THE EFFECTS OF IMMIGRATION, FARM, AND TRADE POLICIES AND THE MACROECONOMIC CONDITIONS ON ILLEGAL IMMIGRATION AND AGRICULTURAL TRADE

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Abstract

The 1986 Immigration Reform and Control Act granted amnesty to existing unauthorized workers, tightened the border control, implemented employer sanctions, and established a new guest-worker program. However, because of the lax border and domestic enforcements and cumbersome guest-worker program, the illegal population in the United States grew to about 12 million by 2004. Due to concerns of wage depression, job loss, fiscal costs, and also national security, congress considered several legislations in recent years to curb the growth of the illegal population. However, congress failed to pass any immigration reforms because of disagreements over providing citizenship to unauthorized workers, and the illegal immigration issue remains unresolved. Because congress did not reform the immigration laws, the U.S. government has drastically increased its workplace raids and border patrols. These raids have led to a severe farm labor shortage during peak operations such as planting and harvest, resulting in unharvested crops, huge losses, and even the outsourcing of farm operations to Mexico.

Given the importance of Mexican labor to U.S. agriculture, this thesis investigates the effects of trade liberalization, U.S. farm supports, immigration policy, and economic growth on illegal immigration and agricultural trade. The theoretical analysis develops an integrated trade-migration model with two countries linked by their commodity and labor markets. Trade is distorted by tariffs before the end of NAFTA and U.S. farm subsidies. Labor flow is restricted by border and domestic enforcements. The theoretical results show that a) NAFTA and farm supports exacerbate the illegal labor flow and increase U.S. exports, b) heightened domestic enforcement and border control contract the flow of illegal workers but also reduce the U.S. exports, c) a U.S. macroeconomic

recession discourages illegal laborers to come to the United States and increases U.S. exports because of lower domestic demand; while economic development in Mexico lowers the wage and income gap between the two countries and reduces the economic incentives for immigration and increases U.S. exports.

The theoretical model is implemented empirically by estimating a system of commodity and labor demand and supply functions for the United States and Mexico using the three-stage least square procedure. The model is estimated over the period 1989-2007. The empirical model also includes U.S. exports to the rest of the world. The estimated equations are used to run simulation analysis for the period 1994-2007 to quantify the effects of NAFTA, U.S. farm policy, immigration policy, and macroeconomics conditions on agricultural production, demand, labor supply, employment, illegal labor flow, and commodity trade. The results of the simulation analyses show trade liberalization under NAFTA increases the illegal labor flow to U.S. agriculture per year by about 37,000 workers and U.S. commodity exports by $157.46 billion per year at the end of NAFTA. In contrast, a decrease in U.S. farm subsidies contracts the illegal labor flow to U.S. agriculture and U.S. exports to Mexico. Increased spending on domestic enforcement and heightened border enforcement decrease the illegal immigrants by about 42,000 and 20,000, respectively, and reduce U.S. exports by 19.34 and 9.20 percent, respectively, in 2007. The results of these enforcements show a distinct tradeoff between a reduction in illegal labor flow and U.S. exports to Mexico because labor shortages adversely impact U.S. production and exports. The current U.S. economic downturn shows 2000 fewer Mexican laborers emigrate per year, while U.S. exports increases on average by 27.97 percent.

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Chapter 1. Introduction

On August 4, 1942, the United States and Mexico signed the Bracero Program, a formal agreement on seasonal labor, which provided thousands of seasonal jobs in U.S. agriculture to poor rural Mexicans who were experiencing economic hardships. In 1952, Congress established the Immigration and Nationality Act, combining all previous immigration and naturalization laws into one Act. The Bracero Program ended in 1964 which slowly paved the way for illegal immigration because of the end of legalized farm employment for Mexican workers in the United States and the returned workers then assisted the new migrants to cross the border through their established network in the United States.

Since illegal immigration was not a huge problem in the 1960s and 1970s, legislation addressed only the number of legal immigrants allowed to enter the United States. But, in the 1980s immigration became a national problem with extensive debate on issues such as providing public services to illegal immigrants, preventing the entry of unauthorized workers, and even legalizing these workers. The U.S. Congressional attempts to restrict the inflow of illegal immigrants started in the 1980s and the Immigration Reform and Control Act (IRCA) was passed in 1986. The Congressional goals of IRCA were to eliminate the stock of unauthorized workers and curb the influx of illegal immigrants. One of the key provisions of IRCA was to provide a one-time amnesty for illegal immigrants to apply for citizenship. But, this provision failed to eliminate the stock of illegal immigrants because a) only about half filed for amnesty and b) it created a future expectation of amnesty which caused more unauthorized entry. To stop the influx of immigrants, IRCA focused on border control and domestic enforcement

by increasing U.S.-Mexican border enforcement and imposing sanctions on employers of undocumented workers (U.S. Department of Agriculture, 2007a).

In spite of IRCA's amnesty provision and strengthened control measures, illegal immigration continued to rise. According to Martin (2007), about 12 million unauthorized immigrants currently reside in the United States, which is reaffirmed by many popular press reports. Furthermore, of the 1.3 million immigrants entering the country annually (Center for Immigration Studies, 2007), about 350,000-500,000 (26-44 percent) are undocumented and their numbers have grown faster in recent years (Hanson, 2006). This continued influx has lead to an extended congressional debate that began at the start of this decade. Several bills have been proposed by the House of Representatives, the Senate, and the White House, addressing issues including increased domestic and border enforcement[1], paths to citizenship[2], and guest-worker programs (Montgomery, 2006). These bills were not passed because of major disagreements among lawmakers on amnesty and guest-worker programs.

Since Congress did not pass any of the proposed bills, the government has resorted to stricter enforcement of IRCA's laws. As a result, work-place raids and border enforcements have dramatically increased in the recent years. The consequence of this increased enforcement have been felt throughout the labor-intensive agricultural sectors as labor shortages have dramatically increased, which resulted in higher cost production and led to increased retail costs. This problem illustrates the dire need for new legislation

[1] These include employer fines for hiring illegal immigrants; employee verification system for employers; border fences; and felony charges for anyone assisting, encouraging, directing, inducing illegal entrance, and for anyone attempting to enter or remaining illegally in the country (Montgomery, 2006).

[2] During the immigration debate the Senate was careful not to call this aspect of their legislation amnesty because of the many requirements (pay a fine and back taxes, pass an English proficiency test, pass background test, and should have lived continuously in the country for more than two years) to gain citizenship (Montgomery, 2006).

which would authorize a guest-worker program to alleviate agricultural labor shortage during peak harvest times.

However, the focus of the U.S. government's solutions to the illegal immigration quandary is to implement updated versions of old legislation (i.e., domestic and border enforcement, and amnesty). When implemented solely, these polices address only the symptoms of illegal immigration. To reach a practical long-term solution toward solving illegal immigration problem, the root causes must also be addressed. These root causes included differences in macroeconomic conditions (specifically, per capita income gap) between the two countries, increased labor shortages in U.S. agricultural production, adverse impacts of U.S. farm policies on Mexican agriculture, and distortive trade policies. Hence, the purpose of this thesis is to comprehensively study illegal immigration by examining the effects of changes in domestic and border enforcements, macroeconomics conditions in the host and the source country, trade distortions, and farm subsidies on the flow of illegal immigration.

The following sections discuss the effects of macroeconomics conditions in both the countries, domestic and border controls, labor shortages in agricultural production, trade distortions, and farm policies on illegal immigration. The penultimate section delineates the objectives of the thesis and the final section presents the organization of the thesis.

Macroeconomic Conditions

The macroeconomic environments of the United States and Mexico have dramatic impacts on the levels of both legal and illegal immigration. One of the major root causes of labor migration is economic inequality. For example, the 2000 per capita GDP based

on purchasing-power-parity measured in international dollars for the United States and Mexico were 34,139 and 9,038 respectively; by 2005 the per capita GDP increased to 41,197 and 10,615 (International Monetary Fund, 2007). These statistics indicate that the per capita GDP in the United States is more than triple that of Mexico. Furthermore, these statistics show that the per capita GDP grew 21 percent for the United States and 17 percent for Mexico between 2000 and 2005, i.e., the U.S. economy grew faster than that of Mexico's. The importance of income disparity for illegal immigration is aptly highlighted by Hanson (2006), who showed that a 10 percent decline in Mexican real wages leads to a 6-8 percent increase in border apprehensions. To truly address the immigration problem, these root causes must be at the forefront of the solution. That is, Mexico must make key political, social, and economic reforms to improve its economic conditions. In addition, the United States must not implement domestic policies (e.g., domestic farm subsidies) that hinder Mexico's ability to improve economically.

Because Mexican immigrants enter the United State to improve their wage earnings and because of close family and community ties -- the source of support for these people as they immigrate to the United States -- Mexicans remitted $20 billion of their earnings to Mexico in 2005 (Banco de Mexico, 2006). At 2.8 percent of Mexico's Gross Domestic Product, this is four times larger than Mexican agricultural exports and just less than oil export revenues, which makes labor export revenues very valuable to the Mexican economy (Boucher and Taylor, 2007 and International Monetary Fund, 2007). And of the total remittances sent home throughout Latin America, 40 percent goes to Mexico (International Monetary Fund, 2007), which not only makes the contribution of immigrants important to the U.S. economy but also to the Mexican economy.

In recent years, remittances have dropped off due to increases in raids and economic downturns in the United States, which decreased by 6.9 percent in July 2008 as compared to one year earlier (The Spokesman-Review, 2008). In addition, because of the dollar depreciation, buying power of the dollar in Mexico fell (losing about 8 percent of its value). Thus, macroeconomic conditions and economic downturns in the United States do play a critical role in slowing down the unauthorized entry.

Domestic and Border Enforcements

After the IRCA legislation came into effect in 1986, border enforcement and employer fines were the two main methods of reducing immigrant inflows. However, the government's main focus was on border enforcement, while employer sanctions were hardly enforced. Accordingly, funding for border enforcement has steadily increased over the past three decades. For example, in 2005 expenditures on border enforcement increased to 2.2 billion, a six-fold increase over the past 25 years (Hanson, 2006). Border apprehensions peaked at 1.3 million in 2000 when border patrol officer hours were at about 8,750,000. In 2003 officer hours increased to about 9,000,000; however border apprehensions declined to about 750,000. This indicates increased spending and border patrols do not directly correlate to a rise in border apprehensions.

Under IRCA, employer fines for hiring undocumented workers range from $250-$10,000 per person and up to 6 years in jail for repeat offenders. However, at the beginning of IRCA, domestic control was not seriously enforced. Also, following September 11, 2001, the U.S. Immigration and Customs Enforcement (ICE) decreased the number of man hours devoted to work-site inspection because monitoring critical infrastructure took priority (U.S. General Accounting Office, 2005). For example, from

1999 to 2003, the number of man hours decreased from 480,000 to 18,000. Furthermore, the number of employers paying fines of $5,000 or more fell from 15 in 1990 to 0 in 2004 (U.S. General Accounting Office, 2005).

But in recent years a major emphasis has also been placed on domestic enforcement. For example, only 25 employers were arrested for employing illegal immigrants in 2002, but 716 employers in several businesses were arrested nationwide in 2006 (Abraham and Ballou, 2007). Along with that, since congress has recently failed to pass any legislation to resolve the immigration quandary, ICE has drastically stepped up the number of raids on industries that employ large numbers of immigrant laborers. The agency arrested numerous undocumented workers and company officials in several states. Some of the major raids by ICE since 2006 are highlighted below:

- In December 2006, 1282 undocumented workers were arrested on immigration violations and 65 employees were charged with criminal violation at the Swift Company meatpacking plants (Hart, 2006).
- In July 2006, ICE raided The Garcia Labor Company, which provides temporary-worker contracts in Ohio, Pennsylvania, and Texas, and employs more than 1000 undocumented workers (Olivos-Kah, 2006).
- In 2007, ICE arrested 361 undocumented workers at the Michael Bianco Inc. in New Bedford, Massachusetts (Abraham and Ballou, 2007). This company held $92 million in military contracts from the Department of Defense to manufacture leather goods.
- On May 23, 2007, ICE arrested 136 people on identity theft, social security fraud and other immigration law violations in Springfield, Missouri, and also conduced

raids on 10 other smaller business in 2007 (U.S. Immigration and Customs. 2008a).

- On August 26, 2008, ICE arrested 594 illegal aliens at Howard Industries, Inc., an electric transformer manufacturing facility in Laurel, Mississippi, and carried out 16 other smaller raids throughout the first 8 months of 2008 (U.S. Immigration and Customs. 2008b).

The levels of illegal immigrants have recently plummeted; between August 2007 and May 2008, the number of unauthorized workers decreased by 11 percent or about 1.3 million immigrants (Camorota and Jensenius, 2008). This decline of illegal immigrants is about seven times larger than the reduction of immigrants due to domestic enforcement, which suggests that immigrants are migrating back to Mexico voluntarily at a greater rate than government deportations. Camorota and Jensenius conclude that the drop in illegal immigrants started before the economic downturns; therefore, the increased back-migration is because of employers hiring fewer illegal immigrants due to increased domestic enforcement. But, according to numerous press reports, advocates of immigrants, including Jeffrey Passel of the Pew Hispanic Center, have disputed Camorota and Jensunius' conclusions saying their finding overstate the reality.

Though domestic and border enforcements address the symptoms of illegal immigration, they are an important part of the immigration policy and the U.S. government devotes vast resources to prevent illegal entry into the country and the employment of illegal aliens. While these policies are effective at discouraging illegal immigrants from entering the country and finding jobs once in the country, these policies

do not reduce the economic disparities between the two countries, which is the root cause of illegal immigration.

Agricultural Labor Shortages

Bureaucratic delay and cumbersome paper work in implementing the guest-workers program and quota limits on legal immigration to the United States create a milieu for illegal entry (Hanson, 2006). The majority of immigrants enter the United States from Latin America, particularly from Mexico. There are about 10.5 million Mexican immigrants, which is about 31 percent of the total foreign-born population residing in the United States and accounts for about 10 percent of the population in Mexico (Hanson, 2006). According to the March 2002 Current Population Survey, 57 percent of illegal immigrants are from Mexico because of the close proximity and economic disparity between the two countries (U.S. Census Bureau, 2002). These immigrants are an important source of labor in many sectors of the U.S. economy, and particularly in the farming sectors because where laborers account for 24 percent of the total agricultural labor force, compared to only 17 percent in the cleaning sectors, 14 percent in the construction sectors, and 12 percent in the food preparation industries (Passel, 2006).

Government raids and border security exacerbated labor scarcity in many sectors of the economy, particularly in the agricultural sector. Numerous news media reports have highlighted the adverse impacts of labor shortages and farm outsourcing on farmers nationwide. For example, in 2006, roughly 20 percent of agricultural products were not harvested nationwide due to the unavailability of labor (The Wall Street Journal, 2007). The Rural Migration News provides details of labor shortages in every corner of the

United States and how crucial cultivational operations are adversely affected, which resulted in unharvested fruits and vegetables and heavy financial losses[3] (Rural Migration News, 2007). For example, Washington State produced a television commercial to lure farm workers by emphasizing better working conditions and higher wages to help meet the states labor demand (Gray, 2007). Nevertheless, agricultural labor shortage continued to persist throughout this decade, even though the unemployment rate for U.S. citizens over the age of 25 without a high school diploma averaged between 6.75 and 8.80 between 2000 and 2008 (Bureau of Labor Statistics, 2008). Many of these workers choose not to work in agriculture because of the seasonality and the hard back-breaking nature of the work.

As many crops went unharvested due to labor scarcity, agricultural commodity supply was reduced. Consequently, consumers face higher retail prices for commodities such as fruits and vegetables, as has been the case in the past two years. Without access to legal labor willing to perform labor intensive tasks, U.S. farmers will be unable to meet the nation's demand for fruits and vegetables, which will eventually lead to heavy reliance on foreign imports to provide many of these commodities (Nassif, 2008). These labor shortages have resulted in farm groups being one of the strongest allies for comprehensive immigration reform because many heavily rely on immigrant workers, legal and illegal, to perform many of their labor-intensive farm tasks (Johnson, 2007).

According to Lewis (2007), about 79.3 percent of the newly hired agricultural labor force originates from Mexico, and about 76 percent of these laborers are

[3]In 2006, farm labor shortages resulted in unharvested apples in Washington State, unharvested vegetables in Arizona and California, displaced laborers (resulting from fear of ICE raids) in New York vegetable and dairy farms, unharvested chili farms in New Mexico, and lack of work force in Florida strawberry farms.

unauthorized. Consequently, as the number of undocumented workers dwindles, farm operations are adversely affected and farmers are forced out of business or move their operations across the border to Mexico, particularly those with labor-intensive operations (Devadoss and Wang, 2008). Thus, outsourcing of farm operations to Mexico is already taking hold. For example, Nassif (2008), reports that about 25 large U.S. farms have relocated about 85,000 acres of production to Mexico. Furthermore, in Arizona, new state law intensifying penalties to employers for hiring illegal immigrants has resulted in many farmers moving their operations on Mexico where there is a steady supply of legal labor (Jordan, 2007). This is reaffirmed by Western Growers, a farm association that works to enhance the competitiveness and profitability of its members in California and Arizona, which has twelve agribusinesses currently operating in Mexico and employs about 11,000 workers (Preston, 2007). The president of this association reports that this phenomenon is occurring at an increasing rate.

Outsourcing of farm operations causes capital outflow and losses of jobs supporting agriculture. These phenomena underscore the need to revamp the current guest-worker program, which, according to farmers, is cumbersome and unusable due to complicated bureaucracy. Furthermore, a well-functioning guest-worker program can reduce the need for illegal immigration as migrant workers can return to Mexico and reenter the United States for agricultural employment.

NAFTA and Farm Policies

The Heckscher-Ohlin (H-O) theory asserts that countries will export goods that use their abundant factors intensively. Thus, the United States will specialize in production of and export capital-intensive goods to Mexico because the U.S. capital-labor

endowment ratio is relatively higher than that of Mexico. Mexico will specialize in the production of and export labor-intensive goods to the United States because the Mexican labor-capital endowment ratio is relatively higher than that of the United States. In addition, the H-O model predicts complete free trade will equalize the output prices in both countries. Furthermore, according to the factor-price equalization theorem, free trade causes Mexico's wage-rental ratio to increase and the U.S. wage-rental ratio to decrease, and wage-rental ratios in both countries will eventually be equal. These combined effects will improve the economic conditions of the Mexican labor force. Mexico and the United States took an important step toward free trade and a long-term solution for illegal immigration when NAFTA was implemented in 1994. Through the elimination of trade barriers, Mexico will more aptly benefit from their abundant labor supply by producing labor-intensive products at a low cost and exporting to the United States. Similarly, the United States is relatively capital abundant compared to Mexico and will benefit from producing capital-intensive products at low cost and exporting to Mexico. Through specialization and trade, welfare in both countries will increase, which improves the economic status of Mexico and reduces economic incentives for Mexicans to illegally immigrate to the United States.

Though NAFTA was a crucial step toward free trade, it did not remove all trade distortions, and domestic subsides were not reduced. By slowly eliminating Mexican tariffs on agricultural imports, but not covering government subsidies[4] given to U.S. producers, U.S. farm policies undermine the effectiveness of free trade in agriculture. A comparison of the budgets of the U.S. Department of Agriculture (USDA) and the

[4] In 2000, the U.S. government paid $10.1 billion in subsidies to corn farmers alone, which is ten times the entire agricultural budget in Mexico (Fanjul and Fraser, 2003).

Secretariat of Agriculture, Livestock, Rural Development, Fishing, and Food (SAGARPA), Mexico's equivalent to USDA, substantiates two observations: 1) agricultural trade between the United States and Mexico is far from free trade and 2) the U.S. budget and level of farm support is far greater than that of Mexico. For example, the United States, through the 2002 Farm Act, averaged about $16 billion in farm program payment between 2002 and 2007, and these payments peaked at over $30 billion in 2000 because of low crop prices in 1999 and 2000 (U.S. Department of Agriculture, 2008d). In contrast, SAGARPA, spend only about $1.3 billion or 35 percent of its budget allocated to Program of Direct Support of the Countryside (U.S. Department of Agriculture, 2008d). Furthermore, in 2004, U.S. farmers received about 8 times as much support as the entire Program of Direct Support of the Countryside budget. These data clearly show that free trade policies implemented under NAFTA are undermined by farm policies, particularly in the United States.

Another problem is that U.S. farm subsidies cause overproduction in agriculture. The excess supply is dumped in the Mexican market, driving down agricultural commodity prices. Farming is a way of life for Mexicans and is a very important source of employment, and therefore, the dumping of surplus production affects a large percentage of the population. For example, 27 percent of Mexico's work force is employed in the farm sector, generating about 7 percent of GDP (Rural Migration News, 2007). Mexican farmers cannot compete with the low-priced U.S. commodities and are forced out of business. These farmers and the laborers are displaced, and because they have fewer employment options in Mexico, they illegally immigrate to the United States. Thus, the elimination of U.S. farm supports will allow free trade to benefit Mexico's farm

sector, which will result in lower unemployment and higher income for Mexican farmers. This will improve their economic well-being and decrease incentives for illegal immigration.

As explained above, the labor market can be integrated in both countries through either free migration flows or free trade and investment flows accompanied by economic, political, social, and bureaucratic reforms in Mexico. Since free migration flows are not a possibility, the latter policies are the only options to effectively curb the Mexican migration. Then, Mexicans will not have economic incentives to migrate to the United States.

Objectives

The purpose of this study is to examine theoretically through trade and migration theory and empirically through econometric analysis how government polices and economic conditions affect illegal immigration and agricultural trade between the United States and Mexico. The specific objectives of this thesis are:

1. Examine the effects of macroeconomic conditions, particularly income growth in Mexico and the United States, on incentives for illegal immigration.
2. Analyze the effects of border and domestic enforcement policies on illegal immigration.
3. Consider how U.S. farm subsidy policies have affected the level of illegal immigration and commodity trade.
4. Analyze the effect of NAFTA and trade liberalization on the level of illegal immigration and agricultural trade.

5. Examine the effect of an increase in the Mexican labor endowment on the level of illegal immigration and agricultural trade.
6. Draw policy implications and provide recommendations for solving the illegal immigration problem and promoting freer trade.

Organization

The rest of the thesis is organized as follows. The second chapter reviews literature on the important theoretical and empirical studies encompassing illegal immigration. The third chapter develops a theoretical model comprised of commodity trade and cross-border labor migration to study the interrelationship between trade and illegal immigration and the impacts of policies of one sector on the other sector. The fourth chapter presents the data and sources, econometrically estimates supply and demand equations for agriculture and farm labor for both the United States and Mexico, provides evidence to the theoretical findings, and quantifies the effects of macroeconomic conditions, immigration policies, agricultural policies, and trade policies. The final chapter concludes the thesis and offers policy recommendations for solving immigration problems and enhancing commodity trade.

Chapter 2. Literature Review: Theoretical and Empirical

A voluminous literature on illegal immigration, both theoretical and empirical, has evolved since 1980s. The theoretical literature has taken a restricted view on a large array of topics by studying only labor displacement and wage effects, border and domestic control, and tariffs and immigration. The empirical literature quantified how the border enforcement impacts the immigrant flow and labor displacement and wage effects. This chapter critically reviews past studies, identifies the fertile areas of research, elaborates on the difference between past studies and the current work, and summarizes the contributions of this study to the existing literature.

Past Theoretical Studies

The theoretical study of illegal immigration began as the Immigration Reform and Control Act (IRCA) was passed into law. These early studies offer insight into the effects of an increase in illegal immigration on input prices; wage rates for skilled, unskilled and illegal labor; production; output price ratios; and the labor markets. Other issues studied are the effects of increased border security, employer sanction, and amnesty.

The first three studies reviewed (Ethier (1986a), Ethier (1986b), and Bond and Chen (1987)) build the framework for studying unauthorized entry of unskilled labor. These studies analyze the effects of border enforcement and domestic controls on illegal immigrants and the host country. Ethier (1986a) addresses illegal immigration from the host-country prospective. In this seminal paper on illegal immigration, Ethier observes that international migration is not extensively studied in the literature because it is subsumed in capital theory. He identifies three parameters that are important for any

economic study of migration. First, whether the migration is temporary or permanent has important implications for both the source country and the host country. Second, the type of immigrant labor (skilled or unskilled) also has economic significance for both countries because of brain drain of skilled labor in the source country and sectoral reallocation arising from unskilled labor migration. Third, the legal status of the immigrants is also important because permanent residents remit their earnings less frequently, and also the host country is the primary restrictor when labor inflows are illegal. Ethier focuses on the illegal migration of unskilled labor because the migration of skilled labor is rarely restricted and also studied by others in such areas as brain drain and international capital flow.

Ethier models two types of labor restrictions -- border enforcement and internal enforcement -- to stem illegal immigration. He first studies the effects of an increase in funding for this policy on fiscal issues, income issues, and the bundling problem (wage or employment rate of legal unskilled workers tied to those of illegal workers). To finance this policy, illegal immigrants, legal immigrants, and skilled workers are taxed. Accordingly, illegal immigrants contribute to the tax base along with all other worker groups that support the border enforcement policy. His analysis shows national income is negatively affected by an increase in border enforcement. Since this effect is negative, the country must minimize the costs of the policy implemented. Furthermore, the bundling problem cannot be addressed strictly through border security, and thus an exogenous change in the level of illegal immigration affects both legal and illegal wage and employment rates.

Ethier's analysis of internal enforcement shows that domestic unskilled workers benefit if employers can distinguish between legal and illegal unskilled workers. If no distinction can be made, this policy hurts all unskilled laborers. Thus, domestic enforcement forces employers to distinguish illegal immigrants from their legal counterparts. The cost-minimizing method of reducing illegal immigration is a mixture of both border enforcement policy and internal enforcement.

In his follow-up paper, Ethier (1986b) considers three instruments used for reducing illegal immigration levels: a) border enforcement, b) employer sanctions, and c) amnesty.

If border enforcement is strictly implemented, then illegal immigrants are indistinguishable from legal labor, which implies an equal wage rate for all unskilled labor. Therefore, the wage rate for all laborers is tied to the probability of illegal laborers entering the country, and this probability is based on the level of enforcement at the border. Ethier shows that an increase in border enforcement increases the wages paid to unskilled workers, decreases the level of illegal immigrants, and decreases wages for skilled workers. Furthermore, if rigid unskilled wages are added to the model, the unskilled labor market does not clear, resulting in unemployment; therefore, employment occurs via random selection from the unskilled labor pool and rate of employment determines the level of illegal immigration. Ethier maximizes national income by determining the optimal level for border enforcement. For a marginal change in border enforcement, national income will fall given the market clearing condition. But if a minimum wage exists in the unskilled labor market, this marginal change in border enforcement will increase the employment rate of unskilled workers, redistributing jobs

from illegal immigrants to legal workers, potentially having a positive national income effect.

Employer sanctions have two effects on illegal immigrants. First, acting independently from border enforcement, sanctions discourage illegal immigrants due to the decrease in the employment prospect. Second, employers no longer consider illegal employees as a perfect substitute for legal employees. Therefore, the distinction between the legal and illegal labor groups is made by increasing the cost of employing the latter. The probability of detection for hiring illegal laborers times the fine paid for hiring them accounts for this cost.

Ethier models amnesty by a change in the number of legal workers but not by a change in illegal immigration. Amnesty creates future expectations of legalization and can lead to more illegal immigrant entry into the country, and therefore can have an opposite effect (additional illegal immigrants) than what is intended.

Bond and Chen (1987) extend Ethier's work by using a two-country model to determine the optimal level of enforcement to maximize the host country's welfare and also study the effect of capital mobility on immigration and national welfare. In the model, the host and source country each produce one good using capital and labor under constant returns to scale. Barriers exist to prevent the unrestricted flow of capital and labor, and technologies differ between countries, resulting in a greater wage rate in the host country than in the source country. In the host country, levels of capital, unskilled labor, and illegal immigrants are chosen to minimize the cost of production; and the input demand functions are derived for capital and labor. In the source country, levels of unskilled labor and capital are chosen to minimize the cost of production, and the input

demand functions are derived for capital and labor. In the host country, the domestic wage rate is equal to the illegal wage rate plus the probability of detection[5] times the fine for employing illegal labor. Using the labor demand from the first order conditions and the labor market equilibrium in both countries, they show that an increase in enforcement expenditure causes wages in the source country to decrease, wages in the host country to increase, and the illegal immigration flow decreases.

Next, Bond and Chen consider the case where employers cannot distinguish between legal workers and illegal workers. In this case, all workers earn the same wage rate and the wage linkage equation now incorporates the ratio of illegal workers to the total workers. If increases in enforcement expenditures positively affect the host country's welfare, then a) the host country must be large enough to affect the source country's wages, and b) the marginal expenditure on enforcement must be sufficiently low.

Finally, Bond and Chen examine the effect of capital mobility on illegal immigration. In this case they assume same technologies in both countries are equal and the host country taxes capital earnings from the source country. They conduct a comparative statics analysis to study the effect of domestic enforcement on illegal immigrant inflow, capital outflow, wage and rental rates using the two labor market equilibriums, capital flows, and wage and rental rate linkages equations. It is shown that the capital outflow has negative effects on the national welfare.

The next two studies by Djajic move away from the study of domestic and border controls and focuses on the link between illegal immigration, wage rate, and the labor

[5] This probability is a function of the level of enforcement expenditures allocated by the government.

endowment of the host country. Djajic (1987) uses a two-country, one-good model to analyze the effect of an increase in the source country's labor endowment, a decline in the host country's minimum wage, an increase in host country's capital endowment, and an increase in the discrimination rate toward illegal immigrants on the level of illegal immigration and enforcement rate in a dynamic setting.

The output is produced using capital and labor under constant returns to scale. The host country is capital abundant and the source country is labor abundant. Capital is mobile across countries, but labor restrictions exist between countries. A minimum wage rate is set above the equilibrium wage rate in both countries; as a result, unemployment arises and employment occurs through random selection from the unskilled labor pool. Djajic defines each country's expected wage rate using the minimum wage and the probability of finding a job[6]; but, illegal immigrants earn the expected wage in the host country times the probability of finding a job times a fraction to account for problems associated with illegal status. Therefore, the dynamic change in illegal immigration[7] is equal to the expected wage rate of illegal immigrants in the host country minus the expected wage rate in the source country minus the cost of illegally migrating. Further, the dynamic change in border enforcement[8] is equal to the target level of spending minus the actual level of spending. The target level of spending is a function of the stock of immigrant labor and the probability of not finding a job in the host country. In turn, the

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[6] The probability of finding a job in the host (source) country is endogenously determined by the stock of illegal labor in the host country and exogenously by the host (source) country's minimum wage and capital and labor stock.

[7] $\dot{\lambda} = \frac{d\lambda}{dt}$, where λ represents the stock of migrant labor in the host country and *t* is time.

[8] $\dot{E} = \frac{dE}{dt}$, where E represents the level enforcement spending by the government.

probability of finding a job in the host country is endogenously determined by the stock of illegal labor in the host country where the minimum wage rate, labor, and capital endowments are exogenous variables. In equilibrium, these two dynamic changes determine the level of enforcement and labor stock.

If the source country's labor endowment increases (i.e., population growth is greater than demand for labor), then labor supply in the host country also increases, thus increasing the level of enforcement spending and the rate of unemployment in the host country. If the minimum wage in the host country declines and if the demand for labor in the host country is inelastic, then the effect on the level of enforcement spending depends on whether the decline in unemployment or the increase in the stock of immigrant labor has a greater impact. However, if demand for labor in the host country is elastic, the enforcement rate declines.

Further, Djajic found that if the host country's capital endowment increases, the stock of immigrants increases, but the enforcement level increases or decreases based on the elasticity of the target enforcement rate spending with respect to employment divided by the elasticity of the target enforcement rate spending with respect to the level of immigrants. And, if there is an increase in the discrimination experienced by immigrants, then the equilibrium value of both the rate of illegal immigration and the rate of border enforcement decreases.

In a second study, Djajic (1997) examines the effect an exogenous increase in illegal immigrants has on wages of three classes of workers, resource allocation, and commodity prices in the short- and long-run. The paper begins with a discussion of the causes of illegal immigration, immigrants' occupations, and employer incentives for

hiring illegal immigrants, and the negative and positive effects of illegal immigrants. The causes of illegal immigration warrant no further analysis because of previous discussion. Illegal laborers occupy labor-intensive agricultural, hotel and restaurant trades, textiles, and construction employment. Benefits to employers include evasion of payroll taxes, payment to employees by piece rate, minimizing trade unions constraints, avoiding labor restriction, and ease of layoffs. The negative effects include a decrease in the rate of structural adjustment and technological progress, idle non-underground sectors due to capital reallocation, and use of the host country's social programs without payment into the programs. Positive effects include relief from labor market shortage in low-skilled labor markets, increased consumer base resulting in greater market expansions, more labor to textiles and agricultural markets, and reduced costs to consumers.

Three sectors considered in Djajic's model are: 1) The underground sector produces an intermediate input strictly used in production of a final good in a formal sector in the economy. The intermediate good is produced (in case A) utilizing illegal immigrants, native labor, and capital, and (in case B) when the stock of illegal labor stock is large enough relative to the native labor stock, strictly illegal immigrant labor and capital are used. 2) The skilled sector produces a final good employing part of the intermediate good, skilled labor, and capital. 3) The unskilled sector produces a different final good and requires only capital and unskilled labor. He develops wage linkages for the underground sector and the unskilled sector, and the unskilled sector and the skilled sector, and furthermore, expresses equilibrium conditions for wages, rental rates, and price ratios.

Next, Djajic examines the consequences of an increase of illegal immigration on wages and outputs. In the short-run, this increase has positive wage effects for both skilled and unskilled laborers in case B, negative wage effects for unskilled laborers in case A, and negative wage effects for illegal laborers in both cases. In the long-run, there is no wage effect for native and illegal workers in case A, but all native workers incur an increase in real wages while illegal worker experience a decrease in wages in case B. For cases A and B and in the short- and long-run, there is an increase in output for all sectors.

Djajic's study continues by analyzing the effects of stricter government enforcement of employer sanctions. If the tougher sanctions affect only illegal workers or if illegal workers are only employed in the underground sector (case B), then illegal labor wages decrease due to the higher cost of hiring. In case A, the real wages of all native workers decline due to increases in the cost of hiring both native and illegal workers employed in the underground sector. Thus, such a policy is ineffective at increasing the real income of native workers and negatively affects the output of the skilled and intermediate sectors.

Amnesty is the last policy tool analyzed in Djajic's study. In case A, the only effect of the change in policy is an increase in the native stock of labor. In case B, a redistribution of income from native workers to illegal immigrants transpires and a reduction of output for the skilled and underground sector occurs.

Bandyopadhyay and Bandyopadhyay (1998) examine illegal immigration from the source country perspective and are the first to incorporate trade distortions such as tariffs into their model. They recognize that for detailed analysis of illegal immigration, it is important to study the source country effects. In their two-country model, they

consider small country assumptions for a source country with three sectors: agricultural, manufacturing, and high-tech. The agricultural good is produced using unskilled labor and sector-specific land. The manufacturing good is produced using unskilled labor and capital. The high-tech good is produced using capital and sector specific-skilled labor. The unskilled labor is mobile between the two sectors and it can illegally emigrate from the source to the host country. Capital used in the manufacturing and high-tech sectors is mobile between the two sectors but not across the border. The high-tech and the agricultural sectors are protected by ad-valorem tariffs.

Bandyopadhyay and Bandyopadhyay consider only one sector (manufacturing good which is produced using unskilled labor and capital) for the host country because the focus of their study is on the supply side of illegal immigration. They assume that the host country is small in the capital market, and thus the rental rate is exogenous. As a result of the simultaneous solution of the first order conditions and the fixed rental rate, the wage rate for labor is also fixed in the host country.

Bandyopadhyay and Bandyopadhyay utilize two wage linkage equations to complete the model. First, the source country's unskilled wage rate is linked to the host country's illegal wage rate by taking into account the probability of apprehension during a border crossing, time wasted in attempting to migrate, and time spent finding a job. Second, an equation links the illegal wage rate to the unskilled wage rate in the host country: the unskilled wage rate is equal to the illegal wage rate plus the probability of detecting employment of illegal immigrants times the sanction.

Bandyopadhyay and Bandyopadhyay consider the effect of tariffs and border enforcement policy. If the source country implements a policy reducing the tariff on the

agricultural good, illegal immigration to the host country increases. The rationale for this result is that the agricultural sector shrinks and releases labor, but the manufacturing sector cannot absorb all the released labor, forcing labor to immigrate illegally. If the source country implements a policy reducing the tariff in the high-tech sector, illegal immigration decreases because for this result is that the high-tech sector shrinks and releases capital to the manufacturing sector, which increases its demand for labor, increasing the wages to unskilled workers and causing less incentive for unskilled workers to illegally immigrate. Also, an increase in border security reduces illegal immigration.

Gaytán-Fregoso and Lahiri (2000) extend the two-country general equilibrium analysis of illegal immigration by examining the allocation effects of border enforcement and domestic controls. They define labor markets for then north (host country) and south (source country). In the north, skilled labor produces private goods and enforces the migration policies, and native and illegal labor comprises the unskilled labor force. In the south, the supply of labor is equal to its country's total labor endowment minus the illegal migrants, no distinction is made between skilled and unskilled labor, but illegal immigrants join the unskilled labor pool in the north. Next, they define the probability of successfully crossing the border and the probability of evading domestic enforcement, and budget constraints for each household, repatriation equilibrium, and migration equilibrium.

Through comparative statics analysis, Gaytán-Fregoso and Lahiri show that the share of expenditures for domestic enforcement is between zero and one whether repatriation is exogenous or endogenous. This indicates that the cost-minimizing level of

enforcement is not strictly achieved through domestic enforcement. Furthermore, it is shown that welfare in the north (south) increases (decreases), resulting from a deviation from an initial allocation of resources between border control and domestic enforcement.

Bandyopadhyay (2006) readdresses the effects of changes in tariff policies on illegal immigration by employing a small-union Meade model. Many steps have been taken to liberalize trade in the past, for example, NAFTA has reduced trade barriers between the United States and Mexico. In many developed countries, despite government restrictions on illegal entry, illegal immigration continues due to large wage differences between developed and developing countries. Using a general-equilibrium model, he analyzes the best policy combination (internal enforcement, border enforcement, and the second-best import tariff) under a pre-determined and variable illegal immigration level, which maximizes welfare.

In the context of the model, Bandyopadhyay considers three trading nations A, B, and C. Nation A and B produce and consume good 1 and 2 while only consuming good 3. Nation A exports good 1, B exports good 2, while C exports good 3, and each nation imports the two goods it does not export. International prices are determined by C, but A and B can influence their domestic prices through the use of import tariffs. Nations A and B implement tariffs on their import goods and trade liberalization occurs through a reduction in the tariff rate A imposes on its import goods. Illegal immigration occurs between A and B because A has a greater wage rate then B. The restriction of illegal immigration occurs via border and internal enforcement by country A. Next, he expresses an equation linking the wages in B to A, as well as an equation linking illegal wage rate in A to the legal wage rate and a expenditure-revenue equation. Through the

use of these equations, he expresses illegal immigration as a function of internal and external border enforcement and the tariffs rates A imposes on its import goods.

When pre-determined immigration levels are considered, Bandyopadhyay's results show if country A liberalizes tariff on imports from B, welfare of A increases if A's initial tariff rate exceeds its second-best tariff rate. When variable immigration levels are considered, his results indicate a tariff on good 2 calls for a positive level of border enforcement.

Devadoss and Wang (2008) examine the effect of a decline in labor due to deportation of illegal immigrants on production inputs, factor prices, inter-country factor mobility, and output prices. The authors utilize a two-sector (agricultural and manufacturing), two-factor (labor and capital), and two-country (developed and developing) model for the theoretical analysis. The production functions for each good are constant returns to scale, and capital is immobile across sectors but mobile across countries, whereas labor is mobile across sectors but inter-country mobility is limited due to border security.[9]

Using the first-order conditions and factor-market equilibrium, Devadoss and Wang conduct comparative statics analysis by utilizing Cramer's rule. The analysis shows a decline in total labor due to host-country deportations resulting in a decrease (increase) in labor and capital in both the agricultural and manufacturing sectors in the host (source) country. Wage rates in the host country increase as a result of deportation because the positive wage effect of deportation is larger than the negative wage effect of capital outflow. Wage rates in the source country decrease because the negative wage

[9] Rental rates are equalized across countries but not across sectors, whereas, wages are equal between sectors but not between countries.

effect of returning workers is again greater than the positive effect of capital inflow. Rental rates for each sector increase because the negative effect of outmigration is less than the positive capital outflow effect.

Next, Devadoss and Wang examine the corollary of output prices resulting from inter-country factor mobility, production changes, and factor price changes. In the case where both countries specialize (host country produces only the manufacturing and the source country produces only agricultural good), the host country decreases its demand for the agricultural goods, thus decreasing its excess demand and lowering the price for these goods, whereas the source country increases its demand for the manufacturing good, thus increasing the price for these good. Thus the relative prices[10] change in favor of the host country. If both countries produce both commodities, the effect of outmigration and endogenous capital movement on terms of trade is ambiguous.

This thesis will incorporate the issues discussed in this section into the theoretical model and further extend the understanding of the cause of illegal immigration by considering additional key issues such as income growth and farm supports.

Past Empirical Studies

This section of the literature review focuses on empirical studies conducted by economists.[11] Torok and Huffman (1986) are the first to address the interrelationship between international trade in final commodities and inputs such as illegal immigration.

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[10]The price ratio is $P = \frac{P_1}{P_2}$, where P_1 is the price of agricultural goods and P_2 is the price of manufacturing goods.

[11]However, there is a vast amount of research conducted by non-economists studying issues such as the origin of immigration; the financing of immigrants, remittance, family and community networks to assist the border crossing; and finding employment for illegal immigrants. Some of these studies are Cornelius, 1992, Durand, et al., 1996, Durand and Massey, 1992, Durand, et al., 2001, Durand, et al., 1996, Massey, et al., 1994, Massey, et al., 1994.

They develop an econometric model that integrates U.S.-Mexican winter tomato trade and illegal Mexican immigration. Under the U.S. Immigration Act of 1965, an annual quota of 120,000 legal immigrants was established, giving rise to illegal immigration from Mexico to the United States. Both the United States and Mexico produce fresh market winter tomatoes with low-skilled labor, but the United States also uses low-skilled Mexican workers as illegal labor in tomato production. They considered winter tomato production for their study because this single output is easier to work with than multiple outputs, and winter tomatoes grow only in Florida and the Mexican state of Sinaloa.

Torok and Huffman use monthly data from December to June 1965-1979 to estimate seven equations: 1) U.S. excess demand for fresh market tomatoes, 2) Mexico's excess supply of fresh market tomatoes, 3) U.S. demand for illegal Mexican aliens, 4) Mexico's excess supply of illegal Mexican aliens, 5) the U.S.-Mexican tomato price relationship, 6) the U.S.-Mexico agricultural wage relationship, and 7) the U.S. INS (Immigration and Naturalization Service) apprehension effort. This data range is considered because a) in 1965, the United States ended trade with Cuba, resulting in Mexico becoming the sole trading partner in tomatoes, b) the Bracero Program was abolished in 1964, and c) the legal immigration quota became law in 1965. Torko and Huffman state that the advantage of their model is that it integrates trade in labor and a labor-intensive commodity, such as winter fresh tomatoes, without using a complex general equilibrium model.

Torok and Huffman's results show economic conditions in both countries affect the level of illegal immigration from Mexico to the United States. The factors that push Mexican labor into the United States are an increase in the Mexican population and

unemployment rate, and a decrease in Mexican real wages and the real price on fresh market tomatoes. The factors that pull labor into the United States are a decrease in the U.S. population and unemployment rate, and an increase in the real price of tomatoes in Florida. Increasing the border patrol has small direct effect on immigrant apprehension, but there is a greater indirect effect in the change in Florida agriculture wage rate.

The Hanson and Spilimbergo (1999) study differs from the previous study in that they empirically examine illegal immigration flows from Mexico to the United States by considering changes in the real wage rates for both countries and the effects of changes in border enforcement. Income earning differences and relief from economic downturns in Mexico create an environment for Mexicans to migrate (both legal and illegal) to the United States. They observe that data pertaining to the level of illegal immigration is not available, and therefore, they study through the proxy variable, border apprehensions. The INS database provides data on border apprehensions for the period 1963-1996. This period includes the start of illegal immigration from Mexico at the end of the Bracero Program in 1964. They view border enforcement as an endogenous variable because border resources may increase, if Mexico's economy weakens, to counteract the increases in attempted border crossings.

In developing the empirical model, Hanson and Spilimbergo consider migration theory which considers migration as an investment decision. The decision to migrate is dependent on the real wage rate in Mexico and the United States, and the probability of being detected at the border. Also included in the migration equation are variables to take into account the future changes in wages and border detection, and individual characteristics influencing the cost of migration. The number of migrants attempting to

cross the border and the probability of being apprehended define a function for border apprehensions. The total expenditures allocated to border enforcement and total number of migrants illegally crossing defines the probability of being apprehended. A reduced-form model is required because the probability of being apprehended and total number of migrants attempting to illegally migrate are not observed.

The final set of variables used in the estimation of border apprehensions are border enforcement hours and spending, Mexican real wage, U.S. real wage, U.S. peso-wage, time trend, a monthly dummy variable to control for seasonality in apprehensions, U.S. unemployment rate, Mexican real minimum wage, U.S. real minimum wage, and dummy variables to account for the 1987 Immigration and Reform Control Act and the 1990 Immigration Act. As predicted by the theoretical analysis, the elasticity of border apprehensions with respect to border enforcement is positive. The results show a negative correlation for the Mexican real wage and a positive correlation for the U.S. real wage rate. The border apprehension to Mexican real wage elasticity is -0.64 to -0.86. The purchasing power of U.S. wages in terms of pesos is significant, showing illegal immigrants maintain links to Mexico through remittances and temporary outmigration. They conclude policies that reduce the wage gap between the United States and Mexico, such as NAFTA, reduce the flow of illegal immigrants. Their findings also show that the U.S.-Mexican labor markets are tightly linked, because in the same month, a drop in the Mexican wage rates results in increase border apprehensions.

Ferri, Gómez-Plana, and Martín-Montaner (2006) assess the effects illegal North-African immigration into Spain in the 1990s had on production and welfare using a computable general equilibrium (CGE) model. They analyze two situations: 1) an

increase in illegal immigration, and 2) an increase in legal immigrants from outside countries. An evaluation of both scenarios offers insight into the effects of an amnesty policy.

This is a notable study because immigration has increased in the majority of Organization of Economic Cooperation and Development countries since the early 1980s. The foreign labor entry into the host country increases labor endowment, allowing for greater consumptions opportunities, and in turn, augmenting productivity, incomes, consumption, and social welfare. According to neo-classical trade theory, these changes do not occur without changes in factor prices, the size of the productive sectors, and the income distribution. In addition, when considering a large-scale, more realistic model, the direction of these changes becomes more unclear.

Ferri, Gómez-Plana, and Martín-Montaner consider a more realistic model by incorporating three factors (skilled labor, unskilled labor, and capital), eleven sectors, twelve household income brackets, a public sector, and market imperfections (market imperfections include trade unions, remittances, or taxes on labor). Two considerations in the development of the model arise surrounding the legal status and type of job illegal immigrants acquire: 1) illegal or temporary immigrants tend remit a large portion of their income to the source country, and 2) the majority of illegal immigrants do not pay income taxes or make social contributions. As a result of remittances, illegal immigrant income flow within the host country is negligible. On the other hand, immigrant labor tends to complement skilled labor and capital while acting as a substitute for unskilled labor.

Ferri, Gómez-Plana, and Martín-Montaner's focus is on the host country; therefore, they include a simplified rest-of-the-world to complete the model. The application of perfect competition assumptions for capital and each good imply no firm has market power and prices are determined through equilibrium, creating an environment in which no firm earns unusually large profits. Two labor market distortions are modeled: 1) employees have labor market power, and 2) distinct wage rates for legal and illegal unskilled laborers. With these distortions, they model equations representing zero-profit firms, equilibrium conditions, and macroeconomic constraints.

The results of Ferri, Gómez-Plana, and Martín-Montaner's study have important implications. All types of immigration (e.g., legal, illegal, temporary, permanent, skilled, or unskilled labor) have positive effects on GDP and total employment. Imposing restriction on any of these labor groups will hurt the economy, and legalization of illegal immigrants increases total unskilled employment which benefits domestic skilled workers and immigrants. Furthermore, the study shows that domestic and foreign workers are not perfect substitutes. The results have five significant policy implications. First, market power instituted through trade unions decreases the positive economic effects of immigration. Second, legalization results in decreased levels of remittances[12] and increased levels of consumptions and investments or savings. Third, legalization has different effects on various production sectors. Fourth, legalization has minimal effects on the welfare of each individual household. Fifth, the positive effects of each household's welfare are larger when trade unions have minimal power.

[12] Families that received a remittance either immigrate themselves or no longer receive funding after legalizations.

Hanson (2006) underscores major findings in recent literature addressing illegal immigration. The section pertaining to the estimation of the illegal immigration stocks is reviewed. Three main methods offer insight into the illegal immigration population: (a) the difference between the total immigrant population where the legal immigrant population offers the most common method of estimation; (b) macro-level surveys offer insight into the legal status of individual immigrants, which is not possible through the first method; and (c) the U.S. government collects border patrol data on the number of unauthorized immigrants attempting to enter the United States through its borders.

When the government conducts population surveys, no inquires are made about the legal status of the participant. As a result, the total foreign-born population is not equal to the unauthorized population, and illegal entry is the difference between the two populations. The total foreign-born population is comprised of permanent legal over relevant years[13] and the legal temporary immigrants. For simplistic purposes, he combines the permanent and temporary legal residents into total legal foreign born. The total foreign-born population is always underestimated; therefore, the measured foreign born is less than the actual foreign born. But the measurement of the legal immigrant population is done with greater accuracy because records are readily available on the number of visas issued in a given year. Undercount rates exist for each category, ranging from 10-25 percent for the total population and 2-5 percent for legal immigrants.

The Mexican Migration Project is the most utilized survey inquiring into the demographics of the immigrant population. Immigrants returning to Mexico are surveyed in the winter months, the most likely time for their return. The survey began in

[13] The permanent legal population is discounted by the mortality rate and immigration rate.

1982 and was administered a couple of times through the late 1990s. Mexicans as a whole are not represented by the survey because the survey accounts for rural communities with high migration probabilities. Furthermore, due to the location of the survey, households that have entirely migrated to the United States are excluded from the survey. Additional surveys include the Legalized Persons Survey. For this project, two surveys were issued first in 1989 and a follow-up survey in 1992. This survey targeted immigrants which were granted legal residency under the IRCA amnesty provision to cover the demographics of the previously illegal population.

Securing the U.S.-Mexican border is a Department of Homeland Security responsibility and this task is performed by border patrol officers assigned to the "linewatch" duty. Their job is to maintain and monitor surveillance equipment and to staff check points at major border crossings. Because the vast majority of illegal immigrants enter the United States by crossing the U.S.-Mexican border, the U.S. government devotes a substantial amount of resources to securing the border. But despite a six-fold increase in resources between 1980 and 2004, illegal immigration continues to rise, resulting in an increase in border apprehensions. Border apprehensions offer an inaccurate approximation of illegal immigrant levels in the country because illegal immigrants who voluntarily return to Mexico are not processed by the justice system and an immigrant may be caught several times in a month attempting to enter illegally.

In conclusion, Hanson shows that no exact estimates of illegal immigrants exist for medium or long intervals because the estimates of the illegal immigration population using the difference between the total population and legal population only exist for a few specific years and the border apprehensions do not offer accurate estimates of the illegal

population. The U.S. government is leery of asking the legal status of immigrants for fear that illegal immigrants will not participate in the survey.

Devadoss and Luckstead (2008) show the displacement, wage, and the distributional effects of the addition of 100 new immigrants into the California vegetable market. The authors show that immigrant laborers, contribute greatly to the production of vegetables in California, and without these laborers the cost of production would dramatically increase. The analysis utilizes the California agricultural labor market in this study because it is the largest agricultural labor market in the United States, accounting for 36 percent of all agricultural employment. Furthermore, because 95 percent of the laborers employed are foreign born, this labor market is representative of all labor-intensive agricultural production.

The study shows that for an addition of 100 immigrant laborers, native employment decreases by only 1.23 - 3.61 laborers, which shows that the concern that native workers are losing their jobs to immigrant workers is unjustifiable. This result stands because the percentage of native workers in labor-intensive agricultural production is very low. For native workers, wages decline inconsequently by 0.0003 percent and in the worst case scenario by 0.0006 percent, indicating wage reduction due to an increase in immigrant workers is very small. The last result shows for an increase of 100 immigrant laborers, the value added per worker to vegetable production is $23,458.[14] There are about 66,000 workers employed in vegetable production; therefore, these workers contribute $1.55 billion to the total direct value of production in a year.

[14] The value added accounts for the displacement effect of domestic workers and the complementary effect on material inputs, capital, and skilled workers.

The conclusions from these results lead to a strong policy recommendation. Field jobs are predominantly performed by undocumented workers. Therefore, border crack-down and work-place raids result in unharvested crops, adverse effects on production and profitability for labor-intensive farm production, and in extreme cases, farmers have moved their operations to Mexico to follow their labor supply. The consequence is higher vegetable costs to consumers. In order for the United States to remain competitive, a guest-worker program to replace lost workers from raids and border crack-downs is desperately needed.

The following studies highlight the wage effects of illegal immigrants on domestic workers. Borjas (2003) estimated that between 1980-2000, U.S. real wages declined by about 3 percent and unskilled workers' wages fell by almost 9 percent due to immigration. Furthermore, Borjas (2003) and Borjas and Katz (2005) found that if wages are compared in groups, such as education-work and experience-years, the groups with relatively high inflow of immigration also have relatively slow wage growth. However, Bohn and Sanders (2005) reported that if a few data points are removed, Borjas's findings are easily changed. Furthermore, it is important to control for changes in technology, increasing trade with developing countries, and decreases in the real minimum wage in examining wage effects of immigration. Additionally, Raphael and Ronconi (2005) documented that high rates of imprisonment for American high school dropouts negatively affect wage rates in the experience-education group, and if that is controlled, the immigration effects on wages is reduced. Friedberg and Hunt (1995) also reported that the effects of immigrants on low-skilled native workers are very small, i.e., a 10 percent rise in immigrants reduces the low-skilled wages by only 1 percent and has

no effect on unemployment during the economic expansion. This finding is also corroborated by Butcher and Card (1991), Card (1990 and 2001), Friedberg (2001), and Lewis (2003). Ottaviano and Peri (2006) found that if natives are scarce in certain occupations and immigrants are relatively abundant, then immigrants could be a complement to the U.S. workers in that sector. Accounting for this complementarily effect, Devadoss and Luckstead estimated that for the period 1980-2000, the immigrant work force boosted the average wage of U.S. born workers by about 2 percent. For example, U.S. farm laborers are scarce in particular for performing such operations as fruit picking, vegetable harvesting, pesticide spraying, milking dairy cows, cleaning milking barns, and other hard manual labor. Furthermore, while immigrants can perform these tasks, U.S. workers are more adept at operating harvesters and combines. Thus, foreign-born workers perform labor intensive and hard manual work, and thus, complement U.S. workers in the agricultural operations.

This thesis builds on the papers reviewed in this section by empirically studying the vertical integration of U.S. agricultural production and illegal agricultural labor. The empirical analysis captures the wage differences between U.S. legal labor, U.S. illegal labor, and the Mexican wage rate; accounts for U.S. farm subsidies utilized in the U.S. commodity market; the level of domestic and border enforcement; and quantifies the theoretical findings.

Differences between Past Studies and the Current Study

The model developed in this thesis is unique in that it incorporates immigration, trade, and agricultural support policies, and also macroeconomic conditions to congruently study the immigration flow and commodity trade. The theoretical model

draws on Ethier (1986a) and Bond and Chen (1987) to incorporate domestic enforcement, but focuses on the effect of this enforcement not only on the illegal laborer market but also on the commodity market. Following Bandyopadhyay and Bandyopadhyay (1998), the model incorporates border control and migration theory to study illegal labor flows and the repercussions on the commodity market. Unlike in any previous study, this thesis examines the effect of macroeconomics conditions, such as GDP growth in the United States and Mexico, on illegal immigration flows and its consequences on the commodity market. Because of the increase in commodity trade between countries and the adverse impacts of U.S. farm policies on Mexican commodities and labor markets, this thesis also incorporates U.S. farm policies in the model which has not been studied by the past studies. Past studies (e.g., Bandyopadhyay and Bandyopadhyay (1998)) have incorporated trade policies, such as tariff reduction, using a small country framework to examine the impact on illegal migration. Furthermore, Torok and Huffman (1986) utilized the interrelationship between trade of labor-intensive commodity and unauthorized immigrant labor to empirically examine the impact of illegal immigrants on the host country. However, because of the large volume of agricultural trade between the two countries, it is not justifiable to use small country assumptions and to only study the trade of a singular agricultural product. Hence, for this thesis, a large country framework is used to examine the effect of trade liberalization not only on the entire agricultural market but also its repercussions on the labor market. Previous work either studies theoretical or empirical aspects of illegal labor immigration; in contrast, this thesis includes both theoretical analysis and empirical implementation of the theoretical

findings to provide a comprehensive analysis of the interrelationships of labor migration and commodity trade.

Chapter 3. Theoretical Analysis

This chapter presents the theoretical analysis of the first five objectives of this thesis, i.e., provides the qualitative analysis of the impacts of macroeconomic conditions, domestic and border enforcements, farm policies and trade policies, and labor endowment on immigration and commodity trade. To implement this analysis, this chapter develops a model with two countries (United States and Mexico) integrated through agricultural commodity trade and cross-border migration. However, this theoretical model is expanded to include the rest of the world. The United States and Mexico have been linked through trade and unskilled labor markets for several decades, but these links have strengthened since NAFTA was implemented in 1994. Agricultural exports from the United States (Mexico) to Mexico (United States) have increased three (five) times since 1994 (FAS, 2008), which highlights the increase in agricultural trade since NAFTA was implemented.

As stated in the introduction chapter, Mexican immigrants account for about 31 percent of the foreign-born population residing in the United States because of the congruent location and employment opportunities. A large percentage of illegal laborers are used in production of U.S. goods and services. According to Passel (2006) and National Agricultural Worker Survey (NAWS, 2008b), illegal immigrants comprise about 54 percent of agricultural, 17 percent of cleaning, 14 percent of construction, and 12 percent of food preparation industries labor forces. Immigrant labor from Mexico has been an important part U.S. agricultural production since the start of the Bracero Program in 1942. According to the NAWS, in 2001-2002, immigrant labor accounts for 78 percent of all U.S. agricultural employment, and of these laborers about 75 percent were

from Mexico. These statistics illustrate the importance of Mexican laborers in U.S. agricultural production.

In this model, the United States utilizes illegal labor from Mexico to produce agricultural commodities exported to Mexico. The inter-country labor mobility is restricted for unskilled workers because of U.S. border enforcement and employer sanction policies, which prevents illegal labor from entering the United States and punishes employers for utilizing this labor. This, coupled with quotas on legal labor, creates a setting for illegal labor immigration. The United States distorts the commodity trade by offering subsidies while Mexico protects its producers by imposing a tariff on its commodity imports.

Figure 3.1 depicts the interrelationships between the agricultural commodity markets, labor markets, and policy variables in both countries. The endogenous variables are enclosed in rectangles and the exogenous/policy variables are enclosed in ovals. The labor markets in both countries are used in the production of agricultural commodities. However, Mexican laborers are faced with a decision, either to work in Mexico or illegally immigrate to the United States. If their decision is to immigrate, they could be apprehended at the border and sent back to Mexico, where these laborers can reenter the Mexican labor market or reattempt to enter the United States. The probability of getting apprehended is influenced by the U.S. government's resource allocation to border enforcement. Immigrants that successfully enter the U.S. illegal labor market also face the probability, based on the U.S. Governments domestic enforcement efforts, of being apprehended and sent back to Mexico, where the labor cycle restarts. Those illegal laborers seeking employment in the U.S. agricultural combined with the U.S. domestic

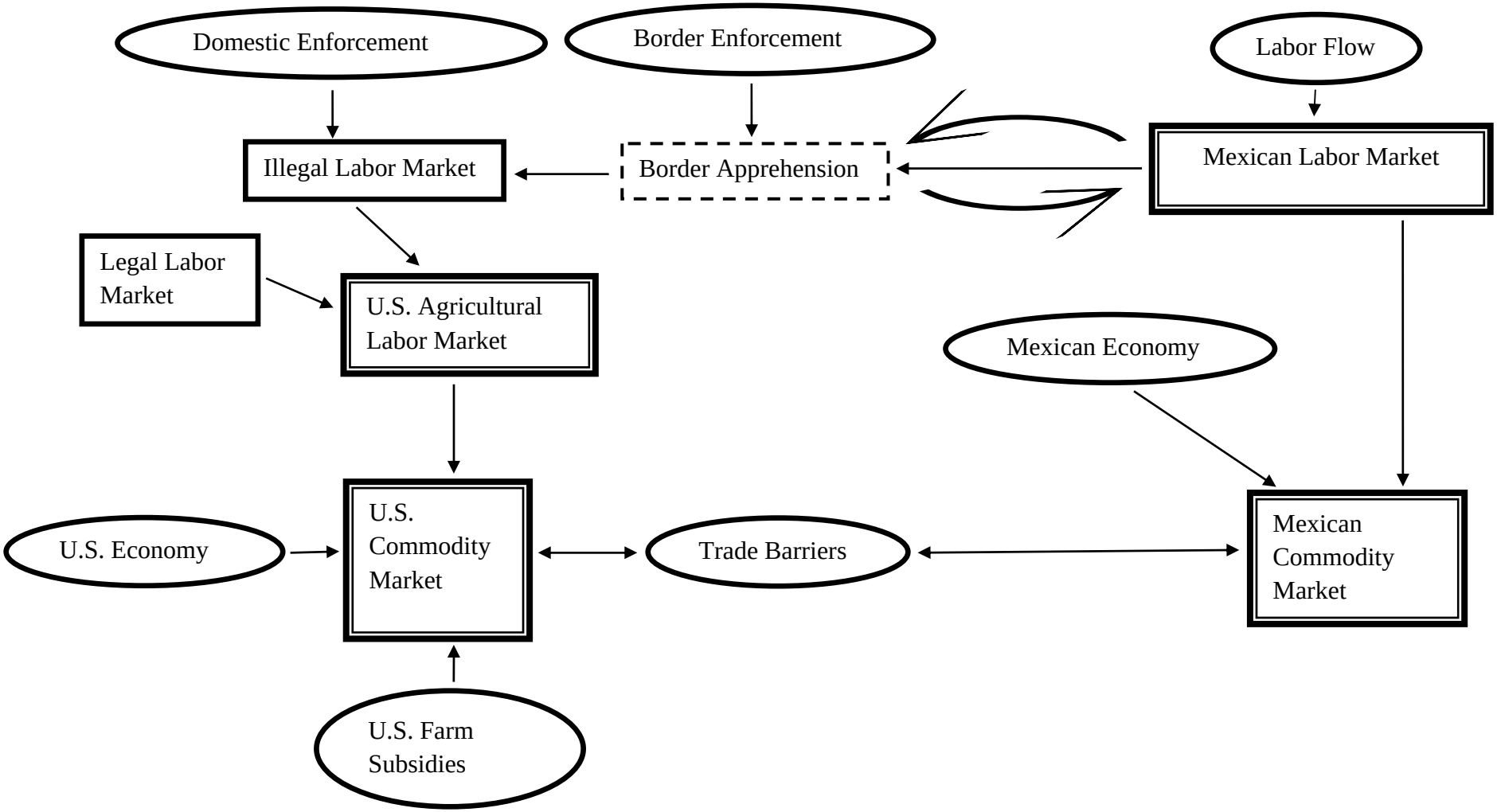

Figure 3.1: Policy Effects on Labor Markets and Commodity Markets

farm laborers comprise the U.S. agricultural labor force which is a major input in U.S. commodity production.

In both countries the economic conditions influence both the labor market and the commodity market. If the U.S. economy is expanding, then more labor is drawn from Mexico; however, if the economy is contracting, fewer incentives exist for laborers to illegally enter the United States. If the Mexican economy is growing, then fewer workers tend to immigrate; however, if the economy is slowing, more laborers are inclined to illegally immigrate.

The commodity markets are influenced by U.S. subsidies and trade barriers, which also indirectly impact the labor markets. The U.S. government provides subsidies to increase U.S. agricultural production and the Mexican government protects its production by implementing trade barriers such as tariffs. U.S. subsidies result in excess production of agricultural commodities which are dumped in the Mexican market. Though Mexico was protecting its farmers though trade restrictions, much of these trade barriers were eliminated under NAFTA, which makes the Mexican farmers more susceptible to U.S. dumping. Unable to compete, Mexican farmers are forced out of business and enter the labor migration cycle described above.

These interrelationships are captured in the mathematical model developed below.

Labor Market

The labor market specifications for the United States are

(1) $$L_U^S = L_U^S\left(W_U\right)$$

(2) $$L_U^D = L_U^D\left(W_U, P_U^S\right)$$

where L_U^S is the supply of U.S. unskilled labor, W_U is the U.S. unskilled wage rate, L_U^D is

the U.S. demand for unskilled labor, and P_U^S is the U.S. price support received by producers.

The excess labor demand is expressed as

(3) $$L_E^D = L_U^D\left(W_U, P_U^S\right) - L_U^S\left(W_U\right).$$

Because the U.S. government imposes employer fines for hiring illegal labor, the wage rate for a domestic unskilled worker is not equal to wage rate for an illegal worker. Following Bond and Chen (1987), this wage discrepancy is expressed as

(4) $$W_U = W_I + \beta(E)c$$

where W_I is the wage rate for an illegal worker, β is the probability an employer is caught hiring an illegal laborer defined as a function of the government expenditures (E) allocated to domestic enforcement, and c is the fine for hiring an illegal laborer. Thus, the U.S. wage rate for unskilled workers is equal to the illegal wage rate plus probability of getting caught times the penalty per illegal workers.

The labor market specifications for Mexico are

(5) $$L_M^D = L_M^D\left(W_M, P_M\right)$$

where L_M^D is the demand for unskilled labor in Mexico, W_M is the Mexican unskilled wage rate, and P_M is the Mexican commodity prices. The total supply of Mexican unskilled labor $(\bar{L})$ is assumed to be taken as exogenous. Following Bandyopadhyay and Bandyopadhyay (1998), this model utilizes a simpler version of labor migration decision (equations 6a – 9b, given below), which depends on the amount of time wasted migrating, the probability of being caught crossing the border, the wage rate in Mexico,

and the illegal wage rate in the United States. The labor wasted (L_W) in migration is

(6a) $L_W = rL_I$

where r is time wasted in crossing the border, and L_I is total labor attempting to migrate. The probability of getting caught at the border is denoted by d. Then, the total supply of illegal labor to the United States is

(6b) $L_I^S = (1-d)(1-r)L_I$.

Combining these two identities yields

(7) $L_W = \frac{r}{[(1-d)(1-r)]} L_I^S$.

The Mexican excess labor supply or the illegal labor supply to the United States is total supply of labor minus the labor demand and labor wasted:

(8a) $L_I^S = \bar{L} - L_M^D(W_M, P_M, \mathbf{Z}) - L_W$.

Substituting (7) into (8a) and solving for L_I^S yields

(8b) $L_I^S = \left[\frac{(1-d)(1-r)}{1-d(1-r)}\right]\left[\bar{L} - L_M^D(W_M, P_M)\right] = \psi\left[\bar{L} - L_M^D(W_M, P_M)\right]$.

Thus, $\psi = \frac{(1-d)(1-r)}{1-d(1-r)}$ is the porosity coefficient, which incorporates the labor wasted coefficient and the probability of being caught crossing the border. The U.S. government attempts to control the illegal labor entering the country through border enforcement. As government expenditures increase for border enforcement, the probability of an illegal immigrants getting caught (d) increases which leads to a lower ψ $\left(\frac{\partial \psi}{\partial d} < 0\right)$.

In their decision to immigrate, Mexican laborers consider the Mexican wage rate

and the U.S. illegal wage rate. The Mexican wage rate is defined by weighing the U.S. illegal wage rate with the probability of successfully crossing the border and the Mexican wage rate with the probability of getting caught and re-entering the Mexican labor market, which yields

(9a) $$W_M = (1-d)(1-r)W_I + d(1-r)W_M.$$

Solving for W_M yields the wage linkage equation between Mexico's wage rate and the U.S. illegal wage rate:

(9b) $$W_M = \frac{(1-d)(1-r)}{1-d(1-r)}W_I = \psi W_I.$$

Commodity Market

The specifications for the agricultural commodity market in the United States are

(10) $$A_U^S = A_U^S\left(P_U^S, W_U\right)$$

(11) $$A_U^D = A_U^D\left(P_U, \mathbf{Z}_U\right)$$

where A_U^S is the U.S. commodity supply, A_U^D is the U.S. commodity demand, and $\mathbf{Z}_U$ is a vector of macroeconomic variables affecting the demand for the commodity. Producers receive an output subsidy for their commodity production which is captured by the U.S. price wedge equation:

(12) $$P_U^S = P_U + s_U$$

where producer support price $\left(P_U^S\right)$ is equal to consumer price $\left(P_U\right)$ plus the subsidy $\left(s_U\right)$ the government provides domestic support to producers. Since the United States is a net exporter of output, the excess supply is expressed as

(13) $$A_E^S = A_U^S\left(P_U^S, W_U\right) - A_U^D\left(P_U, \mathbf{Z}_U\right).$$

The specifications for the commodity market in Mexico are

(14) $$A_M^S = A_M^S\left(P_M, W_M\right)$$

(15) $$A_M^D = A_M^D\left(P_M, \mathbf{Z}_M\right)$$

where A_M^S is the Mexican commodity supply, P_M is the Mexican commodity price, A_M^D is the Mexican commodity demand, and $\mathbf{Z}_M$ is a vector of macroeconomics variables that influence the Mexican demand for the commodity. Mexico is a net importer of the agricultural commodity and imposes an advalorem tariff (T) on agricultural imports. The price linkage equation is expressed as

(16) $$P_M = P_U\left(1+T\right).$$

Mexico's excess demand is expressed as

(17) $$A_E^D = A_M^D\left(P_M, \mathbf{Z}_M\right) - A_M^S\left(P_M, W_M\right).$$

The presence of output price in the labor demand function (equations 2 and 5) and of wage rates in the commodity supply function (equations 10 and 14) captures the vertical link between the labor market and the commodity market (also see Devadoss, 2008). The equilibrium conditions require that the Mexican excess supply of unskilled labor, i.e., supply of illegal labor, equal the U.S. excess demand of unskilled labor, and that the Mexican commodity excess demand equal the U.S. commodity excess supply. After equating these equations and substituting for the wage and price linkage identities, these equilibrium conditions are written as

(18a) $$L_U^D\left(W_I + \beta(E)c, P_U + s_U\right) - L_U^S\left(W_I + \beta(E)c\right) - \psi\left[\bar{L} - L_M^D\left(\psi W_I, P_U\left(1+T\right)\right)\right] = 0$$

$$(18b)\quad A_M^D\left(P_U(1+T),\mathbf{Z}_M\right)-A_M^S\left(P_U(1+T),\psi W_I\right) -A_U^S\left(P_U+s_U,W_I+\beta(E)c\right)+A_U^D\left(P_U,\mathbf{Z}_U\right)=0$$

Comparative Statics Analysis

If specific functional forms for the commodity and labor functions are known, then equations (18a) and (18b) can be solved to obtain the equilibrium illegal wage rate and U.S. commodity prices $\left(\widetilde{W}_I,\widetilde{P}_U\right)$, which can be substituted into equations (1), (2), (5), and (10), (11), (14), and (15) to solve for equilibrium supply, demand, prices $\left(\widetilde{W}_U,\widetilde{W}_M,\widetilde{L}_U^S,\widetilde{L}_U^D,\widetilde{L}_M^D,\widetilde{A}_U^S,\widetilde{A}_U^D,\widetilde{A}_M^S,\widetilde{A}_M^D\right)$. Then, illegal labor and commodity trade flows can be obtained as $\widetilde{L}_E=\widetilde{L}_U^D-\widetilde{L}_U^S=\psi\left[\bar{L}-\widetilde{L}_M^D\right]$ and $\widetilde{A}_E=\widetilde{A}_U^S-\widetilde{A}_U^D=\widetilde{A}_M^D-\widetilde{A}_M^S$.

However, for general functional forms, explicit solutions for the endogenous variables in equations (18a) and (18b) cannot be solved. Therefore, to examine the effects of marginal changes in the exogenous variables ($T, s_U, E, \psi, \mathbf{Z}_M, \mathbf{Z}_U$, and $\bar{L}$) on the endogenous variables,[15] equations (18a) and (18b) must be totally differentiated and solved for the endogenous variables. Totally differentiating (18a) and (18b) and rewriting in the form $Ax=d$:

$$(19)\quad \begin{bmatrix} \dfrac{\partial L_U^D}{\partial W_U}-\dfrac{\partial L_U^S}{\partial W_U}+\psi^2\dfrac{\partial L_M^D}{\partial W_M} & \dfrac{\partial L_U^D}{\partial P_U^S}+\psi(1+T)\dfrac{\partial L_M^D}{\partial P_M} \\ -\left(\dfrac{\partial A_M^S}{\partial W_M}\psi+\dfrac{\partial A_U^S}{\partial W_U}\right) & \left(\left(\dfrac{\partial A_M^D}{\partial P_M}-\dfrac{\partial A_M^S}{\partial P_M}\right)(1+T)-\dfrac{\partial A_U^S}{\partial P_U^S}+\dfrac{\partial A_U^D}{\partial P_U}\right) \end{bmatrix} * \begin{bmatrix} dW_I \\ dP_U \end{bmatrix} = \begin{bmatrix} -\psi P_U\dfrac{\partial L_M^D}{\partial P_M}dT-c\beta'\left(\dfrac{\partial L_U^D}{\partial W_U}-\dfrac{\partial L_U^S}{\partial W_U}\right)dE-\left(-\bar{L}+L_M^D+\psi W_I\dfrac{\partial L_M^D}{\partial W_M}\right)d\psi+\psi d\bar{L}-\dfrac{\partial L_U^D}{\partial P_U^S}ds_U \\ -P_U\left(\dfrac{\partial A_M^D}{\partial P_M}-\dfrac{\partial A_M^S}{\partial P_M}\right)dT+\dfrac{\partial A_U^S}{\partial P_U^S}ds_U+\dfrac{\partial A_U^S}{\partial W_U}c\beta'dE+\dfrac{\partial A_M^S}{\partial W_M}W_I d\psi-\dfrac{\partial A_M^D}{\partial \mathbf{Z}_M}d\mathbf{Z}_M-\dfrac{\partial A_U^D}{\partial \mathbf{Z}_U}d\mathbf{Z}_U \end{bmatrix}$$

[15]Employer sanction, i.e., fines per undocumented worker (c), is held constant.

The determinant of A is

(20)

$$
\begin{aligned}
|A| = &+\left(\left(\frac{\partial L_U^D}{\partial W_U}-\frac{\partial L_U^S}{\partial W_U}\right)+\psi^2\frac{\partial L_M^D}{\partial W_M}\right)\left(\frac{\partial A_M^D}{\partial P_M}(1+T)+\frac{\partial A_U^D}{\partial P_U}\right)+\frac{\partial L_U^S}{\partial W_U}\left(\frac{\partial A_M^S}{\partial P_M}(1+T)+\frac{\partial A_U^S}{\partial P_U^S}\right)\\
&-\left((1+T)\frac{\partial A_M^S}{\partial P_M}\frac{\partial L_U^D}{\partial W_U}\right)-\left(\psi^2(1+T)\frac{\partial A_M^S}{\partial P_M}\frac{\partial L_M^D}{\partial W_M}\right)-\left(\frac{\partial A_U^S}{\partial P_U}\frac{\partial L_U^D}{\partial W_U}\right)-\left(\psi^2\frac{\partial A_U^S}{\partial P_U}\frac{\partial L_M^D}{\partial W_M}\right)\\
&+\left(\psi\frac{\partial A_M^S}{\partial W_M}\frac{\partial L_U^D}{\partial P_U^S}\right)+\left(\psi^2(1+T)\frac{\partial A_M^S}{\partial W_M}\frac{\partial L_M^D}{\partial P_M}\right)+\left(\frac{\partial A_U^S}{\partial W_U}\frac{\partial L_U^D}{\partial P_U^S}\right)+\left(\psi(1+T)\frac{\partial A_U^S}{\partial W_U}\frac{\partial L_M^D}{\partial P_M}\right)
\end{aligned}
$$

Comparing the similar terms and using plausible coefficients of demand and supply function, one can ascertain that the determinant is positive, and thus, the matrix A is nonsingular. Following the Cramer's Rule, dW_I and dP_U are solved for in terms of the exogenous variables:

(21a)

$$
\begin{aligned}
dW_I = \frac{1}{|A|}*\Bigg[&P_U\left(-\psi\frac{\partial L_M^D}{\partial P_M}\left(\left(\frac{\partial A_U^D}{\partial P_U}-\frac{\partial A_U^S}{\partial P_U^S}\right)\right)+\left(\frac{\partial A_M^D}{\partial P_M}-\frac{\partial A_M^S}{\partial P_M}\right)\left(\frac{\partial L_U^D}{\partial P_U^S}\right)\right)dT\\
&+\left[\left[-\left(\psi(1+T)\frac{\partial L_M^D}{\partial P_M}\right)\frac{\partial A_U^S}{\partial P_U^S}\right]-\frac{\partial L_U^D}{\partial P_U^S}\left(\left(\frac{\partial A_M^D}{\partial P_M}-\frac{\partial A_M^S}{\partial P_M}\right)(1+T)+\left(\frac{\partial A_U^D}{\partial P_U}\right)\right)\right]ds_U\\
&+\left[\left(-c\beta'\left(\left(\frac{\partial A_M^D}{\partial P_M}-\frac{\partial A_M^S}{\partial P_M}\right)(1+T)+\left(\frac{\partial A_U^D}{\partial P_U}-\frac{\partial A_U^S}{\partial P_U^S}\right)\right)\left(\frac{\partial L_U^D}{\partial W_U}-\frac{\partial L_U^S}{\partial W_U}\right)\right)-\left(\left(\frac{\partial L_U^D}{\partial P_U^S}+\psi(1+T)\frac{\partial L_M^D}{\partial P_M}\right)\frac{\partial A_U^S}{\partial W_U}c\beta'\right)\right]dE\\
&+\left[\left(-\left(\left(\frac{\partial A_M^D}{\partial P_M}-\frac{\partial A_M^S}{\partial P_M}\right)(1+T)+\left(\frac{\partial A_U^D}{\partial P_U}-\frac{\partial A_U^S}{\partial P_U^S}\right)\right)\left(-\bar{L}+L_M^D+\psi W_I\frac{\partial L_M^D}{\partial W_M}\right)\right)+\left(-\frac{\partial A_M^S}{\partial W_M}\left(\frac{\partial L_U^D}{\partial P_U^S}+\psi(1+T)\frac{\partial L_M^D}{\partial P_M}\right)W_I\right)\right]d\psi\\
&+\left[\left(\frac{\partial L_U^D}{\partial P_U^S}+\psi(1+T)\frac{\partial L_M^D}{\partial P_M}\right)\frac{\partial A_M^D}{\partial \mathbf{Z}_M}\right]d\mathbf{Z}_M\\
&+\left[\left(\frac{\partial L_U^D}{\partial P_U^S}+\psi(1+T)\frac{\partial L_M^D}{\partial P_M}\right)\frac{\partial A_U^D}{\partial \mathbf{Z}_U}\right]d\mathbf{Z}_U\\
&+\left[\psi\left(\left(\frac{\partial A_M^D}{\partial P_M}-\frac{\partial A_M^S}{\partial P_M}\right)(1+T)+\left(\frac{\partial A_U^D}{\partial P_U}-\frac{\partial A_U^S}{\partial P_U^S}\right)\right)\right]d\bar{L}
\end{aligned}\Bigg]
$$

(21b)

$$dP_U = \frac{1}{|A|} * \left[\begin{array}{l} + \left[-P_U \left(\frac{\partial L_U^D}{\partial W_U} - \frac{\partial L_U^S}{\partial W_U} + \psi^2 \frac{\partial L_M^D}{\partial W_M} \right) \left(\frac{\partial A_M^D}{\partial P_M} - \frac{\partial A_M^S}{\partial P_M} \right) + \psi P_U \left(- \frac{\partial A_M^S}{\partial W_M} \psi - \frac{\partial A_U^S}{\partial W_U} \right) \frac{\partial L_M^D}{\partial P_M} \right] dT \\ + \left[\left(\frac{\partial L_U^D}{\partial W_U} - \frac{\partial L_U^S}{\partial W_U} + \psi^2 \frac{\partial L_M^D}{\partial W_M} \right) \frac{\partial A_U^S}{\partial P_U^S} + \left(- \frac{\partial A_M^S}{\partial W_M} \psi - \frac{\partial A_U^S}{\partial W_U} \right) \frac{\partial L_U^D}{\partial P_U^S} \right] ds_U \\ + \left[\psi^2 c\beta' \frac{\partial L_M^D}{\partial W_M} \frac{\partial A_U^S}{\partial W_U} - c\beta' \psi \left(\frac{\partial L_U^D}{\partial W_U} - \frac{\partial L_U^S}{\partial W_U} \right) \frac{\partial A_M^S}{\partial W_M} \right] dE \\ + \left[W_I \frac{\partial A_M^S}{\partial W_M} \left(\frac{\partial L_U^D}{\partial W_U} - \frac{\partial L_U^S}{\partial W_U} \right) + \left(-\bar{L} + L_M^D \right) \left(-\psi \frac{\partial A_M^S}{\partial W_M} - \frac{\partial A_U^S}{\partial W_U} \right) - \psi W_I \frac{\partial L_M^D}{\partial W_M} \frac{\partial A_U^S}{\partial W_U} \right] d\psi \\ + \left[- \left(\frac{\partial L_U^D}{\partial W_U} - \frac{\partial L_U^S}{\partial W_U} + \psi^2 \frac{\partial L_M^D}{\partial W_M} \right) \frac{\partial A_M^D}{\partial \mathbf{Z}_M} \right] d\mathbf{Z}_M \\ + \left[- \left(\frac{\partial L_U^D}{\partial W_U} - \frac{\partial L_U^S}{\partial W_U} + \psi^2 \frac{\partial L_M^D}{\partial W_M} \right) \frac{\partial A_U^D}{\partial \mathbf{Z}_U} \right] d\mathbf{Z}_U \\ + \left[-\psi \left(- \frac{\partial A_M^S}{\partial W_M} \psi - \frac{\partial A_U^S}{\partial W_U} \right) \right] d\bar{L} \end{array} \right].$$

Equations (21a) and (21b) are the core equations used for the analysis below.

Exogenous Effects on Wage Rates and Prices

This section utilizes (21a) and (21b) to determine the total change in dw_I and dP_U resulting from a change in each of the individual exogenous variables by setting the exogenous variables not in question to zero.[16]

Tariff Effect

Next, the effect of a tariff reduction -- as implemented in NAFTA -- on the illegal wage rate and the U.S. commodity price is examined. To consider the effect of a reduction in Mexico's tariff rate on the illegal wage rate, equation (21a) is condensed as

[16] Due to the nature of the vertically integrated and two-country model, the impacts of some of the exogenous variables on dW_I and dP_U are not definitive.

$$(22a)\quad \frac{dW_I}{dT} = \frac{P_U\left\{\overbrace{\left[\psi\frac{\partial L_M^D}{\partial P_M}\left(\frac{\partial A_U^S}{\partial P_U^S}-\frac{\partial A_U^D}{\partial P_U}\right)\right]}^{\substack{(1)\\(+)}}+\overbrace{\left[\left(\frac{\partial A_M^D}{\partial P_M}-\frac{\partial A_M^S}{\partial P_M}\right)\left(\frac{\partial L_U^D}{\partial P_U^S}\right)\right]}^{\substack{(2)\\(-)}}\right\}}{|A|}.$$

In equation (22a), the first set of terms relates the push effect of labor released in Mexico. The signs in the parentheses indicate the effect of the set of terms. As the tariff rate decreases, the commodity price in Mexico also declines, leading to a lower demand for labor in Mexico and releasing more labor to enter into the United States. This increased labor supply reduces the illegal wage rate. The magnitude of the illegal wage rate change depends on how the U.S. commodity supply and demand, and thus, excess supply reacts to the price increase and ψ, i.e., how porous the border is. The second set of terms captures the pull effect of labor demand in the United States. That is, a decrease in the tariff rate will increase U.S. prices for the agricultural commodity augmenting the U.S. labor demand, and thus, raises the illegal wage rate. The level of increase by the illegal wage rate depends on the responsiveness of agricultural demand and supply in Mexico, i.e., excess demand, to a decrease in Mexican commodity prices. The overall effect on the illegal wage rate is indeterminate because it is not clear which effect, i.e., pull or push, is dominant.

To consider the effect of NAFTA on U.S. commodity prices, equation (21b) is simplified as

(22b)

$$\frac{dP_U}{dT} = \frac{\left\{ \overbrace{\left[-P_U \left(\frac{\partial L_U^D}{\partial W_U} - \frac{\partial L_U^S}{\partial W_U} + \psi^2 \frac{\partial L_M^D}{\partial W_M} \right) \left(\frac{\partial A_M^D}{\partial P_M} - \frac{\partial A_M^S}{\partial P_M} \right) \right]}^{\substack{(1) \\ (-)}} + \overbrace{\left[\psi P_U \frac{\partial L_M^D}{\partial P_M} \left(-\frac{\partial A_M^S}{\partial W_M} \psi - \frac{\partial A_U^S}{\partial W_U} \right) \right]}^{\substack{(2) \\ (+)}} \right\}}{|A|}.$$

In equation (22b), the first set of terms capture the effect of tariff reduction on U.S. prices through the Mexican commodity price changes. As a result of trade liberalization, Mexican price declines, which leads to a higher demand and lower supply, and thus, an increase in excess demand, which causes U.S. commodity prices to increase. The magnitude of this increase depends on the labor release in Mexico and labor absorption in the United States. The second set of terms is related to the push effect in Mexico. Specifically, a reduction in the tariff rate decreases Mexican commodity prices, forcing labor demand to go down which negatively affects the wage rate in both countries. This lower wage rate increases the commodity supply in both countries, which lowers U.S. commodity prices. The magnitude of this increase in U.S. commodity prices depends on how the commodity supply responds to a lower wage rate in both countries. Because the tariff directly influences Mexican commodity prices, the direct effect in the first set of terms is likely to dominate the indirect effect through the labor market in the second set of terms. Therefore, the overall effect of Mexico's tariff reduction is to increase U.S. commodity prices.

Subsidy Effect

To study the effect of an increase in the U.S. commodity subsidy on the illegal wage rate, equation (21a) is reduced to

(23a)

$$\frac{dW_I}{ds_U} = \frac{\left\{ \overbrace{\left[-\psi(1+T)\frac{\partial L_M^D}{\partial P_M}\frac{\partial A_U^S}{\partial P_U^S} \right]}^{\substack{(1)\\(-)}} + \overbrace{\left[-\left(\left(\frac{\partial A_M^D}{\partial P_M} - \frac{\partial A_M^S}{\partial P_M} \right)(1+T) + \left(\frac{\partial A_U^D}{\partial P_U} \right) \right) \frac{\partial L_U^D}{\partial P_U^S} \right]}^{\substack{(2)\\(+)}} \right\}}{|A|}.$$

The first set of terms in equation (23a) traces the effect of the subsidy on the illegal wage rate through an output price change and Mexican labor demand. That is, an increase in the subsidy raises the U.S. producer price and expands the U.S. commodity production. This surplus production is dumped in Mexico, forcing Mexican commodity prices to plummet. As a result of the price decrease, Mexican labor demand contracts and displaces agricultural workers. These unemployed farm workers tend to migrate illegally to the United States which leads to excess supply of labor and this depresses the illegal wage rate. The second set of terms in equation (23a) outlines the effect of the U.S. farm subsidy on the illegal wage rate through the output price change and U.S. labor demand. The augmented U.S. farm subsidy increases the producer price and expands production, which leads to higher demand for labor and wage rate. The magnitude of the increase in the wage rate depends on how responsive the demand and supply, and thus, the excess demand in Mexico and the domestic demand in the United States are to a price change. The net effect of the U.S. production subsidy on the wage rate will be positive because the demand effect of a U.S. price increase on labor will be larger than the supply effect of a labor release from a lower commodity price in Mexico.

To study the effect of an increase in the U.S. production subsidy on the

commodity price, equation (21b) is condensed to

(23b)

$$\frac{dP_U}{ds_U} = \frac{\left\{ \overbrace{\left[\left(\frac{\partial L_U^D}{\partial W_U} - \frac{\partial L_U^S}{\partial W_U} + \psi^2 \frac{\partial L_M^D}{\partial W_M} \right) \frac{\partial A_U^S}{\partial P_U^S} \right]}^{\substack{(1) \\ (-)}} + \overbrace{\left[\left(-\frac{\partial A_M^S}{\partial W_M} \psi - \frac{\partial A_U^S}{\partial W_U} \right) \frac{\partial L_U^D}{\partial P_U^S} \right]}^{\substack{(2) \\ (+)}} \right\}}{|A|}.$$

The first set of terms in equation (23b) traces the effect of the change in subsidy on the market price through an increase in the producer price, the U.S. commodity supply, and the resulting labor market change in both countries. An increase in the U.S. production subsidy increases the price to producers, which expands output and decreases commodity prices. The magnitude of the decline in commodity prices depends on how responsive the U.S. excess demand is to labor released in Mexico. The second set of terms tracks the effect of the change in subsidy on the U.S. producer price through labor demand and the repercussions on wage rates and production. That is, an increase in the subsidy raises the U.S. producer price, which increases the labor demand and the wage rates in both countries. This causes the production to decline and results in a higher commodity price. The first set of terms is a direct price effect and the second set of terms is an indirect wage effect. The direct effect should dominate the indirect effect, thus commodity prices should decrease in response to a production subsidy.

Domestic Enforcement Effect

Because the Congress failed to pass any meaningful immigration reforms since IRCA in 1986, the department of Homeland Security intensified its domestic raids in recent years to curtail the stock of unauthorized workers in the United States. For this

stepped-up enforcement, the Department of Homeland Security increased its expenditures on domestic control. Hence it is worth examining the impact of this higher domestic spending on the illegal wage rate. Equation (21a) can be simplified as

(24a)

$$\frac{dW_I}{dE} = \frac{\left\{ \overbrace{\left[-\left(\left(\frac{\partial A_M^D}{\partial P_M} - \frac{\partial A_M^S}{\partial P_M} \right)(1+T) + \left(\frac{\partial A_U^D}{\partial P_U} - \frac{\partial A_U^S}{\partial P_U^S} \right) \right) \left(\frac{\partial L_U^D}{\partial W_U} - \frac{\partial L_U^S}{\partial W_U} \right) c\beta' \right]}^{(1)}_{(-)} + \overbrace{\left[-\left(\frac{\partial L_U^D}{\partial P_U^S} + \psi(1+T) \frac{\partial L_M^D}{\partial P_M} \right) \frac{\partial A_U^S}{\partial W_U} c\beta' \right]}^{(2)}_{(+)} \right\}}{|A|}.$$

In this equation, the first set of terms reflects the direct effect, in that increased spending on domestic control reduces the excess demand for Mexican labor. This reduction in excess demand causes the illegal wage rate to decline. The magnitude of this decline depends on the probability of catching illegal employment, the amount of sanctions, and the responsiveness of U.S. excess supply and Mexican excess demand in the commodity market. The second set of terms traces the indirect effect of the enforcement through the commodity market. Explicitly, higher domestic spending causes the wedge between the illegal and the U.S. wage rates to be greater, leading to a higher U.S. wage rate. This higher U.S. wage rate reduces the U.S. commodity supply, causing U.S. and Mexican commodity prices to rise. This higher price increases labor demand and puts upward pressure on the illegal wage rate. Because domestic enforcement directly influences the wage rate, this effect will dominate the indirect effect working through the commodity market.

The impact of higher domestic spending on commodity prices is discussed next. Equation (21b) can be reduced as

$$(24b)\quad \frac{dP_U}{dE} = \frac{\left\{ \overbrace{\left[\psi^2 c\beta' \frac{\partial L_M^D}{\partial W_M} \frac{\partial A_U^S}{\partial W_U} \right]}^{\substack{(1)\\(+)}} + \overbrace{\left[-\psi c\beta' \left(\frac{\partial L_U^D}{\partial W_U} - \frac{\partial L_U^S}{\partial W_U} \right) \frac{\partial A_M^S}{\partial W_M} \right]}^{\substack{(2)\\(-)}} \right\}}{|A|}.$$

The first set of terms in equation (24b) describes how an increase in domestic enforcement affects price through the U.S. commodity market. This increase raises the U.S. wage rate, forcing commodity supply to decrease and thus increasing U.S. commodity prices. The level of price increase depends on how responsive the Mexican labor demand is to the change in the Mexican wage, the probability of an illegal employee getting caught, the fine for employing illegal labor, and the porous nature of the border. The second set of terms captures the effect of high domestic expenditures on commodity prices through the Mexican commodity market. Specifically, the increase in expenditures reduces the illegal wage rate because of lower demand for illegal workers due to employer sanctions. This leads to immigrants returning to Mexico (as evident from the recent trend of unauthorized workers migration back to Mexico), which lowers the Mexican wage rate. Consequently, the Mexican commodity supply expands which leads to a lower commodity price both in Mexico and the United States. The extent of the price decrease depends on how responsive U.S. excess demand for labor is to the wage rate, the probability of an illegal employee getting caught, the fine for employing illegal labor, and the porous nature of the border. The net effect of domestic enforcement on U.S. commodity prices will be positive because the direct illegal labor demand effect in the United States (the set of first terms) is likely to dominate the indirect labor supply effect in Mexico (the second set of terms).

In equations (24a) and (24b), the term $c\beta'$ offers an insight on the U.S. government's commitment to enforcing its domestic enforcement policy. Between the start of IRCA in 1986 and the start of the recent congressional debate on illegal immigration, the United States did not strictly implement its domestic enforcement policy. During this period the values of $c\beta'$ are low. As previously stated in Chapter 1, in 2006 the United States stepped up the enforcement of its domestic policies, and consequently, for this period the value of $c\beta'$ is high.

Border Enforcement Effect

Since September 11, 2001 and Congress's failure to enact any immigration reform, the Department of Homeland Security has dramatically heightened its border enforcement measures. To evaluate this effect, the illegal wage rate equation (21a) is condensed to

(25a)

$$\frac{dW_I}{d\psi} = \frac{\left\{ \overbrace{\left[\left(-\left(\frac{\partial A_M^D}{\partial P_M} - \frac{\partial A_M^S}{\partial P_M} \right)(1+T) + \left(\frac{\partial A_U^S}{\partial P_U^S} - \frac{\partial A_U^D}{\partial P_U} \right) \right) \left(-\left(\bar{L} - L_M^D \right) + \psi W_I \frac{\partial L_M^D}{\partial W_M} \right) \right]}^{\substack{(1) \\ (-)}} + \overbrace{\left[-W_I \left(\frac{\partial L_U^D}{\partial P_U^S} + \psi (1+T) \frac{\partial L_M^D}{\partial P_M} \right) \frac{\partial A_M^S}{\partial W_M} \right]}^{\substack{(2) \\ (-)}} \right\}}{|A|}.$$

As previously explained, greater border enforcement causes ψ to decrease creating a less porous border. Both sets of terms in equation (25a) reflect how heightened border security raises the illegal wage rate. The first set of terms demonstrates the Mexican labor-market effect. As border enforcement is tightened, ψ decreases, which prevents migrants from entering the United States. This U.S. border tightening depresses the

Mexican wage rate and increases the Mexican labor demand. Since fewer laborers enter the U.S. labor market, the illegal wage rate goes up. The magnitude of the illegal wage reduction depends on how responsive the U.S. commodity excess supply and the Mexican excess demand are to changes in prices. The second set of terms reflects the Mexican commodity-market effect. Specifically, as border enforcement increases, the Mexican wage rate reduces, expanding the commodity production. As more laborers are used in Mexican agriculture, fewer laborers enter the United States, driving the illegal wage rate up. The degree to which the wage rate increases depends on how responsive the labor demand is to a price increase. Thus, both effects raise the illegal wage rate.

To assess the effect an increase in border enforcement has on the commodity price, equation (21b) is reduced to

(25b)

$$\frac{dP_U}{d\psi} = \frac{\left\{ \overbrace{\left[W_I \left(\frac{\partial L_U^D}{\partial W_U} - \frac{\partial L_U^S}{\partial W_U} \right) \frac{\partial A_M^S}{\partial W_M} \right]}^{\substack{(1)\\(+)}} + \overbrace{\left[-\left(\bar{L} - L_M^D \right) \left(-\psi \frac{\partial A_M^S}{\partial W_M} - \frac{\partial A_U^S}{\partial W_U} \right) - \psi W_I \frac{\partial L_M^D}{\partial W_M} \frac{\partial A_U^S}{\partial W_U} \right]}^{\substack{(2)\\(-)}} \right\}}{|A|}.$$

The first set of terms in equation (25b) expounds the impact of border control on U.S. commodity prices through the repercussions in the Mexican commodity market. As border enforcement increases, more laborers remain in Mexico which reduces the Mexican wage rate. This wage decrease expands the Mexican commodity supply, decreasing Mexico's excess demand, forcing commodity prices to decrease. The level of price reduction depends on how responsive the U.S. excess demand for labor is to a change in the wage rate. The second set of terms reflects the change in commodity prices

through commodity supply adjustments in response to wage rate adjustments. As border enforcement tightens, illegal labor supply in the United States contracts. This causes U.S. producers to augment their demand for domestic labor, which increases the wage rate. The wage rate increase reduces the U.S. commodity supply which raises commodity prices. The magnitude of the price increases depends on the excess supply of labor in Mexico, the porous nature of the border, and responsiveness of labor demand in Mexico to the change in the wage rate. The net effect of tighter border control is to raise commodity prices because the labor shortage effect is likely to dominate the commodity market effect.

Macroeconomic Effect

The economic environment, such as recession or expansion in both the United States and Mexico, plays an integral role on the illegal wage rates. For instance, the current economic recession in the United States is causing illegal immigrants to voluntarily return to Mexico since jobs are harder to find for immigrants (Spagat, 2008). To examine the effect of an increase in U.S. and Mexican income or GDP on the illegal wage rate, equation (21a) is reduced to

$$(26a)\quad \frac{dW_I}{d\mathbf{Z}_U} = \frac{\overbrace{\left[\left(\frac{\partial L_U^D}{\partial P_U^S} + \psi\left(1+T\right)\frac{\partial L_M^D}{\partial P_M}\right)\frac{\partial A_U^D}{\partial \mathbf{Z}_U}\right]}^{(+)}}{\left|A\right|}$$

$$(26b)\quad \frac{dW_I}{d\mathbf{Z}_M} = \frac{\overbrace{\left[\left(\frac{\partial L_U^D}{\partial P_U^S} + \psi\left(1+T\right)\frac{\partial L_M^D}{\partial P_M}\right)\frac{\partial A_M^D}{\partial \mathbf{Z}_M}\right]}^{(+)}}{\left|A\right|}.$$

Equation (26a) [(26b)] expresses how economic growth in the United States [Mexico]

increases the illegal wage rate. Specifically, income growth in the United States [Mexico] creates greater commodity demand which reduces [expands] excess commodity supply [demand], raising commodity prices in both countries. This leads to greater labor demand and thus higher wage rate.

To analyze the effect of an increase in income or GDP in the United States and Mexico on commodity prices, equation (21b) is condensed to

$$(27a)\quad \frac{dP_U}{d\mathbf{Z}_U} = \frac{\overbrace{\left[-\left(\left(\frac{\partial L_U^D}{\partial W_U} - \frac{\partial L_U^S}{\partial W_U}\right) + \psi^2 \frac{\partial L_M^D}{\partial W_M}\right)\frac{\partial A_U^D}{\partial \mathbf{Z}_U}\right]}^{(+)}}{|A|}$$

$$(27b)\quad \frac{dP_U}{d\mathbf{Z}_M} = \frac{\overbrace{\left[-\left(\left(\frac{\partial L_U^D}{\partial W_U} - \frac{\partial L_U^S}{\partial W_U}\right) + \psi^2 \frac{\partial L_M^D}{\partial W_M}\right)\frac{\partial A_M^D}{\partial \mathbf{Z}_M}\right]}^{(+)}}{|A|}.$$

Equation (27a) [(27b)] traces how an economic expansion in the United States [Mexico] increases commodity prices. GDP growth in the United States [Mexico] generates greater commodity demand which decreases [boosts] excess commodity supply [demand], leading to a higher commodity price. The degree to which the price increases depends on how responsive the labor markets are to an increase in the U.S. and Mexican wage rates.

Labor Endowment Effect

Even thought Mexico is a poor country, it is economically more prosperous than its southern neighbors (e.g., Belize and Guatemala). Workers from these poorer countries tend to migrate to Mexico, and eventually trek to the United States. Therefore, it is worth examining the effect of an increase in the total labor supply on the illegal wage rate.

Equation (21a) reduces to

$$(28a)\quad \frac{dW_I}{d\bar{L}} = \frac{\overbrace{\left[\psi\left(\left(\frac{\partial A_M^D}{\partial P_M} - \frac{\partial A_M^S}{\partial P_M}\right)(1+T) - \left(\frac{\partial A_U^S}{\partial P_U^S} - \frac{\partial A_U^D}{\partial P_U}\right)\right)\right]}^{(-)}}{|A|}.$$

Equation (28a) illustrates that as the labor supply increases, the illegal wage rate decreases. The extent of the wage rate decrease is contingent on the responsiveness of U.S. commodity excess supply and Mexican commodity excess demand to price changes.

To analyzes the effect of an increase in total labor supply on commodity prices, equation (21b) is simplified as

$$(28b)\quad \frac{dP_U}{d\bar{L}} = \frac{\overbrace{\left[-\psi\left(-\frac{\partial A_M^S}{\partial W_M}\psi - \frac{\partial A_U^S}{\partial W_U}\right)\right]}^{(-)}}{|A|}.$$

Equation (28b) demonstrates that as Mexico's labor supply augments, commodity prices decrease. The rationale for this result is that as the labor supply increases, wage rates in both countries decrease, leading to greater commodity supply and lower prices.

Below the net effect of a change in exogenous variables on the illegal wage rate and commodity price is summarized.

- The effect of trade liberalization on the illegal wage rate is ambiguous because it is unclear whether the push or pull effect is dominant, but increases commodity prices.
- Additional U.S. farm supports drives the illegal wage rate up and pushes commodity prices down.
- Greater spending on U.S. domestic enforcement reduces the illegal wage rate and

increases commodity prices.

- Heightened border enforcement increases illegal wage rates and commodity prices.
- Economic expansion in both the United States and Mexico augment illegal wage rates and commodity prices.
- A greater labor endowment in Mexico depresses illegal wage rates and commodity prices.

Direction of Labor Flow and Trade

This section analyzes the effects of changes in tariffs and subsidies, domestic and border controls, macroeconomic conditions, and the Mexican labor endowment on illegal labor migration and trade flows. As shown in equations (18a) [(18b)], excess demand and supply for illegal labor [commodity] trade are equal. Therefore, the excess supply of labor (8b) and excess demand for the commodity (17) are totally differentiated to determine changes in the illegal labor employment in the United States and U.S. commodity exports to Mexico, which yields:

$$\begin{aligned} dL_I^S = {} & \left[\bar{L} - L_M^D\right] d\psi + \psi d\bar{L} - \psi^2 \frac{\partial L_M^D}{\partial W_M} dW_I \\ & - \psi W_I \frac{\partial L_M^D}{\partial W_M} d\psi - \psi(1+T)\frac{\partial L_M^D}{\partial P_M} dP_U - P_U \frac{\partial L_M^D}{\partial P_M} dT - \frac{\partial L_M^D}{\partial \mathbf{X}_M} d\mathbf{X}_M \end{aligned} \tag{29a}$$

$$\begin{aligned} dA_E^D = {} & \frac{\partial A_M^D}{\partial P_M}(1+T)dP_U + \frac{\partial A_M^D}{\partial P_M} P_U dT + \frac{\partial A_M^D}{\partial \mathbf{Z}_M} d\mathbf{Z}_M \\ & - \frac{\partial A_M^S}{\partial P_M}(1+T)dP_U - \frac{\partial A_M^S}{\partial P_M} P_U dT - \frac{\partial A_M^S}{\partial W_M}\frac{\partial W_M}{\partial W_I} dw_I - \frac{\partial A_M^S}{\partial W_M}\frac{\partial W_M}{\partial \psi} d\psi. \end{aligned} \tag{29b}$$

Tariff Effect

To analyze the effect of trade liberalization under NAFTA on illegal labor flows,

dW_I and dP_U from equations (22a) and (22b) are substituted into (29a). Holding all other exogenous variables, except the tariff, constant in equation (29a), the change in illegal labor flow resulting from the tariff reduction is expressed as

(30a)

$$\frac{dL_I^S}{dT} =$$
$$-\psi^2 \frac{\partial L_M^D}{\partial W_M} \frac{P_U \left\{ \left[-\psi \frac{\partial L_M^D}{\partial P_M} \left(\frac{\partial A_U^D}{\partial P_U} - \frac{\partial A_U^S}{\partial P_U^S} \right) \right] + \left[\left(\frac{\partial A_M^D}{\partial P_M} - \frac{\partial A_M^S}{\partial P_M} \right) \left(\frac{\partial L_U^D}{\partial P_U^S} \right) \right] \right\}}{|A|}$$
$$-\psi(1+T) \frac{\partial L_M^D}{\partial P_M} \frac{\left\{ \left[-P_U \left(\frac{\partial L_U^D}{\partial W_U} - \frac{\partial L_U^S}{\partial W_U} + \psi^2 \frac{\partial L_M^D}{\partial W_M} \right) \left(\frac{\partial A_M^D}{\partial P_M} - \frac{\partial A_M^S}{\partial P_M} \right) \right] + \left[\psi P_U \left(-\frac{\partial A_M^S}{\partial W_M} \psi - \frac{\partial A_U^S}{\partial W_U} \right) \frac{\partial L_M^D}{\partial P_M} \right] \right\}}{|A|}$$
$$-P_U \frac{\partial L_M^D}{\partial P_M}.$$

On the right-hand side of equation (30a), the first set of terms expresses the impact of the wage rate change, the second set of terms articulates the effect of a price change, and the third set of terms shows the direct effect of a tariff change on illegal labor flows. Even though the effect of tariff reduction on commodity prices is positive, the effect on the wage rate is unclear, and the direction of illegal labor flow change is ambiguous in (30a). However, since a reduction in the tariff rate will increase U.S. production, leading to an excess demand for labor, and this tariff reduction will decrease Mexican production, resulting in a release of farm workers, illegal immigration into the United States is likely to expand.

To examine the effect of a tariff reduction on commodity trade, dW_I and dP_U from equations (22a) and (22b) are substituted into (29b). Holding all other exogenous variables, except the tariff, constant in equations (29b), the effect of a tariff reduction on

commodity trade can be written as

(30b)

$$\frac{dA_E^D}{dT} =$$
$$-\psi\frac{\partial A_M^S}{\partial W_M}\frac{P_U\left\{\left[-\psi\frac{\partial L_M^D}{\partial P_M}\left(\frac{\partial A_U^D}{\partial P_U}-\frac{\partial A_U^S}{\partial P_U^S}\right)\right]+\left[\left(\frac{\partial A_M^D}{\partial P_M}-\frac{\partial A_M^S}{\partial P_M}\right)\left(\frac{\partial L_U^D}{\partial P_U^S}\right)\right]\right\}}{|A|}$$
$$+(1+T)\left(\frac{\partial A_M^D}{\partial P_M}-\frac{\partial A_M^S}{\partial P_M}\right)\frac{\left\{\left[-P_U\left(\frac{\partial L_U^D}{\partial W_U}-\frac{\partial L_U^S}{\partial W_U}+\psi^2\frac{\partial L_M^D}{\partial W_M}\right)\left(\frac{\partial A_M^D}{\partial P_M}-\frac{\partial A_M^S}{\partial P_M}\right)\right]+\left[\psi P_U\left(-\frac{\partial A_M^S}{\partial W_M}\psi-\frac{\partial A_U^S}{\partial W_U}\right)\frac{\partial L_M^D}{\partial P_M}\right]\right\}}{|A|}$$
$$+\left(\frac{\partial A_M^D}{\partial P_M}-\frac{\partial A_M^S}{\partial P_M}\right)P_U.$$

On the right-hand side of equation (30b), the first set of terms illustrates the wage rate effect, the second set of terms captures the price effect, and the third set of terms shows the direct effect of a change in the tariff rate on U.S. exports. Even though the effect of a tariff reduction on commodity prices is positive, the effect on the wage rate is ambiguous, and the direction of commodity trade is unclear. However, since a reduction in the tariff rate increases the excess demand, U.S. exports should increase.

Subsidy Effect

To consider the effect of a burgeoning U.S. farm support on illegal labor flows, dW_I and dP_U from equations (23a) and (23b) are substituted into (29a). Holding all other exogenous variables constant, except the subsidy, the change in illegal labor flow in response to a higher subsidy is expressed as

(31a)

$$\frac{dL_I^S}{ds_U} =$$

$$-\psi^2 \frac{\partial L_M^D}{\partial W_M} \frac{\left\{\left[-\left(\psi(1+T)\frac{\partial L_M^D}{\partial P_M}\right)\frac{\partial A_U^S}{\partial P_U^S}\right]-\left[\frac{\partial L_U^D}{\partial P_U^S}\left(\left(\frac{\partial A_M^D}{\partial P_M}-\frac{\partial A_M^S}{\partial P_M}\right)(1+T)+\left(\frac{\partial A_U^D}{\partial P_U}\right)\right)\right]\right\}}{|A|}$$

$$-\psi(1+T)\frac{\partial L_M^D}{\partial P_M} \frac{\left\{\left[\left(\frac{\partial L_U^D}{\partial W_U}-\frac{\partial L_U^S}{\partial W_U}+\psi^2\frac{\partial L_M^D}{\partial W_M}\right)\frac{\partial A_U^S}{\partial P_U^S}\right]+\left[\left(-\frac{\partial A_M^S}{\partial W_M}\psi-\frac{\partial A_U^S}{\partial W_U}\right)\frac{\partial L_U^D}{\partial P_U^S}\right]\right\}}{|A|}.$$

In equation (31a), the first set of terms tracks the effect of a change in the illegal wage rate. Since the illegal wage rate is likely to increase in response to a production subsidy, illegal labor will be attracted to the United States to seek employment. The second set of terms demonstrates the effect of the U.S. commodity price change. An increase in the subsidy will lead to higher U.S. producer price and commodity production, leading to increased labor demand and thus attract illegal labor from Mexico. Thus, U.S. indulgences in farm supports encourage unauthorized entry into the United States.

To analyze the effect of an increase in U.S. farm subsidies on commodity trade, dW_I and dP_U from equations (23a) and (23b) are substituted into (29b). Holding all other exogenous variables constant, except the subsidy, the change in commodity trade is reduced to

(31b)

$$\frac{dA_E^D}{ds_U} =$$

$$-\frac{\partial A_M^S}{\partial W_M}\psi\frac{\left\{\left[-\left(\psi(1+T)\frac{\partial L_M^D}{\partial P_M}\right)\frac{\partial A_U^S}{\partial P_U^S}\right]-\left[\frac{\partial L_U^D}{\partial P_U^S}\left(\left(\frac{\partial A_M^D}{\partial P_M}-\frac{\partial A_M^S}{\partial P_M}\right)(1+T)+\left(\frac{\partial A_U^D}{\partial P_U}\right)\right)\right]\right\}}{|A|}$$

$$\left(\frac{\partial A_M^D}{\partial P_M}-\frac{\partial A_M^S}{\partial P_M}\right)(1+T)\frac{\left\{\left[\left(\frac{\partial L_U^D}{\partial W_U}-\frac{\partial L_U^S}{\partial W_U}+\psi^2\frac{\partial L_M^D}{\partial W_M}\right)\frac{\partial A_U^S}{\partial P_U^S}\right]+\left[\left(-\frac{\partial A_M^S}{\partial W_M}\psi-\frac{\partial A_U^S}{\partial W_U}\right)\frac{\partial L_U^D}{\partial P_U^S}\right]\right\}}{|A|}.$$

The first set of terms traces the effect of a change in the illegal wage rate. Since the illegal wage rate is likely to increase in response to production subsidy, illegal immigrants are lured to the United States. This reduces the labor supply in Mexico and raises the Mexican wage rate, causing the Mexican commodity supply to decrease and the import demand to rise. The second set of terms captures the effect of a price change. Greater U.S. subsidies will lead to a higher U.S. producer price and commodity production, which expands excess supply. Because enormous farm supports augment production, and this surplus production is dumped in Mexico, U.S. exports should expand.

Domestic Enforcement Effect

To examine the effect of an increase in the domestic enforcement in the United States on illegal labor flows, dW_I and dP_U from equations (24a) and (24b) are substituted into (29a). Holding all other exogenous variables, except for domestic enforcement, constant in equations (29a), the change in illegal labor flow in response to tighter domestic control can be stated as

(32a)

$$\frac{dL_I^S}{dE} =$$

$$-\psi^2 \frac{\partial L_M^D}{\partial W_M} \frac{\left\{\left[-c\beta'\left(\left(\frac{\partial A_M^D}{\partial P_M} - \frac{\partial A_M^S}{\partial P_M}\right)(1+T) + \left(\frac{\partial A_U^D}{\partial P_U} - \frac{\partial A_U^S}{\partial P_U^S}\right)\right)\left(\frac{\partial L_U^D}{\partial W_U} - \frac{\partial L_U^S}{\partial W_U}\right)\right]\right\}}{|A|}$$

$$\frac{-\left[\left(\frac{\partial L_U^D}{\partial P_U^S} + \psi(1+T)\frac{\partial L_M^D}{\partial P_M}\right)\frac{\partial A_U^S}{\partial W_U}c\beta'\right]}{|A|}$$

$$-\psi(1+T)\frac{\partial L_M^D}{\partial P_M} \frac{\left\{\left[+\psi^2 c\beta' \frac{\partial L_M^D}{\partial W_M}\frac{\partial A_U^S}{\partial W_U} - c\beta'\psi\left(\frac{\partial L_U^D}{\partial W_U} - \frac{\partial L_U^S}{\partial W_U}\right)\frac{\partial A_M^S}{\partial W_M}\right]\right\}}{|A|}.$$

The first set of terms in equation (32a) shows the wage effect. Since tighter domestic control is likely to reduce the illegal wage rate, the unauthorized entry will contract. The second set of terms demonstrates the price effect. Increased domestic enforcement will make production more expensive, leading to a higher commodity price and increased demand for labor. The net effect of domestic enforcement is to reduce the cross-border migration because the wage effect is likely to dominate the price effect.

To consider the effect of an increase in the domestic enforcement on commodity trade, dW_I and dP_U from equations (24a) and (24b) are substituted into (29b). Holding all other exogenous variables, except for domestic enforcement, constant in equation (29b), the change in U.S. exports to Mexico is obtained as

(32b)

$$\frac{dA_E^D}{dE} =$$

$$-\frac{\partial A_M^S}{\partial W_M}\psi\frac{\left\{\begin{array}{c}\left[-c\beta'\left(\left(\frac{\partial A_M^D}{\partial P_M}-\frac{\partial A_M^S}{\partial P_M}\right)(1+T)+\left(\frac{\partial A_U^D}{\partial P_U}-\frac{\partial A_U^S}{\partial P_U^S}\right)\right)\left(\frac{\partial L_U^D}{\partial W_U}-\frac{\partial L_U^S}{\partial W_U}\right)\right] \\ -\left[\left(\frac{\partial L_U^D}{\partial P_U^S}+\psi(1+T)\frac{\partial L_M^D}{\partial P_M}\right)\frac{\partial A_U^S}{\partial W_U}c\beta'\right]\end{array}\right\}}{|A|}$$

$$+\left(\frac{\partial A_M^D}{\partial P_M}-\frac{\partial A_M^S}{\partial P_M}\right)(1+T)\frac{\left\{\left[+\psi^2 c\beta'\frac{\partial L_M^D}{\partial W_M}\frac{\partial A_U^S}{\partial W_U}-c\beta'\psi\left(\frac{\partial L_U^D}{\partial W_U}-\frac{\partial L_U^S}{\partial W_U}\right)\frac{\partial A_M^S}{\partial W_M}\right]\right\}}{|A|}.$$

The first set of terms in equation (32b) illustrates the wage effect. Since tighter domestic control forces undocumented workers to return to Mexico, this will increase the Mexican workforce and reduce the Mexican wage rate. This lower wage rate will increase Mexican commodity production, leading to lower imports. The second set of terms demonstrates the price effect. Increased domestic enforcement will cause the U.S. wage rate to rise and make production more expensive, leading to lower U.S. commodity supply. This will result in a higher commodity price and lower imports by Mexico. Thus, the effect of domestic enforcement is to reduce U.S. exports to Mexico.

Border Enforcement Effect

To analyze the effect of heightened U.S. border enforcement on illegal labor flows, dW_I and dP_U from equations (25a) and (25b) are substituted into (29a). Holding all other exogenous variables, except for border security, constant in equation (29a), the change in illegal labor flow in response to a change in border control can be written as

(33a)

$$\frac{dL_I^S}{d\psi} =$$

$$-\psi^2 \frac{\partial L_M^D}{\partial W_M} \frac{\left\{\begin{array}{c}\left[-\left(\left(\frac{\partial A_M^D}{\partial P_M}-\frac{\partial A_M^S}{\partial P_M}\right)(1+T)+\left(\frac{\partial A_U^D}{\partial P_U}-\frac{\partial A_U^S}{\partial P_U^S}\right)\right)\left(-\bar{L}+L_M^D+\psi W_I\frac{\partial L_M^D}{\partial W_M}\right)\right] \\ +\left[-\frac{\partial A_M^S}{\partial W_M}\left(\frac{\partial L_U^D}{\partial P_U^S}+\psi(1+T)\frac{\partial L_M^D}{\partial P_M}\right)W_I\right]\end{array}\right\}}{|A|}$$

$$-\psi(1+T)\frac{\partial L_M^D}{\partial P_M}\frac{\left\{\left[W_I\frac{\partial A_M^S}{\partial W_M}\left(\frac{\partial L_U^D}{\partial W_U}-\frac{\partial L_U^S}{\partial W_U}\right)\right]+\left[\left(-\bar{L}+L_M^D\right)\left(-\psi\frac{\partial A_M^S}{\partial W_M}-\frac{\partial A_U^S}{\partial W_U}\right)-\psi W_I\frac{\partial L_M^D}{\partial W_M}\frac{\partial A_U^S}{\partial W_U}\right]\right\}}{|A|}$$

$$+\left[\left[\bar{L}-L_M^D\right]-\psi W_I\frac{\partial L_M^D}{\partial W_M}\right].$$

In equation (33a), the first set of terms shows the wage effect. Strengthened border security controls the illegal entry and thus raises the illegal wage rate. Even though immigrants caught at the border are sent back to Mexico, the higher illegal wage rate in the United States lures them to cross the border repeatedly. The second set of terms illustrates the price effect. As the United States implements additional measures to secure its borders, fewer illegal workers enter the United States, causing cost of production and commodity price to rise. This also results in a higher Mexican commodity price. The higher Mexican price draws would-be immigrant laborers back into Mexican production, which contracts the illegal labor supply. The third set of terms represents the direct effect of an increase in U.S. border security on the illegal labor supply. As a result of the tightened border control, fewer laborers successfully cross the U.S. border, which reduces the supply of unauthorized labor. The combined effect of the three terms should result in fewer illegal laborers entering the U.S. labor market from

Mexico.

To examine the effect of heightened U.S. border security measures on the commodity trade, dW_I and dP_U from equations (25a) and (25b) are substituted into (29b). Holding all other exogenous variables, except for border security, constant in equation (29a), the change in commodity trade resulting from tighter border security can be expressed as

(33b)

$$\frac{dA_E^D}{d\psi} =$$

$$-\frac{\partial A_M^S}{\partial W_M}\psi\frac{\left\{\begin{array}{c}\left[-\left(\left(\frac{\partial A_M^D}{\partial P_M}-\frac{\partial A_M^S}{\partial P_M}\right)(1+T)+\left(\frac{\partial A_U^D}{\partial P_U}-\frac{\partial A_U^S}{\partial P_U^S}\right)\right)\left(-\bar{L}+L_M^D+\psi W_I\frac{\partial L_M^D}{\partial W_M}\right)\right] \\ +\left[-\frac{\partial A_M^S}{\partial W_M}\left(\frac{\partial L_U^D}{\partial P_U^S}+\psi(1+T)\frac{\partial L_M^D}{\partial P_M}\right)W_I\right]\end{array}\right\}}{|A|}$$

$$+\left(\frac{\partial A_M^D}{\partial P_M}-\frac{\partial A_M^S}{\partial P_M}\right)(1+T)\frac{\left\{\left[W_I\frac{\partial A_M^S}{\partial W_M}\left(\frac{\partial L_U^D}{\partial W_U}-\frac{\partial L_U^S}{\partial W_U}\right)\right]+\left[\left(-\bar{L}+L_M^D\right)\left(-\psi\frac{\partial A_M^S}{\partial W_M}-\frac{\partial A_U^S}{\partial W_U}\right)-\psi W_I\frac{\partial L_M^D}{\partial W_M}\frac{\partial A_U^S}{\partial W_U}\right]\right\}}{|A|}$$

$$-\frac{\partial A_M^S}{\partial W_M}W_I.$$

The first set of terms in equation (33b) demonstrates the wage effect. Increased border security reduces the illegal entry and thus drives up the illegal wage rate in the United States but augments the Mexican workforce and lowers the Mexican wage rate, which expands Mexican commodity production. This leads to lower imports. The second set of terms represents the price effect. An increase in border enforcement results in fewer illegal workers in U.S. agricultural production, leading to an increase in U.S. production cost, reduced supply, and a higher U.S. commodity price. This higher price contracts the

excess supply and reduces exports to Mexico. The third set of terms conveys the indirect effect of heightened border enforcement on commodity trade. This effect also reduces U.S. exports to Mexico. Thus, the combined effect of all three terms is to decrease the U.S. exports to Mexico.

Macroeconomic Effect

To study the effect of an increase in macroeconomic variables (i.e., GDP growth) in the United States on illegal labor flows, dW_I and dP_U from equations (26a) and (27a) are substituted into (29a). Holding all other exogenous variables, except the macroeconomic effect, constant in equation (29a), the change in illegal labor flow corresponding to a change in macroeconomic effects takes the form

(34a)

$$\frac{dL_I}{d\mathbf{Z}_U} =$$
$$-\psi^2 \frac{\partial L_M^D}{\partial W_M} \frac{\left[\left(\frac{\partial L_U^D}{\partial P_U^S} + \psi(1+T)\frac{\partial L_M^D}{\partial P_M}\right)\frac{\partial A_U^D}{\partial \mathbf{Z}_U}\right]}{|A|}$$
$$-\psi(1+T)\frac{\partial L_M^D}{\partial P_M} \frac{\left[-\left(\frac{\partial L_U^D}{\partial W_U} - \frac{\partial L_U^S}{\partial W_U} + \psi^2 \frac{\partial L_M^D}{\partial W_M}\right)\frac{\partial A_U^D}{\partial \mathbf{Z}_U}\right]}{|A|}.$$

The first set of terms in the above equation represents the wage effect. An economic expansion leads to more U.S. commodity demand, resulting in higher commodity prices and illegal wage rates, which attract undocumented workers into the United States. The second set of terms shows the price effect. Growth in U.S. GDP increases the U.S. and Mexican commodity prices, which expand the Mexican labor demand and shrinks the excess supply of labor, resulting in fewer immigrants. However, since the wage effect

should dominate the price effect, entry of undocumented workers into the United States should rise.

To study the effect of an economic expansion in Mexico on illegal labor flows, dW_I and dP_U from equations (26b) and (27b) are substituted into (29a). Holding all other exogenous variables, except the macroeconomic effect, constant in equation (29a), the change in illegal labor flow corresponding to a change in macroeconomic effects yields

$$\frac{dL_I^S}{d\mathbf{Z}_M} =$$

$$(34b)\quad -\psi^2 \frac{\partial L_M^D}{\partial W_M} \frac{\left[\left(\frac{\partial L_U^D}{\partial P_U^S} + \psi(1+T)\frac{\partial L_M^D}{\partial P_M}\right)\frac{\partial A_M^D}{\partial \mathbf{Z}_M}\right]}{|A|}$$

$$-\psi(1+T)\frac{\partial L_M^D}{\partial P_M} \frac{\left[-\left(\frac{\partial L_U^D}{\partial W_U} - \frac{\partial L_U^S}{\partial W_U} + \psi^2 \frac{\partial L_M^D}{\partial W_M}\right)\frac{\partial A_M^D}{\partial \mathbf{Z}_M}\right]}{|A|}.$$

The first set of terms in the above equations represents the wage effect. A macroeconomic expansion increases the illegal and Mexican wage rates, leading to less Mexican labor demand and expanding the excess supply of labor. The second set of terms shows the price effect. Growth in GDP increases the U.S. and Mexican commodity prices, which expands the Mexican labor demand and shrinks the excess supply of labor. However, since the price effect should dominate the wage effect, fewer Mexican workers will seek to migrate.

To analyze the effect of U.S. GDP growth on commodity trade, dW_I and dP_U from equations (26a) and (27a) are substituted into (29b). Holding all other exogenous variables, except the macroeconomic effect, constant in equation (29b), the change in commodity trade resulting from income growth can be stated as

$$\frac{dA_E^D}{d\mathbf{Z}_U} =$$

(35a)
$$-\frac{\partial A_M^S}{\partial W_M}\psi\frac{\left[\left(\frac{\partial L_U^D}{\partial P_U^S}+\psi(1+T)\frac{\partial L_M^D}{\partial P_M}\right)\frac{\partial A_U^D}{\partial \mathbf{Z}_U}\right]}{|A|}$$
$$\left(\frac{\partial A_M^D}{\partial P_M}-\frac{\partial A_M^S}{\partial P_M}\right)(1+T)\frac{\left[-\left(\frac{\partial L_U^D}{\partial W_U}-\frac{\partial L_U^S}{\partial W_U}+\psi^2\frac{\partial L_M^D}{\partial W_M}\right)\frac{\partial A_U^D}{\partial \mathbf{Z}_U}\right]}{|A|}$$

The first set of terms in equation (35a) illustrates the wage effect. The U.S. income growth raises the illegal and Mexican wage rates leading to reduced commodity supply in Mexico and expanding the Mexican excess demand. The second set of terms expounds the price effect. A macroeconomic expansion causes the U.S. and Mexican commodity prices to rise, which shrink the excess demand. However, since the price effect should dominate the wage effect, the commodity trade should decline.

To analyze the effect of GDP growth in Mexico on commodity trade, dW_I and dP_U from equations (27a) and (27b) are substituted into (29b). Holding all other exogenous variables, except the macroeconomic effect, constant in equation (29b) the change in commodity trade flow resulting from income growth can be written as

$$\frac{dA_E^D}{d\mathbf{Z}_M} =$$

(35b)
$$-\frac{\partial A_M^S}{\partial W_M}\psi\frac{\left[\left(\frac{\partial L_U^D}{\partial P_U^S}+\psi(1+T)\frac{\partial L_M^D}{\partial P_M}\right)\frac{\partial A_M^D}{\partial \mathbf{Z}_M}\right]}{|A|}$$
$$\left(\frac{\partial A_M^D}{\partial P_M}-\frac{\partial A_M^S}{\partial P_M}\right)(1+T)\frac{\left[-\left(\frac{\partial L_U^D}{\partial W_U}-\frac{\partial L_U^S}{\partial W_U}+\psi^2\frac{\partial L_M^D}{\partial W_M}\right)\frac{\partial A_M^D}{\partial \mathbf{Z}_M}\right]}{|A|}$$
$$+\frac{\partial A_M^D}{\partial \mathbf{Z}_M}.$$

The first set of terms in equation (35b) demonstrates the wage effect. Income growth raises the Mexican wage rate, leading to reduced commodity supply and expanding the Mexican excess demand. The second set of terms expounds the price effect. Income growth causes the Mexican commodity prices to rise, which increases the Mexican production and reduces the excess demand. The third effect is the direct effect of Mexican income growth, which causes greater Mexican domestic demand and thus expands the excess demand. The wage and direct effects should dominate the price effect, causing the excess demand to expand.

Labor Endowment Effect

To examine the effect of an increase in the labor force (i.e., immigrants entering Mexico from other Latin American countries) on illegal labor flows, dW_I and dP_U from equations (28a) and (28b) are substituted into (29a). Holding all other exogenous variables, except the labor supply, constant in equations (29a), the change in illegal labor flow resulting from an increase in the labor supply is given by

$$\frac{dL_I^S}{dL} = -\psi^2 \frac{\partial L_M^D}{\partial W_M} \frac{\left[\psi\left(\left(\frac{\partial A_M^D}{\partial P_M} - \frac{\partial A_M^S}{\partial P_M}\right)(1+T) + \left(\frac{\partial A_U^D}{\partial P_U} - \frac{\partial A_U^S}{\partial P_U^S}\right)\right)\right]}{|A|} - \psi(1+T)\frac{\partial L_M^D}{\partial P_M}\frac{\left[-\psi\left(-\frac{\partial A_M^S}{\partial W_M}\psi - \frac{\partial A_U^S}{\partial W_U}\right)\right]}{|A|} + \psi. \quad (36a)$$

The first set of terms in equation (36a) demonstrates the wage effect. As the labor supply increases, the wage rate declines in both countries, causing the Mexican labor demand to

increase, which in turn contracts the illegal labor supply. The second set of terms illustrates the price effect. An expansion of the labor supply reduces commodity prices in both countries, forcing the Mexican labor demand to decline, which augments the unauthorized labor flow from Mexico to the United States. The third term shows the direct effect of an increase in labor supply, which increases the illegal labor flow into the United States. The direct effect and price effect should dominate the wage effect, causing greater illegal immigrant flow into the United States.

To consider the effect of an increase in the Mexican labor force on commodity trade, dW_I and dP_U from equations (28a) and (28b) are substituted into (29b). Holding all other exogenous variables, except for the labor variable, constant in equations (29b), the change in U.S. exports resulting from a change in the labor supply is expressed as

$$\frac{dA_E^D}{d\bar{L}} =$$

$$-\frac{\partial A_M^S}{\partial W_M}\psi\frac{\left[\psi\left(\left(\frac{\partial A_M^D}{\partial P_M}-\frac{\partial A_M^S}{\partial P_M}\right)(1+T)+\left(\frac{\partial A_U^D}{\partial P_U}-\frac{\partial A_U^S}{\partial P_U^S}\right)\right)\right]}{|A|} \tag{36b}$$

$$\left(\frac{\partial A_M^D}{\partial P_M}-\frac{\partial A_M^S}{\partial P_M}\right)(1+T)\frac{\left[-\psi\left(-\frac{\partial A_M^S}{\partial W_M}\psi-\frac{\partial A_U^S}{\partial W_U}\right)\right]}{|A|}$$

The first set of terms in equation (36b) articulates the wage effect. An increase in exogenous labor supply in Mexico from surrounding Latin American countries drives the illegal and Mexican wage rates down, which expands the Mexican commodity supply. This expansion depends on the elasticities of Mexican excess demand and U.S. excess supply. The second set of terms captures the price effect. Since immigrants from Central America ultimately seek work in the United States, commodity supply in the United

States is likely to expand more than in Mexico and causing U.S. exports to increase.

Below, the net effect of a change in exogenous variables on the flow of illegal labor and commodity trade is summarized.

- A decrease in the Mexican tariff rate and an increase in U.S. farm supports exacerbate the illegal labor flow and increase commodity trade.
- Greater U.S. spending on domestic enforcement and heightened U.S. border control reduce the flow of illegal labor but also decrease U.S. exports.
- Macroeconomic expansion in the United States increases the incentives for illegal laborers to enter the United States and decreases U.S. exports; while the economic expansion in Mexico reduces the incentive for immigrants to illegally enter the United States and increases U.S. exports.
- A greater labor endowment in Mexico increases the number of immigrants attempting to illegally cross the border and increase U.S. exports.

Chapter 4. Empirical Analysis

This chapter undertakes the empirical analysis to examine the objectives of this thesis and quantifies the theoretical results of Chapter 3. Specifically, it presents the empirical model, discusses data sources, describes the estimation techniques, and presents the empirical results for the U.S. labor market, Mexican labor demand, and the commodity markets in both countries. The empirical model also includes U.S. exports to the rest of the world. Thus, the empirical model expands the theoretical model by including the rest of the world in the analysis.

Empirical Specifications

This subsection derives the supply of agricultural products and the demand for agricultural labor using profit maximization and the demand for agricultural products and the supply of labor using utility theory and presents the empirical specifications for the agricultural markets and the labor markets.

Supply of Agricultural Products and Demand for Agricultural Labor

The production function for agricultural products $\left(A_i^S\right)$ is defined as

(1) $$A^S = A^S(L, \mathbf{G})$$

where L is labor and **G** is a vector of inputs used in agricultural production. The profit function is

(2) $$\pi = PA^S(L, \mathbf{G}) - WL - \mathbf{RG}$$

where P is the price of agricultural products, W is the wage rate for labor, and **R** is a vector of input prices corresponding to the input vector. To derive the input demand functions, the profit function is partially differentiated with respect to the endogenous variables L and **G** and is set equal to zero:

$$(3) \qquad \frac{\partial \pi}{\partial L} = P\frac{\partial A^S}{\partial L} - W = 0$$

$$(4) \qquad \frac{\partial \pi}{\partial \mathbf{G}} = P\frac{\partial A^S}{\partial \mathbf{G}} - \mathbf{R} = 0$$

The labor demand and input demand are solved as

$$(5) \qquad L^{D*} = L^*(P, W, \mathbf{R})$$

$$(6) \qquad \mathbf{G}^* = \mathbf{G}^*(P, W, \mathbf{R})$$

To obtain the agricultural supply function, the input demand functions are substituted in the production function, yielding

$$(7) \qquad A^S = A^S(L^*(P, W, \mathbf{R}), \mathbf{G}^*(P, W, \mathbf{R})) = A^{S*}(P, W, \mathbf{R})$$

Demand for Agricultural Products and Supply of Labor

The consumer's utility function is expressed as

$$(8) \qquad U^D = U^D(A, T)$$

where A is a bundle of agricultural goods, T is leisure time: T = N – L where N is total labor available and L is labor hours. The expenditure equation is E = PA + W(N – L), where E is income.

The utility maximization problem is

$$(9) \qquad U = U^D(A, T) + \lambda[E - PA - WT].$$

The first-order conditions are

$$(10) \qquad \begin{aligned} \frac{\partial U}{\partial A} &= \frac{\partial U^D(A, T)}{\partial A} - \lambda P = 0 \\ \frac{\partial U}{\partial T} &= \frac{\partial U^D(A, T)}{\partial T} - \lambda W = 0 \\ \frac{\partial U}{\partial \lambda} &= E - PA - WT = 0. \end{aligned}$$

The solution to the above system of equations yields commodity and leisure demand

(11) $A^{*} = A^{*}(P, W, E)$

(12) $T^{*} = T^{*}(P, W, E)$.

Since labor supply is $N - T^{*}$, $L = L^{*}(P,W,E)$. Note that the wage coefficient for L is positive (for T is negative) as long as labor supply is positively sloped.

Literature on the estimation of supply and demand for labor markets is extensive, but for the purpose of this study, only key papers in this area are reviewed. In his seminal work, Schuh (1962) estimates demand and supply equations for hired farm labor for the period 1929-1957. Because the price of hired farm labor and the quantity employed are jointly determined, a simultaneous-equation estimation method is employed to avoid inconsistency bias. The supply of hired agricultural labor is defined as a function of the real wage rates, income from nonagricultural employment, the level of unemployment, and the size of the civilian labor force. The demand for hired agricultural labor is defined as a function of the real wage rates of hired farm labor, agricultural output prices index, agricultural input price index, and technology. Schuh draws on previous work (Koyck 1954, Nerlove 1958a, Nerlove 1958b) to estimate the long- and short-run elasticities. Schuh explains when labor supply and demand are estimated to obtain the long-run elasticities, the lagged dependent variable needs to be included as an independent variable. Schuh reports short- and long-run demand elasticity with respect to wage rate (-0.12 and -0.40) and real farm prices (0.15 and 0.52). In addition, short- and long-run supply elasticities with respect to wage rates (0.25 and 0.78) are reported.

Hammonds, Yadav, and Vathana (1973) estimated demand and supply functions similar to Schuh (1962), using a two-stage least squares technique with data covering the period 1941-1969. In their model, the demand equation is a function of real farm wage,

real farm income, a time trend, and a productivity index. The supply equation is a function of real farm wage, a time trend, unemployment rate, and real non-farm wage rates. Hammonds Yadav, and Vathana (1973) report short- and long-run demand elasticities (-0.85 and -1.05).

Duffield and Coltrane (1992) estimate farm labor demand and supply equations using two-stage least squares and test for disequilibrium in the hired farm labor market for the period from 1949 to 1989. They estimate the demand equation using the real-wage rate for hired labor; family labor, operators, and unpaid workers; one-year lagged farm employment; an index of prices received deflated by prices paid; number of farms in operation; and a trend variable. The supply equation is estimated with the real wage, family labor, lagged dependent variable in the demand equation, and an index of adjusted nonagricultural wages deflated by the Consumer Price Index. Duffield and Coltrane report short- and long-run demand elasticities with respect to wage (-1.38 and -3.14) and real farm price (0.58 and 1.31). In addition, they reported short- and long-run supply elasticities with respect to wage rate (0.36 and 0.76) and non-farm wage (-0.18 and -0.37).

The literature on supply response analysis is vast, and this thesis covers only the relevant studies in this area. Therefore, in the interest of brevity and thesis focus, Colman's (1983) comprehensive examination of supply response analyses is briefly reviewed. The standard empirical specification is that quantity supplied is a function of output prices and input prices, as derived in the above theoretical section, and other variables effecting agricultural production. Colman reviews one programming method and three econometric methods (two-stage procedures, directly-estimated supply

response systems, and directly-estimated partial commodity supply models) of supply response analysis. For this thesis, the focus is on the directly-estimated commodity supply model because the majority of agricultural supply-response models are subsumed by this category. Furthermore, the aggregate commodity supply estimation using time-series or pooled time-series cross-section data accounts for a substantial proportion of this type of model. Limitation occurs when using aggregated time-series data to estimate multiple outputs. This can lead to *ad hoc* models that do not strictly adhere to neo-classical theory. In addition, agricultural production is dependent on many factors throughout the year or in some cases several years, and production at a given period is highly dependent on past decisions. Therefore, extensive literature which derives specific functional forms and relevant variables for various supply response models exists.

Literature estimating the commodity demand is extensive, but it generally discusses model development and estimation of various demand systems (Teklu, 1988). Since the focus of this thesis is on illegal immigration and commodity trade and not commodity demand analysis, linear commodity demand models are estimated along the line of Timmer and Alderman (1979). They observe that even though consumer theory is derived from the individual or consumer household decision, empirical analysis uses per-capita estimation of aggregate market data. This approach results in individual consumer behavior being drastically distorted by the aggregation process. Consumer theory indicates the appropriate variables for demand estimations as shown in equation (11). These variables include own prices, cross prices, income, and other factors that influence demand. Timmer and Alderman derive the specific functional form through judgment

and empirical fit and eventually use a linear-demand function. They utilize the data from the Indonesian Socio-Economic Survey V (1979) for their analysis and estimate income and price elasticities for demand for food in Indonesia. For urban consumers, the rice demand elasticity with respect to income for the low-income group is 0.99 and for the high-income group is 0.07, and the price elasticity for the low-income group is -1.92 and for the high-income group is -0.74.

Following from the above studies and the theoretical analysis, the empirical model for the labor and commodity markets are given below.

Labor Market

The empirical specifications for labor market demand and supply functions are

(13) Demand: $L^D = \alpha_0 + \alpha_1 W + \alpha_2 P + \alpha_3 L^D_{t-1} + \alpha_4 V_1 + \alpha_5 V_2 + \alpha_6 V_3 + \alpha_7 T + \mu_1$

(14) Supply: $L^S = \beta_0 + \beta_1 W + \beta_2 L^S_{t-1} + \beta_3 NW + \beta_4 CL + \beta_5 UN + \beta_6 T + \mu_2$

where L^D is hired farm-labor employment, W is hired farm real wage rate, P is price of agricultural products, L^D_{t-1} is one-year lagged dependent variable, V_1 is number of farms, V_2 is an index of technology or productivity, V_3 is non-farm income, T is a trend variable, L^S is domestic farm-labor supply, L^S_{t-1} is lagged dependent variable, NW is an index of nonfarm wage rates deflated by CPI, CL is the size of the civilian labor force, and UN is unemployment rate.

Commodity Market

The empirical specifications for the commodity market demand and supply functions are

(15) $A^S = \gamma_0 + \gamma_1 P^S + \gamma_2 W + \gamma_3 \mathbf{G} + \mu_3$

(16) $A^D = \theta_0 + \theta_1 P^C + \theta_2 Y + \theta_3 \mathbf{H} + \mu_4$

where A^S is the quantity of agricultural products supplied, P^S is producer price including government support, W is the wage rate paid to laborers, $\mathbf{G}$ is a vector of input costs to produce agricultural products, A^D is the quantity of agricultural products consumed, P^C is consumer price, Y is personal disposable income, $\mathbf{H}$ is a vector of macroeconomic variables influencing demand for agricultural products.

Data

The following section discuss data and their sources for variables used in estimating the U.S. labor market, the U.S. commodity market, the Mexican labor market, and the Mexican commodity market. In addition, data sources for the price linkage equations connecting the U.S. consumer price and producer price, the Mexican consumer price and producer price, U.S. and Mexican market prices, and the wage linkage equations connecting the U.S. legal wage rate and illegal wage rate and the illegal wage rate and the Mexican unskilled wage rate are discussed. The data period used for the analysis is 1989-2007.

U.S. Labor Market

The U.S. labor market data is compiled for the following variables: agricultural labor; farm wage rates; total number of U.S. farms; non-farm wage rates for the manufacturing industry; total non-farm employees; and an index of agricultural prices received. The agricultural labor data is collected from the National Agricultural Statistics Service (NASS) of the U.S. Department of Agriculture. The NASS' quarterly Farm Labor report is used to compile these data (U.S. Department of Agriculture, 2008a). Agricultural labor data is obtained from the July report because this month is the peak

month for agricultural operations (Duffield and Coltrane, 1992). To account for the proportion of legal laborers working in agriculture, The National Agricultural Workers Survey of the U.S. Department of Labor (2008b) is utilized. For this survey, nearly 50,000 farm workers have been interviewed on a wide range of topics including wages paid and the legal status of the workers. This survey data is used to calculate the percentage of legal laborers working in agriculture. The total number of legal farm laborers (U.S. labor supply) is computed by multiplying the percentage of legal laborers by the July farm labor data provided by NASS. Furthermore, using this survey, the agricultural wage rate is calculated by averaging the legal workers wage rates for each year. Nominal variable are converted into real terms using the GDP deflator (U.S. Department of Commerce, 2008a). The GDP deflator is the most appropriate indicator of inflation over time because it allows for the basket of goods to change over time as the composition of GDP changes (Mankiw, 1992).

The total number of farms in operation in the United States is collected from the Quick Stats data base in the NASS website (U.S. Department of Agriculture, 2008b). Data for the total non-farm employment data and the non-farm wage rates for the manufacturing industry were retrieved from the Bureau of Labor Statistics of the U.S. Department of Labor (2008a).

The agricultural price received index is retrieved from NASS. The complete time series data set is not available from one source, but rather available from three different sources within NASS. For the period 1998-2007, the prices received index is collected from the Quick Stats data base, “Average Annual Index Numbers of Prices Received and Average Index Numbers of Prices Paid” (U.S. Department of Agriculture, 2008b). For

the period 1993-1998, this index is obtained from the Agricultural Prices annual report (U.S. Department of Agriculture, 2008c). And, for the period 1989-1993, the prices received index is retrieved from the Statistical Bulletin 917 published by NASS (U.S. Department of Agriculture, 2008d). The prices received index is adjusted by the Producer Support Estimate (PSE) to account for the subsidies paid to agricultural producers (Organization for Economic Co-Operation and Development, 2008).

U.S. Commodity Market

The variables used in estimation the U.S. commodity market are: the total value of crop production, U.S. exports to Mexico, U.S. net exports to the rest of the world, agricultural wage rate, prices received index, producer support estimate, consumer price index (CPI), and personal income. The total value of agricultural production, which is used to estimate the U.S. commodity supply, is compiled from the Economic Research Service of the U.S. Department of Agriculture (2008e). The domestic demand for U.S. agricultural commodities is computed as the total value of agricultural production minus the value of agricultural exports plus the value of agricultural imports. The value of agricultural exports and imports were collected from Foreign Agricultural Statistics of the U.S. Department of Agriculture (2008f). The data sources for the agricultural wage rate, prices received index, and PSE are described above. The personal income and the Food and Beverage CPI data were collected from the Bureau of Economic Analysis of the U.S. Department of Commerce (2008b and 2008c).

Mexican Labor Market

The variables used for the Mexican labor market include economically active population in agriculture, unskilled wage rate, and producer price indexes for agriculture,

manufacturing, and textiles. The economically active population in agriculture was collected from Food and Agricultural Organization of the United Nations (Food and Agricultural Organization, 2008c). Unskilled wage data is compiled from the Comision Nacional de los Salarios Minimos (2008) and is converted into real terms using the Mexican GDP deflator, which is collected from the International Monetary Fund (2008). The producer price index data for agriculture, manufacturing, and textiles is assembled from the Banco de Mexico (2008).

Mexican Commodity Market

The variables included in the Mexican commodity market are: value of agricultural production, Mexican net exports to the United States and the rest of the world, Mexican unskilled wage, agricultural prices paid and consumer price indexes, and GDP.

The total value of agricultural production, which is used to estimate the commodity supply, is collected from the Food and Agricultural Organization (2008a). Mexican demand for agricultural products is computed as total value of agricultural products minus the value of exports plus the value of imports. The data for the value of exports and imports were retrieved from Food and Agricultural Organization (2008b). Unskilled wage data is collected as described above and the agricultural consumer price index is compiled from the Banco de Mexico (Banco de Mexico, 2008). The GDP data is collected from the International Monetary Fund (2008).

Price Linkage Equations

The data collected for the price linkage equations includes the U.S. prices received index, U.S. food and beverage consumer price index, Mexican producers price

index, Mexican agricultural consumer price index, U.S.-Mexican exchange rate, and Mexican tariff schedule. The data source for the U.S. and Mexican prices received indexes and the U.S. and Mexican consumer prices indexes are collected as described above. The exchange rate data is collected from the Economics Research Service (U.S. Department of Agriculture, 2008g). The pre-NAFTA tariff rate (Congress, 1994) for all of agriculture is expressed as a weighted average of the tariff rates for the top 21 agricultural imports (in terms of value) by Mexico (U.S. Department of Agriculture, 2008f).[17] The average value of imports over the period 1990-1994 for each of the top 21 products is collected. The weights were computed as the ratio of the average value of imports for each individual product to the average value of imports for all products.

Wage Linkage Equations

Data collected for the wage linkage equations includes the U.S. agricultural wage rate, illegal wage rate, Mexican unskilled wage rate, the probability of an undocumented worker apprehended at the border, worksite enforcement budget, average employer fine for hiring an undocumented worker, and the probability of an illegal worker being caught domestically. Data source pertaining to the U.S. agricultural wage rate and the Mexican unskilled wage rate is described above. The illegal wage rate is calculated using the National Agricultural Worker Survey (NAWS), which reports wage rates for undocumented agricultural workers surveyed for each year. These wage rates are averaged over the number of undocumented workers surveyed to get a time series on illegal wage rate in agriculture. The probability of an illegal immigrant being

[17]The top 21 agricultural products by value are: grain sorghum, corn, wheat, rice, vegetable prepared or preserved, fresh vegetables except potatoes, dried beans, barley, vegetables frozen, fresh fruit, potatoes, vegetables dried dehydrated, fresh melons, dried peas, frozen fruit, oats, fresh fruit citrus, dried lentils, olives prepared or preserved, dried chickpeas, and rye.

apprehended at the border is the ratio of the total number of border apprehensions to the total number of undocumented workers attempting to enter the United States for the period 2006-2007 (U.S. Department of Homeland Security, 2007a). The total number of attempts is calculated by adding the total number of border apprehensions with the yearly net change in the unauthorized population in the United States, which is retrieved from the Population Estimates of the U.S. Department of Homeland Security (2007b). The worksite enforcement budget is provided by U.S. Immigration and Customs Enforcement (ICE). The average 2007 fine resulting from worksite raids is the ratio of the amount of money collected from criminal fines, restitutions, and civil judgment worksite enforcement cases to the total number of criminal arrests and administrative arrests resulting from ICE raids (U.S. Department of Homeland Security, 2008). The probability of an undocumented worker being caught is calculated using wage linkage equation for the U.S. legal and illegal wage rates. This probability is the ratio of the difference between the legal and the illegal wage rate to the average fine rate.

Empirical Methodology

Since the model contains a system of equations and the error terms across equations are likely to be correlated, estimating this system of equations using ordinary least squares techniques will result in inconsistent and biased estimates. Therefore, the three-stage least square (3SLS) estimation procedure is utilized to estimate the parameters in the system of equations. This estimation procedure involves three stages: 1) the reduced form model for each equation in the system is estimated and the fitted values for the endogenous variables are used as regressors to estimate the 2SLS parameters, 2) the 2SLS residuals for each equation are used to estimate the cross-

equation variance and covariance by applying the seeming unrelated procedure, and 3) the generalized least squares are applied to estimate the parameters in the system of equations (Pendyck and Rubinfeld, 1991). Thus, this system estimation leads to gain in efficiency. The system weighted R-Square from the 3SLS is 0.97, which indicates the variations in the endogenous variables are captured by the model.

Empirical Results

This section presents the empirical results for the agricultural labor markets and commodity markets in both countries. The econometric results for the U.S. agricultural labor market and commodity market are presented in Table 4.1, Mexican markets in Table 4.2, and variable definitions in Table 4.3.

U.S. Labor and Commodity Markets

The U.S. agricultural labor demand is estimated using the U.S. real wage rate, real producer price including subsidies, number of U.S. farms, and a binary variable as explanatory variables. The real wage rate and output price are important determinants of the labor demand, and the signs for the estimated coefficients adhere to the theoretical analysis elaborated in Chapter 3. The labor demand elasticity with respect to wage rate is very inelastic at -0.41, indicating that a one percent increase in the wage rate decreases labor demand by 0.41 percent. This elasticity is comparable to the elasticity of-0.85 reported by Hammonds, Yadav, and Vathana (1973), but more than that reported by Schuh (-0.12), and less than that reported by Duffield and Coltrane (-1.38), which is the only study that reported a relatively elastic wage elasticity. As expected, the estimated coefficient for producer price support is positive and significant at a 10 percent level. The labor demand elasticity with respect to output prices is relatively inelastic at 0.30,

Table 4.1: U.S. Agricultural Labor and Commodity Markets Estimates and Price and Wage Linkage Identities[a]

US Labor Demand

USALD = 194.26 – 61.02 USRLWR + 2.50 USRPRS + 0.43 USF + 90.91 D99
(0.22) (-2.16)** (1.93)* (1.40) (2.48)**
[-0.41] [0.30]

US Labor Supply

USALS = 1387.47 + 96.88 USRLWR – 54.52 USRMW – 6.35 USTNFE
(6.99)*** (3.51)*** (-3.59)*** (-2.44)***
[1.12] [-1.16]

US Agricultural Demand

USRVDAP = 200.11 – 0.49 USRFBCPI + 0.01 USRPI
(1.35) (-0.48) (2.69)**
[-0.43] [0.37]

US Agricultural Supply

USRVAP = 79.35 + 1.30 USNPRS – 4.86 USRLWR
(3.98)***(7.37)*** (-2.00)**
[0.80] [-0.16]

US Producer and Consumer Price Linkage

USRFBCPI = 139.70 + 0.25 USPR
(20.04)**(3.78)*

U.S. Real Legal and Illegal Wage Rate Identity

USRLWR = USRIWR + 0.0003(6072.87)

U.S. Net Exports to the Rest of the World

USNEROW = 37.75-0.14 USRFBCPI

[a]Values in parenthesis are t-ratios and values in brackets are elasticities.

*Significant at 10 percent level.

**Significant at 5 percent level.

***Significant at 1 percent level.

indicating a one percent increase in the prices received increases labor demand by 0.30 percent. This is comparable to the elasticity of 0.58 reported by Duffield and Coltrane, but slightly higher than the elasticity of 0.15 reported by Schuh. The estimated coefficient for the number of farms is positive. A dichotomous variable is created, one for the year 1999 and zero otherwise, to account for the sharp increase in labor use arising from a rise in unauthorized workers in agriculture in that year.

The U.S. agricultural labor supply estimation utilizes the real agricultural wage rate, real manufacturing wage rate, and total non-farm employment as regressors. The estimated results corroborate the theoretical predictions regarding the direction of the impacts of the variables and are significant at 5 percent level. The real wage rate is a fundamental determinant of labor supply. The supply elasticity with respect to the wage rate is elastic at 1.12, indicating labor supply increases by 1.12 percent to a one percent change in the wage rate. This elasticity is considerably more elastic than the supply elasticities reported by Schuh (0.25) and Duffield and Coltrane (0.36). As expected from the theory, wage rates in the other sector (manufacturing) exert a negative influence on agricultural labor supply. The cross-wage elasticity is also elastic at -1.16, which indicates a one percent increase in the manufacturing wage rate reduces the labor supply to agriculture by 1.16 percent. This result is consistent with outmigration of illegal labor from agriculture to construction during the housing boom in the early part of this decade. The negative estimated coefficient for the total non-farm employment indicates as employment rises in non-farm sectors, the labor supply to agriculture reduces. This result indicates during the economic boom, as experienced in the early part of this decade, agricultural workforce is pulled away to the manufacturing sector where the employment

is non-seasonal and steady work is readily available. Furthermore, non-farm employment provides opportunity for agricultural workers to move to urban areas where the amenities such as better education and recreation are readily available.

The U.S. agricultural commodity demand is estimated using real food and beverage CPI and real personal income as explanatory variables. The prices paid by consumers and personal income are essential determinants of commodity demand. The signs of the estimated coefficients are consistent with the theoretical expectations. The price elasticity of demand is inelastic at -0.43, indicating consumers of agricultural products lower their demand for an increase in prices. The income elasticity of demand is relatively inelastic at 0.37, which shows if income rises by one percent, then commodity demand increase by 0.37 percent. Demand elasticities for aggregate agricultural commodities are not available, but Timmer and Alderman (1979) report price elasticity of rice demand for urban population for the low income households at -1.92 and for the high income households at -0.74 and the income elasticity for the low income households at 0.99 and for the high income households at 0.07.

Prices received including subsidy and the real wage rates are critical determinants of commodity supply. These variables are used as regressors in the estimation of commodity supply. The estimated coefficients for both these variables are significant at 5 percent level. The supply elasticity is inelastic at 0.80, indicating a one percent rise in price leads to 0.80 percent rise in agricultural production. The commodity supply elasticity with respect to the wage rate is relatively inelastic at -0.16, implying supply decreases by 0.16 percent for a one percent increase in the wage rate.

The linkage equation for U.S. consumer-producer prices is necessary because, unlike in the theoretical model in Chapter 3, the empirical analysis distinguishes producer and consumer prices by accounting for transportation, processing costs, and market margins. As a result, prices received by farmers including subsidies are used in the supply estimation, while the food and beverage CPI is used in the demand estimation. To estimate the U.S. price linkage equation, the food and beverage CPI is regressed on the supply prices. The estimated coefficient for the supply prices is positive and significant at a 10 percent level. The estimated intercept is significant at a 1 percent level and positive, implying that there is a significant market margin between the producer and consumer prices.

The U.S. agricultural legal and illegal wage linkage equation illustrates the relationship between the U.S. legal wage rate and illegal wage rate, by accounting for the probability of illegal workers getting arrested and employer fines. As described in the Domestic and Border Enforcements section in the introduction chapter, in 2006, ICE drastically increased its focus on worksite raids. For example, in 2007, ICE carried out about 4900 criminal and administrative arrests, compared to just over 1200 in 2005 (U.S. Department of Homeland Security, 2008b). However, the probability of an undocumented worker or an employer getting arrested remains very low. This probability is even lower for the agricultural sector because farms are widely spread throughout the country, and they are in remote locations. In fact, according to ICE news, no farm operations have been raided since the increase worksite enforcement in 2006 (U.S. Department of Homeland Security, 2008c). The average fine for hiring an undocumented worker is $6073. Because farm employers penalize undocumented

workers by offering lower wage rates based on their perceived risk, the wage gap between the agricultural legal and illegal wage rate is captured by the aforementioned probability (which is a function of the budget for worksite raids) and the average employer fine per undocumented worker.

Mexican Labor and Commodity Markets

The econometric results for the Mexican agricultural labor market and commodity market and also the equilibrium conditions for labor and commodity markets are presented in Table 4.2. The Mexican labor demand estimation utilizes real wage rate, real agricultural producer price index, and real textile producer price index as explanatory variables. As derived in the theoretical analysis, the wage and price variables are key determinants of labor demand. The signs for the estimated coefficients support the theoretical specification. Both the real wage rate and the textile producer price index are significant at 5 percent level. The labor demand elasticity with respect to the wage rate is at -0.10. This is considerably more inelastic than the average estimated international labor demand wage elasticity (-0.42) as reported by Espey and Thilmany (2000). The agricultural producer price elasticity is very inelastic at 0.004, meaning the Mexican labor demand rises by an insignificant amount when producer prices increase. The estimated coefficient for textile prices is positive, indicating when textile prices rise, cotton production increases which augment demand for all agricultural inputs including labor. The elasticity of labor demand with respect to textile prices is very inelastic at 0.13, implying that the increase in labor demand is small when textile prices increase.

Table 4.2: Mexican Agricultural and Labor Market Estimates and Price and Wage Linkage Identities[a]

Mexican Labor Demand

MALD = 8316.76 – 18.77 MRW + 0.39 MRAPPI + 10.32 MRTPPI
(59.92)***(-5.34)*** (0.23) (5.96)***
[-0.10] [0.004] [0.13]

Mexican Agricultural Demand

MRVDAP = 1227.66 – 17.87 MACPI + 0.13 MGDP
(23.24)***(-9.24)*** (5.38)***
[-2.46] [1.09]

Mexican Agricultural Supply

MRVAP = 375.97 + 0.77 LMRVAP + 2.05 MRAPPI – 1.97 MW – 4.87 MRMPPI
(1.69) (18.18)*** (1.80)* (-1.57) (-2.97)***
[0.40] [-0.11]

Mexican Producer and Consumer Price Linkage

MRAPPI = 21.74 + 0.72 MRACPI
(1.79)* (6.54)***

U.S. and Mexican Price Linkage Identity

MRACPI = USRFBCPI (ER) (1+T) + TC

Mexican Illegal Wage Identity

MRW = (1-0.61)(1-0.21) USRIWR + 0.61(1-0.21) MRW
MRW = ψ USRIWR = 0.59 USRIWR

Labor Market Equilibrium

USALD-USALS = ψ (MALS-MALD)

Commodity Market Equilibrium

USRVAP + USRIREM – USREREM – USRVDAP = (ER) MRVDAP + MREREUS – MRIREUS - (ER)MRVAP

[a]Values in parenthesis are t-ratios and values in brackets are elasticities.

*Significant at 10 percent level.

**Significant at 5 percent level.

***Significant at 1 percent level.

Table 4.3: Variable Definitions

USALD	U.S. July Farm Employment
USRLWR	U.S. Real Legal Wage Rate
USRPRS	Real Price Received by Farmers including the Producer Subsidy Estimate
USF	Number of Farms in the United States
D99	Binary Variable for the year 1999
USALS	U.S. July Legal Farm Employment
USRMW	U.S. Real Manufacturing Wage
USTNFE	Total Non-Farm Employment
USRVDAP	U.S. Real Value of Agricultural Product Demand
USRFBCPI	U.S. Real Food and Beverage CPI
USRPI	U.S. Real Personal Income
USRVAP	U.S. Real Value of Agricultural Production
USNPRS	U.S. Nominal Price Received by Farmers including PSE
USPR	U.S. Price Received
USIWR	U.S. Illegal Wage Rate
USNEROW	U.S. Net Exports to the Rest of the World
LMRVAP	Lagged Mexican Real Value of Agricultural Production
MRVAP	Mexican Real Value of Agricultural Production
MRAPPI	Mexican Real Agricultural PPI
MW	Mexican Wage Rate
MRMPPI	Mexican Real Manufacturing PPI
MRVDAP	Mexican Real Value of Agricultural Production Demanded
MACPI	Mexican Agricultural CPI
MGDP	Mexican GDP
MALD	Mexican Total Employment in Agriculture
MALS	Mexican Agricultural Labor Supply
MRW	Mexican Real Wage Rate
MRAPPI	Mexican Real Agricultural PPI
MRTPPI	Mexican Real Textile PPI
MRACPI	Mexican Real Agricultural CPI
ER	Exchange Rate between the United States and Mexico
T	Mexican Tariff Rate
TC	Transportation Costs
USRIREM	U.S. Real Imports from the Rest of the World Excluding Mexico
USREREM	U.S. Real Exports to the Rest of the World Excluding Mexico
MREREUS	Mexican Real Exports to the Rest of the World Excluding U.S.
MRIREUS	Mexican Real Imports from the Rest of the World Excluding U.S.

The Mexican agricultural commodity demand is estimated using the agricultural CPI and GDP as explanatory variables, and the estimated coefficients confirm the theoretical predictions. The estimated coefficients for both the variables are significant at the 5 percent level. The commodity demand elasticities with respect to the agricultural CPI and GDP are -2.46 and 1.09, respectively. The price elasticity is elastic, implying that a one percent increase in prices reduces the consumption by 2.46 percent. The nearly unitary income elasticity reflects the commodity demand increases 1.09 percent when income increases by one percent.

The explanatory variables used for estimating the Mexican agricultural commodity supply are the lagged dependent variable, agricultural producer price index, wage rate, and manufacturing producer price index. As expounded in the theoretical discussion, the agricultural commodity prices, wage rate, and input prices are important determinants for estimating commodity supply, and the estimated coefficients support the theoretical prediction. Production in a given year is highly dependent on the level of last year production because of the inflexibility in switching the crop pattern in developing countries such as Mexico. Because of this inflexibility, the lagged dependent variable is included in the estimation, and the estimated coefficient for this variable is highly significant. The elasticity of agricultural commodity supply with respect to the producer price and wage rate are 0.40 and -0.11, respectively. The inelastic price elasticity shows that a 1 percent increase in the commodity price raises the commodity supply by 0.40 percent. The inelastic wage elasticity reflects the minimal reduction in commodity supply when the wage rate increases. An input price index is not available for Mexican

agricultural production; therefore, the manufacturing producer price index is used as a proxy for prices of inputs such as fertilizer, pesticides, and machineries.

The U.S.-Mexican price linkage equation is constructed to show the relationship between the Mexican agricultural CPI and the U.S. agricultural CPI after taking into account the exchange rate, ad valorem tariff imposed by Mexico, and transportation cost between the countries. The ad valorem tariff is included in the model because the trade liberalization under NAFTA calls for removal of the tariff, which can be used to examine the effect of trade liberalization on commodity trade and labor migration.

The linkage equation for Mexican producers-consumer prices is needed to account for the transportation, processing costs, and market margins. The estimated coefficient for the consumer price is positive as expected and is significant at 5 percent level. The estimated intercept is significant and positive, implying there exists considerable market margins between the producer and consumer prices.

The linkage equation for the Mexican unskilled wage rate and illegal wage rate in the United States explains the connection between these two wage rates by accounting for the probability an illegal immigrant is detained while attempting to cross the border and the time an illegal immigrant wastes during migration. Since late 2001, the U.S. government has drastically increased its border enforcement efforts for national security reasons, particularly on the southern border. As a result, the probability of an undocumented worker being apprehended is 60 percent. Furthermore, 20 percent of an immigrant's total work time is wasted while attempting to emigrate from Mexico to the United States. Given these statistics, the price wedge coefficient ψ indicates that the Mexican wage rate is 60 percent of the illegal wage rate.

Simulation Results

This section presents the simultaneous-equation simulation model to examine the effects of changes in the policy variables on the endogenous variables for the *ex post* simulation over the period 1994 to 2007. Using the historical values of the policy variables, a benchmark simulation is run. Seven alternate scenarios are run: NAFTA, U.S. farm policy, two immigration policies (domestic enforcement and border control), two economic policies (U.S. and Mexican income growths), and Mexico's labor endowment. Comparisons of alternate scenarios to the benchmark provide the effects of these various policies. Furthermore, the lagged dependent variable in the Mexican commodity supply causes the current year values to influence subsequent values; this adds a dynamic element to the analysis. Due to the strong interrelationships in the model, the repercussions of changes in exogenous policy variables are felt throughout the labor and commodity markets in both countries. The model predicts changes in U.S. and Mexican commodity demand and supply, prices received by U.S. and Mexican producers, prices paid by consumers, U.S. labor supply and demand, Mexican labor demand, U.S. illegal wage rate, U.S. legal wage rate, Mexican wage rate, and labor and trade flows. In the interest of brevity and thesis focus, the following discussion is centered more on illegal wage rate, consumer price, and labor and trade flows.

NAFTA Effect

In this analysis, the baseline incorporates the reduction of the tariff rate from 71 percent in 1994 to zero percent in 2007, as phased out under NAFTA. In the alternate scenario, the tariff was reduced linearly from 0.71 at the beginning of the simulation period to 0.36 in 2004, resembling fairly close to the Uruguay Round tariff schedule for

developing countries, and from 0.36 in 2004 to 0.1 in 2007. Thus, the alternate scenario predicts the effects on endogenous variables if the tariff was not cut as deeply as that under NAFTA. Comparison of the alternate to the baseline scenarios provides the analysis for the impacts of NAFTA. The simulation results, presented in Table 4.4.1, are consistent with the theoretical predictions. Specifically, the higher tariff under the alternate scenario leads to a decrease in Mexico's excess demand because agricultural products are taxed higher as they enter Mexico, causing U.S. exports to Mexico to decrease, as shown in the theoretical analysis. The simulation results show, the net change in trade for 1994 is $ -0.29 billion, which is further exacerbated to $ -17.10 billion by the end of NAFTA. The reduction in exports causes U.S. commodity price to decrease, ranging from -0.03 percent in 1994 to -1.50 percent in 2007. In response to lower market prices, U.S. producer price also falls. Because of this lower price, U.S. commodity supply decreases and demand increases. As imports are restricted by Mexico, the commodity price in Mexico increases, which causes supply to rise and demand to fall. In response to higher trade barriers and lower imports by Mexico in the alternate scenario, U.S. diverts its exports to rest of the world.

As a result of the higher tariff in the alternate scenario, the U.S. producer price declines and U.S. famers curtail their production, leading to lower demand for farm workers. As shown in Table 4.4.2, the U.S. labor demand decreases from -0.04 percent in 1994 to -1.70 percent in 2007. This decreases the legal farm wage rate and the illegal wage rate for immigrant workers, as predicted by the theoretical analysis. The illegal wage rate decreases from -0.06 percent in 1994 to -1.83 percent in 2007. In response to this lower illegal wage rate, fewer illegal immigrants enter into the United States because

Table 4.4.1: Baseline Estimates and NAFTA's Impact on the U.S. and Mexican Agricultural Markets

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
US Ag. Dd (billion $)	161.91	168.07	178.45	185.62	182.71	176.35	184.14	193.89	189.76	202.91	222.41	232.95	234.30	265.73
Impact (%)	0.02	0.04	0.07	0.10	0.14	0.20	0.24	0.29	0.35	0.40	0.43	0.48	0.56	0.56
US Ag. Sy (billion $)	182.18	198.26	206.41	206.46	201.26	188.40	195.74	208.78	203.08	219.30	235.88	237.00	242.16	287.35
Impact (%)	-0.14	-0.32	-0.57	-0.89	-1.27	-1.86	-2.33	-2.69	-3.35	-3.72	-4.14	-4.80	-5.50	-5.29
Mexican Ag. Dd (billion p)	216.23	232.03	235.55	240.25	244.55	253.49	249.97	262.48	267.45	276.47	284.87	277.45	273.93	285.39
Impact (%)	-0.10	-0.65	-1.96	-3.71	-6.67	-10.88	-15.65	-18.92	-24.29	-33.64	-43.29	-51.41	-61.36	-68.06
Mexican Ag. Sy (billion p)	210.26	219.90	224.34	235.05	227.11	244.87	250.65	258.78	255.98	257.04	246.49	276.99	264.81	271.91
Impact (%)	0.03	0.15	0.34	0.54	0.88	1.20	1.49	1.73	2.15	2.82	3.63	3.55	4.20	4.58
US Food CPI (index)	146.89	147.68	152.01	159.09	159.40	165.20	169.33	174.68	178.27	180.43	185.69	189.30	196.29	201.31
Impact (%)	-0.03	-0.09	-0.16	-0.23	-0.32	-0.43	-0.54	-0.64	-0.76	-0.90	-1.05	-1.20	-1.35	-1.50
US Price Received (index)	103.46	103.70	110.31	107.66	103.57	93.04	95.17	100.29	97.40	110.15	116.44	112.64	115.74	134.87
Impact (%)	-0.22	-0.54	-0.92	-1.46	-2.08	-3.13	-3.89	-4.44	-5.44	-5.64	-6.20	-7.22	-7.95	-7.57
Mexican Ag. CPI (index)	30.48	39.85	56.47	69.31	77.59	89.68	93.00	97.19	101.90	106.77	114.09	119.37	126.65	130.55
Impact (%)	0.15	0.55	0.91	1.21	1.72	2.18	2.66	3.06	3.57	4.49	5.19	5.44	5.79	6.28
Mexican PPI (index)	30.13	37.26	51.88	63.13	71.11	82.13	82.19	90.77	92.60	97.73	108.03	113.24	119.70	123.43
Impact (%)	0.11	0.42	0.72	0.97	1.36	1.73	2.18	2.37	2.85	3.56	3.97	4.16	4.44	4.82
US Net Exports to ROW (bil $)	15.77	25.61	24.01	19.01	14.60	10.42	10.57	12.70	10.76	13.34	9.34	3.20	5.51	17.68
Impact (%)	0.04	0.07	0.13	0.27	0.48	0.92	1.18	1.21	1.73	1.67	2.86	9.70	6.57	2.34
Net Exports to Mex. (billion $)	4.50	4.59	3.96	1.83	3.95	1.63	1.02	2.20	2.56	3.04	4.14	0.85	2.35	3.94
Impact (billion $)	-0.29	-0.71	-1.32	-2.07	-2.87	-3.95	-5.13	-6.33	-7.67	-9.19	-11.00	-12.81	-14.98	-17.10

Table 4.4.2: Baseline Estimates and NAFTA's Impact on the U.S. and Mexican Labor Markets

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
US Lablor Dd (1000s)	1091.19	1057.96	1010.91	1082.74	1054.05	1090.65	1031.74	1015.46	972.89	966.03	964.95	941.84	884.29	841.28
Impact (%)	-0.04	-0.10	-0.18	-0.26	-0.36	-0.46	-0.60	-0.72	-0.87	-1.01	-1.15	-1.28	-1.49	-1.70
US Labor Sy (1000s)	666.61	655.02	578.72	549.47	570.06	577.85	521.94	486.86	477.88	470.84	497.22	467.87	410.96	399.45
Impact (%)	-0.05	-0.12	-0.24	-0.39	-0.50	-0.67	-0.93	-1.17	-1.40	-1.62	-1.73	-2.02	-2.52	-2.80
Mexican Labor Dd (1000s)	8663.40	8647.44	8664.86	8660.29	8627.25	8583.09	8642.34	8623.26	8629.06	8591.94	8580.58	8539.83	8471.44	8518.32
Impact (%)	0.00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.04
US Legal Wage Rate ($)	5.70	6.04	5.76	5.96	6.60	7.19	7.71	7.24	7.47	7.79	8.08	8.29	8.80	9.17
Impact (%)	-0.06	-0.12	-0.23	-0.35	-0.43	-0.54	-0.65	-0.83	-0.96	-1.08	-1.20	-1.33	-1.42	-1.51
US Illegal Wage Rate ($)	5.59	5.92	5.63	5.81	6.43	6.70	7.00	6.96	7.10	7.29	7.41	7.39	7.59	7.56
Impact (%)	-0.06	-0.13	-0.24	-0.36	-0.44	-0.58	-0.71	-0.87	-1.01	-1.15	-1.31	-1.49	-1.64	-1.83
Mexican Wage rate (p)	13.99	16.81	21.98	24.63	30.22	32.11	35.41	37.59	39.85	41.78	43.46	45.17	47.22	48.95
Impact (%)	0.00	-0.01	-0.02	-0.03	-0.04	-0.06	-0.08	-0.09	-0.11	-0.13	-0.15	-0.16	-0.18	-0.19
Illegal Immigration (1000)	424.58	402.94	432.20	533.27	483.99	512.80	509.80	528.60	495.00	495.19	467.73	473.97	473.33	441.83
Impact (%)	-0.02	-0.06	-0.11	-0.12	-0.18	-0.23	-0.27	-0.30	-0.37	-0.44	-0.53	-0.55	-0.60	-0.70

of the reduced pull effect. Furthermore, as Mexican farm prices rise in response to larger trade barriers in the alternate scenario, agricultural production and labor demand increase in Mexico. Specifically, the empirical results show that Mexico's labor demand increases marginally by the end of the NAFTA period, which further contracts the emigration out of Mexico because of the reduced push effect. The results show that the unauthorized entry into U.S. agriculture in 2007 fell by about 3093 laborers.

These results show that NAFTA actually enhanced the illegal entry, rather than reducing it as predicted by the NAFTA proponents. The rationale for this contradictory result is that NAFTA is not a complete free trade because U.S. did not remove its farm subsidies, which is the topic of discussion next.

Subsidy Effect

The baseline scenario for the U.S. farm support analysis is run using the historical farm support as measured by the producer subsidy estimate (PSE). In the alternate scenario, the subsidy is phased out linearly by 7.14 percent per year from 1993 to 2007. Comparing the alternate scenario to the baseline offers insight into the impacts of lowering the farm supports. A subsidy reduction causes the U.S. commodity supply to decline and contracts the U.S. exports to Mexico, as illustrated in the theoretical analysis. The U.S. commodity supply declines by an average of about 2.0 percent per year over the simulation period. The results show that real value of exports decline by an average of $3.42 billion over the simulation period (Table 4.5.1). U.S. exports to the rest of the world also decline by an average of about 4 percent. The reduced U.S. supply and lower exports to Mexico result in higher consumer prices both in the United States and in Mexico, which is consistent with the theoretical results. The U.S. consumer price

Table 4.5.1: Baseline Estimates and the Impact of Farm Supports on the U.S. and Mexican Agricultural Markets

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
US Ag. Dd (billion $)	161.91	168.07	178.45	185.62	182.71	176.35	184.14	193.89	189.76	202.91	222.41	232.95	234.30	265.73
Impact (%)	-0.05	-0.07	-0.13	-0.16	-0.33	-0.47	-0.48	-0.51	-0.49	-0.42	-0.46	-0.47	-0.39	-0.33
US Ag. Sy (billion $)	182.18	198.26	206.41	206.46	201.26	188.40	195.74	208.78	203.08	219.30	235.88	237.00	242.16	287.35
Impact (%)	-0.16	-0.24	-0.50	-0.74	-1.59	-2.55	-2.78	-2.92	-2.91	-2.51	-2.89	-3.09	-2.51	-2.01
Mexican Ag. Dd (billion p)	216.23	232.03	235.55	240.25	244.55	253.49	249.97	262.48	267.45	276.47	284.87	277.45	273.93	285.39
Impact (%)	-0.07	-0.29	-1.11	-2.03	-5.67	-10.30	-13.12	-14.44	-14.91	-16.22	-21.71	-23.76	-20.11	-18.52
Mexican Ag. Sy (billion p)	210.26	219.90	224.34	235.05	227.11	244.87	250.65	258.78	255.98	257.04	246.49	276.99	264.81	271.91
Impact (%)	0.02	0.07	0.19	0.29	0.75	1.14	1.26	1.33	1.33	1.37	1.83	1.65	1.39	1.26
US Food CPI (index)	146.89	147.68	152.01	159.09	159.40	165.20	169.33	174.68	178.27	180.43	185.69	189.30	196.29	201.31
Impact (%)	0.12	0.16	0.30	0.39	0.76	1.02	1.07	1.14	1.06	0.95	1.12	1.17	0.93	0.88
US Price Received (index)	103.46	103.70	110.31	107.66	103.57	93.04	95.17	100.29	97.40	110.15	116.44	112.64	115.74	134.87
Impact (%)	0.75	1.01	1.79	2.44	4.90	7.50	7.69	7.87	7.56	5.93	6.61	7.03	5.51	4.43
Mexican Ag. CPI (index)	30.48	39.85	56.47	69.31	77.59	89.68	93.00	97.19	101.90	106.77	114.09	119.37	126.65	130.55
Impact (%)	0.10	0.25	0.52	0.66	1.46	2.07	2.23	2.33	2.19	2.17	2.60	2.51	1.90	1.71
Mexican PPI (index)	30.13	37.26	51.88	63.13	71.11	82.13	82.19	90.77	92.60	97.73	108.03	113.24	119.70	123.43
Impact (%)	0.07	0.19	0.41	0.53	1.15	1.64	1.83	1.81	1.75	1.72	1.99	1.92	1.45	1.31
US Net Exports to ROW (bil $)	15.77	25.61	24.01	19.01	14.60	10.42	10.57	12.70	10.76	13.34	9.34	3.20	5.51	17.68
Impact (%)	-0.15	-0.13	-0.26	-0.44	-1.13	-2.21	-2.34	-2.15	-2.41	-1.76	-3.04	-9.45	-4.55	-1.37
Net Exports to Mex. (billion $)	4.50	4.59	3.96	1.83	3.95	1.63	1.02	2.20	2.56	3.04	4.14	0.85	2.35	3.94
Impact (billion $)	-0.19	-0.32	-0.75	-1.14	-2.44	-3.74	-4.31	-4.83	-4.71	-4.43	-5.52	-5.92	-4.91	-4.66

increases by an average of about 0.8 percent over the baseline. As the consumer/market prices increase, price received by the farmers from the open market also increase. Because of the higher consumer price, commodity demand declines in both countries.

The decline in U.S. commodity supply leads to lower demand for labor, which causes both the U.S. legal wage rate and the illegal wage rate to fall, as illustrated in the theoretical analysis. The decline in the illegal wage rate is on average 0.65 percent (Table 4.5.2). As a result of this wage decline, the flow of illegal immigrants to U.S. agriculture falls by an average of 0.20 percent or about 1000 illegal immigrants. As more Mexican workers remain in Mexico and prices received by farmers increase, Mexican production also increases.

The empirical results corroborate the theoretical findings that a reduction in U.S. farm subsidy leads to less saturation of Mexican markets with U.S. exports. Consequently, Mexican commodity prices are not depressed and Mexican farmers continue to produce and also effectively compete with U.S. exports. As a result they are not displaced and only fewer Mexicans tend to migrate to the United States. Therefore, phasing out the U.S. farm subsidies will help to curb illegal immigrants flow. Furthermore, the impacts of NAFTA and farm subsidy scenarios indicate that liberalizing agricultural trade without phasing out the U.S. farm subsidies hurts Mexican farmers.

Domestic Enforcement Effect

The baseline for the domestic enforcement analysis is run using the domestic enforcement expenditure as the gauge for the level of worksite enforcement. The alternate scenario is run with a 10 percent increase in the expenditure budget over the baseline. Comparing the alternate scenario to the baseline offers insight into the impacts

Table 4.5.2: Baseline Estimates and the Impact of Farm Supports on the U.S. and Mexican Labor Markets

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
US Lablor Dd (1000s)	1091.19	1057.96	1010.91	1082.74	1054.05	1090.65	1031.74	1015.46	972.89	966.03	964.95	941.84	884.29	841.28
Impact (%)	-0.04	-0.07	-0.16	-0.21	-0.44	-0.62	-0.71	-0.77	-0.75	-0.68	-0.79	-0.81	-0.67	-0.64
US Labor Sy (1000s)	666.61	655.02	578.72	549.47	570.06	577.85	521.94	486.86	477.88	470.84	497.22	467.87	410.96	399.45
Impact (%)	-0.06	-0.09	-0.22	-0.33	-0.66	-0.94	-1.14	-1.31	-1.25	-1.13	-1.24	-1.33	-1.18	-1.09
Mexican Labor Dd (1000s)	8663.40	8647.44	8664.86	8660.29	8627.25	8583.09	8642.34	8623.26	8629.06	8591.94	8580.58	8539.83	8471.44	8518.32
Impact (%)	0.00	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.01	0.01
US Legal Wage Rate ($)	5.70	6.04	5.76	5.96	6.60	7.19	7.71	7.24	7.47	7.79	8.08	8.29	8.80	9.17
Impact (%)	-0.07	-0.10	-0.22	-0.30	-0.56	-0.77	-0.80	-0.93	-0.86	-0.75	-0.86	-0.88	-0.66	-0.59
US Illegal Wage Rate ($)	5.59	5.92	5.63	5.81	6.43	6.70	7.00	6.96	7.10	7.29	7.41	7.39	7.59	7.56
Impact (%)	-0.07	-0.10	-0.22	-0.31	-0.58	-0.82	-0.88	-0.96	-0.90	-0.80	-0.94	-0.98	-0.77	-0.71
Mexican Wage rate (p)	13.99	16.81	21.98	24.63	30.22	32.11	35.41	37.59	39.85	41.78	43.46	45.17	47.22	48.95
Impact (%)	-0.01	-0.01	-0.02	-0.03	-0.05	-0.09	-0.09	-0.10	-0.09	-0.09	-0.11	-0.11	-0.08	-0.07
Illegal Immigration (1000)	424.58	402.94	432.20	533.27	483.99	512.80	509.80	528.60	495.00	495.19	467.73	473.97	473.33	441.83
Impact (%)	-0.02	-0.04	-0.07	-0.08	-0.19	-0.26	-0.27	-0.27	-0.27	-0.25	-0.31	-0.30	-0.23	-0.23

of tighter domestic enforcement on the illegal wage rate, illegal labor flow, agricultural trade flows, the U.S. consumer price, and other endogenous variables. Greater spending on domestic enforcement reduces the illegal labor demand, as employers are concerned about federal government's sanctions, including heavy fines and jail time. The results show that the decline in labor demand is more pronounced in the recent years, which is consistent with current events, i.e., stricter workplace raids have not only led to curtailing of illegal employment, but also undocumented workers are returning to Mexico. For example, Camarota and Jensenius (2008) report illegal immigrants are leaving the United States voluntarily. Because of the heightened workplace raids, the wedge between U.S. legal wage rate and illegal wage rate widens. Specifically, as the demand for illegal labor declines, the illegal wage rate for farm workers also declines. The simulation results in Table 4.6.1 show that a 10 percent increase in domestic expenditure reduces the illegal wage rate on average by 11.49 percent. Since 2002, particularly after 2005, the government has drastically increased domestic expenditure; therefore, a 10 percent increase in the expenditure reduces the illegal wage rate by 36.11 in 2006 and 55.23 in 2007, which is a significantly larger decline than in 1994, when the illegal wage rate fell only by 0.18 percent. The lower labor demand and depressed illegal wage rate reduced the illegal agricultural labor flow by 9.12 percent or about 42,000 illegal immigrants in 2007. This result is consistent with a recent survey conducted by the National Statistics and Geography Institute, which reports a 42 percent drop in total Mexican immigration (Olson, 2008).

The lower labor demand reduces the U.S. agricultural production. As U.S. production declines, fewer farm products are exported to Mexico. As shown in Table

Table 4.6.1: Baseline Estimates and the Impact of Domestic Enforcement on the U.S. and Mexican Labor Markets

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
US Lablor Dd (1000s)	1091.19	1057.96	1010.91	1082.74	1054.05	1090.65	1031.74	1015.46	972.89	966.03	964.95	941.84	884.29	841.28
Impact (%)	0.00	-0.01	-0.02	-0.03	-0.04	-0.05	-0.08	-0.12	-0.20	-0.31	-0.47	-0.72	-1.15	-1.80
US Labor Sy (1000s)	666.61	655.02	578.72	549.47	570.06	577.85	521.94	486.86	477.88	470.84	497.22	467.87	410.96	399.45
Impact (%)	0.01	0.03	0.06	0.09	0.13	0.18	0.26	0.44	0.69	1.07	1.53	2.44	4.13	6.30
Mexican Labor Dd (1000s)	8663.40	8647.44	8664.86	8660.29	8627.25	8583.09	8642.34	8623.26	8629.06	8591.94	8580.58	8539.83	8471.44	8518.32
Impact (%)	0.00	0.00	0.01	0.01	0.01	0.02	0.03	0.04	0.06	0.09	0.14	0.21	0.32	0.47
US Legal Wage Rate ($)	5.70	6.04	5.76	5.96	6.60	7.19	7.71	7.24	7.47	7.79	8.08	8.29	8.80	9.17
Impact (%)	0.01	0.03	0.06	0.08	0.11	0.14	0.18	0.31	0.48	0.71	1.07	1.61	2.33	3.40
US Illegal Wage Rate ($)	5.59	5.92	5.63	5.81	6.43	6.70	7.00	6.96	7.10	7.29	7.41	7.39	7.59	7.56
Impact (%)	-0.18	-0.40	-0.75	-1.14	-1.50	-2.03	-2.69	-4.34	-6.69	-10.15	-15.51	-24.10	-36.11	-55.23
Mexican Wage rate (p)	13.99	16.81	21.98	24.63	30.22	32.11	35.41	37.59	39.85	41.78	43.46	45.17	47.22	48.95
Impact (%)	-0.01	-0.04	-0.06	-0.10	-0.14	-0.21	-0.29	-0.45	-0.70	-1.11	-1.73	-2.64	-3.93	-5.81
Illegal Immigration (1000)	424.58	402.94	432.20	533.27	483.99	512.80	509.80	528.60	495.00	495.19	467.73	473.97	473.33	441.83
Impact (%)	-0.03	-0.07	-0.12	-0.15	-0.24	-0.31	-0.43	-0.65	-1.06	-1.62	-2.60	-3.84	-5.74	-9.12

Table 4.6.2: Baseline Estimates and the Impact of Domestic Enforcement on the U.S. and Mexican Agricultural Markets

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
US Ag. Dd (billion $)	161.91	168.07	178.45	185.62	182.71	176.35	184.14	193.89	189.76	202.91	222.41	232.95	234.30	265.73
Impact (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01	-0.02
US Ag. Sy (billion $)	182.18	198.26	206.41	206.46	201.26	188.40	195.74	208.78	203.08	219.30	235.88	237.00	242.16	287.35
Impact (%)	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.02	-0.03	-0.05	-0.07	-0.11	-0.17	-0.26	-0.33
Mexican Ag. Dd (billion p)	216.23	232.03	235.55	240.25	244.55	253.49	249.97	262.48	267.45	276.47	284.87	277.45	273.93	285.39
Impact (%)	0.00	0.00	0.00	-0.01	-0.02	-0.03	-0.04	-0.06	-0.11	-0.20	-0.34	-0.51	-0.77	-1.11
Mexican Ag. Sy (billion p)	210.26	219.90	224.34	235.05	227.11	244.87	250.65	258.78	255.98	257.04	246.49	276.99	264.81	271.91
Impact (%)	0.00	0.00	0.01	0.01	0.03	0.05	0.08	0.13	0.23	0.40	0.73	1.08	1.83	2.80
US Food CPI (index)	146.89	147.68	152.01	159.09	159.40	165.20	169.33	174.68	178.27	180.43	185.69	189.30	196.29	201.31
Impact (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.04	0.05
US Price Received (index)	103.46	103.70	110.31	107.66	103.57	93.04	95.17	100.29	97.40	110.15	116.44	112.64	115.74	134.87
Impact (%)	0.00	0.00	0.01	0.01	0.01	0.02	0.02	0.04	0.05	0.07	0.10	0.15	0.21	0.26
Mexican Ag. CPI (index)	30.48	39.85	56.47	69.31	77.59	89.68	93.00	97.19	101.90	106.77	114.09	119.37	126.65	130.55
Impact (%)	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.03	0.04	0.05	0.07	0.10
Mexican PPI (index)	30.13	37.26	51.88	63.13	71.11	82.13	82.19	90.77	92.60	97.73	108.03	113.24	119.70	123.43
Impact (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.03	0.04	0.06	0.08
US Net Exports to ROW (bil $)	15.77	25.61	24.01	19.01	14.60	10.42	10.57	12.70	10.76	13.34	9.34	3.20	5.51	17.68
Impact (%)	0.00	0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.02	-0.02	-0.05	-0.20	-0.17	-0.08
Net Exports to Mex. (billion $)	4.50	4.59	3.96	1.83	3.95	1.63	1.02	2.20	2.56	3.04	4.14	0.85	2.35	3.94
Impact (%)	-0.03	-0.07	-0.15	-0.57	-0.40	-1.44	-3.42	-2.64	-3.66	-4.78	-5.55	-43.46	-24.75	-22.67

4.6.2, the agricultural trade flow is reduced by 0.03 percent in 1994 and 22.67 percent in 2007. This is consistent with the larger decline of illegal labor employment in recent years. The decline in U.S. supply and lower exports to Mexico causes the consumer price to increase in both countries. Because migrant farm workers are returning back into Mexican agricultural employment, Mexican farm supply increases.

The results confirm the theoretical findings that an increase in the worksite enforcement will deter employers from hiring illegal immigrants. However, this policy reduces trade between the countries. Thus, domestic enforcement has a tradeoff between curbing the undocumented workers versus lower agricultural production and exports.

Border Enforcement Effect

The impact of border control can be analyzed using enforcement spending or man hours patrolling the border. Both these variables have an impact on border apprehensions. Consequently, in this study, the probability of border apprehension is used as the policy variable to stem the flow of immigrants. The baseline is run using a border apprehension probability (d) increasing from 0.30 in 1994 to 0.40 in 2001, which reflects a fairly porous border. To account for the increase in border security after 9/11, d increases from 0.50 in 2002 to 0.60 in 2007. The value of 0.60 for d in 2007 was calculated based on the actual data. The alternate scenario is run by considering heightened border enforcement because of increased illegal immigration and national security concerns, which are evident from the larger budget allocation for border fencing and also minuteman operations monitoring the border. Thus, d is set at 0.60 in the alternate scenario. Thus, comparing the alternate scenario to the baseline offers insight into the effect of heightened border security on the endogenous variables.

As the probability of apprehension of illegal immigrants at the border increases, the flow of undocumented workers into the United States lessens. As shown by Table 4.7.1, if the border security level in 1994 is same as the security level in 2007, then the inflow of undocumented workers would have declined by 2.96 percent or about 12,950 in 1994. This large decline in illegal immigrant flow holds during much of the 1990s. These results are consistent with the real world occurrences. For instance, the National Statistics and Geography Institute survey reports that tightened border security drastically increased the apprehension rate (Olson, 2008). The contraction of the illegal labor supply to U.S. agriculture drives up the U.S. illegal wage rate, while reducing the Mexican wage rate as more workers are turned back to Mexico. The U.S. illegal wage rate increases by an average 1.27 percent in the 1990s; whereas the Mexican wage rate decreases by an average of 1.45 percent during this period. As the number of illegal farm workers dwindles, the U.S. legal wage rate rises. In response to this increase in the wage rate, domestic farm labor supply increases; however total domestic labor use declines because of fewer unauthorized farm workers entering into the country.

The increase in the illegal and legal wage rates drives up the cost of production in U.S. agriculture. As a result, the U.S. agricultural production decreases, which results in fewer U.S. exports to Mexico. The U.S. exports to Mexico fall by about 5.0 percent over the simulation period (Table 4.7.2). Because of the decline in U.S. production and fewer exports entering Mexico, the consumer price of agricultural products increases in both countries.

The empirical results of an increase in border security corroborate the findings of the theoretical analysis in that both the illegal labor flow and commodity trade decrease.

Table 4.7.1: Baseline Estimates and the Impact of Border Enforcement on the U.S. and Mexican Labor Markets

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
US Lablor Dd (1000s)	1095.90	1062.68	1015.18	1086.94	1058.47	1095.01	1036.01	1019.41	975.14	967.90	966.38	942.79	884.78	841.28
Impact (%)	-0.43	-0.44	-0.42	-0.39	-0.42	-0.40	-0.41	-0.39	-0.23	-0.19	-0.15	-0.10	-0.06	0.00
US Labor Sy (1000s)	658.37	646.74	571.27	542.21	562.44	570.37	514.67	480.17	474.07	467.69	494.81	466.28	410.14	399.45
Impact (%)	1.25	1.28	1.30	1.34	1.36	1.31	1.41	1.39	0.80	0.67	0.49	0.34	0.20	0.00
Mexican Labor Dd (1000s)	8650.46	8634.45	8653.15	8648.83	8615.21	8571.25	8630.80	8612.62	8623.00	8586.92	8576.75	8537.29	8470.13	8518.32
Impact (%)	0.15	0.15	0.14	0.13	0.14	0.14	0.13	0.12	0.07	0.06	0.04	0.03	0.02	0.00
US Legal Wage Rate ($)	5.62	5.96	5.69	5.89	6.53	7.11	7.64	7.17	7.43	7.75	8.05	8.27	8.79	9.17
Impact (%)	1.37	1.32	1.27	1.21	1.16	1.06	0.98	0.99	0.55	0.45	0.34	0.22	0.11	0.00
US Illegal Wage Rate ($)	5.51	5.84	5.56	5.74	6.36	6.63	6.93	6.89	7.06	7.25	7.39	7.37	7.58	7.56
Impact (%)	1.39	1.35	1.30	1.25	1.19	1.14	1.08	1.03	0.58	0.48	0.37	0.25	0.13	0.00
Mexican Wage rate (p)	14.18	17.08	22.29	24.99	30.66	32.61	35.95	38.12	40.17	42.07	43.70	45.33	47.31	48.95
Impact (%)	-1.36	-1.56	-1.41	-1.45	-1.43	-1.52	-1.51	-1.39	-0.80	-0.69	-0.54	-0.37	-0.19	0.00
Illegal Immigration (1000)	437.53	415.93	443.91	544.73	496.03	524.64	521.34	539.24	501.07	500.21	471.57	476.51	474.64	441.83
Impact (%)	-2.96	-3.12	-2.64	-2.10	-2.43	-2.26	-2.21	-1.97	-1.21	-1.00	-0.81	-0.53	-0.27	0.00

Table 4.7.2: Baseline Estimates and the Impact of Border Enforcement on the U.S. and Mexican Agricultural Markets

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
US Ag. Dd (billion $)	161.93	168.09	178.46	185.63	182.73	176.37	184.15	193.90	189.77	202.92	222.42	232.95	234.30	265.73
Impact (%)	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00
US Ag. Sy (billion $)	182.35	198.43	206.57	206.63	201.44	188.59	195.94	208.98	203.20	219.40	235.96	237.05	242.19	287.35
Impact (%)	-0.09	-0.08	-0.08	-0.08	-0.09	-0.10	-0.10	-0.10	-0.06	-0.05	-0.03	-0.02	-0.01	0.00
Mexican Ag. Dd (billion p)	216.26	232.15	235.76	240.52	244.96	254.01	250.53	263.01	267.78	276.82	285.17	277.65	274.03	285.39
Impact (%)	-0.02	-0.05	-0.09	-0.11	-0.16	-0.20	-0.22	-0.20	-0.12	-0.12	-0.11	-0.07	-0.04	0.00
Mexican Ag. Sy (billion p)	210.14	219.67	223.99	234.59	226.47	244.04	249.66	257.75	255.31	256.39	245.92	276.57	264.58	271.91
Impact (%)	0.06	0.10	0.15	0.20	0.28	0.34	0.40	0.40	0.26	0.25	0.23	0.15	0.09	0.00
US Food CPI (index)	146.85	147.63	151.97	159.05	159.37	165.17	169.29	174.65	178.25	180.41	185.68	189.29	196.28	201.31
Impact (%)	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.00	0.00	0.00
US Price Received (index)	103.29	103.51	110.15	107.52	103.43	92.90	95.05	100.18	97.34	110.10	116.41	112.62	115.73	134.87
Impact (%)	0.17	0.18	0.14	0.13	0.14	0.15	0.13	0.11	0.06	0.05	0.03	0.02	0.01	0.00
Mexican Ag. CPI (index)	30.48	39.83	56.45	69.29	77.56	89.65	92.96	97.16	101.88	106.76	114.07	119.36	126.65	130.55
Impact (%)	0.02	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.02	0.02	0.01	0.01	0.00	0.00
Mexican PPI (index)	30.12	37.25	51.87	63.11	71.09	82.10	82.17	90.74	92.59	97.72	108.02	113.23	119.70	123.43
Impact (%)	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.01	0.01	0.01	0.01	0.00	0.00
US Net Exports to ROW (bil $)	15.78	25.62	24.01	19.02	14.60	10.42	10.58	12.70	10.76	13.35	9.34	3.20	5.51	17.68
Impact (%)	-0.03	-0.02	-0.02	-0.02	-0.03	-0.04	-0.04	-0.03	-0.02	-0.01	-0.01	-0.03	-0.01	0.00
Net Exports to Mex. (billion $)	4.64	4.72	4.09	1.98	4.11	1.80	1.21	2.38	2.67	3.13	4.21	0.90	2.37	3.94
Impact (%)	-3.13	-2.88	-3.34	-7.51	-3.98	-9.60	-15.35	-7.62	-4.05	-2.90	-1.72	-5.72	-1.17	0.00

These finding show the same tradeoff between immigration and commodity trade as in the domestic enforcement scenario.

U.S. Macroeconomic Effect

The U.S. economic recession has received the foremost attention among the public and policy makers because about 2.6 million workers have lost their jobs in 2008 (CNN, 2009). The impacts of this economic downturn reverberate into the rest of the economy, including the agricultural sector. The economic crisis puts the illegal immigrants in a more vulnerable position as employers are no longer interested in hiring undocumented workers because of the immigration policy. Consequently, many of the immigrants are returning back to Mexico, causing a larger than usual reverse-migration (Spagat, 2008). Given this economic backdrop, it is worth examining the impact of sluggish U.S. economic growth. In the baseline scenario, the economic conditions are captured by the historical data on real personal income. The alternate scenario incorporates a modest 5 percent reduction in real personal income. Comparing the alternate scenario to the baseline provides the impacts of an economic recession on the illegal wage rate, illegal labor flow, agricultural trade flows, the U.S. consumer price, and other endogenous variables.

A decrease in the real personal income in the United States causes the demand for agricultural products to decline, causing the U.S. consumer and producer prices to fall. As shown in Table 4.8.1, the commodity market price declines by an average of 0.29 percent, while the producer price declines by an average of 1.83 percent as the market margins do not fall significantly even during the sluggish economy and the producers incur the biggest losses. A lower U.S. commodity demand causes the excess supply to

Table 4.8.1: Baseline Estimates and the Impact of the U.S. Economy on the U.S. and Mexican Agricultural Markets

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
US Ag. Dd (billion $)	161.91	168.07	178.45	185.62	182.71	176.35	184.14	193.89	189.76	202.91	222.41	232.95	234.30	265.73
Impact (%)	-1.54	-1.56	-1.57	-1.60	-1.75	-1.91	-1.98	-1.94	-2.02	-1.95	-1.89	-1.91	-2.03	-1.90
US Ag. Sy (billion $)	182.18	198.26	206.41	206.46	201.26	188.40	195.74	208.78	203.08	219.30	235.88	237.00	242.16	287.35
Impact (%)	-1.10	-1.02	-1.00	-1.03	-1.11	-1.21	-1.23	-1.19	-1.24	-1.17	-1.14	-1.20	-1.26	-1.13
Mexican Ag. Dd (billion p)	216.23	232.03	235.55	240.25	244.55	253.49	249.97	262.48	267.45	276.47	284.87	277.45	273.93	285.39
Impact (%)	0.16	0.50	1.01	1.41	2.11	2.82	3.54	3.63	3.99	4.88	5.66	6.13	6.68	6.82
Mexican Ag. Sy (billion p)	210.26	219.90	224.34	235.05	227.11	244.87	250.65	258.78	255.98	257.04	246.49	276.99	264.81	271.91
Impact (%)	-0.05	-0.11	-0.17	-0.20	-0.27	-0.30	-0.32	-0.32	-0.33	-0.39	-0.45	-0.40	-0.43	-0.43
US Food CPI (index)	146.89	147.68	152.01	159.09	159.40	165.20	169.33	174.68	178.27	180.43	185.69	189.30	196.29	201.31
Impact (%)	-0.28	-0.28	-0.27	-0.27	-0.28	-0.28	-0.29	-0.29	-0.28	-0.29	-0.29	-0.30	-0.31	-0.32
US Price Received (index)	103.46	103.70	110.31	107.66	103.57	93.04	95.17	100.29	97.40	110.15	116.44	112.64	115.74	134.87
Impact (%)	-1.76	-1.74	-1.63	-1.70	-1.83	-2.05	-2.08	-1.98	-2.02	-1.78	-1.72	-1.81	-1.83	-1.63
Mexican Ag. CPI (index)	30.48	39.85	56.47	69.31	77.59	89.68	93.00	97.19	101.90	106.77	114.09	119.37	126.65	130.55
Impact (%)	-0.23	-0.42	-0.47	-0.46	-0.54	-0.57	-0.60	-0.59	-0.59	-0.65	-0.68	-0.65	-0.63	-0.63
Mexican PPI (index)	30.13	37.26	51.88	63.13	71.11	82.13	82.19	90.77	92.60	97.73	108.03	113.24	119.70	123.43
Impact (%)	-0.17	-0.33	-0.37	-0.37	-0.43	-0.45	-0.49	-0.46	-0.47	-0.52	-0.52	-0.50	-0.48	-0.48
US Net Exports to ROW (bil $)	15.77	25.61	24.01	19.01	14.60	10.42	10.57	12.70	10.76	13.34	9.34	3.20	5.51	17.68
Impact (%)	0.35	0.22	0.24	0.31	0.42	0.60	0.63	0.54	0.64	0.53	0.79	2.44	1.51	0.50
Net Exports to Mex. (billion $)	4.50	4.59	3.96	1.83	3.95	1.63	1.02	2.20	2.56	3.04	4.14	0.85	2.35	3.94
Impact (billion $)	0.43	0.55	0.68	0.79	0.91	1.02	1.16	1.21	1.25	1.33	1.43	1.52	1.62	1.71

shift to the right and expands U.S. exports as discussed in the theoretical analysis. The results show that U.S. agricultural exports to Mexico increases on average by 1.12 billion.

Table 4.8.2 shows the decline in U.S. producer price and the resulting lower commodity production leads to reduced demand for farm workers, which causes the illegal wage rate to fall by 0.44 percent. Consequently, the flow of illegal laborers also decreases as highlighted by the theoretical results. The illegal labor flow declines by an average of 0.04 percent, which is equal to a decline of about 2000 Mexican workers seeking employment in U.S. agriculture. According to the National Statistics and Geography Institute, total immigration has dropped by 42 percent from 2006 to 2008 (Olson, 2008). This drop is the result of workplace raids and border control, but the primary reason for the large drop is the economic downturn in the recent years.

In summary, a sluggish economy not only costs jobs for U.S. workers but also for immigrants workers.

Mexican Macroeconomic Effect

The baseline scenario for Mexican macroeconomic conditions is run with historical GDP data. The alternate scenario is run with a 5 percent reduction in GDP. Comparing the alternate scenario to the baseline provides the impact of slower Mexican economic growth.

A drop in the Mexican GDP causes the demand for agricultural products to fall, which leads to lower Mexican consumer and producer prices. The decline in the demand causes excess demand to contract. Consequently, Mexican imports of U.S. Agricultural

Table 4.8.2: Baseline Estimates and the Impact of the U.S. Economy on the U.S. and Mexican Labor Markets

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
US Lablor Dd (1000s)	1091.19	1057.96	1010.91	1082.74	1054.05	1090.65	1031.74	1015.46	972.89	966.03	964.95	941.84	884.29	841.28
Impact (%)	-0.29	-0.29	-0.30	-0.28	-0.29	-0.28	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30	-0.32	-0.34
US Labor Sy (1000s)	666.61	655.02	578.72	549.47	570.06	577.85	521.94	486.86	477.88	470.84	497.22	467.87	410.96	399.45
Impact (%)	-0.44	-0.44	-0.49	-0.51	-0.51	-0.50	-0.56	-0.59	-0.59	-0.58	-0.55	-0.57	-0.66	-0.68
Mexican Labor Dd (1000s)	8663.40	8647.44	8664.86	8660.29	8627.25	8583.09	8642.34	8623.26	8629.06	8591.94	8580.58	8539.83	8471.44	8518.32
Impact (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
US Legal Wage Rate ($)	5.70	6.04	5.76	5.96	6.60	7.19	7.71	7.24	7.47	7.79	8.08	8.29	8.80	9.17
Impact (%)	-0.48	-0.45	-0.47	-0.47	-0.44	-0.41	-0.39	-0.42	-0.40	-0.39	-0.38	-0.38	-0.37	-0.37
US Illegal Wage Rate ($)	5.59	5.92	5.63	5.81	6.43	6.70	7.00	6.96	7.10	7.29	7.41	7.39	7.59	7.56
Impact (%)	-0.49	-0.46	-0.49	-0.48	-0.45	-0.44	-0.43	-0.44	-0.42	-0.41	-0.42	-0.42	-0.43	-0.45
Mexican Wage rate (p)	13.99	16.81	21.98	24.63	30.22	32.11	35.41	37.59	39.85	41.78	43.46	45.17	47.22	48.95
Impact (%)	-0.04	-0.04	-0.04	-0.04	-0.04	-0.05	-0.05	-0.05	-0.04	-0.05	-0.05	-0.05	-0.05	-0.05
Illegal Immigration (1000)	424.58	402.94	432.20	533.27	483.99	512.80	509.80	528.60	495.00	495.19	467.73	473.97	473.33	441.83
Impact (%)	-0.07	-0.05	-0.04	-0.03	-0.04	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03

commodities fall as shown in theoretical analysis. Table 4.9.1 shows that Mexican imports decline by an average of $ 2.8 billion.

As commodity price and agricultural production declines, the wage rate in Mexico also declines which increases the labor demand, and the flow of illegal laborers from Mexico to the United States decreases. Table 4.9.2 shows the illegal labor flow reduces on average by 0.04 percent.

Labor Endowment Effect

This section analyzes the effect of an exogenous increase in Mexico the farm labor force. This increase in labor force is partly due to workers from its southern neighbors seeking employment opportunities in the United States and migrating via Mexico. Middle income countries such as Mexico are “transit routes” for immigrants from low-income countries seeking employment in developed countries (Economist, 2008b). For the baseline, the Mexican farm workers is fixed for each year. In the alternate scenario, the labor supply is increased by 1 percent. Comparison of the baseline to the alternate scenario offers insights into the effect of an increase in the Mexico labor supply on the endogenous variables in the model. As the labor supply increases, agricultural laborers attempting to enter the United States also increases, causing the illegal labor flow to rise, this is consistent with the theoretical results. The simulation results, shown in Table 4.10.1, illustrate that the illegal labor flow increases by an average of 17.83 percent. A greater supply of undocumented workers in U.S. agriculture causes the illegal wage rate to decline. The empirical results indicate that a 1 percent increase in the farm labor endowment in Mexico causes the illegal wage rate to decrease by an average of 8.51 percent.

Table 4.9.1: Baseline Estimates and the Impact of the Mexican Economy on the U.S. and Mexican Agricultural Markets

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
US Ag. Dd (billion $)	161.91	168.07	178.45	185.62	182.71	176.35	184.14	193.89	189.76	202.91	222.41	232.95	234.30	265.73
Impact (%)	0.12	0.08	0.08	0.09	0.10	0.11	0.13	0.14	0.15	0.14	0.13	0.15	0.17	0.16
US Ag. Sy (billion $)	182.18	198.26	206.41	206.46	201.26	188.40	195.74	208.78	203.08	219.30	235.88	237.00	242.16	287.35
Impact (%)	-1.06	-0.67	-0.70	-0.83	-0.90	-1.06	-1.24	-1.27	-1.39	-1.28	-1.28	-1.47	-1.64	-1.52
Mexican Ag. Dd (billion p)	216.23	232.03	235.55	240.25	244.55	253.49	249.97	262.48	267.45	276.47	284.87	277.45	273.93	285.39
Impact (%)	-1.08	-1.72	-2.92	-4.12	-5.51	-7.12	-9.47	-10.04	-11.26	-12.84	-14.84	-17.36	-20.09	-21.30
Mexican Ag. Sy (billion p)	210.26	219.90	224.34	235.05	227.11	244.87	250.65	258.78	255.98	257.04	246.49	276.99	264.81	271.91
Impact (%)	-0.05	-0.07	-0.12	-0.16	-0.22	-0.26	-0.32	-0.34	-0.37	-0.42	-0.50	-0.49	-0.56	-0.57
US Food CPI (index)	146.89	147.68	152.01	159.09	159.40	165.20	169.33	174.68	178.27	180.43	185.69	189.30	196.29	201.31
Impact (%)	-0.27	-0.18	-0.19	-0.22	-0.23	-0.24	-0.29	-0.30	-0.32	-0.31	-0.33	-0.37	-0.40	-0.43
US Price Received (index)	103.46	103.70	110.31	107.66	103.57	93.04	95.17	100.29	97.40	110.15	116.44	112.64	115.74	134.87
Impact (%)	-1.70	-1.14	-1.14	-1.37	-1.48	-1.80	-2.09	-2.10	-2.27	-1.95	-1.93	-2.23	-2.39	-2.18
Mexican Ag. CPI (index)	30.48	39.85	56.47	69.31	77.59	89.68	93.00	97.19	101.90	106.77	114.09	119.37	126.65	130.55
Impact (%)	-0.22	-0.28	-0.33	-0.37	-0.44	-0.50	-0.61	-0.62	-0.66	-0.71	-0.76	-0.80	-0.82	-0.84
Mexican PPI (index)	30.13	37.26	51.88	63.13	71.11	82.13	82.19	90.77	92.60	97.73	108.03	113.24	119.70	123.43
Impact (%)	-0.16	-0.22	-0.26	-0.30	-0.35	-0.39	-0.50	-0.48	-0.52	-0.56	-0.58	-0.61	-0.63	-0.65
US Net Exports to ROW (bil $)	15.77	25.61	24.01	19.01	14.60	10.42	10.57	12.70	10.76	13.34	9.34	3.20	5.51	17.68
Impact (%)	0.34	0.14	0.17	0.25	0.34	0.53	0.63	0.57	0.72	0.58	0.89	2.99	1.97	0.67
Net Exports to Mex. (billion $)	4.50	4.59	3.96	1.83	3.95	1.63	1.02	2.20	2.56	3.04	4.14	0.85	2.35	3.94
Impact (billion $)	-2.18	-1.50	-1.62	-1.94	-2.04	-2.25	-2.74	-2.98	-3.17	-3.15	-3.41	-3.93	-4.48	-4.90

Table 4.9.2: Baseline Estimates and the Impact of the Mexican Economy on the U.S. and Mexican Labor Markets

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
US Lablor Dd (1000s)	1091.19	1057.96	1010.91	1082.74	1054.05	1090.65	1031.74	1015.46	972.89	966.03	964.95	941.84	884.29	841.28
Impact (%)	-0.28	-0.19	-0.21	-0.22	-0.24	-0.25	-0.30	-0.32	-0.34	-0.33	-0.33	-0.37	-0.42	-0.46
US Labor Sy (1000s)	666.61	655.02	578.72	549.47	570.06	577.85	521.94	486.86	477.88	470.84	497.22	467.87	410.96	399.45
Impact (%)	-0.42	-0.29	-0.34	-0.42	-0.41	-0.44	-0.56	-0.63	-0.66	-0.64	-0.62	-0.71	-0.86	-0.91
Mexican Labor Dd (1000s)	8663.40	8647.44	8664.86	8660.29	8627.25	8583.09	8642.34	8623.26	8629.06	8591.94	8580.58	8539.83	8471.44	8518.32
Impact (%)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
US Legal Wage Rate ($)	5.70	6.04	5.76	5.96	6.60	7.19	7.71	7.24	7.47	7.79	8.08	8.29	8.80	9.17
Impact (%)	-0.46	-0.30	-0.33	-0.38	-0.36	-0.36	-0.39	-0.44	-0.45	-0.42	-0.43	-0.46	-0.48	-0.49
US Illegal Wage Rate ($)	5.59	5.92	5.63	5.81	6.43	6.70	7.00	6.96	7.10	7.29	7.41	7.39	7.59	7.56
Impact (%)	-0.47	-0.30	-0.34	-0.39	-0.36	-0.38	-0.43	-0.46	-0.48	-0.45	-0.47	-0.52	-0.56	-0.60
Mexican Wage rate (p)	13.99	16.81	21.98	24.63	30.22	32.11	35.41	37.59	39.85	41.78	43.46	45.17	47.22	48.95
Impact (%)	-0.04	-0.03	-0.03	-0.03	-0.03	-0.04	-0.05	-0.05	-0.05	-0.05	-0.05	-0.06	-0.06	-0.06
Illegal Immigration (1000)	424.58	402.94	432.20	533.27	483.99	512.80	509.80	528.60	495.00	495.19	467.73	473.97	473.33	441.83
Impact (%)	-0.06	-0.04	-0.03	-0.03	-0.03	-0.03	-0.03	-0.03	-0.04	-0.03	-0.03	-0.04	-0.04	-0.05

Table 4.10.1: Baseline Estimates and the Impact of the Mexican Labor Endowment on the U.S. and Mexican Labor Markets

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
US Lablor Dd (1000s)	1091.19	1057.96	1010.91	1082.74	1054.05	1090.65	1031.74	1015.46	972.89	966.03	964.95	941.84	884.29	841.28
Impact (%)	2.74	2.83	2.99	2.83	2.89	2.80	2.99	3.04	3.17	3.19	3.18	3.26	3.45	3.63
US Labor Sy (1000s)	666.61	655.02	578.72	549.47	570.06	577.85	521.94	486.86	477.88	470.84	497.22	467.87	410.96	399.45
Impact (%)	-8.19	-8.28	-9.39	-9.98	-9.52	-9.36	-10.41	-11.15	-11.32	-11.43	-10.76	-11.38	-12.84	-13.23
Mexican Labor Dd (1000s)	8663.40	8647.44	8664.86	8660.29	8627.25	8583.09	8642.34	8623.26	8629.06	8591.94	8580.58	8539.83	8471.44	8518.32
Impact (%)	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
US Legal Wage Rate ($)	5.70	6.04	5.76	5.96	6.60	7.19	7.71	7.24	7.47	7.79	8.08	8.29	8.80	9.17
Impact (%)	-8.92	-8.53	-9.13	-9.05	-8.18	-7.61	-7.27	-7.92	-7.78	-7.59	-7.48	-7.49	-7.23	-7.13
US Illegal Wage Rate ($)	5.59	5.92	5.63	5.81	6.43	6.70	7.00	6.96	7.10	7.29	7.41	7.39	7.59	7.56
Impact (%)	-9.10	-8.71	-9.36	-9.29	-8.40	-8.15	-8.01	-8.25	-8.20	-8.11	-8.15	-8.40	-8.37	-8.64
Mexican Wage rate (p)	13.99	16.81	21.98	24.63	30.22	32.11	35.41	37.59	39.85	41.78	43.46	45.17	47.22	48.95
Impact (%)	-0.69	-0.79	-0.79	-0.84	-0.78	-0.84	-0.86	-0.86	-0.86	-0.89	-0.91	-0.92	-0.91	-0.91
Illegal Immigration (1000)	424.58	402.94	432.20	533.27	483.99	512.80	509.80	528.60	495.00	495.19	467.73	473.97	473.33	441.83
Impact (%)	19.89	20.88	19.58	16.04	17.52	16.51	16.71	16.11	17.15	17.08	18.01	17.70	17.59	18.88

The lower illegal wage rate reduces the cost of production in the United States. This increases agricultural production and shifts the excess supply to the right, causing the market price to decline both in the United State and Mexico. Table 4.10.2 shows that exports increase by an average of $710 million agricultural labor markets, and Mexican labor demand. Identities linking the agricultural consumer price and producer price in both countries, the U.S. and Mexican consumer prices, the U.S. illegal wage rate to the Mexican wage rate, the U.S. illegal wage rate to the U.S. legal wage rate, and market clearing conditions are included in the model. The estimated equations are simulated to analyze the effect of NAFTA, U.S. farm subsidies, domestic expenditures for worksite enforcement, border enforcement, the macroeconomic conditions in the United State and Mexico, and an increase in the Mexican labor supply. The simulation results support the theoretical predictions.

Table 4.10.2: Baseline Estimates and the Impact of the Mexican Labor Endowment on the U.S. and Mexican Agricultural Markets

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
US Ag. Dd (billion $)	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Impact (%)	161.91	168.07	178.45	185.62	182.71	176.35	184.14	193.89	189.76	202.91	222.41	232.95	234.30	265.73
US Ag. Sy (billion $)	0.11	0.10	0.10	0.09	0.09	0.09	0.09	0.09	0.09	0.08	0.08	0.08	0.08	0.07
Impact (%)	182.18	198.26	206.41	206.46	201.26	188.40	195.74	208.78	203.08	219.30	235.88	237.00	242.16	287.35
Mexican Ag. Dd (billion p)	0.31	0.33	0.36	0.39	0.42	0.48	0.49	0.47	0.50	0.48	0.46	0.47	0.47	0.40
Impact (%)	216.23	232.03	235.55	240.25	244.55	253.49	249.97	262.48	267.45	276.47	284.87	277.45	273.93	285.39
Mexican Ag. Sy (billion p)	0.14	0.43	0.84	1.14	1.59	2.05	2.45	2.49	2.73	3.29	3.69	3.90	4.08	4.03
Impact (%)	210.26	219.90	224.34	235.05	227.11	244.87	250.65	258.78	255.98	257.04	246.49	276.99	264.81	271.91
US Food CPI (index)	-0.02	-0.05	-0.07	-0.06	-0.07	-0.05	-0.02	0.00	0.03	0.04	0.06	0.10	0.14	0.16
Impact (%)	146.89	147.68	152.01	159.09	159.40	165.20	169.33	174.68	178.27	180.43	185.69	189.30	196.29	201.31
US Price Received (index)	-0.25	-0.24	-0.23	-0.22	-0.21	-0.20	-0.20	-0.20	-0.19	-0.19	-0.19	-0.19	-0.19	-0.19
Impact (%)	103.46	103.70	110.31	107.66	103.57	93.04	95.17	100.29	97.40	110.15	116.44	112.64	115.74	134.87
Mexican Ag. CPI (index)	-1.57	-1.49	-1.35	-1.37	-1.37	-1.49	-1.44	-1.36	-1.39	-1.20	-1.12	-1.15	-1.12	-0.96
Impact (%)	30.48	39.85	56.47	69.31	77.59	89.68	93.00	97.19	101.90	106.77	114.09	119.37	126.65	130.55
Mexican PPI (index)	-0.20	-0.36	-0.39	-0.37	-0.41	-0.41	-0.42	-0.40	-0.40	-0.44	-0.44	-0.41	-0.38	-0.37
Impact (%)	30.13	37.26	51.88	63.13	71.11	82.13	82.19	90.77	92.60	97.73	108.03	113.24	119.70	123.43
US Net Exports to ROW (bil $)	-0.15	-0.28	-0.31	-0.30	-0.32	-0.33	-0.34	-0.31	-0.32	-0.35	-0.34	-0.32	-0.29	-0.29
Impact (%)	15.77	25.61	24.01	19.01	14.60	10.42	10.57	12.70	10.76	13.34	9.34	3.20	5.51	17.68
Net Exports to Mex. (billion $)	0.31	0.19	0.20	0.25	0.32	0.44	0.44	0.37	0.44	0.36	0.52	1.55	0.92	0.30
Impact (billion $)	0.34	0.44	0.53	0.59	0.63	0.69	0.74	0.76	0.79	0.83	0.86	0.89	0.90	0.92

Chapter 5. Conclusions

This chapter summarizes the thesis and offers policy recommendations based on the theoretical and empirical results. At the end of the Bracero Program in 1964 the U.S. Congress established the U.S. Immigration Act of 1965. The termination of the Bracero Program ended 22 years of legal seasonal labor from Mexico, while the 1965 Immigration Act restricted the number of legal immigrants entering the country each year to 120,000. Since the demand for this workforce is far greater than 120,000, this act created an environment for illegal immigration. Furthermore, the need for immigrant workers in the farm sector perpetually exceeded the total quota due to strong agricultural economic growth. Consequently, the illegal immigrant population continued to grow in the United States.

To curb this flow of illegal immigrants, the U.S. Congress passed the 1986 Immigration Reform and Control Act (IRCA). This Act granted citizenship to the existing unauthorized population, tightened the border control to stem the entry of new immigrants, and implemented employer sanctions to prevent hiring of undocumented workers. However, these actions failed to accomplish the congressional goals and by the middle of this decade 12 million unauthorized immigrants were residing in the United States. As a result, pressure was mounting on politicians to resolve the immigration problems. In response to such pressure, the U.S. Congress reopened the debate on illegal immigration because of concerns of wage depression, job loss, taxpayer costs, and also national security. But, due to disagreements, particularly about providing citizenship to illegal immigrants, congress did not pass any immigration reforms, including a more flexible guest-workers program which the farm sector desperately needs. Because of

congress's failure to reform the immigration laws, the U.S. government has drastically increased its border patrols and workplace raids. This has led to severe labor shortage in the agricultural sector during harvest time, resulting in unharvested crops and huge losses.

Given the importance of immigrant workers to U.S. agriculture, this study investigated the effects of NAFTA, U.S. farm policy, immigration policy, and economic growth on immigrant flow and agricultural trade. Prior to NAFTA Mexico protected its farmers by restricting trade through tariffs. Since NAFTA's implementation freer trade has prospered, but U.S. agricultural subsidies undermine the effectiveness of NAFTA and trade liberalization. U.S. farm policy keeps the producers prices artificially high, which causes farmers to overproduce and dump the excess production in Mexico. Mexican farmers, unable to compete with cheaper imports from the United States, are forced out of the business. Since employment opportunities are very limited in Mexico, these now unemployed farmers immigrate to the United States.

Under IRCA, the U.S. government tried to reduce the inflow of illegal immigrants mainly through border security. But, these policies failed to curb illegal immigration because they did not address the root causes of mass migration from Mexico. Because of the legislative deadlock in the middle of this decade, the immigration reform failed, and the government drastically heightened border security and domestic enforcement. Macroeconomic conditions are one of the core reasons immigrants enter the United States illegally. The per capita GDP in the United States is about four times larger than that of Mexico. This disparity, coupled with an equally large wage gap, is the main cause of legal and unauthorized immigrants leaving Mexico for the United States.

Theoretical research on illegal immigration took root in 1986 when Ethier differentiated migration from capital theory by distinguishing legal migrants from illegal migrants. Stemming from Ethier's work, the effect of an increase in border controls on illegal labor migration, optimal levels of domestic and border controls, the effect of migration on the host country's wage rate, and the effect of border enforcement on the source country and illegal migration have been studied in the context of a two country trade model. Empirical research on illegal immigration is scarce because of data limitations. However, illegal immigration flows have been estimated by using border apprehensions as a proxy variable, the effects of illegal immigrants and legal immigrants on the host country in a CGE framework, and the effect of a change in the illegal farm workforce on domestic worker displacement and wage rates in vegetable production have been analyzed by past studies.

This thesis builds on this body of work by theoretically and empirically studying the link between agricultural production, cross-border migration, and trade. Using an integrated trade-migration model by incorporating the complex relationship among demand, supply, trade, and labor migration, this study analyzes the impacts of trade liberalization, farm subsidies, border and domestic enforcements, macroeconomic conditions, and source country's labor endowment on illegal labor migration and commodity trade.

The theoretical analysis utilizes a model with two countries (United States and Mexico) integrated through agricultural commodity trade and illegal labor migration. The United States subsidizes its agricultural production and is a net exporter of agricultural commodities. Mexico is a net importer of agricultural products and the

government protected its producers with tariffs before the end of NAFTA. Mexican laborers attempt to enter the United States illegally, but a portion of them are apprehended by border enforcement agents and returned to Mexico. The Mexican wage rate is linked to the U.S. illegal wage rate by incorporating the probability of being caught at the border and the time wasted in immigrating. The successful migrants enter the U.S. labor market as unauthorized laborers and earn a wage rate lower than their legal counter parts because of the added risk of employer sanctions for hiring undocumented workers.

The results of the theoretical analysis show that a) trade liberalization and increased farm supports intensify the illegal labor flow and increase commodity trade, b) increased resource allocation to domestic enforcement and border control contracts the flow of illegal labor but also reduces commodity trade, c) macroeconomic growth in the United States increases the incentives for illegal laborers to enter the United States and decreases commodity trade; while economic development in Mexico reduces the wage and income gap between the United States and Mexico, reducing economic incentives for immigration and increases commodity trade, and d) population growth and immigration to Mexico from its southern neighbors increase the number of workers crossing the U.S. border illegally and expand U.S. exports.

To quantitatively examine the interrelationships between the commodity market and labor flow, an empirical model with seven equations and seven identities is constructed. For the United States, labor demand and supply, commodity demand and supply, and producer-consumer price linkage and a wage wedge linking U.S. farm wage and illegal wage rates are specified. For Mexico, the labor demand, commodity demand

and supply, and producer-consumer price linkage, a price linkage between the U.S. market price and the Mexican market price, and a wage identity linking the Mexican minimum wage and U.S. illegal wage rate are defined. A world market commodity equilibrium and labor market equilibrium are also included in the model. The three-stage least square technique is utilized to estimate consistent and unbiased coefficients and correct cross-equation correlation in the error terms.

Using the estimated equations, a dynamic simulation is run to analyze the effect of NAFTA, U.S. farm policy, immigration policies, macroeconomic recession, and labor endowment increase in Mexico. The results of the simulation analysis are consistent with the theoretical results. Specifically, trade liberalization under NAFTA increases the illegal labor flow to U.S. agriculture by about 3,093 laborers and increases commodity trade $17.10 billion by the end of NAFTA. On the other hand, a decrease in subsidies paid to agricultural producers contracts the illegal labor flow to U.S. agriculture by an average of 0.20 percent and commodity trade by $3.42 billion over the simulation period. Increased spending on domestic enforcement decreases the illegal labor flow by about 42,000 in 2007; while commodity trade declines by an average of 8.11 percent. If the recent tighter border security were enforced from 1994, the illegal labor force to U.S. agriculture would have declined by 8147. Because of the heightened border enforcement, U.S. exports to Mexico declines by an average of 5 percent. The results for these two scenarios show a distinct tradeoff between a reduction in illegal labor flow and commodity trade. The results from an economic slowdown in the United States shows Mexican laborers are less likely to illegally emigrate by about 2000 to worker in U.S. agriculture, while commodity trade increases on average by 1.12 billion. Finally, an

exogenous increase in the Mexican labor supply increases labor flows to the United States by about 83,000 and increases trade by an average of 17.83 percent.

Policy Implications

The Heckscher-Ohlin (HO) theory predicts that through free trade, the United States and Mexico will export goods that use their abundant factors intensively. Because of free trade, the United States will further specialize in production and export more capital-intensive goods since the U.S. capital-labor ratio is relatively higher than that of Mexico, and Mexico will specialize in the production and export more of labor-intensive goods. Consequently, complete free trade will equalize the output prices in both countries. Furthermore, according to the factor-price equalization theorem, free trade causes Mexico's wage-rental ratio to increase and eventually equal the U.S. wage-rental ratio, and thus, improving the economic conditions of Mexican labor force. However, these results of the HO theorem are based on several key assumptions including identical technology in both countries, perfect competition, and no policy distortions. These assumptions almost always never hold in the real world. For example, the United States provides massive farm subsidies which leads to excessive production and dumps the surplus commodities such as corn in Mexico. This flooding of the Mexican market with U.S. commodities is possible because the tariffs restricting imports from the United States are removed under NAFTA. These excessive exports from the United States depress the commodity prices in Mexico, causing huge losses for farmers and forcing them out of business. Because of a lack of job opportunities, these unemployed farmers trek to the United States seeking work. Thus, to stem the flow of migration of Mexican workers to the United States, it is crucial that the United States phases out its farm

supports. Elimination of U.S. farm subsidies will help Mexican farmers to compete effectively with U.S. exports and improve their profitability and stay employed in agriculture. This would reduce the incentive for Mexicans to illegally enter the United States. Thus, removal of U.S. farm supports will go a long way to capture the full effect of free trade under NAFTA.

As stated in the introduction, Mexico must also reform its economic, political, and social policies to help stimulate income growth and create jobs, which will result in fewer illegal immigrants entering the United States. Economic and political reforms include, but are not limited to, increasing economic competition through privatization of nationalized companies, increasing personal saving, improving banking and financial systems, reducing citizen reliance on government programs, and increasing investment in infrastructure (Economist, 2007). These reforms will improve the Mexican technology in many sectors and bring it closer to the level of U.S. technology. In addition, Mexico should also continue its reforms in the justice system, education, and health care.

As part of the government's solutions in solving the illegal immigration problem, the Department of Homeland Security has drastically stepped up the workplace raids on industries that employ a large number of immigrant laborers and also fined businesses and imprisoned employers for hiring illegal immigrants. Furthermore, Arizona and Mississippi have passed voter-approved legislation such as an employer sanction law which imposes stricter regulations and penalties, including permanent revocation of the license of businesses for hiring illegal immigrants (The Economist, 2008; and CNN, 2007). In response to the economic downturns and new national- and state-level workplace enforcements and restrictions, illegal immigrants are being deported or

"voluntarily" leave the United States. The departure of these illegal immigrants has caused labor shortages in labor-intensive operations such as vegetable production, food processing, and manufacturing (Gans, 2007 and Wall Street Journal, 2007). In response to these labor shortages, agricultural producers and manufacturing businesses, particularly in the border states, have moved their operations to Mexico, i.e., they followed their workforce (Jordan, 2007). U.S. low-skilled workers tend to support this increase in raids because they are concerned that they will lose jobs to undocumented workers and their wages will decrease.

However, heightened border security, workplace raids, and outmigration of labor from economic downturn are causing labor-shortages for farmers who heavily rely on undocumented workers (Johnson, 2007). Growers who are in dire need of workers support legislations that legalize these immigrants. Though the immigration reform was intensely debated in the U.S. Congress and dragged on acrimoniously over a two-year period, several problematic issues were never resolved and the lawmakers eventually failed to enact any immigration legislation. American agriculture, particularly labor-intensive production, relies heavily on immigrant workers for farm operations. U.S. farmers employed about 3 million immigrant farm workers, which highlight how much U.S. agriculture relies on these laborers.

Any reduction of the immigrant workforce, by deporting undocumented workers and scuttling the guest-worker program, has several adverse implications for U.S. agriculture. Producers in several states have been beset with labor scarcity and are experiencing devastating effects on farm production and profitability, particularly in labor-intensive crops because farmers could not complete many of the basic tasks such as

planting and harvesting. Government policies aimed at deporting unauthorized workers severely curtail the supply of seasonal and non-seasonal labor to crop production. As a result, many crops have gone unharvested and have even caused farmers to go out of business. Consequently, consumers have also incurred higher costs for fruits and vegetables at the grocery stores.

The current IRCA guest-worker program has come under sharp attack by the U.S. businesses, particularly by farmers, because it requires cumbersome paperwork, and unduly bureaucratic delays are not conducive to procuring seasonal laborers at the time of peak farm operations such as vegetable and fruit picking. Therefore, U.S. government policies aimed at deporting unauthorized workers -- without taking adequate measures to supply farm laborers through guest workers program -- will adversely affect the supply of farm laborers to crop production. If immigration reform allows a well-functioning guest-worker program, it can increase the availability of the farm workforce and will have a positive impact on agricultural production and profitability, as well as, reducing the cost of agricultural products to consumers. Thus, a sound guest-worker program is crucial for U.S. farmers to remain competitive in labor intensive agricultural production, which would reduce consumer prices of U.S. agricultural products.

Since the middle of this decade the U.S. economy has slowed, and the country is currently facing unprecedented economic hardships. This economics recession, coupled with increased domestic raids and heightened border security, has resulted in immigrants returning to Mexico. For example, an 11% (about 1.3 million immigrants) drop in undocumented workers occurred between August 2007 and May 2008 (Camorota and Jensenius, 2008). The utmost priority among the policy makers is to fix the economic

hardships. Consequently, resolving the immigration problems has been overshadowed by the economic crisis. However, even during the economic recession, farmers have to carry out their farm operation and need farm labor. If the government does not address this labor shortage, farmers will continue to incur heavy losses.

References

Abraham, Y. and R. B. Ballou. 2007. “350 are held in immigration raid New Bedford factory employed illegals, US says”. The Boston Globe. Retrieved on March 7 2007 from http://www.boston.com/news/local/articles/2007/03/07/350_are_held_in_immigration_raid/

Banco de Mexcio. 2008. *Statistics*. Retrieved on 2 October from http://www.banxico.org.mx/sitioingles/PortalesEspecializados/inflacion/inflacion.html.

Banco de Mexico. 2006. Remesas Familiares. Retrieved 15 July, 2007, from http://www.banxico.gob.mx/eInfoFinanciera/FSinfoFinanciera.html

Bandyopadhyay, S. 2006. "Illegal Immigration and Second-best Import Tariffs." Review of International Economics. 14(1): 93-103.

Bandyopadhyay, S., and S. C. Bandyopadhyay. 1998. "Illegal immigration: a supply side analysis." Journal of Development Economics. 57(2): 343-360.

Bohn, S., and Sanders, S. 2005. *Refining the Estimation of Immigration’s Labor Markets Effects.* Mimeo, University of Maryland.

Bond, E. W., and T.-J. Chen. 1987. "The welfare effects of illegal immigration." Journal of International Economics. 23(3-4): 315-328.

Borjas, G., Friedman, R., and Katz L.F. 1997. ‘How much do immigrants and trade affect Labor markets outcome.’ *Brookings Papers on Economic Activity*. pp. 1-90

Borjas, G.J. 2003. ‘The labor demand curve is downward sloping: Reexamining the impact of immigration the labor market.’ Quarterly Journal of Economics. 118(4), 1335-1374.

Borjas, G.J. and Katz, L.F. 2005. *The Evaluation the Mexican-born work force in the United States*. NBER working paper 11281.

Boucher, S. R. and J. E. Taylor. 2007. "Policy Shocks and the Supply for Mexican to U.S. Farms." Choice. 21(1): 37-42.

Bureau of Labor Statistics. 2008. *Databases, Tables & Calculators by Subject*. Retrieved on September 10, 2008 from http://data.bls.gov/cgi-bin/surveymost.

Butcher, K.F. and Card, D. 1991. “Immigration and Wages: Evidence from the 1980’s.” The American Economic Review. 81(2) 292-296.

Camorota, S. A. and K. Jensenius. 2008. Homeward Bound Recent Immigration Enforcement and the Decline in the Illegal Alien Population. Backgrounder, Center for Immigration Studies.

Card, D. 1990. ‘The Impact of the Mariel Boatlift on the Miami labor Market.’ Industrial And Labor Relation Review. 43(2), 245-257.

Card, D. 2001. ‘Immigrant inflows, Native outflows, and the local labor market impacts of Higher immigrating.’ Journal of Labor Economics. 19(1), 22-64.

Center for Immigration Studies. 2007. "Current Number." Retrieved 22 May, 2007, from http://www.cis.org/topics/currentnumbers.html.

CNN. 2007. Illegal Immigrants Packing up and Leaving Arizona. Internet site: http://www.cnn.com/2007/US/12/22/immigrants.leave.ap/index.html. (Accessed 22 December, 2007).

CNN. 2009. Bloody Monday: Over 71,400 job lost: http://money.cnn.com/2009/01/26/news/economy/job_cuts/index.htm.

Colman, D. 1983. “A Review of the Art of Supply Response Analysis.” Review of Marketing and Agricultural Economics. 51(3): 201-230.

Comision Nacional De Los Salarios Minimos. 2008. *Secretaria Del Trabajo Y Prevision Social*. Retrieved on 13 October 2008 from http://www.conasami.gob.mx/.

Congress, 1st Session, November 4, 1993. *Message from the President of the United States Transmitting North American Free Trade Agreement, Texts of Agreement, Implementing Bill, Statement of Administrative Action and Required Supporting*. Statements House Document 103-159, Volume 2.

Cornelius, W. A. 1992. *From Sojourners to Settlers: The Changing Profile of Mexican Migration to the United States*, ed. J. A. Bustamante, C. W. Reynolds, and R. Hinojosa-Ojeda. Stanford California, Stanford University Press.

Devadoss, S. 2008. “An Evaluation of Canadian and U.S. Policies of Log and Lumber Markets,” Journal of Agricultural and Applied Economics. 40(1): 171-184.

Devadoss, S., and J. Luckstead. 2008. "Contributions of Immigrant Farm Workers to Californial Vegetable Production." Journal of Agricultural and Applied Economics 40(3).

Devadoss, S., and L. Wang. 2008. "Illegal Immigration Deportation and Endogenous Capital Out-flights." Department of Agricultural Economics and Rural Sociology. University of Idaho.

Djajic, S. 1987. "Illegal aliens, unemployment and immigration policy." Journal of Development Economics. 25(1): 235-249.

Djajic, S. 1997. "Illegal immigration and resource allocation." International Economic Review. 38(1): 97.

Duffield, J. A. and R. Coltrane 1992. "Testing for Disequilibrium in the Hired Farm Labor Market." American Journal of Agricultural Economics. 74(2): 412-420.

Durand, J., and D. S. Massey. 1992. "Mexican Migration to the United States: A Critical Review." Latin American Research Review. 27(2): 3-42.

Durand, J., D. S. Massey, and R. M. Zenteno. 2001. "Mexican Immigration to the United States: Continuities and Changes." Latin American Research Review. (36)1: 107-127.

Durand, J., E. A. Parrado, and D. S. Massey. 1996. "Migradollars and Development: A Reconsideration of the Mexican Case." International Migration Review. 30(2): 423-444.

Durand, J., et al. 1996. "International Migration and Development in Mexican Communities." Demography. 33(2): 249-264.

Espey and Thilmany. 2000. “Farm Labor Demand: A Meta-Regression Analysis of Wage Elasticities.” Journal of Agricultural and Resource Economics. 25(1):252-266.

Ethier, W. J. 1986a. "Illegal Immigration: The Host-Country Problem." American Economic Review. 76(1): 56.

Ethier, W. J. 1986b. "Illegal Immigration." American Economic Review. 76(2): 258.

Fanjul, G. and A. Fraser. 2003. Dumping Without Borders: How U.S. Agricultural Policies are Destroying the Livelihoods of Mexican corn farmers. Oxfam Briefing Papers. **50**.

FAS (2008). U.S.TRADE EXPORTS - BICO COMMODITY AGGREGATIONS, Foreign Agricultural Service. Retrieved on 25 September 2008 from http://www.fas.usda.gov/ustrade/USTExBICO.asp?QI=

Ferri, J., A. G. Gómez-Plana, and J. A. Martín-Montaner. 2006. "Illegal immigration booms and welfare in the host country." European Journal of Population. 22(4): 353-370.

Food and Agricultural Organization. 2008a. United Nations. *FAOStat*. Retrieved on 20 October 2008 from http://faostat.fao.org/site/613/DesktopDefault.aspx?PageID=613#ancor.

Food and Agricultural Organization. 2008b. United Nations. *TRADEStat*. Retrieved on 20 October 2008 from http://faostat.fao.org/site/406/default.aspx.

Food and Agricultural Organization. 2008c. United Nations. *PopSTAT*. Retrieved on 23 October 2008 from http://faostat.fao.org/site/550/DesktopDefault.aspx?PageID=550#ancor.

Friedberg, R.M. 2001. "The Impact of Mass Migration on the Israeli Labor Market." The Quarterly Journal of Economics. 116(4): 1373-1408.

Friedberg, R.M., and Hunt, J. 1995. "The impacts of immigrants on host country wages, employment and growth." Journal of Economic Perspectives. 9(2), 23-44.

Gaytán-Fregoso, H., and S. Lahiri. 2000. "Foreign aid and illegal immigration." Journal of Development Economics. 63(2): 515-527.

Gray, L. 2007. "Washington Video Seeks Farm Labor To Avert a Shortage." ImmigrateUSA.us. 27 May. Retrieved 8 June, 2007, from http://www.immigrateusa.us/index.php?option=com_content&task=view&id=944&Itemid=48.

Hammonds, T. M., R. Yadav, et al. 1973. "The Elasticity of Demand for Hired Farm Labor." American Journal of Agricultural Economics. 55(2): 242-245.

Hanson, G. H. 2006. "Illegal Migration from Mexico to the United States." Journal of Economic Literature. 44(4): 869-924.

Hanson, G. H. 2006d. "Illegal Migration from Mexico to the United States." Journal of Economic Literature. 44(4): 869-924.

Hanson, G. H., and A. Spilimbergo. 1999. "Illegal immigration, border enforcement, and relative wages: Evidence from apprehensions at the US-Mexico border." American Economic Review. 89(5): 1337-1357.

Hart, Jordana. 2006. 'Arrest of 1300 Undocumented Workers in Raids on Meat Packing Plants Uncovers Identify Theft Scheme.' *ImmigrateUSA.us*, 13 December. Retrieved on 23 May from

http://www.immigrateusa.us/index.php?option=com_content&task=view&id=535&Itemid=69

International Monetary Fund. 2007. Retrieved May 6, 2007, from http://www.imf.org/external/pubs/ft/weo/2007/01/data/weorept.aspx?sy=2000&ey=2007&scsm=1&ssd=1&sort=country&ds=.&br=1&c=273%2C156%2C111&s=PPPPC&grp=0&a=&pr1.x=57&pr1.y=18#cs1.

International Monetary Fund. 2008. World Economic and Financial Surveys. World Economic Outlook Database. Retrieved on 15 October 2008 from http://www.imf.org/external/pubs/ft/weo/2008/01/weodata/index.aspx.

Johnson, M. 2007. U.S. Farmers Facing Labor Shortages. Associate Press.

Jordan, M. 2007. Arizona Squeeze On Immigration Angers Business. The Wall Street Journal.

Jordan, M. 2007. “Arizona Squeeze on Immigration Angers Business: Employers Who Hire Illegals Face Shutdown; Outsourcing to Mexico." *Wall Street Journal*, 14 December, pp. A1 and A17.

Koyck 1954. Distributed Lags and Investment Analysis. Amsterdam, North Holland Publishing Co.

Lewis, E. 2007. "The Impact of Immigrants on American Workers and Businesses." Choices. 22(1): 49-56.

Lewis, E. 2003. *Local, open economies within the U.S.: How do Industries respond to immigration?* Federal Reserve Bank of Philadelphia Working Paper 04-01.

Mankiw N.G. Macroeconomics, Worth Publishers, New York, 1992.

Martin, P. 2007. "Immigration Reform, Agriculture, and Rural Communities." Choices. 21(1): 43-47.

Massey, D. S., et al. 1994. "An Evaluation of International Migration Theory: The North American Case." Population and Development Review. 20(4): 699-751.

Massey, D. S., L. Goldring, and J. Durand. 1994. "Continuities in Transnational Migration: An Analysis of Nineteen Mexican Communities." The American Journal of Sociology. 99(6): 1492-1533.

Montgomery, D. 2006. Senate Passes Immigration Reform. The Spokesman-Review**:** 6.

Nassif, T. 2008. Fram Workers, Guest Workers and Immigration. The Wall Street Journal.

Nerlove, M. 1958a. "Distributed Lags and Estimation of Long-Run Supply and Demand Elasticities: Theoretical Considerations." Journal of Farm Economics. 40: 301-311.

Nerlove, M. 1958b. Distributed Lags and Demand Analysis for Agricultural and Other Commodities. Agricultural Hb., U.S. Department of Agriculture.

Olivos-Kan, Andrea. 2006. 'ICE Raids Target Undocumented Workers, While Unemployed U.S. workers Refuse Jobs.' *ImmigrateUSA.us.* 31 July. Retrieved on 23 May 2007 from http://www.immigrateusa.us/index.php?option=com_content&task=view&id=205&Itemid=69

Olson, A. 2008. "Mexican Emigration drops sharply." *The Spokesman-Review*. 21 November. pp. A4.

Organisation for Economic Co-Operation and Development. 2008. Trade and Agricultural Directory. http://www.oecd.org/document/59/0,3343,en_2649_33773_39551355_1_1_1_1,00.html

Ottaviano G., and G. Peri. 2006. *Rethinking the Gains from Immigration: Theory and Evidence from the U.S.* NBER working paper: w11672**.**

Passel, J. S. 2006. The Size and Characteristics of the Unauthorized Migrant Population in the U.S. Estimates Based on the March 2005 Current Population Survey, vol. 2008, Pew Hispanic Center. Retrieved on September 9, 2008 from http://pewhispanic.org/files/reports/61.pdf.

Passel, J. S. 2006. "The Size and Characteristics of the Unauthorized Migrant Population in the U.S. Estimates Based on the March 2005 Current Population Survey." Retrieved September 9, 2008, from http://pewhispanic.org/files/reports/61.pdf.

Pendyck, R.S. and D.L. Rubinfeld. 1991. Econometric Models and Economic Forecasts. McGarw-Hill, Inc.

Preston, J. 2007. Short on Labor, Farmers in U.S. Shift to Mexico. The New York Times.

Raphael, S., and Ronconi, L. 2005. *Reconciling National and Regional Estimates of the Effects of Immigration on U.S. Labor Markets: The Confounding Effects of Native Male Incarceration Trends*. University of California-Berkeley Mimeo.

Rural Migration News. 2007. "Farm Labor Shortage." 14(1). Retrieved 15 June, 2007, from http://migration.ucdavis.edu/rmn/more.php?id=1182_0_4_0.

Schuh, G. E. 1962. "An Econometric Investigation of the Market for Hired Labor in Agriculture." Journal of Farm Economics. 44(2): 307-321.

Spagat, E. 2008. “Job loss reversing immigration surge.” The Spokesman-Review. 25 October. pp. A1.

Teklu, T. 1988. “Demand Systems from Cross-Section Data: An Application to Indonesia,” Canadian Journal of Agricultural Economics. 36:83-101.

The Economist. 2007. “Mexico’s road.” The World in 2008. Retrieved on 20 November 2008 from http://www.economist.com/theworldin/displaystory.cfm?story_id=10094102.

The Economist. 2008a. “A Turning Tide? Many of the Past Decade’s Migrants to Europe and America are Beginning to Go Home Again,” 28 June-4 July: 30-32.

The Economists 2008b. You Don’t Have to be Rich. 3 January 2008. Retrieved on 25 November 2008 from http://www.economist.com/research/articlesBySubject/displaystory.cfm?subjectid=894664&story_id=10286131

The Spokesman-Review. 2008. Mexico City: Money sent back to Mexico drops.

The Wall Street Journal. 2007. “Immigration Non-Harvest.” 20 July, A12.

The Wall Street Journal. 2007. Immigration Non-Harvest. July 20, 2007. A12.

Timmer, C.P. and H. Alderman. 1979. “Estimating Consumption parameters for Food Policy Analysis. American Journal of Agricultural Economics. 61(5): 982-987.

Torok, S.J. and W.E. Huffman. 1986. “U.S. Mexican Trade in Winter Vegetables and Illegal Immigration.” American Journal of Agricultural Economics. 68(2): 246-260.

U.S. Census Bureau. 2002. *Population Survey March 2002*. Retrieved 1 June, 2007, from http://www.census.gov/population/www/socdemo/migrate.html.

U.S. Department of Agricultural. 2008f. Foreign Agricultural Service. U.S. Trade Exports - BICO Commodity Aggregations. Retrieved on 5 October 2008 from http://www.fas.usda.gov/ustrade/USTExBICO.asp?QI=

U.S. Department of Agricultural. 2008g. Economic Research Service. *Data*. Retrieved on 8 October 2008 from http://www.ers.usda.gov/Data/ExchangeRates/

U.S. Department of Agriculture. 2007a. "Immigration Reform and Control Act of 1986." Washington DC, Retrieved on May 24, 2007, from http://www.ers.usda.gov/publications/ah719/ah719f.pdf.

U.S. Department of Agriculture. 2008a. *Farm Labor*. Retrieved on 1 October 2008 from http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1063.

U.S. Department of Agriculture. 2008b. *Quick Stat (Agricultural Statistics Data Base)*. Retrieved on 29 September 2008 from http://www.nass.usda.gov/Data_and_Statistics/Quick_Stats/index.asp.

U.S. Department of Agriculture. 2008c. "Farm and Commodity Policy: Government Payments and the Farm Sector." Washington DC, Retrieved on September 9, 2008, from http://www.ers.usda.gov/Briefing/FarmPolicy/gov-pay.htm.

U.S. Department of Agriculture. 2008c. *Agricultural Prices*. Retrieved on 2 October 2008 from http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1002.

U.S. Department of Agriculture. 2008d. *Mexico: Policy*. Briefing Rooms, ERS Washington DC,

U.S. Department of Agriculture. 2008d. *Publications: Statistical Bulletins*. Retrieved on 2 October 2008 from http://www.nass.usda.gov/Publications/Statistical_Bulletins/Final_Estimates_1987_1993.asp.

U.S. Department of Agriculture. 2008e. *Data Sets Farm Income: Data Files*. Retrieved on 3 October 2008 from http://www.ers.usda.gov/data/farmincome/FinfidmuXls.htm

U.S. Department of Commerce. 2008a. Bureau of Economic Analysis. *Implicit Price Deflators for Gross Domestic Product*. Retrieved on 30 September 2008 from http://www.bea.gov/national/index.htm.

U.S. Department of Commerce. 2008b. Bureau of Economic Analysis. *National Income and Product Accounts Table*. Retrieved on 3 October 2008 from http://www.bea.gov/national/nipaweb/TableView.asp?SelectedTable=58&Freq=Qtr&FirstYear=2006&LastYear=2008.

U.S. Department of Commerce. 2008c. Bureau of Economic Analysis. *CPI Detailed Report, monthly*. Retrieved on 12 October 2008 from http://www.bea.gov/national/nipaweb/TableView.asp?SelectedTable=58&Freq=Qtr&FirstYear=2006&LastYear=2008.

U.S. Department of Homeland Security. 2007a. Yearbook on Immigration Statistics. Enforcement. Retrieved on 30 October 2008, from http://www.dhs.gov/ximgtn/statistics/publications/YrBk07En.shtm.

U.S. Department of Homeland Security. 2007b. "Estimates of the Unauthorized Immigrant Population Residing in the United States: January 2006." Population Estimates. Retrieved on 30 October 2008, from http://www.dhs.gov/xlibrary/assets/statistics/publications/ois_ill_pe_2007.pdf

U.S. Department of Homeland Security. 2008b. "Frequently Asked Questions About Worksite Enforcement." Retrieved on 10 November 2008 from http://www.ice.gov/pi/news/factsheets/worksite.htm.

U.S. Department of Homeland Security. 2008c. U.S. Immigration and Customs Enforcement. *NEWS*. Retrieved on 11 November 2008 from http://www.ice.gov/pi/investigations/worksite/newsreleases.htm.

U.S. Department of Labor. 2008a. Bureau of Labor Statistics. Employment, Hours, and Earnings from the Current Employment Statistics Survey (National). Retrieved on 27 September 2008 from http://data.bls.gov/PDQ/servlet/SurveyOutputServlet.

U.S. Department of Labor. 2008b. Employment and Training Administration. The National Agricultural Workers Survey. Retrieved on 29 September 2008 from http://www.doleta.gov/agworker/naws.cfm.

U.S. General Accounting Office. 2005. "Immigration Enforcement: Preliminary Observations on Employment Verification and Worksite Enforcement Efforts. GAO-05-822T.

U.S. Immigration and Customs. 2008a. *136 workers apprehended after worksite enforcement at George's Processing poultry-processing plant as part of an ongoing criminal investigation*. News Releases, Washington DC, Retrieved 8 September, 2008, from http://www.ice.gov/pi/news/newsreleases/articles/070523springfield.htm

U.S. Immigration and Customs. 2008b. *595 arrested in ICE enforcement operation at Mississippi transformer manufacturing facility*. News Releases, Washington DC, Retrieved 8 September 2008, from http://www.ice.gov/pi/investigations/worksite/newsreleases.htm?searchstring=illegal%20AND%20alien.