Effects of NAFTA on Agricultural Wages and Employment in Mexico

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Abstract

This paper measures the impact of NAFTA-induced real border price changes of Mexican imports and exports on wages and employment of agricultural workers in Mexico. I find that changes in real border prices of crops did not affect agricultural wages. On the other hand, increases in the real price of vegetables (main agricultural export) were associated with an increase in employment in the cultivation of vegetables whereas the drop in the real price of corn (main agricultural import) reduced the employment in the corn sector. This is in line with the predictions of neoclassical trade theory: in the absence of mobility costs or sector-specific skills, factors moved smoothly from import-competing sectors into export sectors.

Keywords: Trade liberalization; agricultural wages; agricultural employment; Mexico.
JEL codes: F13, F16, J43.

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1. Introduction

The effect of international trade on the wages and employment of workers in developing countries has stirred a heated debate. Great concerns are related to the fact that one of the effects of trade liberalization may be to lower wages or employment of unskilled workers, such as agricultural workers.

Trade theory predicts that product market integration affects domestic labor markets through changes in relative product prices. Consequently, product price movements have been used extensively to estimate the potential effects of trade liberalization on labor markets (Leamer and Levinsohn (1995)). Given the increased importance of trade liberalization of agricultural commodities, it is of great interest to study how product price changes affect labor in the agricultural sector. Nevertheless, to date there are no empirical studies on the impact of openness to trade on wage earners in the agricultural sector. Previous studies on the impact of trade on wages and employment in developing countries have focused on the manufacturing sector and have mostly considered unilateral trade liberalizations (see Goldberg and Pavcnik (2004) and Harrison (2006) for a review; Galiani and Sanguinetti (2003) for Argentina; Attanasio et al. (2004), and Goldberg and Pavcnik (2005) for Colombia; Robertson (2004), Feliciano (2001), Hanson and Harrison (1999), and Revenga (1997) for Mexico; Currie and Harrison (1997) for Morocco; Goh and Javorcik (2005) for Poland).

This paper looks at the North American Free Trade Agreement (NAFTA) to study how wages and employment in the agricultural sector in Mexico responded to trade liberalization. January 1, 2008 marked the culmination of NAFTA's 14-year transition to free trade between Mexico, the United States and Canada. Given Mexico's recent opening to agricultural trade, its proximity to the United States, and the importance of its agricultural sector, Mexico is an ideal candidate for an analysis of any impact of trade liberalization on the agricultural labor market.

As shown by McMillan et al. (2004) and Prina (2009), NAFTA-induced tariff cuts caused a reduction in the real Mexican border price of corn, an imported commodity, and an increase in the real Mexican border price of fruits and vegetables, which are exported commodities.[1] I look at the impact of NAFTA-triggered border price changes of crops imported from the U.S.

[1] Also, Nicita (2009) finds that tariff liberalization in Mexico during the 1989-2000 period decreased the price of a basket of agricultural goods.

and exported to the U.S. on agricultural workers in Mexico. I relate the intertemporal variation in the real Mexican border price of corn, tomatoes, and melons to variation in wages and employment of landless workers engaged in agricultural activities. An important caveat is that not all border price changes in the data stem from product market integration. However, to the extent that trade liberalization affects the price of a commodity,[2] this analysis illustrates the potential impact of integration on agricultural labor.

I use border price data from the U.S. Department of Agriculture, Foreign Agricultural Service, and individual and municipality level data from the Mexican National Employment Surveys (ENEs) collected in 1991, 1993, and 1995-2000. The detail of the data allows for a more disaggregated analysis and enables me to control for differences across individuals and municipalities that may be correlated with changes in wages and employment. Currie and Harrison (1997) show the importance of using micro data to control for within sector characteristics when analyzing the impact of trade reform on employment. Moreover, the use of border prices of both imports and exports enables me to account both for price reductions due to increased import competition and for beneficial effects of increases in the prices of exports.

Several papers that study the impact of trade reforms on wages and employment in the industrial sector in developing countries show almost no impact on wages and small effects on employment (Wacziarg and Wallack (2004), and Papageorgiu et al. (1991)). The most popular explanation for the lack of a response is the presence of restrictive labor regulations that inhibit both labor mobility and wage flexibility. For Mexico, Feliciano (1994) finds that the trade reforms between 1986 and 1990 had no statistically significant impact on relative wages or relative employment in the manufacturing sector. She attributes her results to the difficulty of firing workers under Mexican labor law. Revenga (1997) also suggests that the small labor market response found in Mexico and Morocco might be due to labor regulations. This should not happen in the agricultural sector where most contracts are informal and most workers are temporary. Another possible explanation for the lack of an employment response is the presence of imperfect competition, with fewer players and high barriers to entry. Currie and Harrison (1997)

[2]Robertson (2004) shows that in Mexico changes in prices are consistent with the changes in tariffs triggered by the trade liberalization that occurred during the 1986-1999 period.

show that this is the case for Morocco during the 1980s; firms adjusted to trade reforms by reducing profit margins and raising productivity, rather than by reducing employment. Again, this does not seem a plausible explanation for the agricultural sector, which is characterized by many farmers and low barriers to entry.

The results of my study suggest that labor mobility and flexibility of rural labor markets insulated workers from any adverse impact. In fact, changes in agricultural border prices do not seem to affect wages. This is what would be expected in a standard competitive market with easy mobility across sectors (such as corn, fruits, or vegetables) because tasks are mostly unskilled and there is little likelihood of sector-specific skills. In contrast, changes in agricultural border prices tend to affect employment: increases in the real price of vegetables (main agricultural export) are associated with an increase in employment in the cultivation of vegetables whereas the drop in the real price of corn (main agricultural import), reduces employment in the corn sector. These results stand out when the analysis is conducted at the regional level, considering border, central, and southern Mexican states separately. In fact, the response of employment to price increases varies with regional exposures to trade openness and regional characteristics. In particular, the NAFTA-induced drop in the real price of corn seems to have decreased employment in the corn sector in both border and central regions, and the border region was subject to a more substantial impact. Also, the NAFTA-induced increase in the real price of tomatoes seems to have raised employment in the cultivation of vegetables in the central states, and decreased employment in the cultivation of corn and fruits in the border states. Furthermore, employment in the southern states does not seem to respond to real price changes. These results emphasize the importance of accounting for regional differences. Most previous studies do not consider that states far away from the border might be less affected by trade liberalization. Goods that are traded in well-connected regions are not necessarily traded in other regions. Furthermore, there are significant differences in the quality of soil and distance and connection to the U.S. border at the regional level (Levy (2004), and Levy et al. (2002)).

The following section briefly illustrates the changes in trade restrictions caused by NAFTA and portrays the agricultural trade between Mexico and the United States. Section 3 describes the individual and municipality data, and the data on border prices of agricultural commodities that span the 1989-2005 period. Section 4 outlines the empirical strategy to measure the impact of changes in border prices that were triggered by NAFTA on agricultural

wages and employment in Mexico. Finally, Section 5 summarizes the results and concludes.

2. NAFTA and Agricultural Trade between Mexico and the U.S.

Mexico's opening started in the early '80s with a reduction of some trade restrictions on exports in response to a severe balance of payment crisis and continued when Mexico became a full member of the General Agreement on Tariffs and Trade (GATT) in 1985. However, no major changes in the structure of border protection of agricultural products were undertaken until the North American Free Trade Agreement (NAFTA) took effect on January 1, 1994. With NAFTA, the structure of border protection for Mexico's agricultural sector was radically transformed. Likewise, the United States and Canada experienced similar changes.

The aim of NAFTA was to eliminate all agricultural tariffs and quantitative restrictions on trade between the U.S. and Mexico. Many tariffs were eliminated immediately with the others being phased out over periods of 5, 10, or 15 years. This implies that agricultural products became duty-free on January 1, 1998, 2003, or 2008.

Agricultural trade plays a crucial role in U.S.-Mexico economic relations despite the uneven size of the two economies. Mexican agriculture is a much more significant factor in the Mexican economy than U.S. agriculture is in the U.S. economy. Agriculture contributes 10% to Mexico's gross domestic product and employs about 22% of the labor force, which amounts to about 8 million workers. In contrast, in the U.S., agriculture accounts for only 2% of GDP and employs about 2.7% of the labor force, which is slightly less than 4 million workers.

The United States is Mexico's most significant agricultural trading partner whereas Mexico and Canada are the largest agricultural trading partners of the United States. U.S.-Mexico agricultural trade is largely complementary; that is, the United States tends to export different commodities to Mexico than Mexico exports to the United States.

U.S. exports of agricultural goods to Mexico are led by grains, with corn being the leading commodity, followed by rice, wheat, barley, potatoes, and apples. During the 1989-1993 period, corn shipments to Mexico were low whereas, for the 1994-2004 period, U.S. exports of corn soared to 6% per

year.[3] As shown in Figure 1, U.S. corn exports to Mexico account for almost all Mexican corn imports.

Agricultural Mexican exports to the U.S. are led by vegetables and fruits. Considering vegetables, their exports increased at 0.8% annually during the 1989-1993 period. This is a very small rate compared to the 6.2% yearly increase in the period post NAFTA (1994-2004). As shown in Figure 2, Mexican vegetable exports to the U.S. account for about 65% of U.S. vegetable imports. Tomatoes are the leading export crop. As illustrated by Figure 3, more than 85% of the tomatoes imported from the U.S. come from Mexico. Considering fruits, Mexican exports rose at 2.8% per year between 1989 and 1993, and at 4.8% per year after that. As shown in Figure 4, Mexican fruit exports to the U.S. account for about 20% of U.S. fruit imports. Melons are the leading export crop. As illustrated by Figure 5, around half of the melons imported by the U.S. come from Mexico.

Considering reductions in the Mexican tariff for corn imported from the U.S., Prina (2009) finds that a 1% decrease in the tariff caused a statistically significant decrease in its border price by 0.20% after controlling for inflation in Mexico. Similarly, the findings of McMillan et al. (2005), suggest that corn producer prices for Mexican farmers fell as a result of NAFTA.

Considering reductions in the U.S. restrictions on imports of tomatoes and melons from Mexico, Prina (2009) finds that a 1% decrease in the tariff caused an increase in border price of 0.20% for tomatoes and 0.10% for melons. Thus, there is some evidence that NAFTA increased the border price of the agricultural commodities exported from Mexico to the U.S.: specifically tomatoes and melons.

Overall, these changes in border prices could impact wages and employment of agricultural workers. The following sections investigate the nature of this effect.

[3]U.S. exports of corn to Mexico include both yellow and white corn. Mexican corn farmers typically grow white corn, which is used to make food products. Yellow corn is typically used to feed animals. However, there is some substitutability between yellow and white corn. Food-grade yellow corn is used to make corn flakes, chips, beer, and other foods, and white corn can be used as animal feed (Zahniser and Coyle 2004).

3. Data Description

The data at the individual and municipality level, which come from the National Employment Surveys (Encuesta Nacional de Empleo (ENE)) in Mexico, were collected in 1991, 1993, and 1995-2000. Despite the fact that they have been performed at irregular intervals, they are comparable in terms of the sampling frame, the sampling methodology, the timing, and the questionnaires used. The surveys are representative at the national level, and for those from 1996, 1998, and 2000, the surveys are also representative at the state level. They were undertaken using stratified sampling during the second quarter of each survey year. The size of the sample varies from year to year. Finally, the dataset is not a panel, as each subject was interviewed only once, but a repeated cross-section.

Along with each ENE survey, an Agricultural Supplement was carried out for those individuals who participated in agricultural activities. The ENE surveys and the Agricultural Supplement contain information on demographics, education, and employment, which include data on weekly wages and number of hours worked. Also, by using information on farmers and workers belonging to each municipality, I can compute variables at the municipality level, such as an indicator of the land distribution, the fraction of land allocated to each crop category, and the proportion of irrigated land.

As wage variable, I use individual hourly wages, calculated using data on weekly wages and weekly hours worked by worker. As employment variable, I consider the fraction of hours allocated to each crop category in each municipality. Given the nature of the data, which do not follow individuals over time, I believe this is the best measure of employment for the purposes of the analysis.

The border price dataset spans 1989-2005 and has information on the main agricultural goods exported from Mexico to the U.S. and for the main agricultural commodities imported by Mexico from the U.S. I build it using the unit values of imports or exports as monthly border prices.[4] Unit values are computed as the custom values divided by quantities. These data are taken from the U.S. Department of Agriculture, Foreign Agricultural Ser-

[4]By definition, the border price is the import (c.i.f.)or export (f.o.b.) price of a commodity used for calculating the market price support price gap, measured at the farm gate level. An implicit border price may be calculated as the unit value of imports or exports (Glossary of Agricultural Policy Terms, OECD).

vice.[5] The level of commodities aggregation is at the Foreign Agricultural Trade of the United States (FATUS) level, which aggregates HS 10-digit codes. The unit values, in U.S. dollars, are deflated using the Producer Price Index at the farm level from the U.S. Bureau of Labor Statistics and transformed into Mexican pesos using the monthly exchange rate from Banco de Mexico.

I merge the individual and municipality data with the border price dataset. The surveys contain information regarding the different sectors in which agricultural workers are employed: corn, vegetables, fruits, and other crops. Therefore, I consider a unique border price for each group. In particular, for the categories "corn," "vegetables," and "fruits," I use the border prices of corn, tomatoes, and melons, respectively. This is a reasonable choice since these are the most important goods produced in the grain, fruit, and vegetable categories. In addition, tomatoes and melons are the leading crops imported to the U.S. for vegetables and fruits, respectively, whereas corn is the primary exported grain from the United States.[6] Finally, since the surveys were conducted in the second quarter of each year, I compute the average prices using the monthly prices of April, May, and June.

The final outcome is a dataset consisting of about 10 years of data on border prices, agricultural workers, and key characteristics at the municipality level.

Table 1 reports basics summary statistics for individual and municipality variables for Mexico and by regions. An agricultural worker is paid, on average, 10.4 Mexican pesos per hour.[7] At both national and regional levels, there are not strong wage differentials by sectors (corn, fruits, vegetables, and other crops). Only corn wages appear slightly lower than the others. This seems reasonable, since no particular skills are required to work in one crop or another. On average, hourly wages are higher in the northern region than in the central and southern regions. This is true also by sectors. The average hours worked in the field by a worker in a week are 43. Workers in

[5]These data are originally collected by the Census Bureau of the U.S. Department of Commerce.

[6]Another possibility would be to consider an average border price whose weight is given by the amount produced either at the national or state level. I discarded this possibility, since, for some of these goods, the border price is not available.

[7]Wages are deflated using the CPI from Banco de Mexico with base year 1994. Hence, 10.4 Mexican pesos converts to about 1 U.S. dollar.

the border states work about an hour more while workers in the south work about an hour less. The same findings stand out looking by sectors. Women are more involved in agricultural activities in the north, than in the center, than in the south. About 44% of the workers have not completed primary school, this percentage being higher for the south.

4. Empirical Analysis

The approach used in this study is reduced-form. I investigate whether shifts in trade openness, measured as price changes, were associated with shifts in agricultural wages and employment. This section lays out the basic empirical framework and discusses the main results.

4.1. Wages

First, I consider the impact of NAFTA-induced price changes on hourly wages of workers in different crops, k. In the presence of barriers to workers' mobility, or crop-specific skills, or rents enjoyed by workers owing to imperfect competition, there would be wage effects. In particular, price movements for crop k, which move the derived demand function for hired workers in sector k, would positively affect wages in sector k. Hence there would be a positive relationship between price and wage changes in sector k. Absence of such patterns would indicate that NAFTA had no significant impact, as such barriers or rents do not exist. Furthermore, this finding would be corroborated if employment shifted across sectors according to changes in relative border prices.

To measure the effect of a price change of crop k as well as of price change of crop $j \neq k$ on the wage of a worker in crop k, I should estimate:

$$w_{imt}^{k} = \alpha_0 + \alpha_1^k P_t^k + \sum\nolimits_{j \neq k} \alpha_1^j P_t^j + \alpha_2 X_{imt} + \alpha_3 Z_{mt} + \nu_{imt} \qquad (1)$$

where w_{imt}^{k} is the hourly log wage of worker i into crop k, in municipality m, at time t. P_t^k and P_t^j are the log border prices of crop k and $j \neq k$, respectively. The crops considered in the analysis are corn, fruits, and vegetables. X_{imt} is a vector of worker characteristics, Z_{mt} is a vector of municipality characteristics,[8] and ν_{imt} is an individual error.

[8]Controls at the individual level include gender, age, marital status and, education level. Controls at the municipality level include average land size and technology indicators (e.g. irrigation, machinery, and animals).

In (1) however, border prices are explanatory variables measured at a higher level of aggregation than the dependent variable. This does not allow me to control for yearly effects that could affect wages. Therefore, the estimate of α_1^k would measures the impact of many other variables that could be changing yearly, other than prices. Furthermore, this specification would cause to add built-in correlation between the dependent and the explanatory variables when deflating both wages and border prices to control for inflation. Thus, in order to assess the real impact of NAFTA-induced border price changes on wages, I follow a two-step procedure as in Donald and Lang (2007). In the first step, I regress wages on year dummies, λ_t^k, and workers and municipality characteristics with OLS:

$$w_{imt}^k = \lambda_t^k + [\cdot] + \xi_{imt} \tag{2}$$

where[9]

$$\lambda_t^k = \alpha_0 + \alpha_1^k P_t^k + \sum\nolimits_{j \neq k} \alpha_1^j P_t^j + \varepsilon_t \tag{3}$$

ε_t is an yearly error term and ξ_{imt} is an individual-specific term that is independent of the other errors. I include municipality fixed effects in the regressions to account for omitted time-invariant municipality characteristics.

In the second step, I regress with OLS the estimates of the year dummy coefficients on the deflated (to correct for the inflation trend) yearly border prices.

$$\widehat{\lambda}_t^k = \beta_0 + \beta_1^k P_t^k + \sum\nolimits_{j \neq k} \beta_1^j P_t^j + \varepsilon_t + (\widehat{\lambda}_t^k - \lambda_t^k) \tag{4}$$

Therefore, the strategy consists of estimating the effect of each year on wages separately and then regressing these coefficients on the crop prices. β_1^k and β_1^j are the coefficients of interest. They measure how much of the yearly changes in wages can be explained by NAFTA-induced border price changes.

I also perform this analysis at the regional level, dividing Mexican states into three groups: border, central, and southern states.[10] States far away

[9] Where $[\cdot] = \alpha_0 + \alpha_2 X_{imt} + \alpha_3 Z_{mt}$.

[10] Border states are: Baja California, Chihuahua, Coahuila, Nuevo Leon, Sonora, and Tamaulipas. Central states are: Aguascalientes, Baja California Sur, Colima, Distrito Federal, Durango, Estado de Mexico, Guanajato, Hidalgo, Jalisco, Michoacan, Morelos, Nayarit, Puebla, Queretaro, San Luis Potosi, Sinaloa, Tlaxcala, and Zacatecas. Southern states are: Campeche, Chiapas, Guerrero, Oaxaca, Quintana Roo, Tabasco, Veracruz, and Yucatan.

from the border might be less affected by trade liberalization since goods that are traded in well-connected regions are not necessarily traded in other regions. Furthermore, differences in the quality of soil as well as distance and connection to the U.S. border might be important. In particular, border states have mostly arid land that can be used for corn whereas southern and central states have a soil that is more suitable for all types of agricultural purposes. However, the southern states have much higher transportation costs than do the border and central states due to the radial structure of highways and railways in Mexico. In fact, all of the commodities coming from the south and directed to the U.S. border must pass through the center of Mexico. Finally, ferry transportation, which would allow for a more rapid connection, is not well developed.[11] Thus, I expect border states to have been affected by the reduction in corn prices, and central states to have been more influenced by trade liberalization in all agricultural goods.

4.2. Employment

A similar two-step procedure is applied for employment with some important differences. First, it is worth focusing on the employment measure used because it is not the most obvious choice of employment variable. This variable is defined as the fraction of hours spent working on crop k, in municipality m, year t:

$$H_{mt}^{k} = \frac{\sum_i h_{imt}^{k}}{\sum_i h_{imt}} \tag{5}$$

The nature of the data makes this the relevant measure. Given that I do not have a panel but rather, repeated cross-sections, I am not able to observe individual changes in the sector of employment or in the number of hours worked in a given sector. Therefore, I cannot use any variable at the individual level. The alternative is to use an employment measure at the municipality level. I could use either the fraction of workers employed in each sector, or the fraction of hours worked in each sector. However, if an increase in labor demand in a given sector causes only an increase in the hours worked by each individual in that sector, no change would be observed in the fraction of workers employed although the fraction of hours worked

[11] Detailed descriptions of the differences between border, central, and southern Mexican states can be found in Levy (2004), and Levy et al. (2002).

in that sector would increase. That is why I chose as employment measure H^k_{mt}: the fraction of hours spent working on crop k in municipality m.

To measure the effect of a price change for crop k as well as of price change for crop $j \neq k$ on employment in sector k, I should estimate:

$$H^k_{mt} = \gamma_0 + \gamma^k_1 P^k_t + \sum\nolimits_{j \neq k} \gamma^j_1 P^j_t + \gamma_2 W_{mt} + \nu_{mt} \tag{6}$$

where H^k_{mt} is the fraction of hours spent working on crop k in municipality m, at time t. P^k_t and P^j_t are the log border prices of crop k and $j \neq k$, respectively. The crops considered in the analysis are corn, fruits and vegetables. W_{mt} is a vector of municipality characteristics,[12] and ν_{mt} is an error.

As for wages, however, (6) does not allow me to control for yearly effects that could affect employment since border prices are explanatory variables measured at a higher level of aggregation than the dependent variable. Therefore, the estimate of γ^k_1 would measure the impact of many other variables that could be changing yearly, other than prices. Thus, in order to assess the real impact of NAFTA-induced border price changes on employment, I follow a similar two-step procedure to the one outlined above for wages.

Other important issues are worth mentioning. Municipalities in which no one works in crop k have $H^k_{mt} = 0$, whereas municipalities in which all workers are employed in crop k have $H^k_{mt} = 1$. Given that a high number of municipalities do not have at least one worker per crop k (more than 20%), I use a tobit regression with left censoring. Also, for the fraction of hours spent working in corn fields, $H^{k=corn}_{mt}$, I use a tobit regression with left and right censoring because more than 10% of the values are equal to one. Furthermore, I use the number of workers as municipality weight.

In the first step, I regress the fraction of hours spent in crop k on year dummies, θ^k_t, and municipality characteristics, with a tobit regression:

$$H^k_{mt} = \theta^k_t + [\cdot] + \eta_{mt} \tag{7}$$

where[13]

$$\theta^k_t = \gamma_0 + \gamma^k_1 P^k_t + \sum\nolimits^j_{j \neq k} \gamma^j_1 P^j_t + \mu_t \tag{8}$$

[12] Controls at the municipality level include gender composition, average age and education level, average land size and technology indicators (e.g. irrigation, machinery, and animals).

[13] Where $[\cdot] = \gamma_0 + \gamma_2 Z_{mt}$.

μ_t is a yearly error term and η_{mt} is a municipality-specific term that is independent of the other errors.

In the second step, I use OLS to regress the estimates of the year dummy coefficients on yearly border prices that have been deflated to correct for the inflation trend.

$$\widehat{\theta}_t^k = \delta_0 + \delta_1^k P_t^k + \sum\nolimits_{j \neq k}^{j} \delta_1^j P_t^j + \mu_t + (\widehat{\theta}_t^k - \theta_t^k) \tag{9}$$

δ_1^k and δ_1^j are the coefficients of interest. They measure how much of the yearly changes in the fraction of hours spent in a given crop can be explained by price movements.

For both wages and employment, the coefficients of interest are identified with the assumption that unobserved yearly aggregate variables that affect wages are uncorrelated with border prices.

As previously mentioned, this same analysis is performed at the regional level, dividing the Mexican states into three groups: border, central, and southern.

4.3. Results

Tables 2-5 present the estimates of the two-step procedure for the effect of NAFTA-induced changes in real border prices of crops on agricultural wages in Mexico, and border, central, and southern states, respectively. Considering the first step, for all crops, the year dummy coefficients show an increasing trend due to inflation.[14] Considering the second step, the coefficients measuring how much of the yearly changes in the hourly wages can be explained by price movements do not manifest a specific pattern and none of the coefficients, for any sector, are significant. These findings indicate that changes in the real price of crops did not affect agricultural wages.

Tables 6-9 show the estimates of the two-step procedure for the effect of NAFTA-induced changes in real border prices of crops on agricultural employment in Mexico, and border, central, and southern states, respectively. In the first step, no particular yearly trend stands out. The second step regression for Mexico as a whole, which is presented in the bottom part of Table 6, shows that most of the coefficients have the expected sign (i.e., the estimates of δ_1^k are positive) whereas the ones of δ_1^j are negative. This tends

[14]The omitted year is 1997.

to indicate that yearly changes in the fraction of hours spent in crop k are affected positively by a change in the real border price of crop k and negatively by a change in the real price of any other crop. However, at the national level, none of the coefficients are statistically significant. Nevertheless, the analysis at the regional level show some statistically significant effects. Results from the second step for border and central regions, which are reported in the bottom of Tables 7 and 8, show that NAFTA-triggered border prices significantly affected agricultural employment. First, changes in the real price of corn positively influenced the fraction of hours spent in corn at the municipality level in both border and central regions, where the impact is larger in the border states. Given the NAFTA-induced reduction in the real price of corn, as found in McMillan et al. (2004) and Prina (2009), this finding tends to indicate that corn employment decreased in both regions and by more in the border area. Second, in the central states, variation in the real price of tomatoes positively affected the fraction of hours spent in vegetables. Because the real price of tomatoes increased due to trade liberalization (Prina (2009)), this result tends to indicate that the fraction of hours spent in the vegetable sector increased in the central region. Third, in the border states, the increase in the real price of tomatoes induced by NAFTA seems to have caused a reduction in the fraction of hours spent cultivating corn and fruits. Finally, as the results from the second step of Table 9 show, I do not find any significant effect in the southern regions.

Despite a short data series, the estimated employment effects are statistically significant. Overall, trade liberalization in agricultural goods seems to have increased employment in the cultivation of vegetables (which are export competing) and reduced it in the cultivation of corn (which is import competing). This is in line with the predictions of neoclassical trade theory: factors seem to have moved smoothly into export sectors from import-competing sectors.[15]

Regional differences turn out to be important, and the results seem consistent with the regional differences in soil quality and connection to the U.S. border.

[15] I also tried to test the presence of local markets. In order to do so, I regressed hourly wages and hours worked, averaged at the municipality level, on the interaction between crop prices and the fraction of land allocated to each crop in a fixed year. However, the results were not robust to functional form.

5. Conclusions

The weak or absent response of wages and employment in the manufacturing sector to trade reforms have been motivated by the presence of labor regulations that inhibit both labor mobility and wage flexibility, and by the presence of imperfect competition. These explanations do not seem plausible for the agricultural sector characterized by many farmers and low barriers to entry, where most contracts are informal, and most workers are temporary. This paper considers the agricultural labor market in Mexico and measures the impact of NAFTA-induced border price changes of Mexican imports and exports on wages and employment of agricultural workers in Mexico.

The findings show that NAFTA-induced border price changes do not seem to affect agricultural wages. Absence of an effect on wages tends to signal that barriers to workers' mobility or rents do not exist. This result is corroborated by the evidence that NAFTA-induced border price changes affected employment in the border and central regions. In fact, the NAFTA-induced drop in the price of corn seems to have decreased employment in the corn sector in both border and central regions, and yet more so in the border region. Also, the NAFTA-induced increase in the price of tomatoes seems to have raised employment in the vegetable sector in the central states and decreased employment in the corn and fruit sectors in the border states.

Overall, these results are consistent with a standard competitive market with easy mobility across sectors and lack of crop-specific skills, such as the agricultural labor market where tasks are mostly unskilled and there is little likelihood of sector-specific or crop-specific skills. In fact, the results seem to suggest that there is some mobility across agricultural sectors causing employment in k to be positively affected by price changes in k and negatively by price changes in $j \neq k$.

The results from the analysis at the regional level are consistent with those by Hanson (2004) on the distribution of labor income across regions of Mexico during the country's decade of globalization in the 1990's. Hanson considers the border and central states to have high exposure to globalization,[16] , and the southern states to have low exposure to globalization. He finds that labor income in low-exposure states fell relative to high-exposure states by 10%.

Finally, these findings are also in line with evidence from Prina (2009)

[16]Hanson measures globalization as the share of foreign direct investments, imports, or exports assembly in state GDP.

related to farmers' incomes. In fact, she shows an impact of agricultural trade liberalization on the income of farmers working in the border and central states of Mexico, while no statistically significant effect was revealed for southern states.[17]

[17]In particular, Prina (2009) shows an effect of integration on corn farmers in both border and central regions, and on vegetables farmers only in the central region.

[1] Attanasio, O., Goldberg, P.K., Pavcnik, N., 2004. Trade Reforms and Wage Inequality in Colombia. Journal of Development Economics 74, 331-366.

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Figures and Tables

Figure 1: Mexican Corn Imports

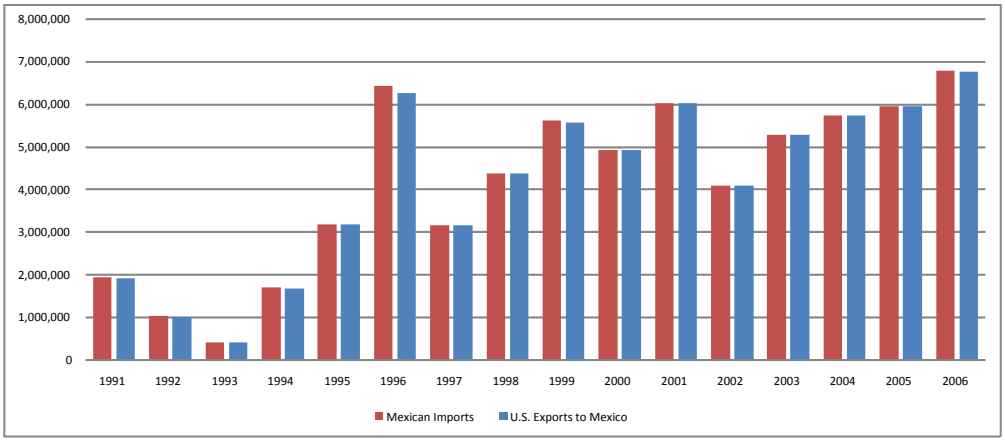

Figure 2: U.S. Vegetable Imports

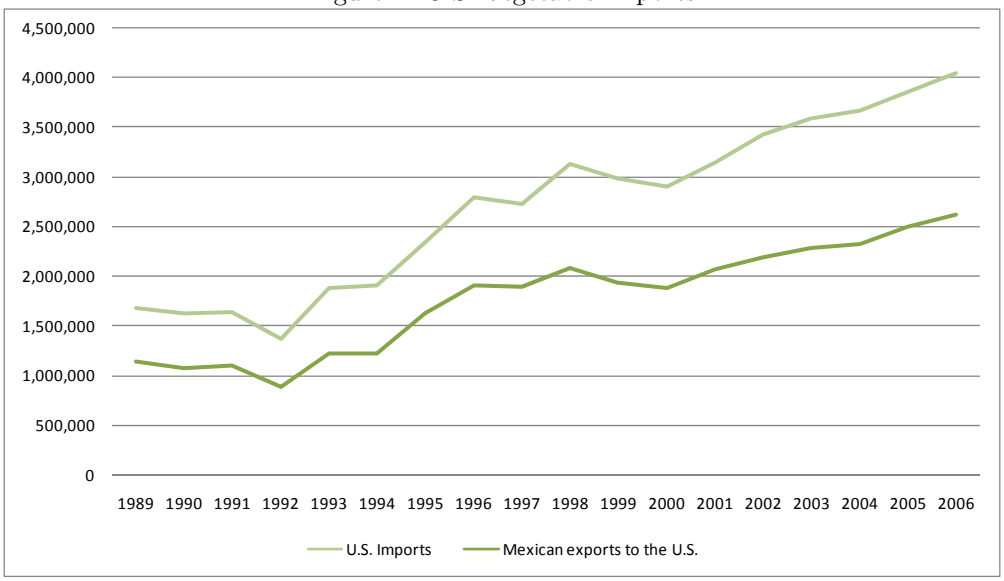

Figure 3: U.S. Tomato Imports

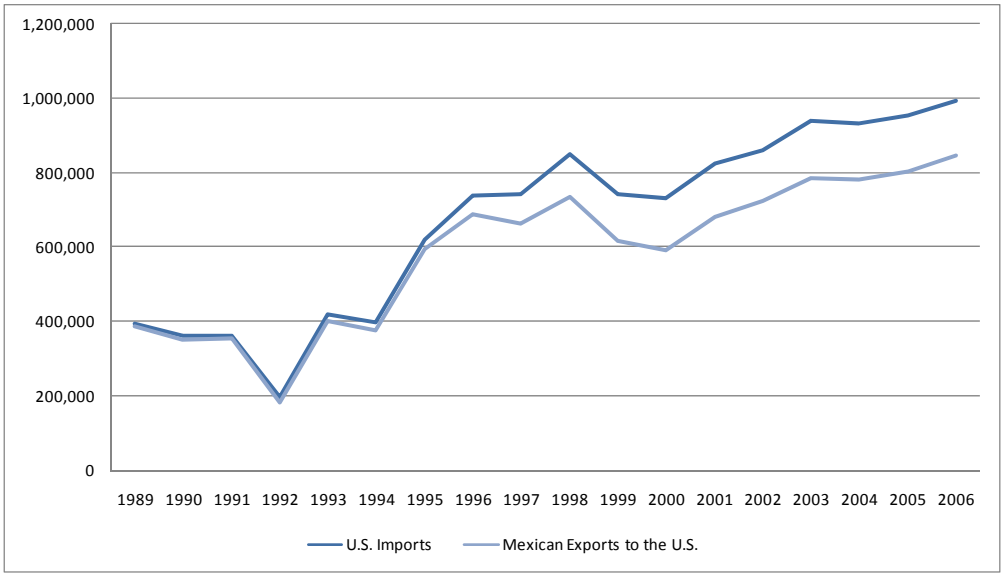

Figure 4: U.S. Fruit Imports

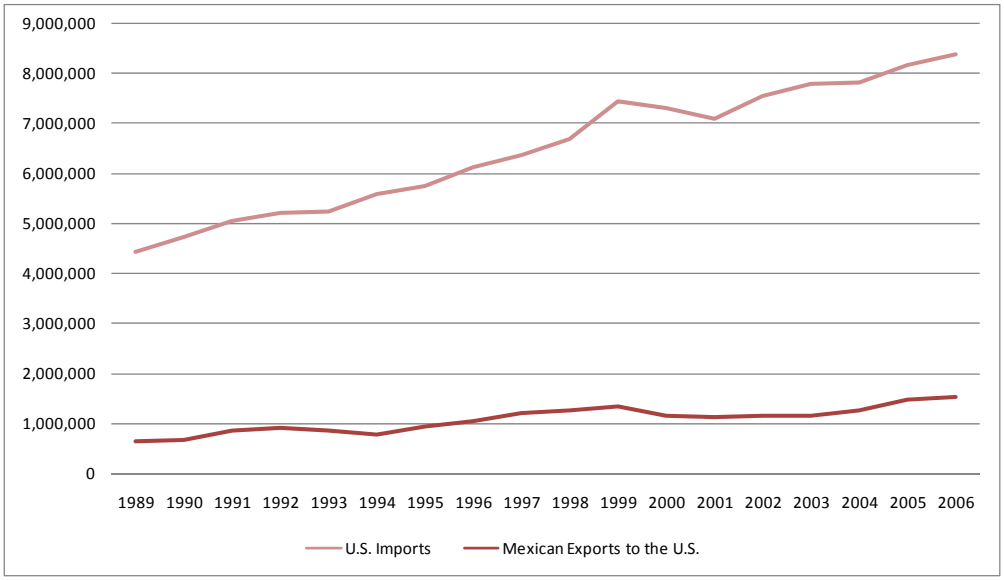

Figure 5: U.S. Melon Imports

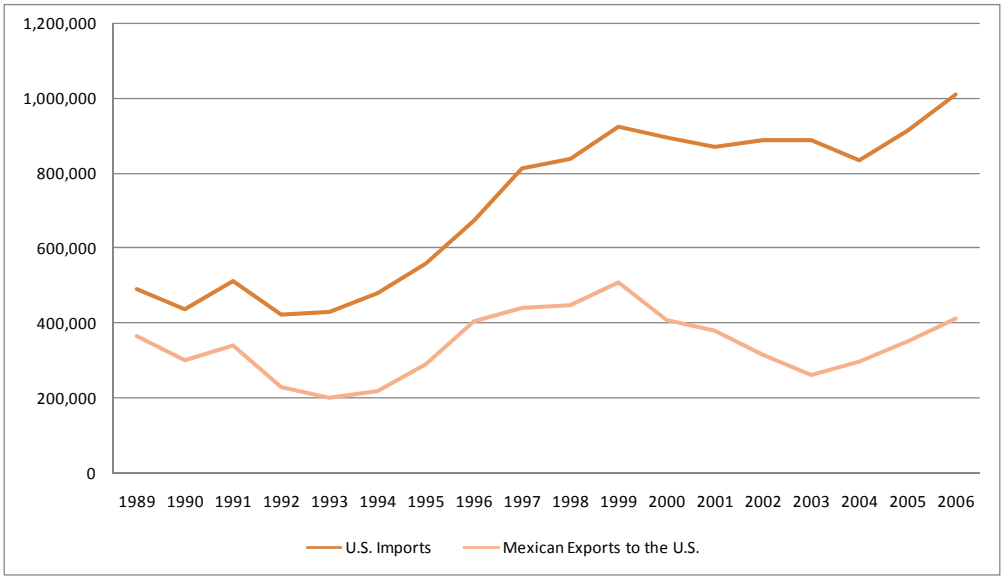

Table 1: Workers' Summary Statistics for Mexico and by Regions

Variable		Mexico	Border States	Central States	Southern States
Obs.		10840	1890	6640	2310
Municipalities		1283	163	752	368
Hourly Wage	**mean**	**10.440**	**11.968**	**10.893**	**7.903**
	s.e.	0.078	0.156	0.110	0.126
Hourly Wage^{corn}	**mean**	**8.960**	**11.628**	**9.458**	**7.391**
	s.e.	0.102	0.469	0.134	0.145
Hourly Wage^{vegetables}	**mean**	**11.665**	**11.761**	**11.697**	**8.058**
	s.e.	0.143	0.169	0.196	0.777
Hourly Wage^{fruits}	**mean**	**10.620**	**12.061**	**12.103**	**7.946**
	s.e.	0.235	0.751	0.355	0.278
Hourly Wage^{others}	**mean**	**11.101**	**12.464**	**11.711**	**8.805**
	s.e.	0.206	0.340	0.335	0.308
Weekly Hours	**mean**	**43.308**	**44.282**	**43.468**	**42.053**
	s.e.	0.129	0.296	0.168	0.267
Weekly Hours^{corn}	**mean**	**43.395**	**45.219**	**44.263**	**41.108**
	s.e.	0.213	1.056	0.264	0.369
Weekly Hours^{vegetables}	**mean**	**42.761**	**43.713**	**42.374**	**40.444**
	s.e.	0.243	0.379	0.310	2.315
Weekly Hours^{fruits}	**mean**	**43.789**	**44.932**	**43.765**	**43.419**
	s.e.	0.333	1.015	0.450	0.564
Weekly Hours^{others}	**mean**	**43.605**	**44.763**	**43.544**	**42.721**
	s.e.	0.283	0.586	0.404	0.533
Female	**mean**	**0.111**	**0.179**	**0.118**	**0.035**
	s.e.	0.003	0.009	0.004	0.004
Age	**mean**	**32.899**	**33.178**	**32.863**	**32.775**
	s.e.	0.148	0.355	0.190	0.318
Literacy	**mean**	**0.560**	**0.555**	**0.572**	**0.529**
	s.e.	0.005	0.012	0.007	0.012

Data from the ENE datasets and Agricultural Supplement, 1991-2000.

Table 2: Two-Step Procedure for Workers' Hourly Wages in Mexico

First Stage: Workers' Hourly Wages on Year Dummies			
Hourly Wages	**Corn**	**Vegetables**	**Fruits**
Year 1991	-0.795***	-0.714***	-0.537***
	(0.07)	(0.063)	(0.109)
Year 1993	-0.586***	-0.424***	-0.252**
	(0.07)	(0.067)	(0.105)
Year 1995	-0.284	0.372	-1.075***
	(0.219)	(0.392)	(0.372)
Year 1996	-0.002	0.245***	-0.070
	(0.07)	(0.079)	(0.099)
Year 1998	0.093**	0.242***	0.181***
	(0.039)	(0.036)	(0.053)
Year 1999	0.254***	0.393***	0.339***
	(0.044)	(0.041)	(0.091)
Year 2000	0.452***	0.586***	0.461***
	(0.044)	(0.041)	(0.083)
Individual Controls	yes	yes	yes
Municipality Controls	yes	yes	yes
Obs.	2988	2649	1162
$\mathbf{R^2}$	0.59	0.56	0.64

OLS regressions with municipality fixed effects, standard errors in parentheses.***, **, * denote significance at the 1, 5, and 10 percent levels. All variables, except dummies, are expressed in logs. Wages are deflated using the CPI from Banco de Mexico with base year 1994. "Year 1997" is the omitted category. Controls at the individual level include gender, age, marital status, and education level. Controls at the municipality level include average land size and technology indicators (irrigation, machinery, and animals). Data come from the 1991-2000 ENE surveys.

Second Stage: Year Dummy Coefficients on Border Prices			
Year Dummy Coefficients	**Corn**	**Vegetables**	**Fruits**
Price of Corn	0.386	0.747	-0.712
	(1.387)	(1.447)	(1.355)
Price of Tomatoes	-0.619	-0.839	0.095
	(0.783)	(0.817)	(0.765)
Price of Melons	-0.536	0.030	-1.369
	(1.195)	(1.247)	(1.168)
Constant	6.254	2.075	12.985
	(7.489)	(7.814)	(7.317)
Obs.	8	8	8
$\mathbf{R^2}$	0.25	0.26	0.49

OLS regressions with standard errors in parentheses.***, **, * denote significance at the 1, 5, and 10 percent levels with 4 degrees of freedom. Prices are in logs and deflated using the CPI from Banco de Mexico with base year 1994.

Table 3: Two-Step Procedure for Workers' Hourly Wages in Mexican Border States

First Stage: Workers' Hourly Wages on Year Dummies			
Hourly Wages	**Corn**	**Vegetables**	**Fruits**
Year 1991	-1.075***	-0.72***	-0.705***
	(0.273)	(0.096)	(0.252)
Year 1993	-0.609**	-0.736***	-0.119
	(0.245)	(0.157)	(0.249)
Year 1995	-0.179	0.309	
	(0.252)	(0.342)	
Year 1996	0.038	0.125	-0.058
	(0.191)	(0.124)	(0.228)
Year 1998	-0.081	0.318***	-0.047
	(0.165)	(0.045)	(0.133)
Year 1999	0.166	0.358***	-0.410
	(0.203)	(0.079)	(0.656)
Year 2000	0.131	0.57***	0.083
	(0.193)	(0.075)	(0.394)
Individual Controls	yes	yes	yes
Municipality Controls	yes	yes	yes
Obs.	172	825	164
$\mathbf{R^2}$	0.84	0.43	0.69

OLS regressions with municipality fixed effects, standard errors in parentheses.***, **, * denote significance at the 1, 5, and 10 percent levels. All variables, except dummies, are expressed in logs. Wages are deflated using the CPI from Banco de Mexico with base year 1994. "Year 1997" is the omitted category. Controls at the individual level include gender, age, marital status, and education level. Controls at the municipality level include average land size and technology indicators (irrigation, machinery, and animals). Data come from the 1991-2000 ENE surveys.

Second Stage: Year Dummy Coefficients on Border Prices			
Year Dummy Coefficients	**Corn**	**Vegetables**	**Fruits**
Price of Corn	1.380	0.652	0.812
	(1.315)	(1.575)	(0.834)
Price of Tomatoes	-1.047	-0.887	-0.418
	(0.742)	(0.889)	(0.509)
Price of Melons	-0.856	0.381	-1.374
	(1.133)	(1.357)	(0.824)
Constant	5.762	0.530	7.760
	(7.103)	(8.504)	(5.316)
Obs.	8	8	7
$\mathbf{R^2}$	0.35	0.30	0.56

OLS regressions with standard errors in parentheses.***, **, * denote significance at the 1, 5, and 10 percent levels with 4 degrees of freedom. Prices are in logs and deflated using the CPI from Banco de Mexico with base year 1994.

Table 4: Two-Step Procedure for Workers' Hourly Wages in Mexican Central States

First Stage: Workers' Hourly Wages on Year Dummies			
Hourly Wages	**Corn**	**Vegetables**	**Fruits**
Year 1991	-0.763***	-0.696***	-0.762***
	(0.093)	(0.086)	(0.259)
Year 1993	-0.587***	-0.379***	-0.665**
	(0.089)	(0.087)	(0.26)
Year 1995	-0.357		-1.136***
	(0.425)		(0.405)
Year 1996	-0.028	0.272***	-0.190
	(0.081)	(0.105)	(0.178)
Year 1998	0.064	0.192***	0.166*
	(0.048)	(0.057)	(0.087)
Year 1999	0.267***	0.417***	0.191
	(0.054)	(0.057)	(0.149)
Year 2000	0.444***	0.577***	0.461***
	(0.054)	(0.057)	(0.141)
Individual Controls	yes	yes	yes
Municipality Controls	yes	yes	yes
Obs.	1956	1789	589
$\mathbf{R^2}$	0.57	0.57	0.65

OLS regressions with municipality fixed effects, standard errors in parentheses.***, **, * denote significance at the 1, 5, and 10 percent levels. All variables, except dummies, are expressed in logs. Wages are deflated using the CPI from Banco de Mexico with base year 1994. "Year 1997" is the omitted category. Controls at the individual level include gender, age, marital status, and education level. Controls at the municipality level include average land size and technology indicators (irrigation, machinery, and animals). Data come from the 1991-2000 ENE surveys.

Second Stage: Year Dummy Coefficients on Border Prices			
Year Dummy Coefficients	**Corn**	**Vegetables**	**Fruits**
Price of Corn	0.259	0.675	-0.439
	(1.369)	(1.822)	(1.713)
Price of Tomatoes	-0.547	-0.757	-0.149
	(0.772)	(1.111)	(0.966)
Price of Melons	-0.557	-0.094	-1.229
	(1.179)	(1.8)	(1.476)
Constant	6.579	2.715	12.200
	(7.391)	(11.606)	(9.248)
Obs.	8	7	8
$\mathbf{R^2}$	0.25	0.19	0.34

OLS regressions with standard errors in parentheses.***, **, * denote significance at the 1, 5, and 10 percent levels with 4 degrees of freedom. Prices are in logs and deflated using the CPI from Banco de Mexico with base year 1994.

Table 5: Two-Step Procedure for Workers' Hourly Wages in Mexican Southern States

First Stage: Workers' Hourly Wages on Year Dummies			
Hourly Wages	**Corn**	**Vegetables**	**Fruits**
Year 1991	-0.78***		-0.289*
	(0.127)		(0.169)
Year 1993	-0.633***		0.005
	(0.147)		(0.144)
Year 1995			
Year 1996	0.046		0.238
	(0.202)		(0.217)
Year 1998	0.194**		0.507***
	(0.079)		(0.115)
Year 1999	0.246***		0.643***
	(0.089)		(0.137)
Year 2000	0.524***		0.631***
	(0.087)		(0.126)
Individual Controls	yes		yes
Municipality Controls	yes		yes
Obs.	860		409
$\mathbf{R^2}$	0.54		0.59

OLS regressions with municipality fixed effects, standard errors in parentheses.***, **, * denote significance at the 1, 5, and 10 percent levels. All variables, except dummies, are expressed in logs. Wages are deflated using the CPI from Banco de Mexico with base year 1994. "Year 1997" is the omitted category. Controls at the individual level include gender, age, marital status, and education level. Controls at the municipality level include average land size and technology indicators (irrigation, machinery, and animals). Data come from the 1991-2000 ENE surveys.

Second Stage: Year Dummy Coefficients on Border Prices			
Year Dummy Coefficients	**Corn**	**Vegetables**	**Fruits**
Price of Corn	0.831		0.008
	(1.819)		(1.331)
Price of Tomatoes	-0.980		-0.498
	(1.109)		(0.811)
Price of Melons	0.245		0.297
	(1.798)		(1.315)
Constant	1.111		2.158
	(11.588)		(8.479)
Obs.	7		7
$\mathbf{R^2}$	0.28		0.32

OLS regressions with standard errors in parentheses.***, **, * denote significance at the 1, 5, and 10 percent levels with 4 degrees of freedom. Prices are in logs and deflated using the CPI from Banco de Mexico with base year 1994.

Table 6: Two-Step Procedure for the Fraction of Hours Worked in k by Municipality in Mexico

First Stage: Fraction of Hours Worked in *k* by Municipality on Year Dummies			
Fraction of Hours Worked	**Corn**	**Vegetables**	**Fruits**
Year 1991	-0.183***	-0.085***	0.066***
	(0.022)	(0.019)	(0.024)
Year 1993	-0.157***	-0.017	0.085***
	(0.022)	(0.02)	(0.025)
Year 1995	-0.119	-0.129	0.073
	(0.092)	(0.091)	(0.11)
Year 1996	-0.048	0.016	0.071*
	(0.034)	(0.031)	(0.038)
Year 1998	-0.037**	0.036**	0.024
	(0.015)	(0.014)	(0.018)
Year 1999	-0.010	0.076***	-0.05***
	(0.016)	(0.014)	(0.018)
Year 2000	-0.089***	0.15***	0.000
	(0.015)	(0.013)	(0.018)
Municipality Controls	yes	yes	yes
Obs.	1282	1282	1282
Pseudo R^2	0.14	0.44	0.03

Tobit regressions with left and right censoring for corn and left censoring for fruits and vegetables, standard errors in parentheses.***, **, * denote significance at the 1, 5, and 10 percent levels. "Year 1997" is the omitted category. Controls at the municipality level include gender composition, average age and education level, average land size and technology indicators (irrigation, machinery, and animals). Data come from the 1991-2000 ENE surveys.

Second Stage: Year Dummy Coefficients on Border Prices			
Year Dummy Coefficients	**Corn**	**Vegetables**	**Fruits**
Price of Corn	**0.279**	-0.165	0.031
	(0.199)	(0.235)	(0.137)
Price of Tomatoes	-0.178	**0.025**	0.058
	(0.112)	(0.132)	(0.077)
Price of Melons	-0.170	-0.200	**0.014**
	(0.171)	(0.202)	(0.118)
Constant	0.839	2.203	-0.725
	(1.077)	(1.27)	(0.74)
Obs.	8	8	8
R^2	0.40	0.50	0.43

OLS regressions with standard errors in parenthesis.***, **, * denote significance at the 1, 5, and 10 percent levels with 4 degrees of freedom. Prices are in logs and deflated using the CPI from Banco de Mexico with base year 1994.

Table 7: Two-Step Procedure for the Fraction of Hours Worked in k by Municipality in Mexican Border States

First Stage: Fraction of Hours Worked in *k* by Municipality on Year Dummies			
Fraction of Hours Worked	**Corn**	**Vegetables**	**Fruits**
Year 1991	-0.128***	-0.257***	0.081**
	(0.026)	(0.036)	(0.034)
Year 1993	-0.011	-0.191***	0.152***
	(0.028)	(0.04)	(0.037)
Year 1995	0.219***	0.141*	-1.743***
	(0.057)	(0.081)	(0)
Year 1996	-0.059*	-0.201***	0.245***
	(0.033)	(0.045)	(0.041)
Year 1998	-0.019	0.007	0.014
	(0.019)	(0.023)	(0.024)
Year 1999	-0.012	0.147***	-0.146***
	(0.019)	(0.022)	(0.024)
Year 2000	-0.107***	0.137***	-0.147***
	(0.02)	(0.023)	(0.025)
Municipality Controls	yes	yes	yes
Obs.	163	163	163
Pseudo R^2	0.46	0.77	0.41

Tobit regressions with left and right censoring for corn and left censoring for fruits and vegetables, standard errors in parentheses.***, **, * denote significance at the 1, 5, and 10 percent levels. "Year 1997" is the omitted category. Controls at the municipality level include gender composition, average age and education level, average land size and technology indicators (irrigation, machinery, and animals). Data come from the 1991-2000 ENE surveys.

Second Stage: Year Dummy Coefficients on Border Prices			
Year Dummy Coefficients	**Corn**	**Vegetables**	**Fruits**
Price of Corn	**0.467***	-1.000	0.125
	(0.198)	(1.322)	(0.308)
Price of Tomatoes	-0.325**	**1.160**	-0.409*
	(0.112)	(0.746)	(0.174)
Price of Melons	0.099	-2.118	**0.198**
	(0.171)	(1.139)	(0.266)
Constant	-0.940	11.310	1.118
	(1.072)	(7.138)	(1.667)
Obs.	8	8	8
R^2	0.76	0.70	0.77

OLS regressions with standard errors in parenthesis.***, **, * denote significance at the 1, 5, and 10 percent levels with 4 degrees of freedom. Prices are in logs and deflated using the CPI from Banco de Mexico with base year 1994.

Table 8: Two-Step Procedure for the Fraction of Hours Worked in k by Municipality in Mexican Central States

First Stage: Fraction of Hours Worked in *k* by Municipality on Year Dummies			
Fraction of Hours Worked	**Corn**	**Vegetables**	**Fruits**
Year 1991	-0.143***	0.016	0.206***
	(0.026)	(0.023)	(0.035)
Year 1993	-0.089***	0.044*	0.17***
	(0.026)	(0.024)	(0.036)
Year 1995	-0.391**	-2.16***	0.737***
	(0.155)	(0)	(0.171)
Year 1996	0.050	0.132***	-0.087
	(0.04)	(0.038)	(0.062)
Year 1998	-0.028	0.065***	0.017
	(0.018)	(0.017)	(0.026)
Year 1999	-0.024	0.109***	-0.077***
	(0.018)	(0.017)	(0.026)
Year 2000	-0.108***	0.225***	-0.003
	(0.017)	(0.016)	(0.025)
Municipality Controls	yes	yes	yes
Obs.	752	752	752
Pseudo R^2	0.18	0.38	0.06

Tobit regressions with left and right censoring for corn and left censoring for fruits and vegetables, standard errors in parentheses.***, **, * denote significance at the 1, 5, and 10 percent levels. "Year 1997" is the omitted category. Controls at the municipality level include gender composition, average age and education level, average land size and technology indicators (irrigation, machinery, and animals). Data come from the 1991-2000 ENE surveys.

Second Stage: Year Dummy Coefficients on Border Prices			
Year Dummy Coefficients	**Corn**	**Vegetables**	**Fruits**
Price of Corn	**0.117***	-1.882	0.200
	(0.053)	(1.733)	(0.762)
Price of Tomatoes	0.053	**1.39***	-0.221
	(0.207)	(0.678)	(0.43)
Price of Melons	-0.543	-2.360	**0.880**
	(0.316)	(1.493)	(0.657)
Constant	2.539	16.519	-5.448
	(1.983)	(9.356)	(4.117)
Obs.	8	8	8
R^2	0.49	0.67	0.45

OLS regressions with standard errors in parenthesis.***, **, * denote significance at the 1, 5, and 10 percent levels with 4 degrees of freedom. Prices are in logs and deflated using the CPI from Banco de Mexico with base year 1994.

Table 9: Two-Step Procedure for the Fraction of Hours Worked in k by Municipality in Mexican Southern States

First Stage: Fraction of Hours Worked in *k* by Municipality on Year Dummies

Fraction of Hours Worked	**Corn**	**Vegetables**	**Fruits**
Year 1991	-0.268***	0.040	-0.031
	(0.067)	(0.032)	(0.06)
Year 1993	-0.386***	0.071**	0.101*
	(0.068)	(0.031)	(0.06)
Year 1995	-3.876***	-0.81***	-2.653***
	(0)	(0)	(0)
Year 1996	-0.264**	0.126***	0.184*
	(0.119)	(0.048)	(0.1)
Year 1998	-0.047	0.065**	0.095**
	(0.054)	(0.025)	(0.048)
Year 1999	0.017	0.062**	0.123**
	(0.054)	(0.026)	(0.049)
Year 2000	-0.068	0.027	0.194***
	(0.053)	(0.026)	(0.047)
Municipality Controls	yes		yes
Obs.	367	367	367
Pseudo R^2	0.06	0.16	0.04

Tobit regressions with left and right censoring for corn and left censoring for fruits and vegetables, standard errors in parentheses.***, **, * denote significance at the 1, 5, and 10 percent levels. "Year 1997" is the omitted category. Controls at the municipality level include gender composition, average age and education level, average land size and technology indicators (irrigation, machinery, and animals). Data come from the 1991-2000 ENE surveys.

Second Stage: Year Dummy Coefficients on Border Prices

Year Dummy Coefficients	**Corn**	**Vegetables**	**Fruits**
Price of Corn	-2.649	-0.629	-2.095
	(3.267)	(0.686)	(2.114)
Price of Tomatoes	1.870	**0.549**	1.624
	(1.843)	(0.387)	(1.193)
Price of Melons	-3.925	-0.933	-3.034
	(2.815)	(0.591)	(1.822)
Constant	27.808	5.863	20.574
	(17.636)	(3.706)	(11.414)
Obs.	8	8	8
R^2	0.58	0.66	0.67

OLS regressions with standard errors in parenthesis.***, **, * denote significance at the 1, 5, and 10 percent levels with 4 degrees of freedom. Prices are in logs and deflated using the CPI from Banco de Mexico with base year 1994.