in Mexico. Furthermore, what role do financial constraints play in influencing school attendance?

A number of dimensions of my paper are unique for the case of Mexico. First, no other study examines the impact of remittances on child labor and schooling in Mexico. Second, using a multinominal logit model I determine what role financial constraints play in school attendance of children, allowing for the distinction between the role of income and remittances in influencing school attendance among children 5-17 years of age. Issues of endogeneity are addressed by estimation of a set of bivariate probit models of schooling, remittances and child labor. Using data from the Mexican Census 2000, I find remittances, which are a result of the migration process, decrease the probability of school attendance, increase school attainment and reduce child labor. The role of remittances in decreasing child labor and increasing school attainment may have long-run implications for migration. An increase in human capital among today's youth may lead to a reduction in migration to the U.S. of future generations.

The migration of the *maquiladora* industry to China could have dire consequences for future flows of migration to the U.S. A decline in capital mobility, or in the form of foreign direct investment (FDI), into the *maquiladora* textile industry, can result in increased unemployment exacerbating the flows of migrants to the U.S. I examine the period 1998-2004 to determine whether the industry has been adversely affected by China's entrance into the World Trade Organization (WTO) by focusing on the performance of the *maquiladora* industry textile production in nineteen Mexican states. No empirical study exists that I know of which analyzes the productivity of the manufacturing industry in Mexico. Therefore, the objective of this paper is to fill this gap by estimating the industry's productivity change (PC), technical change (TC) and efficiency change (EC) from 1998-2004.

First, economic efficiency and productivity growth are estimated utilizing an input distance function, which is dual to a cost function. I employ a translog distance function as a flexible representation of the true underlying distance function to compute PC, TC and EC. Finally, I compute the technical efficiencies (TE) of nineteen Mexican states defined as the additional increase in output that they could obtain from a given level of input, if they were operating on the technological frontier. According to my analysis, average annual PC is 9.74%. Average annual TC is 13.49%. The average annual rate of growth in EC is -3.75%. These results suggest that, on average, positive TC outweighs negative EC. My findings indicate that the *maquiladora* industry remains productive during the period when it faces increased competition from China. Furthermore, there is no evidence to predict a deterioration in Mexico's competitiveness given the stringent competition from China. In order for U.S. firms to continue investing and creating employment in Mexico, the industry's productivity growth must continue to be positive.

Chapter 2

The Effect of Mexican Migration of Labor and Capital on the *Maquiladora* Industry

2.1 Introduction

Considerable disagreement had emerged from the vast amount of research on the impact of Mexican migration on wages of native workers in U.S. labor markets. A widely-cited review article by Friedberg and Hunt (1995) concludes that the effect of immigration on the labor market outcomes of natives is small. A study by Card (1990) on the impact of immigrants into Miami after the Mariel boatlift indicates that a 7 percent increase in the workforce did not have a noticeable effect on either wages or employment in Miami's labor market.

Borjas (2003) criticizes this type of local labor market analysis on two grounds. First, immigrants may not be randomly distributed across labor markets. If they settle in thriving economies, then immigration will be positively correlated with wage increases. Second, natives may respond to immigration by moving their labor or capital to other cities, thereby raising the equilibrium wage, even though immigration in the absence of the flight of native workers would lead to a reduction in the wages of natives. Borjas (2003) examines the national labor market, using a panel of Census data from 1960, 1970, 1980, and 1990, the Public Use Micro-data Samples of the Decennial Census, and the 1999, 2000, and 2001 Annual Demographic Supplement of the Current Population Surveys. Including a fixed-effects model to eliminate unobserved heterogeneity that is time invariant, he concludes that immigration causes a substantial reduction in the wages of native-born unskilled workers: a 10 percent increase in the supply of immigrants reduces wages of skilled native workers by 3 to 4 percent and by as much as 8 percent for all workers. One drawback to this line of research is that it has been carried out using only Census-level data, so that production has not been modeled. In fact, Borjas (2003) has no data on worker or firm production. Thus, he cannot directly link immigration to wages, wage shares, and productivity.

A strand of literature has recently evolved that studies the impact of Mexican migration on wages in Mexico. In one of the first studies, Mishra (2003) examines the effect of emigration on in Mexico. Using the 1970-2000 Mexican and U.S. Census, she concludes that emigration from Mexico had a statistically significant and positive effect on Mexican wages and increased wage inequality in Mexico.

In a similar study, Hanson (2005) considers the regional impact of emigration on labor market earnings in Mexico for high-migration and low-migration states. He finds that the distribution of male earnings in high-migration states shifted to the right relative to low-migration states. During the 1990s, average hourly earnings in high-migration states rose relative to low-migration states by 6-9 percent. However, he assumes that, because Mexican labor is immobile across Mexican regions, region-specific labor supply shocks do not affect regional earning differentials. Hanson also excludes border states from his sample, arguing these states have benefited disproportionately from trade and investment liberalization and the rates of emigration capture the effects of globalization and investment. In Mexico, states with more exposure to globalization tend to have higher migration rates. However, it is unclear why these shocks would not be captured by state fixed effects included in his regression and therefore the border states should be included. Hanson (2005) finds that wages are higher in high-migration states relative to low-migration states in all cohorts in 2000. This is consistent with low-migration states being less industrialized and offering lower wages. Like the literature of the effect of migration on wages in the U.S., Hanson (2005) and Mishra (2003) use individual-level data without accounting for production.

This chapter aims to address this major shortcoming in the literature. In the U.S., firm-level production data are not available, except for regulated industries. However, firm-level data are available for the Mexican *maquiladora* sector. Using the Census 2000 and aggregate state-level *maquiladora* [1] production data drawn from *INEGI's "Maquiladora de Exportacioń"* yearbook, I can jointly model the individual worker and the firm to estimate the impact of interstate and international return migration on wages and employment in Mexico. *Maquiladoras* are part of free enterprise zones established under the North American Free Trade Agreement.[2] They allow duty-free importation of raw materials and payment of export duties only on the value added in production. There are six major *maquiladora* divisions: Food, Beverage, and Tobacco; Textiles, Clothing and Leather; Wood and Wood Products; Chemicals and by-products of Petroleum, Rubber, and Plastics; Social and Personal Services; and Metal Products, Machinery and Equipment. With these data, I can examine for the regional *maquiladora*s the labor market consequences of capital mobility and interstate and return international migration in Mexico. I focus on the *maquiladora* for two reasons: (1) its role as a major source of growth in the Mexican economy, and (2) its role in influencing shifting migration patterns in Mexico. According to Borjas (1996), for the U.S., "a very mobile country", interstate migration involves 3 percent of the population in a given year. Naskoteen and Zimmer (1980) find for the U.S. that the probability of migration increases by 7 percent in response to a 10 percentage increase in the wage differential between the state of origin and the destination state. According to Lara Ibarra and Soloaga (2005), Mexican interstate migration in 1950 constituted 13 percent of the population and in 2000 this increased to 20 percent. Thus the magnitude of interstate migration in Mexico is much more substantial than in the U.S.

To examine the proposed issues, I first assume that *maquiladora* firms are cost minimizers subject to exogenously determined output constraints (driven almost exclusively by U.S. demand) and exogenously determined prices of skilled and unskilled labor. In addition, cost

[1] *Maquiladora's* are in-bond assembly plants in Mexico. The term *maquiladora* derives from the Spanish word *maquilar*, which is the service provided by a miller of grinding wheat into flour. The *maquiladora* provides an assembling service without having ownership of the goods (U.S. General Accounting Office (2003)).

[2] The special tax status of the industry requires U.S. firms in Mexico to report on output, expenses, and inputs.

and demand functions can be shifted by an increase in FDI. I determine the effect of an increase of FDI on wage shares directly from the estimated labor demand functions. Demand functions are derived for Mexican skilled and unskilled labor, and the cost and demand equations are estimated using panel data for the textile *maquiladora* industry in 20 Mexican states over the years 1998-2001. This analysis is replicated for the food, beverage and tobacco industry in 10 Mexican states for the same period.

Separately, I use the Mexican Census 2000 to estimate the effect of migration on wages of workers employed in the *maquiladora* industry. Combined with the previous demand estimates, I can simulate the resulting shift in the demand for each labor type due to FDI, and compute the effect of migration on the wages for skilled and unskilled workers. I then apply this new wage to the shifted demand curve for each labor type and compute the effects on the quantities demanded of each factor and, ultimately, their wage shares.

The paper is organized as follows. In Section 2.2, I present, a cost minimization model of the *maquiladora*, from which I obtain input demand functions for skilled and unskilled workers and derive the own-price and cross-price elasticities of demand. Section 2.3 discusses the relationship between migration and the *maquiladora* industry. Section 2.4 describes the firm-level production data and the individual-level data that are used jointly to determine the impact of immigration on wages and employment. Section 2.5 presents the empirical results. Section 2.6 presents the concluding remarks.

2.2 Theoretical Model

2.2.1 Cost Minimization By the Firm

I assume that the *maquiladora* meets exogenously determined production goals subject to exogenously determined input prices. I find that *maquiladora* production represents a small proportion of GDP in each state, so that, *maquiladoras* are assumed to be price takers in the labor market. The restricted cost function, C_i, for state i is obtained as $C_i = \sum_j p_{ji} x_{ji}$:

$$C_i(y_i, \mathbf{p}_i/b_i; \mathbf{z}) = \min_{b_i \mathbf{x}_i}[(\mathbf{p_i}/b_i)(b_i \mathbf{x}_i)|f(\mathbf{x}_i; \mathbf{z}_i) = y_i], \tag{2.1}$$

where $\mathbf{p}_i = (p_{1i}, \ldots, p_{Ni})$ is a vector of input prices (limited in this study to earnings of skilled and unskilled workers), $\mathbf{x}_i = (x_{1i}, \ldots, x_{Ni})$ is a vector of input quantities (limited in this study to the quantities of skilled and unskilled workers), y_i is output, $\mathbf{z}_i$ is a vector of quasi-fixed inputs and other factors that can shift the cost function (such as FDI), and b_i is a state-specific parameter (since we have aggregate maquiladora production data at the state level). The first-order conditions corresponding to (2.1) are given by

$$y_i = f(\mathbf{x}_i; \mathbf{z}_i) \tag{2.2}$$

and

$$p_i = \phi \partial f(\mathbf{x}_i)/\partial x_{ji} \quad j = 1, \ldots, N, \tag{2.3}$$

where ϕ is the Lagrange multiplier which, in equilibrium, is equal to the marginal cost, $\partial C_i/\partial y_i$. Applying Shephard's Lemma to (2.1), we obtain the input demand functions for factor j:

$$\frac{\partial C_i}{\partial p_{ji}} = x_{ji}(p_{1i}, \ldots, p_{Ni}, y_i), \forall j. \tag{2.4}$$

2.2.2 Translog Cost System

Assuming the availability of panel data (T time-series observations on F states), we can define factor cost shares as $s_{jit} = \frac{\partial \ln C_{it}}{\partial \ln p_{jit}}$. A fixed-effects approach leads to stochastic cost and share equations with the general form

$$C_{it} = (1/b_i) C(p_{1it}, \ldots, p_{Nit},\, y_{it}) \exp(v_{it}) \tag{2.5}$$

and

$$\frac{\partial \ln C_{it}}{\partial \ln p_{jit}} = s(p_{1it}, \ldots, p_{Nit},\, y_{it}) + \omega_{jit}, \forall j, \tag{2.6}$$

where v_{it} and ω_{jit} are two-sided random error terms.

Now we replace b_i with the error term u_{it}, which represents one-sided errors of technical inefficiency that varies by state and time, and add this to the two-sided error term, v_{it}. This accommodates the random-effects model and simplifies to the fixed-effects model if we replace u_{it} with b_i. By specifying an appropriate functional form for the variable cost function, we can derive an estimable expression for variable cost and cost shares given in (2.5) and (2.6). We employ the translog functional form, which provides a convenient second-order approximation to an arbitrary, continuously twice-differentiable restricted cost function. The translog approximation to the cost function in (2.1) is

$$\begin{aligned} \ln C_{it} &= \gamma_0 + \gamma_y \ln y_{it} + \frac{1}{2}\gamma_{yy}(\ln y_{it})^2 + \sum_j \gamma_{jy} \ln y_{it} \ln p_{jit} \\ &+ \sum_j \gamma_j \ln p_{jit} + \frac{1}{2}\sum_j\sum_l \gamma_{jl} \ln p_{jit} \ln p_{lit} \\ &+ \sum_r \gamma_r \ln z_{rit} + \sum_r\sum_j \gamma_{rj} \ln z_{rt} \ln p_{jit} \\ &+ \frac{1}{2}\sum_r\sum_s \gamma_{rs} \ln z_{rit} \ln z_{sit} + \sum_r \gamma_{ry} \ln z_{rit} \ln y_{it} + \ln h(\epsilon_{it}) \end{aligned} \tag{2.7}$$

where

$$h(\epsilon_{it}) = \exp(v_{it} + u_{it}) \tag{2.8}$$

and where $\gamma_{jl} = \gamma_{lj},\ \forall\ j, l,\ \ j \neq l$ and $t = 1, \ldots, T$. The share equations corresponding to (2.1) are

$$s_{jit} = \frac{\partial \ln C_{it}}{\partial \ln p_{jit}} = \gamma_j + \sum_l \gamma_{jl} \ln p_{lit} + \sum_r \gamma_{rj} \ln z_{rt} + \gamma_{jy} \ln y_{it} + \omega_{jit},\ \ \forall j. \tag{2.9}$$

The composite error $\ln h(\epsilon_{it})$ in the cost function is an additive error with a one-sided inefficiency component, u_{ft}, and a standard two-sided noise component, v_{it}, with zero mean. As indicated, the u_{it} can be treated as fixed or random. When panel data are available, the fixed-effects specification avoids the deficiencies of the standard error components approach. With this specification, one must impose strong distributional assumptions on both the v_{it} and u_{it}, as well as maintain the unlikely assumption that both error components are uncorrelated with the explanatory variables in (2.7). With the fixed-effects approach, we require no distributional assumptions; we assume only that the v_{it} term is uncorrelated with the regressors, and we can easily employ instruments if it is not. Thus, we adopt the fixed-effects approach and represent the one-sided component as a state-specific dummy variable b_i.

We wish to incorporate time in (2.7) in a flexible manner. Thus, we include continuous time interacted with the logs of prices and output quantities, as well as first- and second-order terms in time.

Holding output constant, C_{it} is linearly homogeneous in prices. This implies the following restrictions on the cost function parameters:

$$\sum_j \gamma_j = 1 \tag{2.10}$$

$$\sum_j \gamma_{jy} = 0 \tag{2.11}$$

$$\sum_j \gamma_{jz} = 0, \ \forall z \tag{2.12}$$

$$\sum_j \gamma_{jl} = \sum_j \sum_l \gamma_{jl} = 0. \tag{2.13}$$

Since the cost shares sum to 1, we estimate $N-1$ share equations. Estimation of our cost system is carried out using Generalized Method of Moments (GMM), and the results are invariant to the equation dropped.

After estimation, I obtain own and cross-price elasticities of demand, holding output and the prices of other inputs constant, as

$$\eta_{ii} = (\gamma_{ii} + s_i^2 - s_i)/s_i, \ \ \forall i \tag{2.14}$$

$$\eta_{ij} = (\gamma_{ij} + s_i s_j)/s_i, \ \forall i, j; \ i \neq j. \tag{2.15}$$

2.3 Migration and the *Maquiladora* in Mexico

A study of the migration patterns and their impact on the wages and employment of skilled and unskilled workers in *maquiladoras* is of great importance as various U.S. firms have left Mexico in the last few years and re-located to China. This exit is attributed to increased wage costs in Mexico's manufacturing industry in the last decade. [3] Interstate immigration in pursuit of employment in these manufacturing assembly plants can have a detrimental effect on the wages of unskilled workers, especially if the influx is comprised primarily of unskilled workers.

Mexico is an interesting case to study migration because of its large population and land mass and close proximity to the U.S. Of specific interest is the modernization process that occurred historically in the urban centers and particularly along the border regions. In the 1990s, a new migration pattern developed in Mexico, described by the National Population Council (CONAPO) as the "new geography of migration" which represented a pattern of urban-to-urban migration. In previous decades, the migration phenomenon had been one of rural-to-urban migration. This shift is attributed to urbanization in the industrialized cities, the diversification of the Mexican economy, and the development of smaller and intermediate cities. In addition, in the last decade industrialized centers developed in the central and southern states as the *maquiladoras* shifted from their historic northern geographic locations.

The regional and urban economics literature attributes the earlier settling of establishments in the border regions to accessible transportation to the United States. Although many were located along the Mexican-U.S. border, with implementation of new policies by

[3] In a pooled regression using the 1990 and 2000 Mexican Census, I find that log wages in the *maquiladora* industry have decreased over the decade in real 2000 pesos.

the Mexican government to attract more foreign investment to Mexico, *maquiladoras* could be established anywhere in Mexico. In the last few decades, the Mexican government has discouraged certain types of investment in the large metropolitan areas in an effort to shift the focus of even more potential migrants away from the highly congested metropolitan areas. Reasons for discouraging migration to the urban areas include the high cost of providing public services to new urban residents, mounting rates of unemployment and underemployment, and increased crime rates. According to the U.S. General Accounting Office (2003), one reason why plants have looked to other regions in Mexico for locating is to find better-educated workers further away from the border. In fact, increased competition has surfaced from the state of Chiapas, which borders Guatemala, which has in recent years been the source of some of the largest value-added of any textile *maquiladora* in Mexico.

From 1990 to 2000 *maquiladora*, employment growth in the border region grew 145 percent, while employment in the non-border regions in textiles grew by 918 percent (U.S. General Accounting Office (2003)). Border-region employment in 1990 and 2000 was 342,555 and 496,645, while non-border region employment in the textile industry was 22,000 and 224,000. Given the shift in the location of the textile industry, the border-region share of textile employment fell from 49 percent to 17 percent from 1990 to 2001 (U.S. General Accounting Office (2003)).

The relationship between migration and *maquiladoras* employment was first analyzed in the late 1970s by Seligson and Williams (1981). They found that *maquiladora* workers who migrated internally within Mexico did so to reunite with family members and not to pursue employment. However, they did find that recent migrants were more knowledgeable about potential employment opportunities in the *maquiladoras*. In another study on migration and employment in the *maquiladora*, Fernandez-Kelly (1983) found that 70 percent of *maquiladora* workers in their sample were migrants. In a similar study in 1991, Young and Fort (1994) conducted interviews of 1,246 women in the labor force in Ciudad Juarez, Mexico. Forty-six percent of the women in the sample were employed in the *maquiladoras*, twenty-six percent in commerce, twenty percent in services and eight percent in a variety of other occupations. The women employed in the non-*maquiladora* jobs were chosen to match the age range, urban experience, and socio-economic background of the workers employed in the *maquiladora*. They concluded that *maquiladora* women were more likely to have migrated to Ciudad Juarez than were the women working in other jobs (72 percent compared to 43 percent). Of the *maquiladora* women, 82 percent were *interstate* migrants and, of the non-*maquiladora* women, 45 percent were *intrastate* migrants.

Two patterns of employment have been traced to internal migration in Mexico. First, *maquiladoras* absorb workers in transit to the U.S. Second, they employ young, inexperienced females and males from rural areas. Therefore, the assembly plant's labor pool is comprised of individuals with a high tendency to switch jobs, migrate to the U.S. or, in the case of women, exit the labor market for childbearing. Picou and Peluchon (1995) estimated the annual turnover rate in the *maquiladoras* routinely to exceed 100 percent. Sargent (1997) argued that high turnover not only imposes significant personnel costs but also inhibits entry of sophisticated manufacturing facilities that demand substantial worker training.

The *maquiladora* human resources management (HRM) literature examines how an array of economic enticements affects plant-level turnover. There are conflicting conclusions about the relationship between workers compensation and turnover. Galizzi and Lang (1998) and Hom and Griffeth (1995) found that high wages decrease turnover. Miller, Hom and Gomez-Mejia (1994) analyzed the impact of fixed pay and productivity bonuses on turnover in 115 plants in Nogales, Juarez and Reynosa. They concluded that high fixed pay is not associated with lower turnover but productivity related pay increased turnover. Although there is no consensus on the impact of economic enticements on turnover, migration substantially increases personnel costs in the industry. Because of high turnover costs, the firm's labor demand behavior may increase over time in reaction to increased internal migration in Mexico. Therefore, increased immigration can act as both a supply and demand shock, either decreasing or increasing wages. I expect firms in areas with high internal migration to seek out workers with lower mobility.

Another potential source of increased demand for migrant workers is if migrants, on average, are more skilled than natives or have innate abilities not captured by educational attainment or work experience. If so, workers prone to migrate may be the more able, motivated, or productive workers in Mexico. Given the evidence of positive selection of immigrants to the U.S., can we conclude that the migrants who do not leave for the U.S. but instead migrate internally are positively selected among those left behind? If so, an influx of migrants into another state may increase wages if firms seek out migrant workers, on average, more than native workers. In addition, we could see a change in the mix of workers employed in this industry, such that the industry would largely be comprised of migrants, a predication that is consistent with the evidence found by Fernandez-Kelly (1983) and Young and Fort (1994).

2.4 Data

2.4.1 *Maquiladora* Production Data

The empirical analysis uses aggregated state-level data on the textile sector and food, beverages and tobacco sector. The *maquiladora* production data are drawn from *INEGI's "Maquiladora de Exportacioń"* yearbook. The *maquiladora* textile industry is comprised of twenty Mexican states[4] located throughout Mexico, and the *maquiladora* Food, Beverage and Tobacco industry is comprised of ten Mexican states.[5] The states that participate in *maquiladora* production are not restricted merely to the border region area, as was the case

[4]The states are Aguascalientes (Ags), Baja California (BC), Baja California Sur (BCS), Colima (Col), Chiapas (Chs), Mexico City (DF), Durango (Dur), Guanajuato (Gto), Hidalgo (Hgo), Jalisco (Jal), Mexico (Mex), Nuevo Leon (NL), Puebla (Pue), Queretario (Qtr), San Luis Potosi (SLP), Sonora (Son), Tamulipas (Tamp), Tlaxcala (Tla), Yucatan (Yuc), and Zacatecas (Zac).

[5]The states are BCN, Chihuahua (Chih), Coahuila (Coah), Jal, Mex, NL, Qtr, Son, Tamp, and Yuc.

a decade ago, but also include states as far south as Chiapas and Yucatan. The yearbook provides data on production, gross value added, materials, and the quantity and earnings of skilled and unskilled workers. Production is defined as the sum of gross value added and material costs. Material costs are defined as the value of both domestic and imported primary materials, packaging, and other costs incurred in the processing stage.[6] Gross value added includes wage payments by skill type.

Figure 2.1 in the Appendix shows value added for each of the 20 Mexican states in our sample. Surprisingly, the states with the highest value added in textile production are Chiapas and Colima. Chiapas' population has relatively low levels of human capital and high rates of indigenous people. Colima is a relatively small state located in central Mexico but with a significant amount of production in the textile industry. Also, these states have low-migration rates; given the growing presence of the *maquiladora* industry in these poorer states, it is expected that, over time, we would see increased rural-to-urban and urban-to-urban intrastate migration and interstate migration.

Labor employed in the *maquiladora* is sorted into two types of workers: skilled workers, defined as workers involved in the administrative process, and unskilled workers, defined as workers directly involved in the production process.[7] An ideal classification of labor would be by skill type, education, experience and occupation; however, the data provided to us are not disaggregated in this manner. Therefore, to capture the similarities of workers and address the problem of aggregation in the data, workers are sorted by the same skill type as in the 2000 Mexican Census.

Not surprisingly, the ratio of skilled to unskilled labor is relatively low, consistent with the *maquiladora* industry employing a relatively large number of unskilled workers. Earnings are also classified by labor type: unskilled and skilled. Figure 2.3 shows that a large proportion of wage payments go to unskilled workers, as is expected in an industry that predominantly

[6]According to INEGI's *"Maquiladora de Exportacioń"* yearbook, in May 2004, 3.0 percent of material costs were generated in Mexico, and slightly increased to 3.4 percent by May 2005.

[7]The *"Maquiladora de Exportacion"* yearbook defines the two categories as follows: *obreros* and *empleados*.

employs unskilled workers. The breakdown of the personnel employed by skill type and gender is given in Figure 2.2.[8] Women comprise a significant proportion of the labor in this industry; therefore, women are not excluded from our sample. In studies carried out for the U.S., the exclusion of women from a sample is common in an attempt to reduce measurement error, given that female labor force participation is relatively low for earlier cross-sections (Borjas 2003). The ratio of women to men has decreased, as men have increased their presence in this once-female-dominated industry and women have enjoyed increased labor opportunities in other sectors.[9]

Production, gross value added, materials and earnings were adjusted to the base year 2001 by the National Consumer Price Index provided by the *Banco de Mexico*. The data on FDI were collected from INEGI's system *Banco de Información Económica*. In Figure 2.4, FDI is decomposed by receiving state. The five states that receive the largest share of FDI into Mexico are two border states, Baja California and Nuevo Leon, and three central states, Jalisco, Nayarit, and Mexico City. Those receiving the least are four northern/central states, Durango, Zacatecas, Aguascalientes, and Guanajuato, and a southern state, Yucatan. Although border states receive a disproportionately higher amount of FDI, there is no reason to exclude them from the sample, as does Hanson (2005) as these shocks would be captured in the state fixed effects.

The only relevant study of the impact of foreign direct investment on the *maquiladora* industry was conducted by Feenstra and Hanson (1997). They analyzed studies of relative labor demand for a panel of nine two-digit (ISIC) industries in Mexico's 32 states. Their data on employment and wages come from Mexico's Industrial Census for 1975-1988. While aggregating across the divisions, they estimated the shares of skilled and unskilled labor. They found that FDI benefits skilled more than unskilled workers, which may have increased

[8]These data were only available for 2004 and 2005.

[9]See MacLachlan and Aguilar (1998) for background information on changes in the structure of labor force of this industry.

inequality in Mexico. My study differs from theirs in that I do not aggregate across divisions, but study separately the textile and food, beverage and tobacco divisions.

2.4.2 Individual-Level Data

The data used to measure the impact of interstate migration on the relative wages in each state are taken from the Mexican Census 2000. The sample is comprised of 84,743 observations. The sample is restricted to include workers employed in the six major manufacturing divisions: Food, Beverage, and Tobacco; Textiles, Clothing and Leather; Wood and Wood Products; Chemicals and by-products of Petroleum, Rubber, and Plastics; Social and Personal Services; and Metal Products, Machinery and Equipment. Workers are sorted into skilled or unskilled type by occupational classification within the six manufacturing industries. The 1990 and 2000 Mexican Census classifies manufacturing workers into two categories: *obreros/peones* and *jefes*. *Obreros/peones* refers to laborers involved in the production process, while *jefes* refers to workers involved in the administrative process. The classification of workers is the same as that in the *INEGI's "Maquiladora de Exportacioń"* yearbook. Hence, it seems accurate to make inferences from the Mexican Census and use this to complement the *maquiladora* cost-minimization results.

An issue that arises in determining the impact of immigration is knowing which workers are substitutes; that is, which workers compete in the same labor market. For the U.S., immigrants and natives can be viewed as imperfect substitutes in certain occupations, given that immigrants, on average have less human capital and do not speak English. Friedberg and Hunt (1995) studied a natural experiment involving the exodus of 600,000 Russian Jews to Israel, and found that immigrants compete more with one another than with natives. In Mexico's case there are two possibilities. One possibility is to treat interstate immigrants, return international immigrants and natives as perfect substitutes in the *maquiladora* labor market since they speak the same language and have roughly the same skill set. In this case, all workers, natives and immigrants, can be treated as a single factor of production. The second possibility is to treat immigrants differently from natives since immigrants may be more motivated and more productive than natives. Also, international return migrants may have accumulated human capital in the U.S. that is highly rewarded in the manufacturing industry in Mexico. Therefore, our individual-level data is broken down by the assumption that natives and immigrants are imperfect substitutes.

We identify which workers are employed in the textile manufacturing industry, and allow for workers employed in the other five divisions of manufacturing industry to be perfect substitutes with textile workers. The difficulty of capturing the true pool of workers in the manufacturing labor market is exacerbated by unreliable unemployment measures in Mexico. The sample only includes employed workers, and therefore is not capturing the potential number of workers in a given occupation. To capture as many possible substitutes for manufacturing workers, the occupation classification is extended to include workers employed not only in the textile industry but also in the other five divisions of manufacturing. We then analyze the food, beverage and tobacco division, allowing workers employed in the other five division of manufacturing to act as perfect substitutes with workers in this division. Therefore, a simplifying but not unreasonable assumption is made about a single manufacturing labor market existing, comprised of workers in all six divisions of the *maquiladora*. Following Card (2001), we assume that local labor markets are stratified along occupational lines. Within this framework, immigrant inflows affect the structure of wages by raising or lowering the relative population shares of different occupation groups. In theory, an increase of immigrants would raise the supply of workers in a particular occupation, hence putting downward pressure on wages.

The sample is restricted to individuals aged 16-64 who participated in the labor force. The inclusion of individuals as young as 16 is not unreasonable for a developing country such as Mexico, especially since the *maquiladora* industry attracts young workers with relatively little work experience. Weekly monthly earnings are drawn from the sub sample of persons who are employed in the year of the survey, are not students and report positive monthly earnings.

A person is defined to be an interstate in-migrant if he or she resided in another Mexican state in 1995. Figure 2.5 shows the average interstate immigration for the 20 textile Mexican states in our sample. If the person resided abroad in 1995, returned to Mexico and is interviewed in the Mexican Census 2000, then he or she is defined as an international return migrant. This definition should only capture migrants who returned to Mexico from the U.S. and who remained in Mexico at the time of the Census. If a person resided in the same state in 2000 as in 1995, then he or she is defined as a native worker.

Consider a group of workers employed in the manufacturing industry who have skill type *i,s*, and are observed in Mexican state *j*. The (i,s) cell defines worker by skill type in each state in 2000. The measure of the interstate immigrant supply shock for skill type i is defined by:

$$INM_{ij} = \frac{IMMIG_{ij}}{IMMIG_{ij} + RINTL_{ij} + N_{ij}}, \tag{2.16}$$

where $IMMIG_{ij}$ gives the number of interstate immigrants in cell (i,s), N_{ij} gives the corresponding number of natives, and $RINTL_i$ is the number of international return migrants in cell (i,s). INM_{ij} measures the proportion of interstate immigrants to the labor force by skill type.

The measure of the international return migrant supply shock is measured in a similar manner; the shock is defined as:

$$RINT_{ij} = \frac{IMMIG_{ij}}{RINTL_{ij} + IMMIG_{ij} + N_{ij}}, \tag{2.17}$$

where $RINT_{ij}$ measures the proportion of international return migrants to the labor force by skill type.

Table 2.6 illustrates some of the differences between natives and immigrants. Immigrants differ from natives in various dimensions: for example, immigrants are on average more educated and earn higher incomes. This suggests that there is heterogeneity of workers employed in the manufacturing labor market, providing justification for computing the ratio of migrants to natives across occupations within the manufacturing industry. Also, it provides support for finding of Chiquiar and Hanson (2005) who conclude that there is positive and intermediate selection of migrants. Another difference between native workers and immigrants is their marital status. As shown in Table 2.6, a higher proportion of migrants are married.

Borjas (1991) and Card (1990) address the issue of how an influx of immigrants can lead to an outflow of natives. In theory, if the native labor supply curve is upward sloping or perfectly inelastic, then an influx of immigrants would decrease the supply of native workers. For Mexico, an alternative response for natives to inflows of immigrants, particularly for unskilled workers, is to seek employment in the informal sector. A restrictive assumption in the literature is that the relative wage of a particular skill group depends only on the relative population share of that group. This ignores the heterogeneity of ability and motivation, not captured by education or occupation classification that can be apparently different for immigrants and natives. That is, immigrants may be more motivated and more productive than natives with the same education or occupation so that, in a given labor market, immigrants may compete for jobs with other immigrants and not necessarily with natives.

2.5 Empirical Results

The first step is to estimate an individual-level regression, including the interstate immigrant and the international return migrant supply shock as explanatory variables. The regression equation is specified as:

$$w_i = \beta_1 INM_{ij} + \beta_2 RINT_{ij} + \beta_3 X_i + e_i \tag{2.18}$$

where w_i is the log of monthly earnings for workers employed in the manufacturing industry with skill type i. The coefficient β_1 gives the percentage change in wages due to a one-percent change in the number of interstate migrants into a state. The coefficient β_2 gives the corresponding percentage change in wages due to a one percentage change in the number of return migrants into a state. The vector X_i is comprised of individual control variables: experience, marital status, education and ethnicity. The error term is given by e_i.

There are some advantages to using an individual-level regression: (1), the individual-level regression controls for individual-level factors that affect wages, and (2) the individual-level regression results can be directly combined with the estimated *maquiladora* demand elasticities to estimate the effect of in-migration on wages, without the assumption of an national labor market.

It would be ideal to include all textile workers who emigrated to the U.S. as an additional variable to measure the inward supply shift. Mishra (2003) used the U.S. Census to compute this ratio on an aggregate basis for all of Mexico. However, this approach is not applicable to our problem, for a number of reasons. While Mexican emigrants are not included in the Mexican Census, since they reside in the U.S., the U.S. Census undercounts the number of illegal immigrants, and it is not possible to distinguish legal from illegal migrants, thereby possibly omitting a substantial number of former Mexican manufacturing workers. In addition, the state of origin, former occupation, and skill level for Mexican immigrants are not recorded in the U.S. Census. Assuming that the immigrants occupation in the U.S. is the same as the previous occupation in Mexico does not seem warranted.

A critical assumption in our model is that the native component of our migration estimate incorporates interstate and internationally outflows. Furthermore, the assumption is made that the immigration ratio, since it varies across skill type of the individual and is a group variable, is exogenous to the individual.[10] The implications of this assumptions are important for the analysis. Given endogeneity, our estimate of the impact of immigration on wages would be biased. A positive relationship between wages and immigration would indicate that individuals migrate to areas with relatively higher wages.

After estimating the log wage equation, the partial derivative with respect to the inter-state immigration ratio is derived and converted into an elasticity, $\tau_{inm,s}$ and $\tau_{inm,u}$ for skilled

[10]Given the potential of endogeneity I instrumented with various exogenous variables, and the IV results failed to change our results significantly.

and unskilled workers, respectively. Values of $\tau_{int,s}$ and $\tau_{int,u}$, the elasticities of return international migration, are computed analogously. The average of each elasticity for skilled and unskilled textile workers in each state j, obtaining $\tau_{k,sj}$ and $\tau_{k,uj}$, for state j, $k = \text{RINT}, \text{INM}$ is computed. .

Next each state's actual percentage change in international return migration, $\delta_{rint,sj}$ and $\delta_{rintm,uj}$, for skilled and unskilled workers, is computed, as well as the percentage change in interstate immigration, $\delta_{inm,sj}$ and $\delta_{inm,uj}$, for skilled and unskilled workers, in state j. For interstate immigration:

$$\delta_{INM,sj} = \frac{INM_{sj,2000} - INM_{sj,1990}}{0.5(N_{sj,1990} + N_{sj,2000}) + IMMIG_{sj,1990}}, \ \forall j \tag{2.19}$$

$$\delta_{INM,uj} = \frac{INM_{uj,2000} - INM_{uj,1990}}{0.5(N_{uj,1990} + N_{uj,2000}) + INM_{uj,1990}} \ \forall j \tag{2.20}$$

and for international return migration:

$$\delta_{RINT,sj} = \frac{RINT_{sj,2000} - RINT_{sj,1990}}{0.5(N_{sj,1990} + N_{sj,2000}) + INT_{sj,1990}}, \ \forall j \tag{2.21}$$

$$\delta_{RINT,uj} = \frac{RINT_{uj,2000} - RINT_{uj,1990}}{0.5(N_{uj,1990} + N_{uj,2000}) + RINT_{uj,1990}}, \ \forall j \tag{2.22}$$

where $N_{\xi j,t}$ is the native workforce in skill level $\xi = s, u$, state j, and time t. Wages are denoted by W. The wage elasticities (the τ's) are multiplied by the actual migratory percentage changes (the δ's) to obtain the estimated percent change in wages for each skill type due to the actual percent change in each migratory type. The percent change in wages due to the observed percent change in interstate immigration is obtain as:

$$\Delta \log W_{INM,sj} = \tau_{INM,sj}\delta_{INM,sj} \ \forall j, \tag{2.23}$$

$$\Delta \log W_{INM,uj} = \tau_{INM,uj}\delta_{INM,uj} \ \forall j \tag{2.24}$$

The percent change in wages due to the observed percent change in international immigration is obtain as:

$$\Delta \log W_{RINT,sj} = \tau_{RINT,sj}\delta_{RINT,sj}, \ \forall j, \tag{2.25}$$

$$\Delta \log W_{RINT,uj} = \tau_{RINT,uj}\delta_{RINT,uj}, \ \forall j. \tag{2.26}$$

Finally, estimated price elasticities of demand for skilled and unskilled workers are multiplied by the estimated change in wages to obtain the estimated change in employment for each skill type in state j due to migration type k. QL denotes the quantity of skilled and unskilled labor. For interstate immigration the percent change in employment is:

$$\Delta \log QL_{INM,sj} = \eta_{ss,j}\Delta \log w_{INM,sj} + \eta_{su,j}\Delta \log w_{INM,uj}, \ \forall j, \tag{2.27}$$

$$\Delta \log QL_{INM,uj} = \eta_{uu,j}\Delta \log w_{INM,uj} + \eta_{us,j}\Delta \log w_{INM,sj}, \ \forall j. \tag{2.28}$$

For return international migration the percent change in employment is:

$$\Delta \log QL_{RINT,sj} = \eta_{ss,j}\Delta \log w_{RINT,sj} + \eta_{su,j}\Delta \log w_{RINT,uj}, \ \forall j, \tag{2.29}$$

$$\Delta \log QL_{RINT,uj} = \eta_{uu,j}\Delta \log w_{RINT,uj} + \eta_{us,j}\Delta \log w_{RINT,sj}, \ \forall j. \tag{2.30}$$

2.5.1 *Maquiladora*'s Production and Labor Demand

The majority of workers employed in the *maquiladora* industry are unskilled workers. The average *maquiladora* in our sample employs approximately 13,750 unskilled and 653 skilled workers. The earnings in *maquiladoras* are, on average, higher than in domestic manufacturing plants; unskilled workers earn approximately \$1,250 per month, while the skilled workers earn, on average, \$3,700 per month. The estimated price elasticities of factor demand are given in Tables 2.3 and 2.4. η_{ss} represents the own-price elasticity of skilled labor demand with respect to the wage of skilled labor. η_{uu} represents the own-price elasticity of labor demand for unskilled workers. Both estimates indicate that labor demand curves for skilled and unskilled workers are downward sloping. The own-price elasticities indicate that the demand for skilled labor is more wage elastic; that is, firms have a higher responsiveness to changes in the wage of skilled workers compared to unskilled workers. Although this seems contrary to intuition, it is consistent with Fajnzylber and Maloney's (2001) findings for Chile, Mexico and Colombia. They do not offer an explanation for this result. One explanation is that firms train unskilled workers to replace skilled workers at low cost to the firm. Also, firms may be able to substitute away from skilled workers more easily into more capital-intensive processes requiring fewer skilled workers in production. [11] They find elasticities ranging from -.20 to -.80; my estimates for the manufacturing industry fall within this range. η_{su} and η_{us} are the cross-price elasticities of demand, which indicate that a high degree of substitutability exist between skilled and unskilled workers, consistent with my first explanation. This result is interesting because it suggests that firms can more easily substitute away from skilled workers as wages increase.

In my estimation of the cost function, a demand-side shifter, FDI, is introduced to ascertain the impact of foreign capital mobility on the demand for both types of workers across the various states with manufacturing production. The estimates in Tables 2.5 and 2.6 indicate that FDI is more favorable to skilled workers. Hence, capital mobility into Mexico from the U.S. shifts the relative demand for skilled workers, increasing their relative wage. Therefore, increased capital mobility implies increased wage inequality in Mexico.[12] The estimated labor demand functions and elasticities are used below to calculate the impact of migration on wages.

2.5.2 Migration's Impact on Wages and Employment

In the second step, individual-level regressions are estimated to determine the impact of interstate immigration and international return migration on the earnings of individuals employed in the six divisions of the manufacturing industry. Tables 2.7 and 2.8 show these results. Not surprisingly, the estimated coefficients on experience and schooling suggest that additional years of both schooling and experience increase wages. The estimated coefficients on the migration shocks are consistent with Card's (1990) and Friedberg and Hunt's (1995) findings that an influx of migration may not depress wages but rather, migration and higher wages can coexist. Given the reduced form of the wage equation an influx of migration can

[11] The appropriate data to test this hypothesis are unavailable; no studies have examined this substitutability.

[12] The relationship between FDI and inequality is beyond the scope of this paper, but one could estimate inequality over time, by looking at states with relative high rates of capital mobility into the state.

shift both the supply and demand curves. The findings of Borja (2003) suggest that a supply effect out-weights any demand effects of migration, while Card (1990), consistent with our findings, suggests the opposite, that the demand shift can out-weight the supply shift of migration. The Friedberg and Hunt (1995) findings, which support our results, suggest that an influx of Russians into Israel did not depress the wages of natives but, rather, increased wages for natives. They conclude that immigrants compete more with one another than with natives and that immigrants and natives are complementary inputs in production.

Borjas (2003) argues that a positive relationship between wages and immigration may exist because migrants tend to migrate to areas with high wages, and not because migration increases wages through a demand component. Therefore, in addition to estimating the wage equation by ordinary least squares (OLS), we also estimate it by 2SLS using the 1990 interstate and international return migration rates as instruments. The 2SLS results in Table 2.9 and Table 2.10 confirm our previous finding that migration increases wages.

The estimated coefficients on the other included variables are consistent with my hypotheses. For example, there exists evidence of sexual and racial wage differences in the manufacturing industry. The human resource literature finds evidence of sexual wage differences and, even further, evidence of sexual harassment towards women employed in this industry. Our findings are consistent with this literature; women on average earn 20 percent less than men. However, if there are omitted variables that are correlated with gender and that would reduce wages, attributing estimated wage differences to sexual discrimination would be inappropriate. Also, the results suggest racial wage differences, on average, workers belonging to an indigenous group earn 7 percent less. Table 2.11 shows state of origin and the destination state of indigenous migrants. There appears to be no clear migratory pattern for indigenous migrants; flows are from central states to southern states, central to northern states and vice versa. What is of particular interest is the movement of indigenous migrants from the state of Chihuahua to Mexico City. There is also a wage premium for additional years of education (6 percent) and if the individual is married (9 percent). Another consistent result is that the effect on wages of an additional year of experience increases at a decreasing rate. Furthermore, the estimate on the coefficient of our unskilled dummy variable indicates that on average unskilled workers earn substantially less than skilled workers, controlling for the observable individual characteristics. Such a wide wage gap between skilled and unskilled labor could indicate that the analysis does not control adequately for innate ability of the individual. The coefficient estimates on the state dummy variables were all statistically significant at the 5 percent level and all indicated that individuals living in a state other than Chiapas receive higher wages.[13]

As described in the empirical section, the estimates of the elasticity of wages with respect to immigration are used in conjunction with the estimated *maquiladoras* labor demand equation to estimate the impact of immigration on wages and employment of workers in this industry. Tables 2.12 and 2.13 show the estimated percentage change in wages due to immigration. Tables 2.14 and 2.15 show the estimated percentage change in employment due to immigration. There is no significant change in wages, as shown in Table 2.12 and 2.13, or employment, as shown in Tables 2.14 and 2.15, due to interstate immigration or international return migration, with the exception of the Mexican states, BCN and BCS. The California border state BCN receives a disproportionally high inflow of interstate immigration, especially individuals en route to the U.S. The actual influx of interstate immigrants decreased wages by 13.98 percent for unskilled workers in BCN. This may have had a detrimental effect on wage inequality in this border state. This effect is significantly larger than Borjas (2003) finding for the U.S., where a 10 percent increase in the supply of immigrants reduced wages of native workers by 3 to 4 percent for skilled workers and by as much as 8 percent for all workers. Furthermore, the employment of skilled workers is decreased by 5.89 percent due to the influx of unskilled migrants. By contrast, in BCS migration increased wages by 7 percent for unskilled workers. The weighted average effect of migration on wages is negative

[13]Chiapas is one of the poorest states in Mexico.

but small, less than 1 percent. The weighted average effects of migration on employment are also very small, ranging between -.26 and .19 percent.

2.6 Conclusion

The impact of immigration on wages and employment in the U.S. has been examined by a number of researchers, while few studies for Mexico focus on the effects of interstate immigration and international return migration. This paper has attempted to address this issue. Furthermore, an attempt has been made to address a serious shortcoming of studies for the U.S. Borjas (1990), Card (2003) and Mishra (2003) all use Census-level data without modeling the production of the firm. By contrast, I jointly model wages, employment, migration and the productivity of the firm. Butcher and DiNardo (1998) find that in many cities in the U.S. immigrants are slightly less skilled than native workers. In Mexico, immigrants are, on average, more skilled than the average native worker, suggesting the difference can be attributed positive selection on immigration.

The findings in this chapter point to a few interesting conclusions. First, inflows of interstate and international return migrants into the manufacturing labor market from 1998 to 2001 generated large changes in wages and employment for two states, BCN and BCS, but almost no change for the other 18 Mexican states. This result is partially consistent with Card's (1990) finding that the Mariel boatlift influx of migrants into Miami had no significant impact on wages or employment. Furthermore, the common measure in the literature of migrant-to-native stock merits closer examination for the possibility that it is capturing innate abilities of migrants or acting as a proxy for higher turnover in the industry.

Lastly, FDI increases labor demand for skilled workers in all 20 Mexican states, while FDI decreases labor demand for unskilled workers in some states. The impact of FDI may contribute to increased wage inequality in Mexico. More studies are needed to examine the impact of FDI, capital mobility, and internal migration in Mexico on wages and employment.

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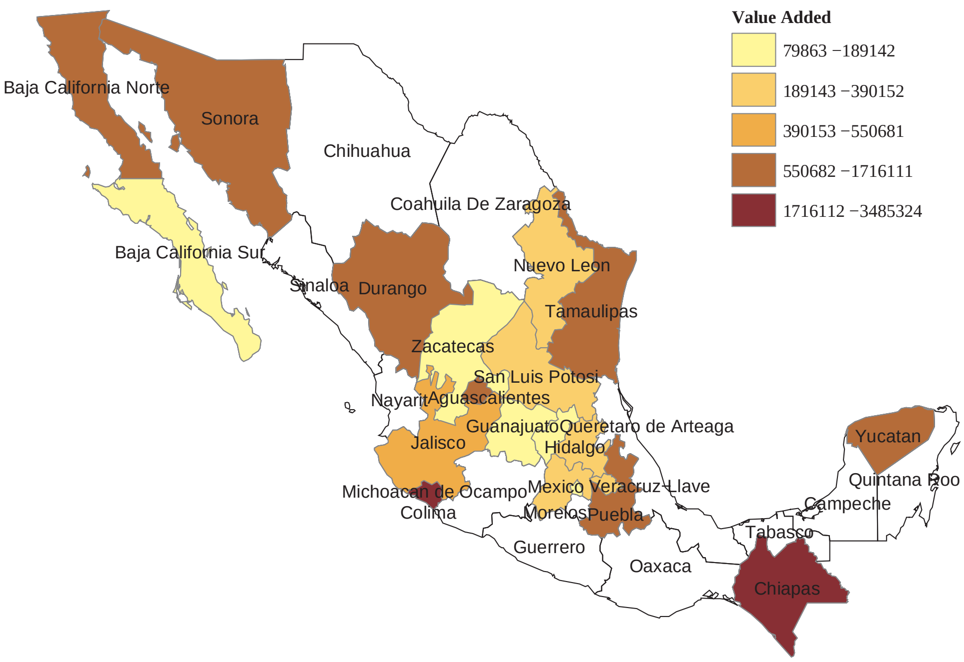
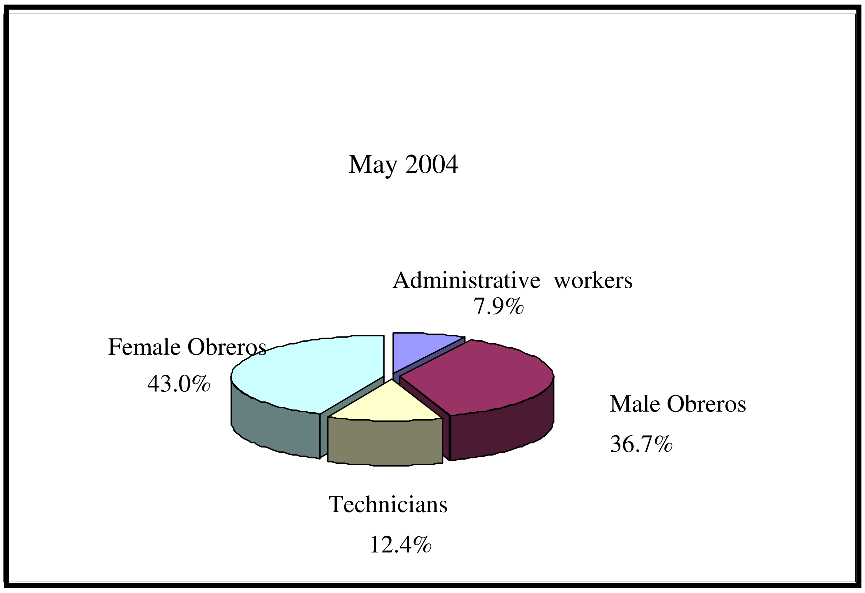


Figure 2.1: Average Value Added in the *Maquiladora* Industry 1998-2001



Source: INEGI's Maquiladora de Exportacion 2005 yearbook

Figure 2.2: Personnel Employed in the *Maquiladora* Industry 2004

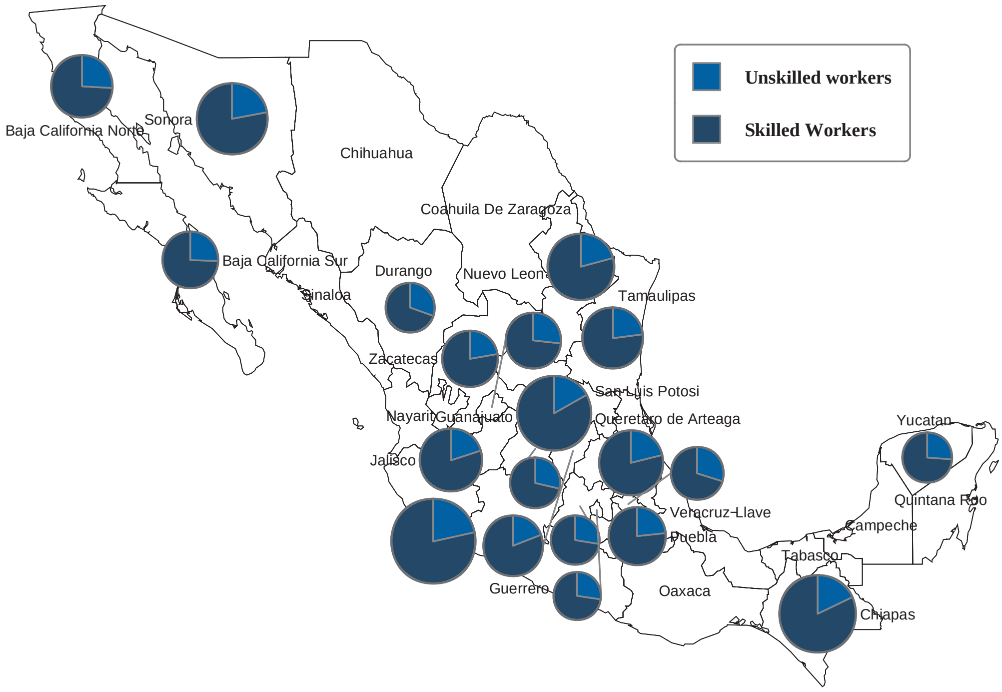


Figure 2.3: Ratio of Skilled to Unskilled Earnings in the Textile Industry 1998-2001

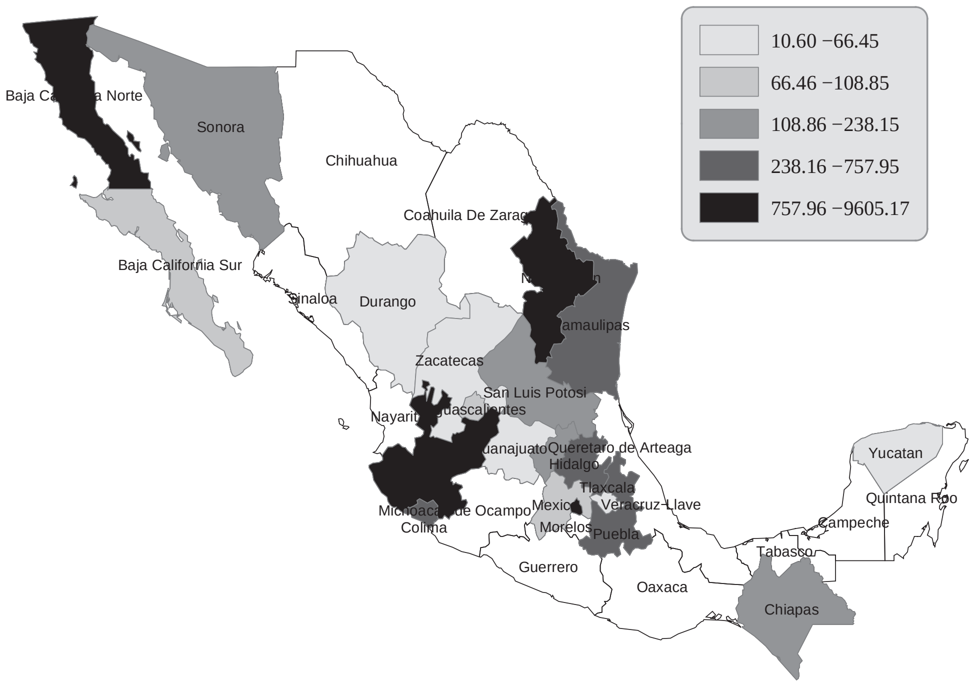


Figure 2.4: Foreign Direct Investment to Mexico 1998-2001

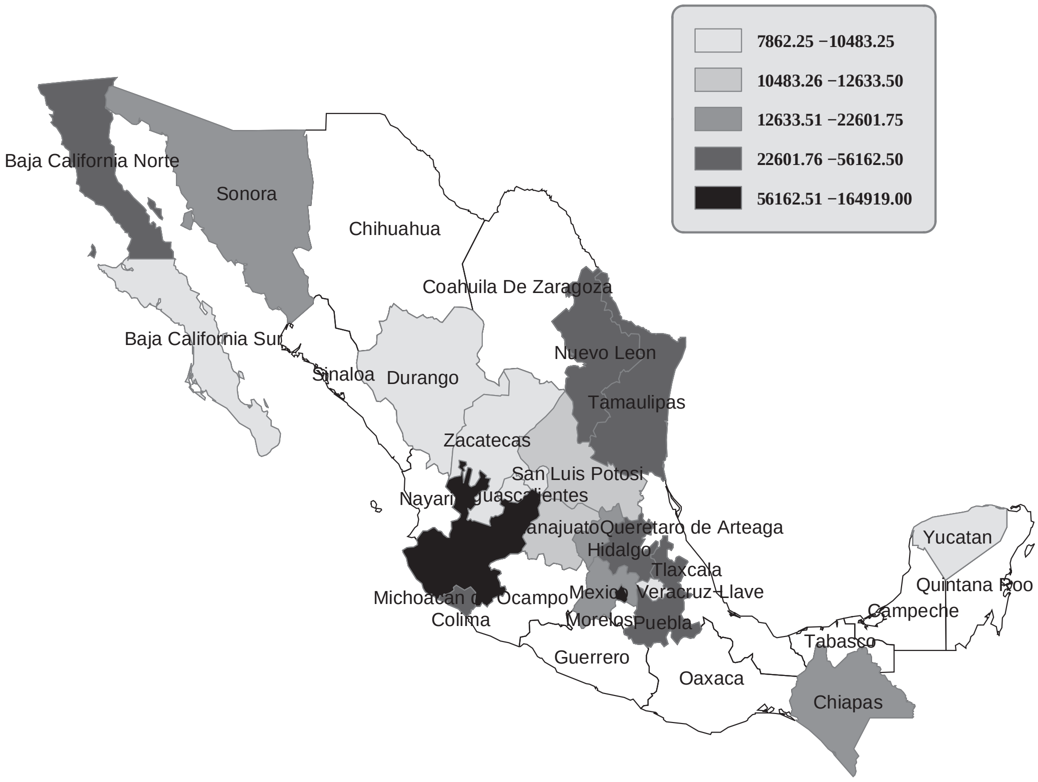


Figure 2.5: Interstate Immigration in Mexico 1998-2001

Table 2.1: Definition of Variables

Variable	Definition
Age	Age
Exper	Work Experience (Age-15 years)
Exper2	Work Experience Squared
Indig	Dummy equal to one if individual belongs to an indigenous group
INM	Ratio of interstate immigration to natives
INM*Skill	Interaction between ratio of interstate immigration and skilled
Log income	Income in pesos
Male	Dummy equal to one if male
Married	Dummy equal to one if married
Output	Output in 2001 constant pesos of textile industry
Q-u	Quantity of unskilled workers employed in the textile industry
Q-s	Quantity of skilled workers employed in the textile industry
RINT	Ratio of international return migrants to natives
RINT*Skill	Interaction between ratio of international return and skilled
School	Years of schooling
VA	Value added in 2001 constant pesos of textile industry
Skilled	Dummy equal to one if unskilled
Wage-u	Wage of unskilled workers in 2001 constant pesos of textile industry
Wage-s	Wage of skilled workers in 2001 constant pesos of textile industry

Table 2.2: Average Characteristics of Natives and Immigrants by Skill Type

	Natives			Interstate Immigrants			International Return		
	All	Unskilled	Skilled	All	Unskilled	Skilled	All	Unskilled	Skilled
Exper	16.4008	16.2240	16.9593	14.3017	14.5562	13.7637	17.0238	17.3576	8.567
Indig	.0475	.0576	.0157	.0376	.0483	.0151	.0201	.0194	.0223
Log Income	7.6026	7.3858	8.2873	7.8178	7.5009	8.4878	7.8736	7.580	8.7731
Male	.8397	.8552	.7908	.8294	.8317	.8246	.9229	.9343	.8880
Married	.5692	.5215	.7196	.6068	.5428	.7420	.6733	.6204	.8358
School	7.5266	6.4102	11.0527	8.6052	6.7576	12.5108	7.9596	6.6520	11.9701
Unskilled	.7595	–	–	.6788	–	–	.7451	–	–

Source: Mexican Census 2000.

Table 2.3: Division 2: Estimated Price Elasticities of Factor Demand by State

State	η_{ss}	η_{uu}	η_{su}	η_{us}
Ags	-0.3654	-0.0459	0.3654	0.0459
BCN	-0.4591	-0.0739	0.4591	0.0739
BCS	-0.4561	-0.0733	0.4561	0.0733
Chis	-0.4740	-0.0819	0.4740	0.0819
Col	-0.4700	-0.0793	0.4700	0.0793
DF	-0.5033	-0.1048	0.5033	0.1048
Dgo	-0.2949	-0.0310	0.2949	0.0310
Mex	-0.4227	-0.0597	0.4227	0.0597
Gto	-0.0099	-0.0294	0.0099	0.0294
Hgo	-0.4897	-0.0922	0.4897	0.0922
Jal	-0.4945	-0.0975	0.4945	0.0975
NL	-0.5101	-0.1115	0.5101	0.1115
Pue	-0.4233	-0.0596	0.4233	0.0596
Qro	-0.4912	-0.0936	0.4912	0.0936
SLP	-0.4999	-0.1011	0.4999	0.1011
Son	-0.4637	-0.0768	0.4637	0.0768
Tamps	-0.4721	-0.0811	0.4721	0.0811
Tlax	-0.4053	-0.0542	0.4053	0.0542
Yuc	-0.4016	-0.0526	0.4016	0.0526
Zac	-0.4699	-0.0796	0.4699	0.0796

Table 2.4: Division 8: Estimated Price Elasticities of Factor Demand by State

State	η_{ss}	η_{uu}	η_{su}	η_{us}
BCN	-0.3298	-0.1270	0.3298	0.1270
Chih	-0.2830	-0.0804	0.2830	0.0804
Coah	-0.3371	-0.1462	0.3371	0.1462
Jal	-0.3319	-0.1571	0.3319	0.1571
Mex	-0.3336	-0.1955	0.3336	0.1955
NL	-0.3370	-0.1879	0.3370	0.1879
Qro	-0.3122	-0.1056	0.3122	0.1056
Son	-0.3227	-0.1165	0.3227	0.1165
Tamps	-0.2950	-0.0886	0.2950	0.0886
Yuc	-0.3238	-0.1182	0.3238	0.1182

Note: Data comes from the *Maquiladora Industrial de Exportacion*. η_{ss} is the own-price elasticity of skilled labor demand. η_{uu} is the own-price elasticity of unskilled labor demand.

Table 2.5: Division 2: Estimated Elasticities of NDFI by State

State	ϵ_{ns}	ϵ_{nu}
Ags	0.0475	-0.0195
BCN	0.0706	0.0175
BCS	0.0648	0.0112
Chis	0.0390	-0.0116
Col	0.0550	0.0037
DF	0.1155	0.0709
Dgo	0.0390	-0.0378
Mex	0.0527	-0.0062
Gto	0.0928	-0.0165
Hgo	0.0730	0.0254
Jal	0.0705	0.0241
NL	0.0851	0.0420
Pue	0.0551	-0.0038
Qro	0.0592	0.0120
SLP	0.0526	0.0072
Son	0.0522	-0.0001
Tamps	0.0592	0.0083
Tlax	0.0318	-0.0298
Yuc	0.0435	-0.0186
Zac	0.0258	-0.0255

Table 2.6: Division 8: Estimated Elasticities of FDI by State

State	ϵ_{ns}	ϵ_{nu}
BCN	0.2795	0.0466
Chih	0.2063	-0.0667
Coah	0.2805	0.0589
Jal	0.2238	0.0046
Mex	0.1610	-0.0410
NL	0.2565	0.0527
Qro	0.1071	-0.1427
Son	0.1998	-0.0407
Tamps	0.2616	-0.0027
Yuc	0.0228	-0.2166

Note: Data come from the *Maquiladora Industrial de Exportacion*. ϵ_{ns} is the FDI elasticity of skilled labor demand. ϵ_{nu} is the FDI elasticity of unskilled labor demand.

Table 2.7: Division 2: 2000 Mexican Census Estimated Log Wage (OLS)

Variable	Est. Coefficient	Est. Std. Error
Constant	6.9143	(0.0173)*
INM	1.1678	(0.1741)*
INM*Skill	-1.1563	(0.1634)*
RINT	5.9190	(0.7319)*
RINT*Skill	-5.5180	(1.2962)*
School	0.0603	(0.0006)*
Male	0.2086	(0.0050)*
Indig	-0.0743	(0.0093)*
Exper	0.0214	(0.0006)*
Exper2	-0.0003	(0.0000)*
Married	0.0910	(0.0042)*
Skilled	-0.6812	(0.0131)*
Ags	0.2400	(0.0199)*
BCN	0.5518	(0.0242)*
BCS	0.4814	(0.0367)*
Col	0.2882	(0.0274)*
DF	0.2323	(0.0131)*
Dur	0.1915	(0.0193)*
Gto	0.2903	(0.0158)*
Hgo	0.0530	(0.0164)*
Jal	0.3257	(0.0163)*
Mex	0.2153	(0.0132)*
NL	0.4071	(0.0145)*
Pue	0.1158	(0.0143)*
Qtr	0.3065	(0.0164)*
Slp	0.0495	(0.0149)*
Son	0.3149	(0.0155)*
Tam	0.3181	(0.0204)*
Tla	0.0537	(0.0161)*
Yuc	0.0413	(0.0137)*
Zac	0.1553	(0.0212)*

Note: Asterisk indicates significance at the .05 level

Table 2.8: Division 8: 2000 Mexican Census Estimated Log Wage (OLS)

Variable	Coefficient	Standard Error
Constant	6.5504	(0.0185)*
INM	0.2025	(0.2011)
INM*Skill	-0.1595	(0.1897)
RINT	7.5426	(1.0638)*
RINT*Skill	-11.3707	(2.1222)*
School	0.0647	(0.0007)*
Male	0.2174	(0.0054)*
Indig	0.0101	(0.0109)
Exper	0.0240	(0.0006)*
Exper2	-0.0003	(0.0000)*
Married	0.0960	(0.0048)*
Skilled	0.5842	(0.0154)*
BCN	0.2814	(0.0197)*
Chih	-0.0074	(0.0117)
Coah	0.0772	(0.0103)*
Mex	-0.0926	(0.0135)*
NL	0.1065	(0.0110)*
Qtr	-0.0151	(0.0135)
Son	0.0065	(0.0108)
Tam	0.0250	(0.0182)
Yuc	-0.3271	(0.0148)*

Asterisk indicates significant at the .05 percent level. Number of observations: 65,784. R-squared is .4491

Table 2.9: Division 2: 2000 Mexican Census Estimated Log Wage (OLS-IV)

	All		Natives		Immigrants	
	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	6.9143	6.8734	6.9084	6.8504	7.1110	7.2153
	(399.9698)**	(182.3879)**	(387.4500)**	(177.1523)**	(86.6105)**	(47.8444)**
INM	1.1678	1.4185	1.0828	1.2333	2.2018	3.5089
	(6.7077)**	(5.7268)**	(5.7752)**	(4.5945)**	(4.4608)**	(4.6673)**
INM*Skill	-1.1563	-1.5245	-1.0480	-1.3505	-2.3874	-3.4606
	(-7.0749)**	(-6.9265)**	(-5.9511)**	(-5.6254)**	(-5.1682)**	(-6.0803)**
RINT	5.9190	10.7404	6.2764	12.4825	1.7231	-8.0046
	(8.0874)**	(4.2584)**	(8.2307)**	(4.9505)**	(0.6364)	(-0.5251)
RINT*Skill	-5.5180	7.1585	-5.9932	10.0748	-1.7736	-24.0262
	(-4.2572)**	(0.9866)	(-4.4186)**	(1.3643)	(-0.3976)	(-0.6388)
School	0.0603	0.0604	0.0593	0.0594	0.0687	0.0681
	(100.6081)**	(86.6149)**	(95.3923)**	(82.0998)**	(29.8929)**	(24.2145)**
Male	0.2086	0.2086	0.2041	0.2041	0.2603	0.2595
	(42.0174)**	(42.2480)**	(39.8702)**	(40.0077)**	(13.1735)**	(13.3013)**
Indig	-0.0743	-0.0727	-0.0785	-0.0767	-0.0205	-0.0222
	(-8.0029)**	(-7.5571)**	(-8.2074)**	(-7.8062)**	(-0.5334)	(-0.5115)
Exper	0.0214	0.0214	0.0218	0.0218	0.0194	0.0194
	(37.0749)**	(35.9367)**	(36.5485)**	(35.3645)**	(8.2282)**	(8.0808)**
Exper2	-0.0003	-0.0003	-0.0003	-0.0003	-0.0002	-0.0002
	(-27.0604)**	(-26.6876)**	(-26.9449)**	(-26.5033)**	(-4.9511)**	(-5.1140)**
Married	0.0910	0.0903	0.0906	0.0899	0.0717	0.0735
	(21.7161)**	(21.8827)**	(20.9482)**	(21.0724)**	(4.3349)**	(4.4557)**
Skilled	-0.6812	-0.6449	-0.6731	-0.6177	-0.7776	-0.9436
	(-51.9247)**	(-16.8999)**	(-48.4952)**	(-15.7039)**	(-17.7038)**	(-5.1290)**
Ags	0.2400	0.1702	0.2483	0.1644	0.0106	0.1313
	(12.0880)**	(4.8870)**	(12.1031)**	(4.6932)**	(0.1171)	(0.5424)
BCN	0.5518	0.4257	0.5714	0.4224	0.2468	0.3799
	(22.8098)**	(7.4211)**	(22.5337)**	(7.2225)**	(2.6357)**	(1.1070)
BCS	0.4814	0.4445	0.4377	0.4142	0.3482	0.1982
	(13.1194)**	(9.0863)**	(10.8357)**	(7.6398)**	(3.3009)**	(1.6706)*
Col	0.2882	0.1334	0.2748	0.0888	0.2731	0.5575
	(10.5344)**	(1.7228)*	(9.6098)**	(1.1588)	(2.5385)**	(1.0055)
DF	0.2323	0.2211	0.2403	0.2328	0.0538	0.0472
	(17.7112)**	(14.8569)**	(17.7405)**	(14.8828)**	(0.7809)	(0.6238)
Dur	0.1915	0.1035	0.1948	0.0862	0.0385	0.2116
	(9.9013)**	(2.2908)**	(9.7669)**	(1.9055)*	(0.4257)	(0.6794)
Gto	0.2903	0.2037	0.2923	0.1848	0.1281	0.3232
	(18.3350)**	(4.6178)**	(17.9898)**	(4.2193)**	(1.5699)	(0.9575)
Hgo	0.0530	0.0075	0.0502	0.0002	-0.0554	-0.0148
	(3.2337)**	(0.3444)	(2.9320)**	(0.0080)	(-0.7462)	(-0.1044)
Jal	0.3257	0.2453	0.3277	0.2282	0.1937	0.3500
	(20.0052)**	(6.1459)**	(19.4688)**	(5.7045)**	(2.4623)**	(1.2704)
Mex	0.2153	0.2006	0.2237	0.2130	-0.0016	-0.0153
	(16.2555)**	(12.9054)**	(16.2682)**	(12.9551)**	(-0.0236)	(-0.2044)
NL	0.4071	0.3441	0.4051	0.3314	0.3509	0.4454
	(28.1161)**	(12.0806)**	(27.0489)**	(11.5503)**	(4.8144)**	(2.1524)**
Pue	0.1158	0.0651	0.1204	0.0609	-0.0521	0.0294
	(8.1023)**	(2.7492)**	(8.1521)**	(2.5478)**	(-0.7146)	(0.1666)
Qtr	0.3065	0.2807	0.3112	0.2828	0.1006	0.1166
	(18.7177)**	(14.5503)**	(18.3894)**	(14.0150)**	(1.2978)	(1.2012)
Slp	0.0495	0.0011	0.0492	-0.0108	-0.0078	0.0984
	(3.3247)**	(0.0423)	(3.2396)**	(-0.4103)	(-0.0949)	(0.5076)
Son	0.3149	0.2533	0.3138	0.2413	0.2406	0.3392
	(20.2896)**	(8.7198)**	(19.5460)**	(8.2555)**	(3.1558)**	(1.6072)
Tam	0.3181	0.2850	0.3199	0.2887	0.1492	0.1405
	(15.6241)**	(11.6411)**	(14.8953)**	(11.0496)**	(1.8457)*	(1.2881)
Tla	0.0537	0.0421	0.0567	0.0480	-0.0795	-0.0879
	(3.3372)**	(2.5674)**	(3.4158)**	(2.8205)**	(-1.0166)	(-1.0741)
Yuc	0.0413	0.0172	0.0452	0.0163	-0.0277	0.0567
	(3.0146)**	(1.0099)	(3.2598)**	(0.9631)	(-0.3238)	(0.3382)
Zac	0.1553	0.0472	0.1478	0.0113	0.0926	0.2952
	(7.3186)**	(0.8402)	(6.7010)**	(0.2001)	(1.0219)	(0.8446)

Table 2.10: Division 8: 2000 Mexican Census Estimated Log Wage (OLS-IV)

	All		Natives		Immigrants	
	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	6.5504	6.1102	6.5628	6.1469	6.5037	5.8080
	(353.4895)**	(162.5939)**	(338.2170)**	(154.1815)**	(97.2337)**	(36.5679)**
INM	0.2025	-0.0299	0.0804	-0.1732	1.0759	0.6379
	(1.0067)	(-0.1419)	(0.3768)	(-0.7204)	(1.6640)*	(0.8914)
INM*Skill	-0.1595	0.0083	-0.0135	0.1672	-1.2410	-0.7557
	(-0.8407)	(0.0421)	(-0.0673)	(0.7400)	(-2.0072)**	(-1.0919)
RINT	7.5426	8.8630	7.0869	8.2374	11.2772	15.1557
	(7.0900)**	(7.9574)**	(6.4265)**	(6.6097)**	(2.7068)**	(3.0652)**
RINT*Skill	-11.3707	-7.1006	-10.2087	-6.7155	-19.1656	-8.1229
	(-5.3579)**	(-3.1763)**	(-4.6002)**	(-2.6307)**	(-2.5849)**	(-0.9544)
School	0.0647	0.1165	0.0639	0.1132	0.0711	0.1459
	(95.0021)**	(30.1976)**	(90.0960)**	(28.2377)**	(28.8424)**	(9.4066)**
Male	0.2174	0.2025	0.2134	0.2004	0.2584	0.2198
	(40.1978)**	(35.2471)**	(38.0720)**	(35.2252)**	(12.7130)**	(9.7418)**
Indig	0.0101	0.0661	0.0091	0.0624	0.0090	0.0763
	(0.9335)	(5.4843)**	(0.8105)	(5.0791)**	(0.2071)	(1.2814)
Exper	0.0240	0.0346	0.0244	0.0344	0.0199	0.0375
	(40.1011)**	(34.7016)**	(39.3936)**	(33.1976)**	(8.4012)**	(8.3983)**
Exper2	-0.0003	-0.0004	-0.0003	-0.0004	-0.0002	-0.0004
	(-28.2925)**	(-29.9579)**	(-28.0564)**	(-28.7034)**	(-4.7471)**	(-5.8661)**
Married	0.0960	0.0393	0.0972	0.0437	0.0642	-0.0195
	(19.9159)**	(6.0222)**	(19.4168)**	(6.5836)**	(3.6106)**	(-0.7789)
Skilled	0.5842	0.3358	0.5687	0.3389	0.6885	0.2108
	(37.9947)**	(13.8519)**	(35.0670)**	(13.2316)**	(13.3126)**	(1.8619)*
BCN	0.2814	0.2632	0.2932	0.2732	0.1317	0.1957
	(14.3131)**	(12.8076)**	(14.2605)**	(11.4853)**	(1.9237)*	(2.5098)**
Chih	-0.0074	-0.0243	-0.0052	-0.0242	-0.0558	-0.0058
	(-0.6358)	(-1.9851)**	(-0.4358)	(-1.7953)*	(-1.1424)	(-0.0988)
Coah	0.0772	0.0771	0.0760	0.0749	0.0553	0.1201
	(7.4574)**	(7.1469)**	(7.0979)**	(6.3268)**	(1.3753)	(2.4649)**
Mex	-0.0926	-0.0996	-0.0939	-0.1021	-0.1009	-0.0419
	(-6.8364)**	(-7.0431)**	(-6.7006)**	(-6.1347)**	(-1.8961)*	(-0.6362)
NL	0.1065	0.0728	0.0956	0.0616	0.2286	0.2531
	(9.6572)**	(6.1868)**	(8.3811)**	(4.5595)**	(5.3022)**	(4.8569)**
Qtr	-0.0151	0.0032	-0.0174	0.0013	-0.0258	0.0122
	(-1.1187)	(0.2263)	(-1.2505)	(0.0788)	(-0.4617)	(0.1910)
Son	0.0065	-0.0184	-0.0024	-0.0285	0.1207	0.1658
	(0.6035)	(-1.6076)	(-0.2134)	(-2.2250)**	(2.7811)**	(3.1408)**
Tam	0.0250	0.0166	0.0164	0.0088	0.0678	0.1111
	(1.3732)	(0.8706)	(0.8591)	(0.3932)	(1.0629)	(1.4585)
Yuc	-0.3271	-0.3057	-0.3347	-0.3158	-0.1711	-0.1642
	(-22.1351)**	(-19.7310)**	(-21.8785)**	(-18.4485)**	(-2.6405)**	(-1.9715)**

Table 2.11: Migration of Indigenous Populations

State of Origin	States of Attraction
Baja California	Chihuahua (Chihuahua)
Chihuahua	Ciudad de Mexico
Coahuila	Ciudad Juarez (Chihuahua)
Distrito Federal	Ciudad de Guadalajara (Jalisco)
Durango	Ciudad Leon (Guanajuato)
Estado de Mexico	Ciudad Matamoros (Tamaulipas)
Guanajuato	Ciudad Merida (Yucatn)
Guerrero	Ciudad Monterrey (Nuevo Leon)
Jalisco	Ciudad Nuevo Laredo (Tamaulipas)
Michoacan	Ciudad Orizaba (Veracruz)
Puebla	Ciudad Puebla (Puebla)
Oaxaca	Ciudad San Luis Potosi (San Luis Potosi)
Sinaloa	Ciudad San Luis Potosi (San Luis Potosi)
Sonora	Ciudad Tampico (Tampico)
Veracruz	Ciudad Tijuana (Baja California)
Zacatecas	Ciudad Torren (Durango) and Ciudad Veracruz (Veracruz)

Source: Indigenous Migration in Mexico, Instituto Nacional Indigenista, 1996.

Table 2.12: Division 2: Estimated Pct. Change in Wage Due to Immigration

STATE	RINTM-U	RINTM-S	INM-U	INM-S
Ags	-0.08	-0.21	-0.50	0.21
BCN	0.11	0.39	-13.98	-0.07
BCS	-0.02	0.00	7.02	0.18
Col	-0.11	-2.61	0.61	0.00
Chs	0.00	0.00	0.04	0.00
Df	0.00	0.00	-0.28	0.00
Dur	-0.14	-0.31	-0.07	0.00
Gto	-0.11	-0.23	0.03	0.00
Hgo	-0.06	-0.06	1.44	0.03
Jal	-0.24	-0.01	-0.03	0.00
Mex	0.00	-0.02	-0.78	-0.03
NL	-0.01	-0.12	-0.02	0.01
Pue	-0.08	-0.02	0.66	0.01
Qtr	-0.03	-0.01	0.03	-0.01
Slp	-0.07	0.03	-0.03	-0.01
Son	-0.05	-0.15	0.07	0.00
Tam	-0.01	-0.05	0.32	-0.30
Tla	0.00	-0.05	1.12	0.00
Yuc	0.00	-0.18	0.07	0.00
Zac	-0.41	-0.13	0.24	0.06
Wtd. Avg.	-0.06	-0.46	-0.57	-0.01

Table 2.13: Division 8: Estimated Pct. Change in Wage Due to Immigration

STATE	RINTM-U	RINTM-S	INM-U	INM-S
BCN	-0.17	-0.08	-2.72	0.18
Chih	0.05	0.02	-0.13	0.02
Coah	0.01	0.02	-0.01	-0.01
Jal	0.34	0.00	-0.01	0.00
Mex	0.00	0.00	-0.14	0.06
NL	0.02	0.03	0.00	-0.01
Qtr	0.05	0.00	0.00	0.03
Son	0.08	0.03	0.01	0.01
Tam	0.01	0.01	0.06	0.68
Yuc	0.01	0.04	0.01	0.00
Wtd. Avg.	-0.01	0.00	-0.62	0.16

Table 2.14: Division 2: Estimated Pct. Change in Employment Due to Immigration

STATE	RINTM-U	RINTM-S	INM-U	INM-S
Ags	0.00	0.04	0.05	-0.31
BCN	0.02	-0.13	0.82	-5.89
BCS	0.00	-0.01	-0.26	2.34
Col	-0.21	1.19	-0.02	0.17
Chs	0.00	0.00	0.00	0.02
Df	0.00	0.00	0.02	-0.13
Dur	0.00	0.04	0.00	-0.03
Gto	-0.01	0.05	0.00	0.01
Hgo	0.00	0.00	-0.11	0.66
Jal	0.02	-0.12	0.00	-0.01
Mex	0.00	0.01	0.06	-0.35
NL	-0.01	0.06	0.00	-0.01
Pue	0.00	-0.03	-0.06	0.32
Qtr	0.00	-0.01	0.00	0.02
Slp	0.01	-0.05	0.00	-0.01
Son	-0.01	0.05	-0.01	0.04
Tam	0.00	0.02	-0.05	0.29
Tla	0.00	0.02	-0.09	0.53
Yuc	-0.01	0.07	-0.01	0.03
Zac	0.02	-0.13	-0.01	0.08
Wtd. Avg.	-0.03	0.19	0.03	-0.25

Table 2.15: Division 8: Estimated Pct. Change in Employment Due to Immigration

STATE	RINTM-U	RINTM-S	INM-U	INM-S
BCN	0.01	-0.03	0.38	-0.96
Chih	0.00	0.01	0.02	-0.05
Coah	0.00	0.00	0.00	0.00
Jal	-0.06	0.11	0.00	0.00
Mex	0.00	0.00	0.01	-0.05
NL	0.00	0.00	0.00	0.00
Qtr	-0.01	0.02	0.00	-0.01
Son	-0.01	0.02	0.00	0.00
Tam	0.00	0.00	0.09	-0.21
Yuc	0.00	-0.01	0.00	0.00
Wtd. Avg.	0.00	0.00	0.10	-0.26

Chapter 3

The Impact of Remittances on School Attendance and Child Labor in Mexico

3.1 Introduction

Much attention has been given to studying the flow of remittances from the U.S. to Latin America. Remittances represent the second- largest source of foreign capital flows to countries like Mexico, El Salvador, and the Dominican Republic. According to estimates by the Banco de Mexico (2005), in 2005 foreign investment in Mexico was $24 billion dollars, compared to remittances of $20 billion dollars. Table 3.1 shows that flows of remittances on an annual basis have increased a more than three-fold from 2000 to 2005.

Amuedo-Dorantes, Bansak and Pozo (2004) identify the motives behind Mexican immigrants' decision to remit back to their families in Mexico. Perhaps the most widely discussed motive lies in the altruistic nature of immigrants, the sense of obligation to remit. As ties weaken with the family in Mexico, remittances are expected to decrease over time. A less altruistic motive to remit is the hope of securing and maintaining a good relationship with their family members in Mexico in case they are deported or voluntarily choose to return to Mexico because of a lack of success in the U.S. As the uncertainties of permanent residency in the U.S. decline, remittances over time will decrease. Another motive to remit is to repay family members, neighbors or a financial institution that helped finance the migrant's journey abroad. Migration costs include transportation and smuggling. It is estimated that the cost of migrating is, on average, $2,000. These costs are usually incurred by the family in hopes that, when the member makes it abroad, he or she will remit the costs incurred plus additional resources for other members to follow in the migration process. Another motive for remitting, suggested by Rosenzweig and Stark (1989), is consumption-smoothing; that is, geographically spreading out labor market participants so that if income at home decreases, those shortfalls can be met by members abroad. A final motive to remit is that of short-term or temporary migrants seeking investment opportunities upon their return to Mexico. They typically carry large sums of *migradollars*[1] back to Mexico and open new businesses, expand farms through purchases of lots, equipment or animals, or invest in public works in the community, such as paving roads, updating sewage systems, or other community-related investments. [2] While all of the above are legitimate motives for remitting, they do not explain the use of remittances once these payments are received by the family in Mexico. In this paper, I am interested in the impact of remittances on schooling and child labor. A question I hope to answer is: do remittances provide a substitute away from child labor towards greater investments in education in Mexico? Furthermore, what role do financial constraints play in influencing school attendance?

The empirical literature finds that family income, parental schooling, sex, number of children, and residence are important determinants of child schooling in developing countries. Parent's demand for the quality of children differs from their demand for the quantity of children, particularly in developing countries. The economic development literature finds that the opportunity cost of schooling, measured as the lost income or productivity generated by children, is very high for poor families so that there is a preference for quantity over quality of children. This is in contrast to families in the U.S. Becker and Tomes (1976) suggest that as parental income rises, the quality elasticity falls and the quantity elasticity rises for families in developed countries. In developing countries, by constrast, children are viewed as investments for two reason; first, children can join the labor market at a young age and ease the financial burdens of the household; second, children can take care of younger siblings or elderly family members, or tend to household or farm chores. The latter is an attractive

[1]Dollars earned in the U.S. that are brought back to Mexico.

[2]Unfortunately, no survey exists to my knowledge that allows us to identify the characteristics of remitters along with their motive for remitting.

alternative to schooling in developing countries because of the direct costs of uniforms, books and registration fees involved in schooling.[3] Additionally, parents may not enroll their children in school because there are no schools at all within a convenient distance, unspecified cultural factors, or because schools are of such low quality that parents do not see the benefits of enrolling their children. Assuming families cannot borrow to finance investment in schooling, the optimal level of investment in schooling will depend primarily on the family's resources; that is, their income constraint. However, with remittances parents can finance additional education to the point where the marginal return to schooling equals the rate of interest.

Many studies have looked at the impact of remittances on economic development and on the economic outcomes of family members left behind. Acosta (2005) uses household-level data from El Salvador to evaluate the impact of remittances on school attendance of children aged 11-17. His dependent variable is a binary indicator of child school attendance and his independent variable of interest is a binary indicator of a child belonging to a household that receives remittances. He erroneously assumes that the best technique to address the endogeneity of remittances is IV estimation. According to Greene (2000) this technique does not produce a consistent estimator for a probit model with a binary endogenous explanatory variable, but is consistent for a probit model with a continuous endogenous explanatory variable.

Using a Cox proportional hazard model, Cox Edwards and Ureta (2003) examine the determinants of school attendance in El Salvador. Their sample is a cross-section of 14,286 individuals aged 6-24 taken from the 1997 El Salvadorian Annual Household Survey. They find that remittances have a larger impact on dropping out of school than does income (net of remittances); in urban areas, the effect of remittances is 10 times the size of the effect of income, and in rural areas the effect is 2.6 times greater. Two possible explanations are given by Cox Edwards and Ureta (2003) for their results. First, if remittance income is more stable

[3] U.S. equivalent primary and secondary education is not provided cost-free by the Mexican government as is the case in the U.S.

than labor income, remittances will serve as a better proxy for permanent income and may explain the difference in impact; second, and consistent with our hypothesis, family members may remit on the condition that remittances are to be spent on the schooling of children. This explanation supports my argument of the endogeneity of remittances in a schooling model.

Perhaps the most comprehensive study conducted on the impact of remittances on economic development in Mexico is by Lopez-Cordova (2004). He studied the impact of remittances on several welfare measures: infant mortality, illiteracy rates and school attendance. Lopez-Cordova (2004) aggregates municipal-level data from the Mexican Census 2000. He estimates the development outcome variable as a function of the fraction of remittance-receiving households in the municipality, along with a vector of additional control variables; GDP per capita, percent of the population in rural communities, fraction of indigenous population, the Gini coefficient, the percent of female-headed households, average years of schooling among people fifteen years of age and older, the share of employment in agriculture and government, the unemployment and homicide rates, a measure of governance quality, the percent of population with running water, the availability of banking services and state and border dummies. In addressing the concern that remittances may be correlated with the error term, he uses instrumental variables (IV) and two-stage least-squares (2SLS) estimators. The instrumental variables he used are rainfall patterns at the municipal level (concentration of rainfall) and distance to Guadalajara. His findings indicate that a 1 percent increase in the share of remittance-receiving households in a municipality reduces infant deaths by 1.2 lives, reduces illiteracy among children by 3 percentage points, and increases school attendance by 11 percent for five-year-old children. The impact is statistically insignificant for six through fifteen-year olds, and negative (by 7 percent) for sixteen and seventeen-year olds. An explanation for these results is that remittances create a disincentive for investing in schooling at older ages and an incentive towards investing in migration cost for oneself or for other family members.

Amuedo-Dorantes and Pozo (2003) use the *Encuesta Nacional de Ingresos y Gastos de los Hogares (ENIGH)* 2002 to evaluate the impact of remittances on adult labor supply of those aged 16-64 in both urban and rural areas in Mexico. They regress the number of hours worked on per capita monthly remittance income and a vector of other exogenous household and individual explanatory variables using instrumental variable Tobit estimation to account for the endogeneity of remittances. Previous studies by Funkhouser (1992) and Rodriguez and Tiongson (2001) ignored the endogeneity of remittances. Amuedo-Dorantes and Pozo (2003) find that women work less in the informal sector and in non-paid work in rural areas in response to greater remittances, while men's labor supply is unaffected.

A number of dimensions of this chapter are unique. First, no paper has examined the impact of remittances on child labor and schooling in Mexico, that is, the question whether remittances provide a substitute away from child labor toward a greater investment in education. Second, the multinominal logit model allows me to determine what role financial constraints and remittances play in the child's school attendance decision. Third, the previous remittance literature fails to account correctly for both the endogeneity of remittances and the simultaneity of remittances, schooling and child labor. Endogeneity is addressed by estimating bivariate probit models of schooling, remittances and child labor.

3.2 Data

The sample is a ten percent random sample of households from the Mexican Census 2000, which contains roughly 10,000,000 observations. Household-level characteristics are assigned to each child. Then the sample is restricted to children aged 17 and under. This leaves roughly 10,315 children in the sample. Children's characteristics are sex, age, schooling, and whether they are the oldest child in the household. Head of household characteristics include age, sex, marital status, schooling, employment, medical insurance coverage and ethnicity. Additionally, I employ information on total household income, urban or rural residence, the employment status of head of household, whether the mother works, the mother's education, the number of school-aged children in the household, and the presence of a car, tv, radio, VCR, computer, refrigerator, trash pickup, water, electricity, and septic system.

The educational system in Mexico is structured like that of the United States. Primary education[4] is from 1st to 6th grade, secondary education[5] is 7th through 9th, high school[6] is 10th through 12, higher education (undergraduate, associate's degree)[7] is 13 and 14, associates and bachelors degree[8] is 15-17 and graduate degree (master's and PhD)[9] is 18-20+.

Before presenting the econometric results, I briefly describe patterns in the data. Table 3.2 provides definitions of our variables. Table 3.3 presents the sample mean by their type of household, remittance recipient or non-recipient. It appears at first glance that children from non-recipient households are more likely to attend school: 70% versus 60% for recipient households. A possible explanation may be that recipient households have greater financial needs and therefore children in these homes substitute away from schooling into the labor market at early ages, with some family members migrating abroad and remitting back to the family to help alleviate the financial constraints of the household. We must be careful in interpreting this finding that, on the surface, suggests that remittances play no role in inducing children to obtain higher years of schooling. Surprisingly, the average schooling level of children in both types of households is the same, about 6.8 years. We would expect that children from recipient households would have lower average years of schooling. Therefore it is not clear from evaluating simple means that remittances may increase schooling for recipient households. We also find evidence that child labor is greater for recipient households 26% than for non-recipient ones 19%, suggesting substitution away from school towards the labor market at early ages.

[4]Known as educacion primaria

[5]Known as educacion secundaria, medio basico, medio elemental

[6]Known as educacion preparatoria, bachillerato, medio superior, medio tecnico, medio professional

[7]Known as professional universitario offered at technical universities

[8]Known as Educacion Superior Professional; licentciatura, ingeniero and other licenciatura equivalent titles

[9]Known as Educacion Posgrado; Maestria, Doctorado, or Especialista

The head of household characteristics indicate that recipient households heads are older (49.07 versus 43.56 years of age), have less schooling (4.23 versus 6.066 years of schooling), are less likely to be indigenous (4.56% versus 10.67%) and have lower monthly incomes (2,666 versus 3,118 pesos). Mothers from recipient households have lower average years of schooling (4.10 versus 5.39) and are less likely to be employed (20.41% versus 24.52%). This is an indication that mothers of children from non-recipient households place a greater emphasis on schooling because they have above-average years of education.

In Tables 3.4 and 3.5, urban and rural households are organized according to the number of school-aged children (children 17 and under). Few systematic differences in the distribution of the number of children of recipient and non-recipient households is found between rural and urban households. For urban households, perhaps the only difference worth noting is that 56.4% of recipient households have three or more school-aged children versus 48.81% for non-recipient households.

In Tables 3.6 and 3.7, urban and rural recipient and non-recipient households are organized according to the age of the child, and show the percent age attending school. The data from this table for rural and urban recipients and non-recipients are also shown in Figure 1. The figure provides a clearer picture. For young children, urban recipients and non-recipients have higher levels of school attendance than their rural counterparts; this levels off at 10 years of age, and then at later ages rural recipient and non-recipient households children attend school at much lower levels than their urban counterparts. This provides justification for an interaction between the variable for urban status and the variable indicating that remittances were received.

At the mean of the sample, we found that recipient households are more likely to send their children into the labor market to help alleviate the financial needs of the family. Table 3.8 provides a breakdown of the percent age of working children by age. It appears that children do not join the formal labor market until the age of 12. This is consistent with the average year of schooling of our sample and the age at which we would expect a family to choose between continuing to fund its children's education or allowing them to enter the labor market to help alleviate financial constraints of the family. For children aged 12-15, the percentage of children working in recipient households is slightly higher than for non-recipient households. At age 16, there appears to be no systematic difference between recipient and non-recipient households in child labor, with the percent age of working children at 31%. At age 17, non-recipient households have a slightly higher percentage of child labor (38.58% versus 37.56%). We must be careful not to conclude that children leave school at age 12 and enter the formal labor market. They could leave school to tend to family businesses without receiving any formal payment or to stay at home and care for younger siblings or older grandparents. In the next section, I analyze monetary and non-monetary causes of leaving school for children aged 9-17.

3.3 A Multinomial Logit Model of the Reasons for Leaving School

Formally, the multinomial logit model I use to predict school abandonment can be written, following Long and Freese (2006) as

$$ln\Omega_{m|b}x = ln\frac{P(y=m|x)}{P(y=b|x)} = x\beta_{m|b} \tag{3.1}$$

for m = 1 to J choices, where b is the base category and $ln\ \Omega_{m|b}x$ is the log odds of an outcome compared to the base group. We are interested in how, ceteris paribus, changes in the elements of x affect the response probabilities, $P(y = j—x)$, j = 0,1,2,....,J. These J equations can be solved to compute the predicted probabilities relative to the base category (b = 1):

$$P(y=m|x) = \frac{exp(x\beta_{m|b})}{\sum_{j=1}^{J} exp(x\beta_{m|b})} \tag{3.2}$$

and we can obtain estimates of $\beta_{2|1}$, $\beta_{3|1}$, $\beta_{4|1}$, $\beta_{5|1}$, $\beta_{6|1}$, and $\beta_{7|1}$, where $\beta_{1|1}$ is restricted to zero. The question asked in the Mexican Census 2000 regarding school abandonment is, "What is your principal motive for leaving school?" The seven possible outcomes are as follows: *Disinterested*: Did not want to attend school or did not like school, *Money*: Lack of money or had to work, *Marriage*: Married or living together, *Distance*: The school was too far or there was not one, *Chores*: My family did not allow me or to help with household chores, *Completed*: Finished my studies, or *Other*. I assume that school-aged children not enrolled in school have dropped out. One disadvantage of my data is that I only observe those who have dropped out, and because my data are not longitudinal I cannot observe the reason for dropouts in *t+1* who otherwise might be receiving remittances in time period *t*.

With these choice variables, the following Multinominal Logit Model (MNLM) was estimated

$$ln\Omega_{m|1} = \beta_{0,m|1} + \beta_{1,m|1}Rremits_i + \beta_{2,m|1}Child_i + \beta_{3,m|1}Head_i + \beta_{4,m|1}Household_i,\ m = 2, ..., 7 \tag{3.3}$$

where the first outcome, *Disinterested*, is specified as the base category. $Rremits_i$ indicates if the household receives remittances from abroad, $Child_i$ denotes a vector of individual control variables for the child: age, oldest, and gender, $Head_i$ denotes a vector of head of household characteristics: marital status, education, ethnicity, age, age squared, and income, and $Household_i$ denotes a vector of household characteristics: number of children in household and urban residency.

An important restriction of the MNLM is the independence of irrelevant alternatives (IIA) assumption, which means that the choice between categories i and j is unaffected by the availability of category k. I employ the Hausman and McFadden (1984) test of the IIA assumption. Let β_a denote the estimates of the parameters obtained from the logit model of the full set of alternatives and β_b denote those from the logit model of the subset of alternatives. If IIA holds, the two sets of our multinomial logit estimates, β_a and β_b, should not be statistically different. In addition to testing whether the IIA property of the MNLM is problematic, the Wald and the Likelihood-Ratio tests are performed to test whether two choices can be combined.

3.3.1 MNLM Results

Table 3.9 reports the estimates of the MNLM in 3.3. The probability of leaving school due to a lack of money is reduced by the receipt of remittances. The impact of remittances is not statistically significant for any other category, suggesting that remittances only alleviate financial pressures but do not affect schooling decisions through any other mechanisms. Not surprisingly, income of the head of household reduces the probability of leaving school due to a lack of money and also reduces the probability of dropping out due to *Distance* and *Other*. Table 3.10 reports that the marginal effect of school abandonment due to a lack of money is 10 percent lower for remittance-receiving households than non-receiving households. The marginal effect on leaving school of an increase in household-head income in Table 3.10 is only 2 percent.

These findings suggest that remittances help to alleviate financial constraints and facilitate schooling costs, while income of the head of household reduces the opportunity cost of attending school. The impact of income could be more long-term, creating a more stable and supportive household environment. It is important to understand the actual mechanism through which a factor operates to reduce the incidence of dropping out of school. One explanation is that remittance-receiving households exhibit a higher propensity to spend on their children's schooling out of remitted funds than other income because such expenditures are a condition for receiving financial support from a family member abroad. The last row of Table 3.10 reports the predicted probability evaluated at the mean of the $x's$. The predicted probability of school drop out due to lack of money is 36 percent, and the predicted probability of school drop out due to disinterestedness is 50 percent.

In an attempt to deal with the IIA restriction, alternatives which are believed to be perfect substitutes for each other or to be closely related are combined. In Table 3.11, *Disinterested, Marriage, Distance, Chores, Completed* and *Other* were grouped into the base category, with *Money* as the only other alternative. Once again, the findings suggest that remittances reduce the probability of leaving school due to a lack of money. In Table 3.12 the alternatives

Marriage and *Chores* are combined into a single alternative on the basis that both fall under family obligations, while *Distance*, *Completed*, *Disinterested*, and *Other* remain as alternative choices. I find that remittances again reduce the probability of leaving school due to a lack of money, tending to household chores or marriage. *Money*, *Marriage*, and *Chores* may be substitutes for each other, so we combined these together in Table 3.13, while *Distinterested*, *Distance*, *Completed*, and *Other* remain as alternatives.

The odds ratio in Table 3.14, column labeled $\exp^{\beta}$, gives the effect of remittance on the different alternatives. For example, the odds ratio for the effect of remittance on leaving school because of *Distance* versus *Money* is 2.1823. This can be interpreted as the odds of leaving school because the distance was too far or there was no school relative to lack of money are 2.1823 times greater for remittance-receiving households than for non-remittance-receiving households, holding the other exogenous variables constant. Similar, the odds are 1.8815 times greater of leaving school because of marriage relative to a lack of money for remittance-receiving households than for non-remittance-receiving households, holding the other exogenous variables constant. The odds of leaving school because the family did not allow attendance or to help with household chores relative to a lack of money are 2.2367 times greater for remittance-receiving households than for non-remittance-receiving households, holding the other exogenous variables constant.

Perhaps the greatest difficulty in estimating a MNLM is the handling of the IIA assumption. As discussed in the previous section, Hausman and McFadden (1984) suggest a formal test of the IIA assumption. Tables 3.15 and 3.16 present the results of the Hausman-McFadden and the Small-Hsiao (1985) tests. Both tests indicate that I can accept the null hypothesis that the odds (Outcome-m vs Outcome-m') are independent of other alternatives. The chi-square test statistics are negative for the omitted categories, *Distance, Completed* and *Other*, which seems odd but is consistent with the findings of Hausman and McFadden (1984).[10] In a more recent paper, Cheng and Long (2006)[11] conclude that these tests are

[10]See Hausman and McFadden (1984) footnote four on page 1226.

[11]This paper was obtained from the authors.

unsatisfactory for applied work. To examine the size properties of the Hausman-McFadden test and the Small-Hsiao test, they conducted Monte Carlo simulations of eight artificial data sets in which the IIA assumption was not violated. They conclude that, even with a sample size of 2000, the Hausman-McFadden test does not converge to an appropriate size. Additionally, they find that the result of the test depends on which alternative is omitted in the restricted model. In a similar analysis, their findings of the Small-Hsiao test reveal that the rejection of the null depends greatly on the omitted alternative, at a null rejection rate of 50%, even in samples of 1000. Although I present these results here, I do so cautiously given the strong IIA assumption that is made and inadequacies of the IIA tests. Additionally, the Wald Test and the Likelihood Ratio Tests for combining outcome categories are presented in Tables 3.17 and 3.18. In the various specifications of the multinominal logit models above, categories are combined, even though the Wald and Likelihood Ratio tests here suggest that aggregation is inappropriate.

3.4 Bivariate Probit Models

Erroneous econometric techniques have been used in the economic development literature on remittances. In this section, I follow Greene (2000) and Maddala (1983) by specifying the model

$$\begin{aligned} y_1^* &= \beta_1' x_1 + \beta_2 y_2 + \epsilon_1, \quad y_1 = 1 \quad if y_1^* > 0, \quad 0 \quad otherwise \\ y_2^* &= \beta_2' x_2 + \epsilon_2, \qquad\qquad y_2 = 1 \quad if y_2^* > 0, \quad 0 \quad otherwise \end{aligned} \tag{3.4}$$

The explanatory variable, y_2, in the first equation appears as a dependent variable in the second equation, so that we estimate a recursive, simultaneous-equations model. Therefore, bivariate probit estimation is still appropriate for the case of a recursive model. If in equation (3.4), y_2 were a continuous independent variable, 2SLS would be appropriate. Acosta (2005) erroneously uses 2SLS estimation which is inappropriate for the estimation of a model similar to equations (3.4) with a binary endogenous variable. According to Wooldridge (2002), a two-step procedure in this case does not produce consistent estimators.

3.4.1 Schooling and Remittances

More specific to the underlying question in this study, equation (3.4) can be re-written as a recursive, simultaneous-equations model of school attendance and the probability of the child belonging to a remittance-receiving household, as follows:

$$Attends_i = \alpha + \delta_1 Rremits_i + \delta_2 Child_i + \delta_3 Head_i + \delta_4 Household_i + \eta_i$$

$$Rremits_i = \gamma + \theta_1 Child_i + \theta_2 Head_i + \theta_3 Household_i + \mu_i \tag{3.5}$$

where $Rremits_i$ is endogenous in the first equation. The instruments used in all our models are the number of migrants in the last five years, a binary variable equal to one if there were migrants in the household in the last five years, length of migration experience and the number of years of mother's education. Unfortunately, given the lack of appropriate econometric techniques that can handle the endogeneity of two binary endogenous variables in both equations, inclusion of $Attends_i$ as an endogenous variable in the second equation is not possible. Under ideal circumstances, I would like to allow for the fact that family members abroad remit under the condition that the child attends school. In other words, do remittances increase school attainment or do households who receive remittances do so because the children continue to attend school and therefore have an additional financial necessity that is eased by remittances? This is the subject of future research.

The bivariate probit results are presented in Table 3.19. In both equations, all the coefficients are statistically significant at the .05 level. The coefficient on $Rremits_i$ suggests that remittances increase the probability that the child attends school. Surprisingly, the coefficient for Male is positive and statistically significant, indicating that male children are more likely to attend school than female children. One might expect the opposite; that is, males are expected to have better labor market opportunities than females, thus facing higher opportunity costs of attending school. However, Cox Edwards and Ureta (2003) find that the hazard of leaving school is 10 percent lower for boys than for girls in their sample. An explanation could be that the return to education is much higher for males than females, creating a relative disincentive for females to obtain higher levels of education. Additionally, in developing countries like Mexico, women traditionally play an important role in the home; women may receive less schooling in order to tend to household chores or care for younger siblings or elderly family members. This would make the opportunity cost of attending school for females much higher than for males. The interaction term, $Male*Rremits$, suggests that the impact of being male on attending school declines with remittances.

I next estimate the following bivariate probit equation:

$$\begin{aligned} AverYear_i &= \alpha + \delta_1 Rremits_i + \delta_2 Child_i + \delta_3 Head_i + \delta_4 Household_i + \eta_i \\ Rremits_i &= \gamma + \theta_1 Child_i + \theta_2 Head_i + \theta_3 Household_i + \mu_i \quad , \end{aligned} \tag{3.6}$$

where $AverYear_i$ is a binary variable equal to one if the child has greater than average years of schooling in the sample (3.96 years). This variable allows one to identify the grade level where dropout rates are concentrated and ascertain if remittances increase the probability that a child receives greater than average years of schooling. Table 3.20 reports these results. The coefficient on $Rremits_i$ is statistically significant at the 0.5 level and positive, indicating remittances play a role in increasing education beyond the average year of schooling. Although the use of educational attainment as a proxy for human capital is commonly used in the literature, a shortcoming is that, although I conclude that remittances increase schooling, unfortunately I cannot ascertain anything about the quality of the education that the child receives. Low returns to education for low-quality education in Mexico create a disincentive for parents to send children to school and keep them out of the labor market at early ages. The quality of the education offered in developing countries is an area yet to be studied in the literature. Furthermore, what role remittances play in improving the quality of a child's education is a question yet to be answered. Future research could include examination of the substitutability between public and private schools for a household with children who receives remittances.

3.4.2 Child Labor and Remittances

In developing countries such as Mexico, children substitute school attendance for employment as a means to obtain higher income streams for their families in the short run while sacrificing higher expected income streams via investments in human capital in the long run. The debate over child labor has centered on the question of whether child labor is costly to society. If children or their parents choose child labor over its alternative, it must be the case that the net economic value (benefits minus the costs) must be positive. The counter argument is that child labor is a market failure reflecting the exploitation of children who cannot choose freely. Such exploitation could be reduced by increasing household incomes and the return to education in developing countries. The market failure may also be inherent in the credit market so that parents cannot borrow against the future earnings of their children to finance the substitution away from work into education. Poor families face enormous barriers to borrowing, including uncertain future health and employment status and a large burden of servicing debt which would put them in a dire situation given their limited incomes.

What effect will an increase in education and elimination of child labor have on the local economy? Table 3.21 shows the estimated total costs and benefits of eliminating child labor in various regions. Moretti's (2004) research in the regional economic literature highlights three social benefits of the accumulation of human capital beyond that of benefits accruing to the individual. First, one benefit to society is that education may generate productivity spill-over effects in the workplace. The second social benefit is that education may reduce the probability that individuals will engage in criminal activities. Lastly, a better-educated electorate will make better decisions on public policy issues and elect better representatives. Another benefit found in the economic development growth literature is attributed to health. Poor working conditions are eliminated and injuries, illnesses and the spread of tropical diseases such as malaria are minimized. The financial burden on the public sector is also minimized.

Given the importance of eliminating child labor not only for the individual but for society at large, in this section I estimate the impact that remittances have on child labor. The following bivariate probit model is estimated:

$$Childworks_i = \phi + \psi_1 Rremits_i + \psi_2 Child_i + \psi_3 Head_i + \psi_4 Household_i + \nu_i$$

$$Rremits_i = \omega + \varphi_1 Child_i + \varphi_2 Head_i + \varphi_3 Household_i + \xi_i \tag{3.7}$$

I find that all of the estimated coefficients in the child labor equation are statistically significant except the estimated coefficients on whether the child is the oldest and the interaction of this variable with whether the child is male. Again, the results in Table 3.22 indicate that remittances reduce child labor, while income has no effect. This result is worrisome because it is expected that an increase in the income of the head of the household reduces the probability that the child works. A concern is the potential endogeneity of income. For example, entrance of the child into the labor market could induce the head of household to reduce his hours of work and to reduce his income, since the loss in income is made up for by the child, thereby increasing again the income constraint for the household. This issue is also a question for future research.

3.5 Conclusion

The results presented in this paper complement and confirm the findings of the literature that explores the effect of remittances on child labor and education. Individual empirical studies have looked at the impact of remittances on various economic development indicators such as infant mortality, illiteracy rates, health and men's labor supply. I would like to see more studies done in this area not so much concerned with the impacts on development but rather dedicated to improving the techniques that are used in modeling the issue correctly.

Although the empirical findings indicate that remittances increase schooling, they do not ascertain anything about the quality of the education that the child receives with the additional income received by the family. Low returns to education for low-quality education in Mexico create a disincentive for parents to send children to school and serve to keep them out of the labor market at early ages. The quality of the education offered in developing countries is an area yet to be studied in the literature. Furthermore, what role remittances play in improving the quality of a child's education is a question yet to be answered. An ideal study would include examination of the substitutability between public and private schools for a household with children that receives remittances.

Although remittances play an important role in higher school attendance, increased educational attainment and reduced child labor, these outcomes are not the only positive effects of remittances. Therefore, developing countries such as Mexico should be cautious about relying strictly on remittances as a source of economic growth. Public policies should reflect an understanding of the importance of education and the larger social benefits that it can convey. However, governments in these countries must be careful about using remittances as a crutch for improving their country's balance of payments and must develop public policies aimed at mitigating the negative externalities that arise because of migration.

3.6 References

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Table 3.1: Remittances and Transaction Type

	2000	2001	2002	2003	2004	2005
Total Remittances [1]	6572.6	8895.2	9814.4	13396.1	16612.7	20034.7
Money Orders	1434.3	803.3	686.5	1623.1	1883.1	1867.0
Personal Checks	8.7	10.2	10.1	6.4	0	0
Electronic Transfers	4642.0	7783.6	8798.0	11512.0	14496.2	17894.9
Cash	487.9	298.2	319.8	254.6	233.6	273.3
Total Number of Remittances [2]	17999.0	27744.2	29953.8	41807.7	50874.3	58739.2
Money Orders	3602.5	1903.5	1780.0	4408.1	4626.4	4017.8
Personal Checks	15.3	10.2	10.4	6.8	0	0
Electronic Transfers	13737.0	25246.4	27703.9	37044.4	45925.2	54376
Cash	644.18	584.0	459.4	348.3	322.6	345.4
Average Remittance [3]	365.1	320.6	327.6	320.4	326.5	341.0
Money Orders	398.1	422.0	385.6	368.2	407.0	464.6
Personal Checks	567.8	998.0	963.7	932.9	0	0
Electronic Transfers	337.9	308.3	317.5	310.7	315.6	329.1
Cash	757.4	510.5	696.1	730.9	723.9	791.2

Source: Banco de Mexico.

[1]Expressed in millions of dollars.

[2]Operations expressed in thousands.

[3]Averages expressed in dollars.

Table 3.2: Definition of Variables

Variable	Definition
Age	Age of child (6-17 years)
Age2	Age of child squared
Age (hh)	Age of head of household
Age2 (hh)	Age of head of household squared
Attends	Dummy equal to one if child attends school, zero otherwise
Car	Dummy equal to one if household owns a car, zero otherwise
Childworks	Dummy equal to one if child works, zero otherwise
Computer	Dummy equal to one if household owns a computer, zero otherwise
Employed	Dummy equal to one if head of household is employed, zero otherwise
Ethnic (hh)	Dummy equal to one if head of household belongs to an indigenous group, zero otherwise
Income (hh)	Income of head of household in pesos
Male	Dummy equal to one if male, zero otherwise
Male (hh)	Dummy equal to one if head of household is male, zero otherwise
Married (hh)	Dummy equal to one if head of household is married, zero otherwise
Medical (hh)	Equal to one if head of household receives health insurance from employer, zero otherwise
Momeduc	Years of schooling of the mother
Momworks	Dummy equal to one if mother is employed, zero otherwise
Nchild	Total number of children in the household
Oldest	Dummy equal to one if child is the oldest child in the household, zero otherwise
Rremits	Dummy equal to one if receives remittances from abroad, zero otherwise
School	Years of schooling of child
School (hh)	Years of schooling of head of household
Urban	Dummy equal to one if resides in urban area (50,000 habitants or more), zero otherwise

Table 3.3: Means: Sample Children 17 and under

Variable	All Households	Recipient Households	Non-Recipient Households
Attends	0.7047	0.6076	0.7079
Rremits	0.0324	1.0000	0.0000
Age	14.3995	14.5483	14.3945
Male	0.5002	0.4969	0.5003
School	6.8371	6.8227	6.8376
Childworks	0.1972	0.2655	0.1949
Oldest	0.6440	0.6291	0.6445
Male (hh)	0.9974	0.9969	0.9974
Age (hh)	43.7464	49.0729	43.5678
School (hh)	6.0071	4.2329	6.0666
Married (hh)	0.9962	0.9906	0.9963
Employed (hh)	0.9775	0.9795	0.9774
Ethnic (hh)	0.1047	0.0456	0.1067
Income (hh)	3104.0417	2666.6758	3118.7080
Momeduc	5.3532	4.1044	5.3951
Momworks	0.2438	0.2041	0.2452
Nchild	3.4673	3.5126	3.4658
Urban	0.3413	0.1626	0.3473
Computer	0.0826	0.0399	0.0841
Car	0.3050	0.3778	0.3026

Note: Income is in pesos

Table 3.4: Distribution of Non-Recipient and Recipient Households, by the Number of School-Aged Children

# of School-Age Children	Non-recipient Households %	Recipient Households %
Urban		
0	1.36	1.87
1	16.81	14.20
2	33.02	27.42
3 or more	48.81	56.5
Rural		
0	0.70	1.02
1	9.68	10.44
2	20.56	18.64
3 or more	69.05	69.90

Table 3.5: Percent of School Attendance: Distribution of Non-Recipient and Recipient Households

# of School-Age Children	Non-recipient Households %	Recipient Households %
Urban		
0	95.91	4.09
1	97.45	2.55
2	97.49	2.51
3 or more	96.53	3.47
Rural		
0	91.41	8.59
1	93.48	6.52
2	94.46	5.54
3 or more	93.86	6.14

Table 3.6: Distribution of Non-Recipient and Recipient Households School Attendance, by the Age of Child

	All Sample		Urban		Rural	
Age of Child	Non-recipient Households %	Recipient Households %	Non-recipient Households %	Recipient Households %	Non-recipient Households %	Recipient Households %
5	74.10	76.12	83.43	77.66	70.03	75.79
6	89.48	92.10	95.04	93.64	87.09	91.79
7	95.22	96.94	97.67	96.41	94.17	97.06
8	96.14	97.39	97.91	98.04	95.43	97.25
9	96.90	97.17	98.35	97.89	96.30	97.02
10	96.07	96.58	97.77	94.68	95.37	96.92
11	95.95	92.28	97.75	97.93	95.18	95.95
12	91.19	90.82	96.15	97.00	89.22	89.76
13	84.26	81.24	92.27	92.27	80.95	79.47
14	75.38	70.39	86.97	81.66	70.72	68.23
15	62.54	53.12	75.54	69.39	56.72	49.75
16	48.84	42.02	64.95	63.64	41.27	37.35
17	40.16	32.27	56.19	51.93	32.04	28.01

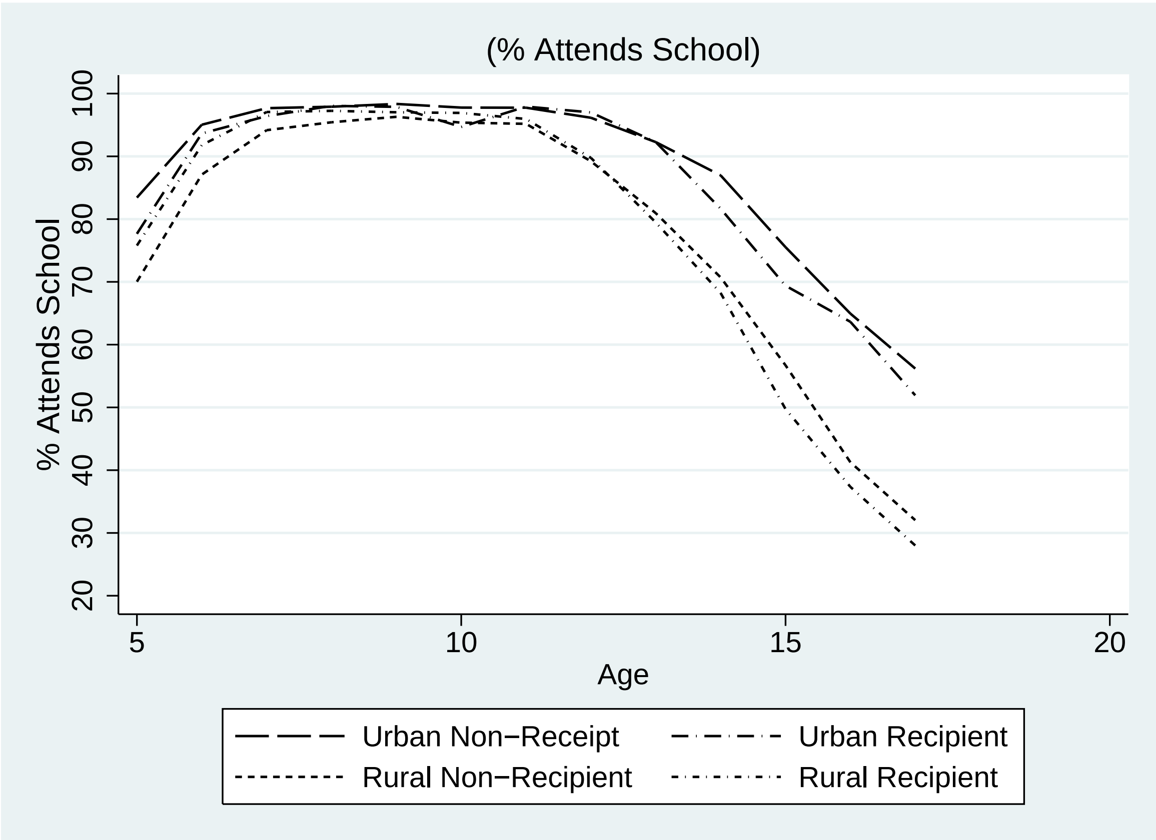

Figure 3.1: Distribution by Age

Table 3.7: Distribution of Non-Recipient and Recipient Households School Attendance, by the Age of Child

	Attends School		Not Attends School	
Age of Child	Non-recipient Households %	Recipient Households %	Non-recipient Households %	Recipient Households %
5	95.21	4.79	95.68	4.32
6	95.45	4.55	96.64	3.36
7	95.24	4.76	96.95	3.05
8	95.22	4.78	96.76	3.24
9	95.29	4.71	95.69	4.31
10	94.96	5.04	95.61	4.39
11	94.81	5.19	95.23	4.77
12	94.25	5.75	94.00	6.00
13	94.40	5.60	93.16	6.84
14	94.07	5.93	92.49	7.51
15	94.40	5.60	91.96	8.04
16	94.77	5.23	93.22	6.78
17	94.90	5.10	92.96	7.04

Table 3.8: Distribution of Non-Recipient and Recipient Households Child Labor, by the Age of Child

	Recipient Household		Non-Recipient Household	
Age of Child	Child Labor %	No Child Labor %	Child Labor %	No Child Labor %
0	0	100	0	100
1	0	100	0	100
2	0	100	0	100
3	0	100	0	100
4	0	100	0	100
5	0	100	0	100
6	0	100	0	100
7	0	100	0	100
8	0	100	0	100
9	0	100	0	100
10	0	100	0	100
11	0	100	0	100
12	6.28	93.71	5.71	94.28
13	10.33	89.67	9.12	90.88
14	16.67	83.33	14.59	85.41
15	25.47	74.53	22.43	77.57
16	31.54	68.46	31.12	68.88
17	37.56	62.44	38.58	61.42

Table 3.9: Multinominal Logit Model: Cause of Leaving School (Seven Alternatives)

Variable	*Money*	*Marriage*	*Distance*	*Chores*	*Completed*	*Other*
Rremits	-.4946	-.0749	.1968	.1158	-.5233	-.1137
	(.1236)**	(.3095)	(.2548)	(.2795)	(.3322)	(.2574)
Age	-.2719	.8107	-.6157	-.2365	.9308	-.4305
	(.0750)**	(.8939)	(.1206)**	(.1562)	(.6375)	(.1012)**
Age2	.0134	-.0104	.0174	.0066	-.0218	.0060
	(.0028)**	(.0292)	(.0052)**	(.0063)	(.0212)	(.0043)
Male	-.2078	-2.1948	-.6301	-1.1765	-.2637	-.0491
	(.0450)**	(.1910)**	(.1170)**	(.1374)**	(.1149)**	(.0942)
Oldest	-.0704	-.2491	.0423	.0344	.1470	.0444
	(.0630)	(.2093)	(.1514)	(.1620)	(.1836)	(.1256)
Male (hh)	.3404	.3978	-.5378	-.0141	-.0430	-.0027
	(.0843)**	(.2347)*	(.2819)*	(.2416)	(.2414)	(.1603)
Age (hh)	-.0363	-.1998	-.0035	-.0886	-.0225	.0370
	(.0111)**	(.0202)**	(.0315)	(.0255)**	(.0255)	(.0254)
Age2 (hh)	.0004	.0019	.00003	.0009	.0003	-.0002
	(.0001)**	(.0002)**	(.0003)	(.0002)**	(.0002)	(.0002)
School (hh)	.0037	.0519	-.0010	.0320	.0405	.1038
	(.0080)	(.0200)**	(.0208)	(.0212)	(.0186)**	(.0147)**
Medical	-.3532	-.1427	-.1535	-.1900	.3562	.2681
	(.0560)**	(.1346)	(.1483)	(.1538)	(.1292)**	(.1079)**
Nchild	-.0111	-.0976	-.0069	.0602	-.0403	-.1474
	(.0135)	(.0423)**	(.0340)	(.0354)*	(.0356)	(.0331)**
Urban	-.1574	.0512	-.5752	-.4720	-.3756	.5168
	(.0567)**	(.1361)	(.1689)**	(.1649)**	(.1401)**	(.1092)**
Employed (hh)	-.1723	-.2015	-.3073	-.5624	.7476	.3338
	(.1354)	(.3884)	(.3035)	(.3020)*	(.5134)	(.3570)
Ethnic (hh)	.1127	-.1552	-.8475	-.0599	.5887	-.2745
	(.0858)	(.2562)	(.2795)**	(.2278)	(.2006)**	(.2256)
Mworks	.0066	-.35518	-.0408	.2236	-.1472	.3694
	(.0620)	(.1809)**	(.1600)	(.1598)	(.1594)	(.1181)**
Income (hh)	-.1378	-.0715	-.3504	-.1307	-.0338	-.1985
	(.0347)**	(.0967)	(.0843)**	(.0922)	(.0886)	(.0744)**
Car	-.2381	.1863	.7969	.4476	.4476	.1631
	(.0691)**	(.1678)	(.1432)**	(.1415)**	(.1415)**	(.1279)
Computer	.9017	-.7076	.2172	.3208	.0434	.3627
	.2004	(.5608)	(.6234)	(.5605)	(.4197)	(.2950)
Constant	2.4036	-7.0489	5.8906	2.5419	-12.2096	2.079
	(.6008)**	(6.8502)	(1.1640)**	(1.2883)**	(4.8541)**	(.9940)**

Status Defined:

Disinterested = Did not want to go to school or did not like school. (base category)

Money = Lack of money or had to work.

Marriage = Married or living together.

Distance = The school was too far or there was not one.

Chores = My family did not allow me or to help with household chores.

Completed = Finished my studies.

Other = Other motive.

Table 3.10: MNL Model: Changes in Probabilities: Cause of Leaving School

Variables	*Money*	*Marriage*	*Distance*	*Chores*	*Completed*	*Other*	*Disinterested*
Rremits	-.1039	.0010	.0114	.0082	-.0079	.0019	.0890
Age	-.0608	.0107	-.0137	-.0034	.0268	-.0126	.0530
Age2	.0030	-.0001	.0003	.0000	-.0006	.00003	-.0025
Male	-.0167	-.0267	-.0124	-.0267	-.0026	.0043	.0809
Oldest	-.0179	-.0028	.0016	.0014	.0042	.0025	.0108
Male (hh)	.0807	.0032	-.0176	.0017	-.0034	-.0047	-.0600
Age (hh)	-.0069	-.0021	.0003	-.0018	-.0001	.0021	.0086
Age2 (hh)	.00007	.00002	-.00000	.00001	.00000	-.00001	-.00009
School (hh)	-.0014	.0005	-.0002	.0006	.0008	.0037	-.0039
Medical (hh)	-.0835	-.0003	-.0011	-.0020	.0133	.0159	.0577
Nchild	-.0002	-.0010	.00009	.0018	-.0007	-.0053	.0053
Urban	-.0321	.0014	-.0123	-.0097	-.0074	.0259	.0343
Employed (hh)	-.0382	-.0016	-.0070	-.0162	.0148	.0131	.0352
Ethnic (hh)	.0298	-.0020	-.0167	-.0023	.0184	-.0105	-.0166
Momworks	-.0031	-.0040	-.0014	.0056	-.0040	.0149	-.0077
Income (hh)	-.0238	.00001	-.0074	-.0015	.0009	-.0048	.0366
Car	-.0707	.0027	.0302	.0002	.0146	.0079	.0147
Computer	.2102	-.0081	-.0054	-.0029	-.0085	-.0029	-.182143
Pr(y|x)	.3639	.0117	.0268	.0260	.0259	.0388	.5065

Note: Marginal Effects.

Table 3.11: Multinominal Logit Model: Cause of Leaving School (Two Alternatives)

Variable	*Money*
Rremits	-.4798
	(.1182)**
Age	.0207
	(.0660)
Age2	.0032
	(.0025)
Male	.0305
	(.0425)
Oldest	-.0602
	(.0596)
Male (hh)	.3321
	(.0789)**
Age (hh)	-.0056
	(.0099)
Age2 (hh)	.0000
	(.0001)
School (hh)	-.0114
	(.0074)
Medical	-.3703
	(.0529)**
Nchild	.0045
	(.0128)
Urban	-.1411
	(.0535)**
Employed (hh)	-.1522
	(.1268)
Ethnic (hh)	.1408
	(.0802)*
Mworks	.0002
	(.0586)
Income (hh)	-.0960
	(.0325)**
Car	-.3291
	(.0651)**
Computer	-.8319
	(.1790)**
Constant	-1.0489
	(.5379)*

Number of Observations: 10,315.

Status Defined:

Money = Lack of money or had to work.

The alternatives, *Disinterested, Marriage, Distance, Chores, Completed, and Other* were grouped into one category. (base category)

Table 3.12: Multinominal Logit Model: Cause of Leaving School (Five Alternatives)

Variable	*Money*	*Marriage/Chores*	*Completed*	*Other*
Rremits	-.5516	.1755	-.4933	-.0234
	(.1239)**	(.2119)	(.3319)	(.2577)
Age	-.1128	-.4099	-.9687	-.3366
	(.0700)	(.1284)**	(.5985)	(.0961)**
Age2	.0072	.0208	-.0238	.0047
	(.0027)**	(.0051)**	(.0200)	(.0041)
Male	-.2468	1.4016	.2761	-.1068
	(.0463)**	(.1162)**	(.1191)**	(.0943)
Oldest	-.0331	-.1150	.1523	.0937
	(.0616)	(.1286)	(.1808)	(.1237)
Male (hh)	.4314	.2520	-.0252	.0700
	(.0835)**	(.1645)	(.2412)	(.1584)
Age (hh)	-.0359	-.1752	-.0147	.0349
	(.0108)**	(.0157)**	(.0255)	(.0252)
Age2 (hh)	.0004	.0017	-.0003	-.0002
	(.0001)**	(.0001)**	(.0002)	(.0002)
School (hh)	.0032	.0405	.0482	.1069
	(.0076)	(.0141)**	(.0175)**	(.0137)**
Medical	-.3929	-.1308	3604	.2614
	(.0549)**	(.1027)	(.1275)**	(.1053)**
Nchild	.0038	.0080	-.0343	-.1022
	(.0127)	(.0261)	(.0336)	(.0309)**
Urban	-.1736	-.1137	-.3987	.5207
	(.0557)**	(.1057)	(.1402)**	(.1065)**
Employed (hh)	-.1780	-.4501	.7710	.3563
	(.1322)	(.2440)*	(.5125)	(.3559)
Ethnic (hh)	.2406	-.0450	.6245	-.2165
	(.0841)**	(.1733)	(.1954)**	(.2240)
Mworks	-.0401	.0483	-.1710	.3536
	(.0607)	(.1214)	(.1574)	(.1145)**
Income (hh)	.0001	-.0004	-.0001	-.0005
	(.0000)**	(.0000)**	(.0000)**	(.0000)**
Constant	-.2318	1.165	13.4091	-.1553
	(.5275)	(.9243)	(4.5245)**	(.8513)

Status Defined:

Money = Lack of money or had to work

Married/Chores = Married, living together, family did not to attend or to help with household chores

Completed = Finished my studies

Other = Other motive

Disinterested/Distance = Did not like/want to go to school, too far or there was not one.

(base category)

Table 3.13: Multinominal Logit Model: Cause of Leaving School (Four Alternatives)

Variable	*Money/Married/Chores*	*Completed*	*Other*
Rremits	-.4287	-.4949	-.0290
	(.1147)**	(.3317)	(.2577)
Age	-.1624	.9716	-.3346
	(.0650)**	(.5992)	(.0962)**
Age2	.0096	-.0239	-.0046
	(.0025)**	(.0200)	(.0041)
Male	.3894	.2755	-.1160
	(.0446)**	(.1195)**	(.0945)
Oldest	-.0558	.1535	.0943
	(.0591)	(.1808)	(.1237)
Male (hh)	.4033	-.0236	.0729
	(.0803)**	(.2412)	(.1584)
Age (hh)	-.0697	-.0143	.0364
	(.0100)**	(.0257)	(.0253)
Age2 (hh)	.0007	.0003	-.0002
	(.0001)**	(.0002)	(.0002)
School (hh)	.0084	.0484	.1070
	(.0072)	(.0175)**	(.0137)**
Medical	-.3501	.3612	.2599
	(.0520)**	(.1275)**	(.1053)**
Nchild	.0009	-.0336	-.1022
	(.0122)	(.0336)	(.0308)**
Urban	-.1674	-.3980	5194
	(.0530)**	(.1402)**	(.1065)**
Employed (hh)	-.2202	.7731	.3604
	(.1264)*	(.5125)	(.3559)
Ethnic (hh)	.2016	.6265	-.2140
	(.0816)**	(.1954)**	(.2240)
Mworks	-.0411	-.1692	.3521
	(.0580)	(.1574)	(.1145)**
Income (hh)	.0000	.0001	-.0005
	(.0000)	(.0000)**	(.0000)**
Constant	.8243	-13.4536	-.1921
	(.4937)	(4.5294)	(.8506)

Status Defined:

Disinterested/Distance = Did not want/like to go to school, too far or there was not one. (base category)

Money/Married/Chores = Lack of money or had to work, or married/living together or my family did not allow me or to help with household chores

Completed = Finished my studies

Other = Other motive

Table 3.14: Impact of Changing Remittance on Causes of Leaving School

Odds Comparing Alternative i to j	β	z	P>|z|	e^{β}	$e^{\beta StdX}$
Money - Marriage	-0.63206	-1.993	0.046	0.5315	0.8872
Money - Distance	-0.78039	-2.833	0.005	0.4582	0.8626
Money - Chores	-0.80500	-2.859	0.004	0.4471	0.8586
Money - Completed	-0.05576	-0.164	0.870	0.9458	0.9895
Money - Other	-0.53197	-1.967	0.049	0.5874	0.9042
Money - Disinterested	-0.53421	-4.257	0.000	0.5861	0.9038
Marriage - Money	0.63206	1.993	0.046	1.8815	1.1271
Marriage - Distance	-0.14832	-0.376	0.707	0.8622	0.9723
Marriage - Chores	-0.17294	-0.437	0.662	0.8412	0.9678
Marriage - Completed	0.57630	1.307	0.191	1.7794	1.1153
Marriage - Other	0.10010	0.256	0.798	1.1053	1.0191
Marriage - Disinterested	0.09785	0.316	0.752	1.1028	1.0187
Distance - Money	0.78039	2.833	0.005	2.1823	1.1592
Distance - Marriage	0.14832	0.376	0.707	1.1599	1.0285
Distance - Chores	-0.02461	-0.068	0.946	0.9757	0.9954
Distance - Completed	0.72462	1.750	0.080	2.0640	1.1470
Distance - Other	0.24842	0.703	0.482	1.2820	1.0482
Distance - Disinterested	0.24618	0.928	0.353	1.2791	1.0477
Chores - Money	0.80500	2.859	0.004	2.2367	1.1646
Chores - Marriage	0.17294	0.437	0.662	1.1888	1.0333
Chores - Distance	0.02461	0.068	0.946	1.0249	1.0047
Chores - Completed	0.74923	1.792	0.073	2.1154	1.1524
Chores - Other	0.27303	0.757	0.449	1.3139	1.0531
Chores - Disinterested	0.27079	0.994	0.320	1.3110	1.0526
Completed - Money	0.05576	0.164	0.870	1.0573	1.0106
Completed - Marriage	-0.57630	-1.307	0.191	0.5620	0.8966
Completed - Distance	-0.72462	-1.750	0.080	0.4845	0.8718
Completed - Chores	-0.74923	-1.792	0.073	0.4727	0.8678
Completed - Other	-0.47620	-1.162	0.245	0.6211	0.9138
Completed - Disinterested	-0.47845	-1.439	0.150	0.6197	0.9134
Other - Money	0.53197	1.967	0.049	1.7023	1.1060
Other - Marriage	-0.10010	-0.256	0.798	0.9047	0.9812
Other - Distance	-0.24842	-0.703	0.482	0.7800	0.9541
Other - Chores	-0.27303	-0.757	0.449	0.7611	0.9496
Other - Completed	0.47620	1.162	0.245	1.6099	1.0943
Other - Disinterested	-0.00225	-0.009	0.993	0.9978	0.9996
Disinterested - Money	0.53421	4.257	0.000	1.7061	1.1064
Disinterested - Marriage	-0.09785	-0.316	0.752	0.9068	0.9816
Disinterested - Distance	-0.24618	-0.928	0.353	0.7818	0.9545
Disinterested - Chores	-0.27079	-0.994	0.320	0.7628	0.9500
Disinterested - Completed	0.47845	1.439	0.150	1.6136	1.0948
Disinterested - Other	0.00225	0.009	0.993	1.0022	1.0004

Definitions:

β = raw coefficient

z = z−score for test of β equal 0

P>|z| = p−value for z−test

e^{β} = exp(β) = factor change in odds for unit increase in X

$e^{\beta StdX}$ = exp(β SD of X) = change in odds for SD increase in X

Table 3.15: Hausman-McFadden Tests of IIA Assumption

Omitted	χ^2	df	$P > \chi^2$
Money	-7.957	85	1.000
Marriage	-1.891	85	1.000
Distance	0.127	85	1.000
Chores	2.915	84	1.000
Completed	-2.647	83	1.000
Other	-2.843	84	1.000

Ho: Odds(Outcome-J vs Outcome-K) are independent of other alternatives.

Table 3.16: Small-Hsiao Tests of IIA Assumption

Omitted	lnL(full)	lnL(omit)	χ^2	df	$P > \chi^2$
Money	-3037.772	-2997.475	80.594	95	0.854
Marriage	-5708.813	-5670.690	76.247	95	0.921
Distance	-5688.463	-5631.095	72.838	95	0.956
Chores	-5706.498	-5670.306	72.385	95	0.959
Completed	-5662.819	-5627.038	71.563	95	0.965
Other	-5395.582	-5359.943	71.277	95	0.967

Ho: Odds(Outcome-J vs Outcome-K) are independent of other alternatives.

Table 3.17: Wald Tests for Combining Outcome Categories

Categories Tested	χ^2	df	$P > \chi^2$
Money - Marriage	469.232	16	0.000
Money - Distance	236.242	16	0.000
Money - Chores	122.591	16	0.000
Money - Completed	101.782	16	0.000
Money - Other	593.396	16	0.000
Money - Disinterested	224.969	16	0.000
Marriage - Distance	251.639	16	0.000
Marriage - Chores	167.779	16	0.000
Marriage - Completed	230.430	16	0.000
Marriage - Other	347.451	16	0.000
Marriage - Disinterested	548.275	16	0.000
Distance - Chores	60.533	16	0.000
Distance - Completed	142.670	16	0.000
Distance - Other	174.147	16	0.000
Distance - Disinterested	238.368	16	0.000
Distance - Completed	142.139	16	0.000
Distance - Other	199.805	16	0.000
Distance - Disinterested	147.729	16	0.000
Completed - Other	221.137	16	0.000
Completed - Disinterested	104.820	16	0.000
Other - Disinterested	488.482	16	0.000

Ho: All coefficients except intercepts associated with given (pair of outcomes are 0 i.e., categories can be collapsed).

Table 3.18: LR Tests for Combining Outcome Categories

Categories Tested	χ^2	df	$P > \chi^2$
Money - Marriage	614.996	16	0.000
Money - Distance	252.005	16	0.000
Money - Chores	138.472	16	0.000
Money - Completed	120.577	16	0.000
Money - Other	693.708	16	0.000
Money - Disinterested	233.757	16	0.000
Marriage - Distance	433.330	16	0.000
Marriage - Chores	241.090	16	0.000
Marriage - Completed	300.933	16	0.000
Marriage - Other	620.968	16	0.000
Marriage - Disinterested	740.290	16	0.000
Distance - Chores	65.187	16	0.000
Distance - Completed	243.684	16	0.000
Distance - Other	202.644	16	0.000
Distance - Disinterested	239.997	16	0.000
Chores - Completed	185.262	16	0.000
Chores - Other	228.134	16	0.000
Chores - Disinterested	167.698	16	0.000
Completed - Other	360.643	16	0.000
Completed - Disinterested	130.833	16	0.000
Other - Disinterested	544.687	16	0.000

Ho: All coefficients except intercepts associated with given
(pair of outcomes are 0 i.e., categories can be collapsed).

Table 3.19: Bivariate Probit Model: Schooling and Remittances

Variable	Coefficient	Std. Error
Attend School Equation		
Constant	-3.4813	(0.0715)*
Rremits	1.6626	(0.0310)*
Age	0.7159	(0.0082)*
Age2	-0.0385	(0.0004)*
Male	0.0489	(0.0111)*
Male*RRemits	-0.1152	(0.0365)*
Male*Oldest	0.0166	(0.0155)
Oldest	0.0531	(0.0132)*
Male (hh)	0.1556	(0.0233)*
Age (hh)	0.0552	(0.0023)*
Age2 (hh)	-0.0005	(0.0000)*
School (hh)	0.0796	(0.0014)*
Married (hh)	0.0371	(0.0228)
Employed (hh)	0.0290	(0.0273)
Ethnic (hh)	0.1325	(0.0131)*
Income (hh)	0.0000	(0.0000)
Rremits*Income (hh)	0.0000	(0.0000)*
Nchild	-0.0730	(0.0025)*
Urban	0.1988	(0.0105)*
Rremits*Urban	0.1533	(0.0494)*
Computer	0.2797	(0.0298)*
Car	0.0601	(0.0113)*
Receiving-Remittance Household Equation		
Constant	-0.5411	(0.1158)*
Age	-0.1322	(0.0117)*
Age2	0.0032	(0.0005)*
Male	0.0137	(0.0127)
Escoacum	0.1118	(0.0045)*
Oldest	-0.0668	(0.0154)*
Male (hh)	-0.7292	(0.0304)*
Age (hh)	-0.0210	(0.0036)*
Age2 (hh)	0.0004	(0.0000)*
School (hh)	-0.0339	(0.0020)*
Married (hh)	0.2307	(0.0336)*
Employed (hh)	0.0206	(0.0434)
Ethnic (hh)	-0.4890	(0.0287)*
Income (hh)	0.0000	(0.0000)*
Nchild	0.0384	(0.0039)*
Urban	-0.2769	(0.0162)*
Computer	-0.1035	(0.0352)*
Car	0.1898	(0.0156)*
ρ	-0.8703	(0.0088)*

Note: Asterisk indicates significance at the .05 level

Table 3.20: Bivariate Probit Model: Average Yrs of Schooling or Greater

Variable	Coefficient	Std. Error
Average Years of Schooling Equation		
Constant	-20.0789	(0.1444)*
Rremits	0.1953	(0.0984)*
Age	2.8514	(0.0190)*
Age2	-0.0989	(0.0007)*
Male	-0.1146	(0.0142)*
Male*RRemits	-0.0617	(0.0587)
Male*Oldest	0.0855	(0.0202)*
Oldest	0.0116	(0.0161)
Male (hh)	0.0049	(0.0284)
Age (hh)	0.0457	(0.0031)*
Age2 (hh)	-0.0004	(0.0000)*
School (hh)	0.0601	(0.0016)*
Married (hh)	0.1327	(0.0278)*
Employed (hh)	0.0568	(0.0350)
Ethnic (hh)	-0.2552	(0.0167)*
Income (hh)	0.0000	(0.0000)
Rremits*Income (hh)	0.0000	(0.0000)
Nchild	-0.0667	(0.0033)*
Urban	0.0867	(0.0121)*
Rremits*Urban	-0.0329	(0.0704)
Computer	-0.1811	(0.0231)*
Car	0.1389	(0.0129)*
Receiving-Remittance Household Equation		
Constant	-1.7337	(0.1254)*
Age	-0.0197	(0.0121)
Age2	0.0015	(0.0005)*
Male	0.0099	(0.0130)
Oldest	-0.0570	(0.0165)*
Male (hh)	-0.8150	(0.0318)*
Age (hh)	0.0008	(0.0041)
Age2 (hh)	0.0002	(0.0000)*
School (hh)	-0.0221	(0.0020)*
Married (hh)	0.2960	(0.0361)*
Employed (hh)	0.0594	(0.0463)
Ethnic (hh)	-0.5693	(0.0305)*
Income (hh)	0.0000	(0.0000)
Nchild	0.0250	(0.0041)*
Urban	-0.2755	(0.0167)*
Computer	-0.0903	(0.0339)*
Car	0.2520	(0.0161)*
ρ	-0.0101	(0.0405)

Note: Asterisk indicates significance at the .05 level

Table 3.21: Total Economic Costs and Benefits of Eliminating Child Labor over the Entire Period (2000 to 2020), in $billion, PPP
(Percentage of aggregate annual gross national income in parentheses)

Region	Transitional Countries	Asia	Latin America	Sub-Saharan Africa	North Africa and Middle East	Global
Total Costs	25.6	458.8	76.6	139.5	59.7	760.3
Education Supply	8.5	299.1	38.7	107.4	39.6	493.4
Transfer implementation	0.7	6.3	1.2	1.5	1.1	10.7
Interventions	0.4	2.4	5.8	0.6	0.2	9.4
Opportunity Cost	16.0	151.0	30.9	30.1	18.8	246.8
Total Benefits	149.8	3,321.3	407.2	723.9	504.1	5,106.3
Education	145.8	3,307.2	403.4	721.8	500.2	5,078.4
Health	4.0	14.0	3.8	2.1	3.9	28.0
Net Economic Benefits	**124.2**	**2,862.4**	**330.6**	**584.4**	**444.4**	**4,346.1**
	(5.1%)	**(27.0%)**	**(9.3%)**	**(54.0%)**	**(23.2%)**	**(213.6%)**
Transfer Payments	13.1	125.8	23.5	29.1	22.1	213.6
Net Financial Benefits	**111.1**	**2,736.6**	**307.1**	**555.4**	**422.3**	**4,132.5**
	(4.6%)	**(25.9%)**	**(8.7%)**	**(51.3%)**	**(22.0%)**	**(21.1%)**

Source: International Labor Organization (2003).

Table 3.22: Bivariate Probit Model: Child Labor and Remittances

Variable	Coefficient	Std. Error
Child Labor Equation		
Constant	-5.5192	(0.5283)*
Rremits	-1.1736	(0.0975)*
Age	0.4990	(0.0712)*
Age2	-0.0074	(0.0024)*
Male	0.5295	(0.0221)*
Male*RRemits	0.1448	(0.0535)*
Oldest	0.0270	(0.0216)
Male*Oldest	0.0256	(0.0249)
Male (hh)	-0.2818	(0.0203)*
Age (hh)	-0.0443	(0.0031)*
Age2 (hh)	0.0004	(0.0000)*
School (hh)	-0.0532	(0.0018)*
Income (hh)	0.0000	(0.0000)*
Employed (hh)	0.0824	(0.0397)*
Ethnic (hh)	-0.0894	(0.0198)*
Nchild	0.0729	(0.0034)*
Urban	-0.1017	(0.0146)*
Rremits*Urban	-0.1763	(0.0666)*
Computer	-0.1214	(0.0292)*
Car	0.0654	(0.0152)*
Constant	-1.7255	(0.7771)*
Receiving-Remittance Household Equation		
Escoacum	0.0401	(0.0066)*
Age	0.0337	(0.1071)
Age2	-0.0012	(0.0037)
Male	-0.0027	(0.0187)
Oldest	-0.0406	(0.0226)
Male (hh)	-0.6985	(0.0433)*
Age (hh)	-0.0146	(0.0057)*
Age2 (hh)	0.0003	(0.0001)*
School (hh)	-0.0271	(0.0030)*
Income (hh)	0.0000	(0.0000)
Married (hh)	0.2191	(0.0463)*
Employed (hh)	0.0406	(0.0640)
Ethnic (hh)	-0.5168	(0.0413)*
Nchild	0.0196	(0.0058)*
Urban	-0.3400	(0.0236)*
Computer	-0.1795	(0.0479)*
Car	0.2642	(0.0224)*
ρ	0.6076	(0.0510)*

Note: Asterisk indicates significance at the .05 level

Chapter 4

Can Productivity Growth Deter the Migration of the *Maquiladora* Industry?

4.1 Introduction

Much attention has been given to the increased competition from China faced by the *maquiladora* industry in Mexico. China's entrance into the WTO in 2001 has raised questions about the long-term viability of the *maquiladora* industry. According to Contreras (2006), the *maquiladora* industry shrank by 0.4 percent annually from 2001 to 2003. China is believed to have challenged the *maquiladora* industry's comparative advantages. Rosen (2003) identifies the comparative advantages for the *maquiladora* industry in Mexico as lower labor costs than in the U.S., close proximity to the U.S. resulting in low transportation costs, and lower costs due to less-stringent environmental regulations than in the U.S. He identifies Mexico's comparative disadvantages to be corruption, excessive bureaucratic red tape, poor utilities and transportation infrastructure, under-investment in human capital, and weak industrial and financial structures. The protection granted to investors by the creation of the *maquiladora* program was set out as a strategy aimed to maximize Mexico's comparative advantages and minimize its comparative disadvantages.

With increased competition from China, can Mexico remain competitive? Rosen (2003) fails to indicate that Mexico's competitive advantage may lie in achieving leadership in reducing costs, providing more added value to goods or putting together supply chains. No study has undertaken a detailed analysis of the competitiveness of the *maquiladora* industry. Furthermore, no study applies stochastic frontier methodology to examine the efficiency and productivity of the manufacturing industry in Mexico. The objective of this chapter is to fill this gap by analyzing this industry's PC, TC and EC from 1998-2004.

Why is the continued success of the *maquiladora* industry important for Mexico? According to the *Consejo Nacional de la Industria de Maquiladora de Exportacion* (CNIME) (2006), the *maquiladora* industry accounts for 8.91% of the formal sector employment. Weakening of this industry will have dire consequences not only for employment but also for migration. The relationship between migration and *maquiladoras* employment was first analyzed in the late 1970s by Seligson and Williams (1981). They found that *maquiladora* workers who migrated internally within Mexico did so to reunite with family members and not to pursue employment. However, they found that recent migrants were more knowledgeable about potential employment opportunities in the *maquiladoras*.

In another study of migration and employment in the *maquiladora*, Fernandez-Kelly (1983) concludes that 70 percent of *maquiladora* workers in their sample were migrants. In a similar study for 1991, Young and Fort (1994) conducted interviews of 1,246 women in the labor force in *Ciudad Juarez*, Mexico. Forty-six percent of the women in the sample were employed in the *maquiladoras*, twenty-six percent in commerce, twenty percent in services and eight percent in a variety of other occupations. They found that *maquiladora* women were more likely to have migrated to *Ciudad Juarez* than were the women working in other jobs (72 percent compared to 43 percent). Of the *maquiladora* women, 82 percent were *interstate* migrants and, of the non-*maquiladora* women, 45 percent were *intrastate* migrants.

Two patterns of employment have been traced to internal migration in Mexico. First, *maquiladoras* provide employment for workers in transit to the U.S. Second, they employ young, inexperienced females and males from rural areas. Therefore, the assembly plant's labor pool is comprised of individuals with a high tendency to switch jobs, migrate to the U.S. or, in the case of women, exit the labor market for childbearing. A potential contraction of the *maquiladora* industry via a loss in foreign direct investment could significantly decrease employment in Mexico and increase migration to the U.S., further exacerbating social and economic problems in Mexico.

Although both the media and the scholarly literature argue that China is a threat to Mexico because China's labor costs are just one-third to one-half of Mexico's, in Table 3.1 I present an assessment by a General Electric (GE) vice president of whether to locate a new production facility in Mexico or in China. He compares the two countries based on eleven criteria. China, not surprisingly, has advantages over Mexico in labor costs, electricity costs, and supplier base. Mexico, surprisingly, out performs China on eight criteria: transportation costs, skilled labor/productivity, international telecommunication costs, technology transfer, manufacturing/management flexibility, protection of intellectual property, transparency in regulation/administration, and free-trade agreements. According to Sahling and Finley (2004), the GE vice president concluded that "Mexico is the better place for companies manufacturing products that are higher up the "value-added chain". Therefore, it is important to evaluate not only the competitiveness of Mexico based on labor costs but also on productivity.

To examine the issue, Section 4.2 presents a theoretical model where economic efficiency and productivity growth are determined with an input distance function, which is dual to the cost function. I estimate a translog input distance function as a flexible representation of the true underlying distance function to compute PC, TC, and EC. TE, computed for 19 Mexican states, is defined as the additional increase in output that can be obtained from a given level of inputs, if firms are operating on the technological frontier. Section 4.3 describes the state-level production data used to study the productivity of the industry. In Section 4.4, estimated results are presented. Conclusions follow in Section 4.5.

4.2 The Input Distance Function

This section restates the theoretical model used in Atkinson, Cornwell, and Honerkamp (2003). An input distance function is used to estimate economic efficiency and productivity growth. The input distance function, which is dual to a cost function, is defined as follows:

$$D(\mathbf{y},\mathbf{x}) = \sup_{\lambda}\{\lambda : (\mathbf{x}/\lambda) \in L(\mathbf{y})\},$$

where the output column vector is denoted by $y = (y_1,\dots,y_S) \in R_+^S$, the input column vector is denoted by $x = (x_1,\dots,x_N) \in R_+^N$, and $L(y)$ is the input requirements set. The dual cost minimization problem is

$$C(\mathbf{y},\mathbf{p}) = \min_{\mathbf{x}}\Big\{\mathbf{px} \, : D(\mathbf{y},\mathbf{x}) = 1\Big\}, \tag{4.1}$$

where the input price row vector is denoted by $\mathbf{p} = (p_1,\dots,p_N) \in R_+^N$ (earnings of skilled and unskilled labor) and the vector of input quantities which solves the minimization problem in (4.1) is represented by $\mathbf{x} = (x_1,\dots,x_N) \in R_+^N$ (quantity of skilled and unskilled labor).

The first-order condition of the cost minimization problem in (4.1) is given by

$$p_n = \mu\frac{\partial D(\mathbf{y},\mathbf{x})}{\partial x_n}, n = 1,\dots,N, \tag{4.2}$$

where p_n corresponds to the price of skilled and unskilled labor and is set equal to the product of the μ, which denotes the Lagrangian multiplier, and $\frac{\partial D(\mathbf{y},\mathbf{x})}{\partial x_n}$, which denotes the partial derivative of $D(\mathbf{y},\mathbf{x})$ with respect to a change x_n.

By multiplying both sides by x_n and summing across the l's, I obtain:

$$\sum_l p_l x_l = \mu\sum_l \frac{\partial D(\mathbf{y},\mathbf{x})}{\partial x_l}x_l. \tag{4.3}$$

By making use of the property that $D(\mathbf{y},\mathbf{x})$ is linearly homogeneous in x, and the normalizing assumption:

$$1 = D(\mathbf{y},\mathbf{x}), \tag{4.4}$$

via Euler's theorem, I obtain:

$$\sum_l \frac{\partial D(\mathbf{y},\mathbf{x})}{\partial x_l}x_l = D(\mathbf{y},\mathbf{x}). \tag{4.5}$$

Using (4.4) and (4.5), equation (4.3) can be rewritten as

$$\mu = \sum_l p_l x_l = C(\mathbf{y},\mathbf{p}). \tag{4.6}$$

Given the new notation above, the n^{th} equation in (4.2) can be expressed as

$$p_n = \Big(\sum_l p_l x_l\Big) \frac{\partial D(\mathbf{y}, \mathbf{x})}{\partial x_n}, \; n = 1, \ldots, N. \tag{4.7}$$

where the distance system now consists of equation (4.7) and equation (4.4).

4.2.1 The Translog Input Distance Function

As a more flexible representation of the true underlying distance function, the translog distance function is defined for state $s, s = 1, \ldots, S$ and time period t, $t = 1, \ldots, T$. The translog distance function is estimated for 19 Mexican states for the period 1998-2004. The general specification is:

$$\begin{aligned}
\ln[D_i(\mathbf{y}_{st}, \mathbf{x}_{st}, t)h(\epsilon_{st})] &= \ln D_i(\mathbf{y}_{st}, \mathbf{x}_{st}, t) + \ln h(\epsilon_{st}) \\
&= \alpha_0 + \gamma_y \ln y_{st} + .5\gamma_{yy}(\ln y_{st})^2 + \sum_n \gamma_n \ln L_{n,st} \\
&+ .5 \sum_n \sum_n \gamma_{nn'} \ln(L_{n,st})(\ln L_{n',st}) + \sum_n \gamma_{yn} \ln L_{n,st} \ln y_{st} \\
&+ \gamma_m \ln expmat_{st} + .5\gamma_{mm}(\ln expmat_{st})^2 \\
&+ \gamma_f \ln fdi_{st} + .5\gamma_{ff}(\ln fdi_{st})^2 + \gamma_{t1} t + .5\gamma_{t2} t^2 \\
&+ \gamma_{t3} t^3 + \gamma_{yt} \ln y_{st} t + \gamma_{mt} \ln expmat_{st} t \\
&+ \gamma_{ft} \ln fdi_{st} t + \sum_n \gamma_{nt} \ln L_{n,st} t + \ln h(\epsilon_{st}),
\end{aligned} \tag{4.8}$$

where y denotes output, L_u is quantity of unskilled labor, L_k is quantity of skilled labor (so that $n = k, u$), $expmat$ is expenditures on intermediate consumption, fdi is foreign direct investment, t denotes a time trend and $\ln h(\epsilon_{st})$ is an error comprised of u_{st}, a one-sided component, and u_{st}, a standard noise component with a zero mean. We express the composite error as:

$$h(\epsilon_{st}) = \exp(v_{st} - u_{st}). \tag{4.9}$$

To model the one-sided component of the error in equation (4.9) the Cornwell, Schmidt and Sickles (1990) fixed-effects approach for time-varying inefficiency is used:

$$u_{st} = \beta_{s0} d_s + \beta_{s1}\, d_s\, t + \beta_{s2}\, d_s\, t^2, \tag{4.10}$$

where β_{s0}, β_{s1}, and β_{s2} are parameters to be estimated for state s. The coefficient estimate β_0 captures time-invariant, state-specific differences in the technology, while β_{s1} and β_{s2} capture time-varying, state-specific differences in technology.

Additionally, the following symmetry restrictions are imposed:

$$\gamma_{nn'} = \gamma_{n'n}, \forall\, n, n',\ n \neq n'. \tag{4.11}$$

Furthermore, the following restrictions are also imposed on the parameters in (4.8), given that $D(\mathbf{y}, \mathbf{x}, t)$ is linearly homogeneous in $\mathbf{x}$:

$$\begin{aligned}
\sum_n \gamma_n &= 1, \\
\sum_n \gamma_{nn'} = \sum_{n'} \gamma_{nn'} = \sum_n \sum_{n'} \gamma_{nn'} &= 0, \\
\sum_n \gamma_{nt} &= 0, \\
\sum_n \gamma_{yn} &= 0.
\end{aligned} \tag{4.12}$$

4.2.2 Measurement of Technical Efficiency and Productivity Change

Having obtained consistent estimators of the u_{st}, I then proceed to compute TE_{st} and its time difference, EC_{st}. TC_{st} is computed from the time difference of the estimated distance function. PC_{st} is then computed as the sum of TC_{st} and EC_{st}.

Estimating equation (4.10) and using the negative of the residuals $-\hat{\beta}_{s0} d_s + \hat{u}_{st} - \hat{v}_{st}$ and adding $\hat{\beta}_{s0} d_s$, I obtain $\hat{u}_{st} - \hat{v}_{st}$. These residuals, which are consistent estimators of $u_{st} - v_{st}$ as $T \to \infty$ are regressed on the right-hand side of (4.10). The fitted values of this regression are then consistent estimators of u_{st}.

Similar to Atkinson, Cornwell, and Honerkamp (2003), non-negativity is imposed on the one-sided error that is used to compute technical inefficiency. The residual $\hat{u}_t = \min_s(\hat{u}_{st})$ defines the estimated frontier intercept in each period. Then, $\hat{u}_t$ is added and subtracted from the fitted version of (4.8) to obtain

$$0 = \ln \hat{D}(\mathbf{y}_{st}, \mathbf{x}_{st}, t) + \hat{v}_{st} - \hat{u}_{st} + \hat{u}_t - \hat{u}_t,$$

$$= \ln \hat{D}(\mathbf{y}_{st}, \mathbf{x}_{st}, t) - \hat{u}_t + \hat{v}_{st} - \hat{u}_{st}^{\mathcal{F}},$$
$$= \ln \hat{D}^{\mathcal{F}}(\mathbf{y}_{st}, \mathbf{x}_{st} t) + \hat{v}_{st} - \hat{u}_{st}^{\mathcal{F}}, \tag{4.13}$$

where the fitted frontier distance function in period t, $\ln \hat{D}^{\mathcal{F}}(\mathbf{y}_{st}, \mathbf{x}_{st}, t)$, is defined as $\ln \hat{D}(\mathbf{y}_{st}, \mathbf{x}_{st}, t) - \hat{u}_t$ and $\hat{u}_{st}^{\mathcal{F}} = \hat{u}_{st} - \hat{u}_t \geq 0$.

TE_{st} can then be estimated as

$$\mathrm{TE}_{st} = \exp(-\hat{u}_{st}^{\mathcal{F}}), \tag{4.14}$$

where TE_{st} lies between 0 and 1. Then, an estimate of EC_{st} is obtain as

$$\mathrm{EC}_{st} = \Delta\mathrm{TE}_{st} = \mathrm{TE}_{s,t+1} - \mathrm{TE}_{s,t}, \tag{4.15}$$

where EC_{st} is simply the change in TE_{st} from t to $t+1$.

After eliminatation of the residuals, $\hat{v}_{st}$ and $\hat{u}_{st}^{\mathcal{F}}$, TC_{st} is estimated as the difference between $\ln \hat{D}^{\mathcal{F}}(\mathbf{y}, \mathbf{x}, t+1)$ and $\ln \hat{D}^{\mathcal{F}}(\mathbf{y}, \mathbf{x}, t)$, holding input and output quantities constant such:

$$\begin{aligned} \mathrm{TC}_{st} &= \ln \hat{D}(\mathbf{y}, \mathbf{x}, t+1) - \hat{u}_{t+1} - [\ln \hat{D}(\mathbf{y}, \mathbf{x}, t) - \hat{u}_t] \\ &= \sum_m \hat{\gamma}_{mt} \ln y_{mft} + \sum_n \hat{\gamma}_{nt} \ln x_{nst} \\ &+ \hat{\gamma}_{t1} + .5\hat{\gamma}_{t2}[(t+1)^2 - t^2] - (\hat{u}_{t+1} - \hat{u}_t). \end{aligned} \tag{4.16}$$

so that the time change in the frontier intercept, $\hat{u}_t$, affects TC_{st} and EC_{st}. Finally, an estimate of productivity change is obtained by $\mathrm{PC}_{st} = \mathrm{EC}_{st} + \mathrm{TC}_{st}$.

4.3 Data

4.3.1 *Maquiladora* Production Data

The empirical analysis uses a panel of 1998-2004 aggregate state-level textile *maquiladora* production data drawn from *INEGI's Maquiladora de Exportacioń* yearbook. The *maquiladora* textile industry is comprised of nineteen Mexican states located throughout Mexico.[1] Unfortunately, because of confidentiality measures implemented by the Mexican government to protect the identity of the firms, firm-level disaggregated data are not available. The states that participate in *maquiladora* production are not restricted merely to the border region area as was the case a decade ago but also include states as far south as Chiapas and Yucatan.

The data on FDI were collected from INEGI's system *Banco de Informacioń Economíca*. The five states that receive the largest share of FDI into Mexico are two border states, Baja California and Nuevo Leon, and three central states, Jalisco, Nayarit, and Mexico City. Those receiving the lowest share are four northern/central states, Durango, Zacatecas, Aguascalientes, and Guanajuato, and a southern state, Yucatan. Although border states receive a disproportionately higher amount of FDI, there is no reason to exclude them from the sample, as does Hanson (2005), since these shocks would be captured in state fixed effects.

The only relevant study of the impact of foreign direct investment on the *maquiladora* industry is conducted by Feenstra and Hanson (1997). They analyzed studies of relative labor demand for a panel of nine two-digit (ISIC) industries in Mexico's 32 states. Their data on employment and wages come from Mexico's Industrial Census for 1975-1988. My study differs in two respects. First, there is no aggregation across divisions, but rather the textile industry is studied separately. Second, I am concerned with the productivity of the state industry and not the impact of FDI on labor demand.[2] In my study FDI is included as a shifter in the distance function. Data on capital are not available; therefore, FDI is used as a proxy to control for investment flows into the *maquiladora* industry. Figure 4.1 shows two types of FDI: FDI into all sectors and FDI into the manufacturing industry. FDI into the

[1] The states are Aguascalientes (Ags), Colima (Col), Chiapas (Chs), Mexico City (DF), Durango (Dur), Guanajuato (Gto), Hidalgo (Hgo), Jalisco (Jal), Mexico (Mex), Nuevo Leon (NL), Puebla (Pue), Queretario (Qtr), San Luis Potosi (SLP), Sonora (Son), Tamulipas (Tamp), Tlaxcala (Tla), Yucatan (Yuc), and Zacatecas (Zac). Although, Baja California Sur (BC Sur) also produces textiles I was unable to obtain data for this state because (BC Sur) did not meet the confidentiality requirements of protecting the identity of the firm.

[2] In Ibarra (2006) I study the impact of FDI on labor demand of skilled and unskilled workers.

manufacturing industry sharply declined in 2001, while FDI into all sectors sharply increased early in our sample and then declined in 2002. FDI from the U.S. has been on the decline since 2002.

Consistent with the decline in investment in the manufacturing industry, Figure 4.2 shows that the number of establishments active in the *maquiladora* industry declined significantly in 2001 and then leveled off in 2004. It appears that a shock, possibly China's entrance into the WTO, affected the *maquiladora* industry, resulting in a significant decline in investment. However, currently there appears to be stability in the industry and additional firms are not leaving.

The quantity of labor employed in the *maquiladora* is sorted into two types of workers: skilled workers, defined as workers involved in the administrative process, and unskilled workers, defined as workers directly involved in the production process.[3] An ideal classification of labor would be by skill type, education, experience and occupation; however, the data provided to us are not disaggregated in this manner. Not surprisingly, the ratio of skilled to unskilled labor is relatively low, consistent with the literature stating that the *maquiladora* industry employs a relatively large number of unskilled workers. Earnings are also classified by labor type: unskilled and skilled. A large proportion of wage payments goes to unskilled workers, as is expected in an industry that is predominantly unskilled. Figures 4.3 and 4.4 show what has happened to employment and earnings in the *maquiladora* industry from 1990-2006. Employment in the industry grew continually since the establishment of the industry and reached a peak in 2001, after which it declined.

Gruben and Kiser (2001) attributed the soaring growth of the industry in 1994 to the adoption of the North America Free Trade Agreement (NAFTA), where in the five years prior to NAFTA, *maquiladora* employment grew 47% and over the first five years after NAFTA employment growth increased by 86%. They suggest two factors that explain

[3]The *"Maquiladora de Exportacion"* yearbook defines the two categories as follows: *obreros* and *empleados*.

maquiladora employment fluctuations: the fluctuating growth rate of U.S. industrial production, and Mexican-to-U.S. as well as Mexican-to-Asian manufacturing wage ratios. When manufacturing activity in the U.S. increases, the result is increased production orders for the *maquiladoras*. The relationship between Mexican-U.S. and Mexican-Asian wage ratios and *maquiladora* employment growth is negative, so when Mexican wages increase relative to U.S and Asian wages, *maquiladora* employment growth declines. According to Canas and Coronado (2002), *maquiladora* employment from 1983-1989 grew annually at an annual average rate of 19.2 percent, from 1990-1994 grew at 6.3 percent, and from 1995-2001 grew a 11 percent per year. However, Canas and Coronado (2002) estimate that from May 2001 to June 2002, 420 plants closed, with three-fourths of them in border states.

Earnings have remained stagnant for technicians and unskilled workers, while earnings of skilled workers, administrative workers, have increased. This finding indicates increased wage inequality between skilled and unskilled workers. This is also consistent with increased relative demand for more highly skilled workers in the *maquiladora* industry.

The "*Industria Maquiladora de Exportacioń*" yearbook also provides data on production, gross value added, and materials. Production, gross value added, materials and earnings were adjusted to the base year 2003 by the National Producer Price Index provided by the *Banco de Mexico*. The data have been normalized by their means before taking their logarithms. Production is defined as the sum of gross value added and material costs. Material costs, inputs in production, are defined as the value of both domestic and imported primary materials, packaging, and other costs incurred in the processing stage.[4] Production, in Figure 4.6, continually increased from 1990-2000, and fell from 2000 to 2001, but has increased onward from 2001 to 2006 reaching record levels. Figure 4.5 shows that value added followed a pattern similar to production.

Gross value added includes labor expenses by skill type. From 1990 to 2001, value added has been on the rise, as is expected as an industry matures and becomes more efficient.

[4]According to INEGI's *"Maquiladora de Exportacioń"* yearbook, in May 2004, 3.0 percent of material costs were produced in Mexico, and slightly increased to 3.4 percent by May 2005.

Over 2001-2002 there was a decline in value added but a steady increase over time through 2006. My hypothesis is, that as firms continue to reach such high levels of value added, the most efficient firms will be those that remain in Mexico, and the less efficient will be those leaving for China. Chandler (2005) suggests that in the border city of Ciudad Juarez older *maquiladoras* that have left in search of lower labor costs have been replaced by high-tech plants that continue to arrive from the U.S. and other countries.

4.4 Empirical Results

We employ Generalized Method of Moments (GMM) to estimate the input distance function and we also correct for heteroskedasticity to obtain robust and consistent standard errors. The restriction $\alpha_0 = 0$ as well as symmetry and linear homogeneity from (4.11) and (4.12) are imposed. Table 4.2 reports the estimated coefficients and asymptotic standard errors. The instruments used are 19 state dummies, an interaction of the state dummies with the prices of skilled and unskilled labor, the prices of skilled and unskilled labor squared, output, output squared, the interaction of output with time, time, time squared, time cubed, material costs, material costs squared, the interaction of material costs with time, the interaction of material costs with time squared, the interaction of material costs with output, the interaction of material costs with FDI, FDI, FDI squared, the interaction of FDI with output, the interaction of value added with FDI, the interaction of value added with material costs, FDI squared, the quantity of unskilled labor interacted with the quantity of skilled labor, value added interacted with skilled and unskilled labor, and the two types of labor interacted with time. The validity of the overidentifying restrictions is tested using the Hansen (1982) J-test statistic. A J-test statistic of 54.5626 with a p-value of .239 indicates that the overidentifying restrictions are valid.

Table 4.3 presents estimated average state TEs, computed using (4.14) over the period 1998-2004. The samples' weighted-average efficiency score is 0.65542. The most efficient state is Qro at .94741. The least efficient state is Yuc at .35985. PC is decomposed into TC and

EC, following the work of Atkinson, Cornwell, and Honerkamp (2003). TC is the movement of the frontier over time. EC measures the movement of a firm towards or away from the frontier. Table **??** presents estimates of PC, TC, and EC over time. In 1999, PC was -6.14%, due to the negative TC and EC in that year. PC is positive in 2000, even though EC is -0.24%. PC rises steadily from 2000 through 2004, even though EC again is negative in 2000, 2003 and 2004. TC rises through 2004, where it reaches 44.20%, a level which is presumably unsustainable in the long-term. Note that this result is not due to a restrictive specificiation of time in the translog model since we interact time with all the other variables in the model and we include first, second and third order terms in time. EC increases steadily from 1999 to 2002 and then declines thereafter to negative 15.85%, due to the inability of firms operating inside the production frontier to keep up with firms on the frontier. That is, a few *maquiladora* firms experienced substantial TC which is unmatched by other firms.

4.5 Conclusion

The purpose of this chapter was to analyze the performance of the Mexican maquiladora textile industry, which was adversely affected by China's free trade policies and membership in the WTO in 2001. The objective of this paper has been to fill a gap in the literature by estimating the industry's PC, TC and EC from 1998-2004. This is the first study to investigate the efficiency and productivity of the *maquiladora* industry. According to my analysis, the average annual PC is 9.74%. The average annual TC is 13.49%. The average annual rate of growth in EC is -3.75%. On average, positive TC outweighs negative EC. The results showed consistent increases in PC and TC from 1998-2004, while EC declined in the last year as frontier firms made huge gains and non-frontier firms were unable to keep up. The findings suggest that the *maquiladora* industry has increased its productive efficiency during a period when it faces increased competition from China.

The approach developed in this paper can serve as a starting point for additional work in this area. An interesting extension would be to investigate sources of technical inefficiencies in this industry and to examine the impact of technical change during this period on the mix of labor, that is, whether technical change is biased towards, skilled or unskilled labor.

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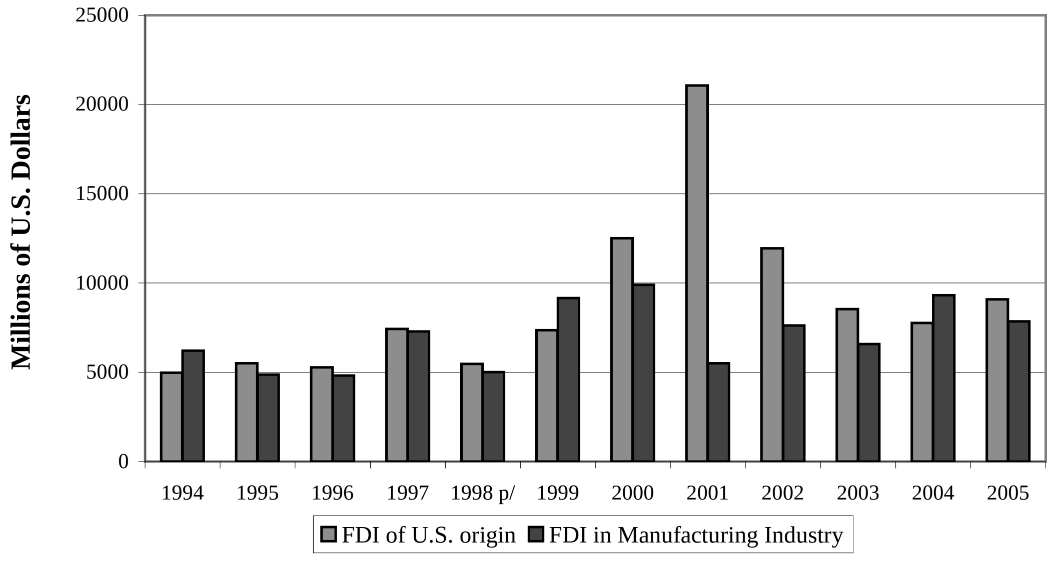
Table 4.1: Where to Locate New Production Facilities - Mexico vs. China

Competitive Factor	**Mexico**	**China**
Labor Costs		X
Electricity Costs		X
Supplier base[1]		X
Transportation costs and transit time	X	
Skilled labor/productivity	X	
International telecommunication costs	X	
Technology transfer	X	
Manufacturing/management flexibility	X	
Protection of intellectural property	X	
Transparency in regulation/administration	X	
Free-trade agreements	X	

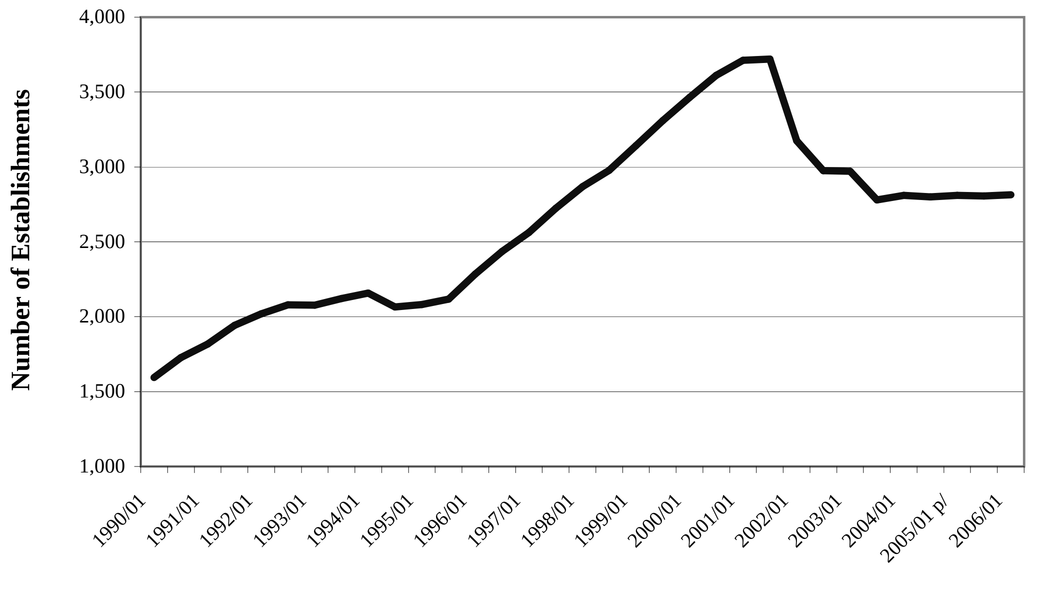
[1]The greater diversity of component suppliers in China compared with Mexico has been cited as a factor that companies making electronic products and electrical items such as computer (monitors, transformers, and car audio systems considered in deciding)to move production to China.

Source: Farouk Salim, Business Development Director, GE International Mexico, presentation based on a GE study comparing manufacturing costs in China, Mexico, India, and Hungary at Mexcon 2002: Maximizing the Cost-Cutting Opportunities of Manufacturing and Assembling in Mexico, San Diego, CA, March 19, 2002, sponsored by the Institute of International Research.



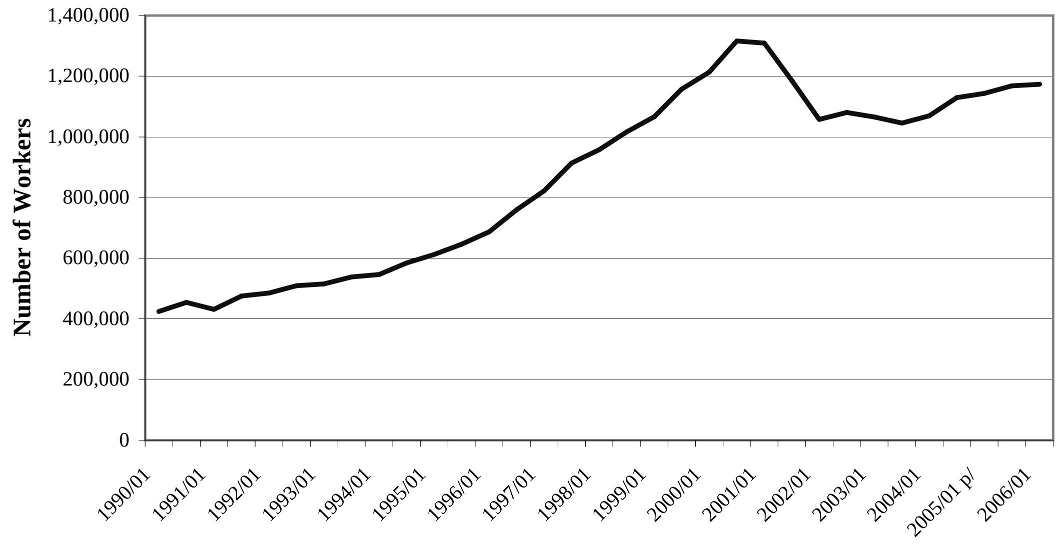
Source : Secretaría de Economía. Dirección General de Inversión Extranjera.

Figure 4.1: Foreign Direct Investment 1990-2006



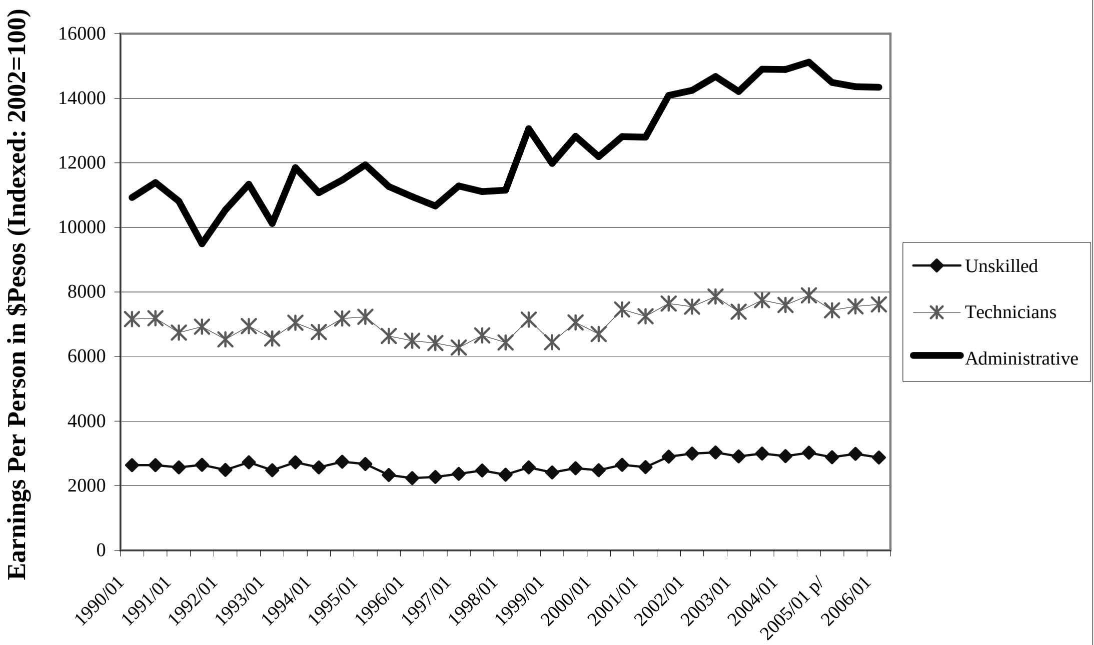
Source: INEGI, Estadística de la Industria Maquiladora de Exportación

Figure 4.2: Number of Establishments in the Maquiladora Industry 1990-2006



Source: Banco de Informacion Economica, Instituto Nacional de Estadistica, Geografia e Informatica

Figure 4.3: Mexico's Maquiladora Employment 1990-2006



Source: INEGI. Estadística de la Industria Maquiladora de Exportación.

Figure 4.4: Earnings in the Maquiladora Industry 1990-2006

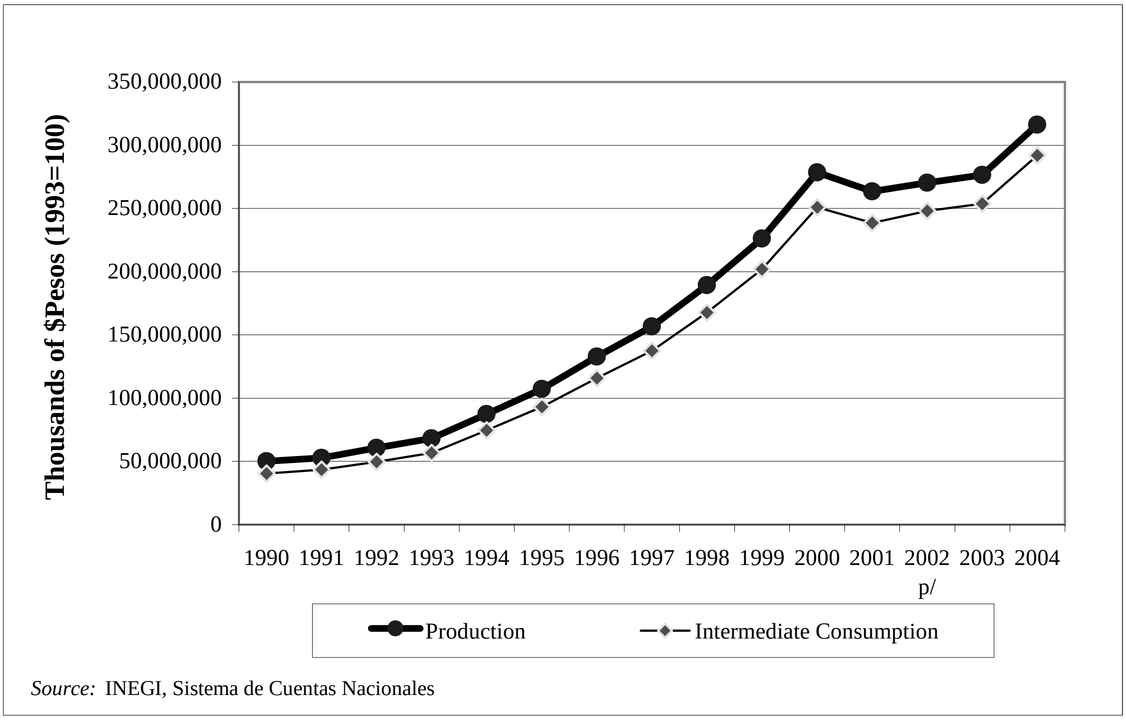


Figure 4.5: Production and Intermediate Consumption in the Maquiladora Industry 1990-2004

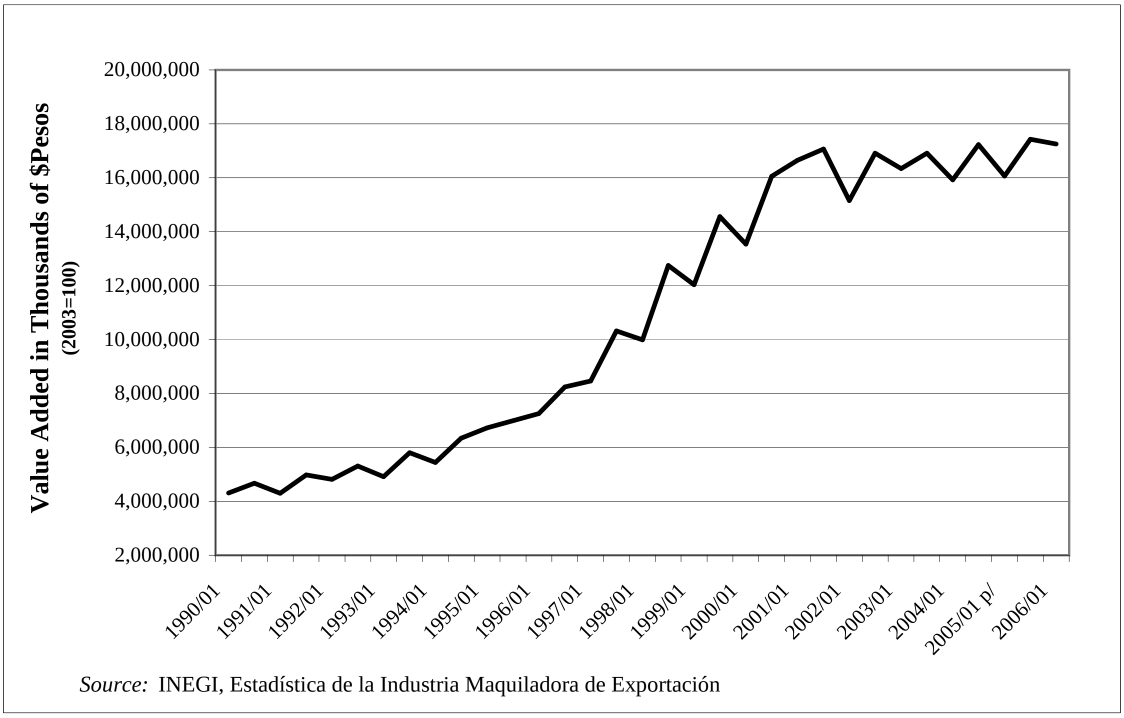


Figure 4.6: Value Added in the Maquiladora Industry 1990-2006

Table 4.2: Estimated Structural Coefficients

Variable	Coefficient	Std. Error
Ags	0.0167	(0.0792)
BCN	-0.1372	(0.0526)*
Chs	0.0782	(0.0684)
Col	-0.0330	(0.0690)
DF	-0.5805	(0.1043)*
Dgo	-0.0136	(0.0912)
Gto	-0.2422	(0.0800)*
Gro	-0.4849	(0.0843)*
Jal	-0.3974	(0.0850)*
Mex	-0.5104	(0.0717)*
NL	-0.3934	(0.0761)*
Pue	0.2692	(0.0601)*
Qro	-0.5668	(0.0872)*
SLP	-0.4309	(0.0881)*
Son	-0.1869	(0.0708)*
Tamps	-0.0156	(0.0620)
Tlax	-0.1976	(0.0795)*
Yuc	0.3806	(0.0752)*
Zac	-0.3253	(0.0921)*
$\gamma_{L_k t}$	-0.0093	(0.0072)
$\gamma_{L_k y}$	-0.1901	(0.0392)*
$\gamma_{L_u L_k}$	0.4383	(0.0372)*
γ_{L_k}	0.3085	(0.0654)*
γ_y	-0.4933	(0.0494)*
γ_{y^2}	-0.1615	(0.0251)*
$\gamma_{{L_k}^2}$	-0.0908	(0.0302)*
γ_t	-0.2279	(0.0432)*
γ_2	0.1350	(0.0217)*
γ_3	-0.0047	(0.0008)*
γ_{ty}	0.0284	(0.0068)*
γ_{tm}	-0.0119	(0.0066)
γ_{tf}	0.0019	(0.0010)
γ_f	0.0239	(0.0150)
γ_{f^2}	0.0108	(0.0038)*
γ_m	-0.2568	(0.0458)*
γ_{m^2}	-0.0842	(0.0249)*

Note: Asterisk indicates significance at the .05 level

Table 4.3: Average State Technical Efficiencies 1998-2004

State	Distance Function Efficiency Score
AGS	0.50259
BCN	0.59322
Chs	0.47366
Col	0.54218
DF	0.92493
Dgo	0.51951
Gto	0.65134
Gro	0.84831
Jal	0.77855
Mex	0.86140
NL	0.77263
Pue	0.39728
Qro	0.94741
SLP	0.80061
Son	0.62030
Tamps	0.52263
Tlax	0.62828
Yuc	0.35985
Zac	0.70839
Avg.	0.54248

Table 4.4: Time Varying PC, TC, and EC

Year	PC	TC	EC
1999	-0.0614	-0.0573	-0.0042
2000	0.0262	0.0286	-0.0024
2001	0.0782	0.0767	0.0015
2002	0.1000	0.0915	0.0085
2003	0.1582	0.2281	-0.0700
2004	0.2835	0.4420	-0.1585
Avg.	0.0974	0.1349	-0.0375

Chapter 5

Conclusion

The issues related to migration, both capital and labor mobility, presented in this paper show that the process of migration exhibits few negative consequences; remittances increase schooling and reduce child labor, interstate and international return migration do not reduce wages or employment opportunities of natives, and productivity growth in the *maquiladora* industry has remained positive through a period of increased competition from China. Further research needs be concentrated on the source country to understand the local labor market needs and implications of labor and capital mobility. The impact of immigration has been examined extensively for the U.S., while few studies exist for Mexico that focus on the effects of interstate immigration and international return migration. This paper has attempted to address the issue for Mexico. Furthermore, I have attempted to address a serious shortcoming of studies for the U.S. Borjas (1990), Card (2003) and Mishra (2003). All of these studies use Census-level data without modeling the production of the firm.

The findings of the first essay point to a few interesting conclusions. First, inflows of interstate and international return migrants into the manufacturing industry labor market from 1998 to 2001 generated large changes in wages and employment for some states, BCN and BCS, but almost no change (relatively small) for the other 18 Mexican states in the industry. This result is partially consistent with Card's (1990) finding that influx of migrants into Miami arising from the Mariel boatlift had no significant impact on wages or employment. Furthermore, the common measure in the literature of migrant to native stock merits closer examination for the possibility of capturing innate abilities of migrants or the possibility of acting as a proxy for higher turnover in the industry. Butcher and DiNardo (1998) find that in many cities in the U.S. immigrants are slightly less skilled than existing native workers. In the analysis for Mexico, the findings suggest immigrants are on average more skilled than the average native worker. Second, I find evidence of unexplained racial and gender wage differences in the manufacturing industry. Lastly, FDI into the 20 Mexican states increased the relative demand for skilled workers in all the states, while FDI decreases labor demand for unskilled workers in some states. The impact of FDI can have a detrimental effect on increased wage inequality in Mexico. Furthermore, more studies are needed to examine the impact of FDI on internal migration shifts in Mexico and the consequences for wages and employment. In contrast, an attempt has been made to model jointly wages, employment, migration and the productivity of the firm.

My results in the second essay complement and confirm the findings of the literature that explores the improvement in welfare indicators that stem from remittances. Various studies have looked at the impact of remittance on economic development indicators. More sophisticated econometrics techniques do not exist which would allow me to model remittances, schooling, child labor, income and consumption goods together to isolate the true impact that remittances have on these development indicators. More studies need to be done in this area but not so much concerned with the impacts for development but rather dedicated to improving the techniques that are used in modeling the issue correctly.

In conclusion, although remittances play an important role in school attendance, increased educational attainment and reduced child labor, I am careful to not suggest that remittances are unambiguously a positive externality of the migration process. Therefore, the governments of developing countries such as Mexico should be cautious about relying strictly on remittances as a source of economic growth. Public policies should reflect the domestic understanding of the importance of education and the larger benefits that it can contribute to society. However, governments in these countries must be careful using remittances to sustain a balance of payments surplus.

The purpose of the third essay was to analyze the performance of the Mexican maquiladora textile industry. The period 1998-2004 is examined to determine whether the industry has been adversely affected by China's entrance into the WTO. The objective of this paper has been to fill a gap in the literature by estimating the industry's PC, TC and EC from 1998-2004. According to my analysis, the average annual PC is 9.74%. The average annual TC is 13.49%. The average annual rate of growth in EC is -3.75%. These results suggest that, on average, positive TC outweighs negative EC. My results showed consistent increases in PC and TC from 1998-2004, while EC was substantially negative in the last year. My findings indicate that the *maquiladora* industry remains productive during the period when it faces increased competition from China. Productivity growth is essential for the continual growth of this sector.

The modeling approach developed in this paper can serve as a starting point for additional work in this area. An interesting extension of this paper would be to investigate probable sources of technical inefficiencies in this industry and to examine the impact of the technical change during this period on the mix of labor, that is, whether technical change is biased towards a factor of production, skilled or unskilled labor.