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Who Benefited More from the North American Free Trade Agreement: Small or Large Farmers? Evidence from Mexico

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Abstract

This paper measures the impact of increasing trade openness between Mexico and the USA resulting from the North American Free Trade Agreement (NAFTA) on the income of small versus large farmers in Mexico. Benefits resulting from higher prices of export goods as well as losses incurred from greater import competition are considered. First, relating NAFTA cuts in trade restrictions to border prices of Mexican exports and imports, it is found that NAFTA-induced tariff reductions decreased the border price of corn, Mexico's main agricultural import, and increased the border prices of tomatoes and melons, Mexico's main agricultural exports. Then, it is shown that the rise in fruit and vegetable prices benefited small farmers more than large farmers; while the drop in corn prices hurt large farmers more. Finally, the results from the regional-level analysis suggests that the effects are stronger in the central states than in the northern and southern states.

1. Introduction

Since the early 1990s, many countries have undergone significant trade liberalization. Changes in a country's exposure to international trade can generate substantial distributional conflict. Most studies on the distributional effects of trade liberalization have focused on the labor market, using wages and skill premia as measures. However, trade openness may also affect inequality through household production and consumption. As highlighted by Rosenzweig (1988), household production is particularly relevant in developing countries, where many individuals are not employed in the formal market for wages, but, instead, work in their household business or on their family farm.

This paper looks at the North American Free Trade Agreement (NAFTA) to study the impact of trade liberalization on the distribution of farm incomes through household production. The date of 1 January 2008 marked the culmination of NAFTA's 14-year transition to free trade between Mexico, the USA, and Canada. NAFTA originated distributional concerns, above all in the agricultural sector. Agriculture contributes about 10% to Mexico's gross domestic product (GDP) and 22% of the labor force is employed in this sector.

Ex ante is unclear how NAFTA would affect the distribution of farm incomes via the production channel. On the one hand, a reduction of trade restrictions for

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Mexican imports of corn would tend to reduce the price of corn in Mexico, affecting farmers negatively. On the other hand, a reduction of trade restrictions for Mexican exports of fruits and vegetables would tend to increase the price of fruits and vegetables in Mexico, benefiting farmers.

Since corn is Mexico's key crop, the focus has been on the consequences of a NAFTA-triggered decline in the real price of corn on employment and on farmers' incomes. Nevertheless, tariff reductions caused by NAFTA affected all agricultural commodities. In addition to corn (Mexico's main agricultural import), fruits and vegetables (Mexico's main agricultural export) were also impacted. Either fruits or vegetables are the main crop for 24% of the farmers who grow for selling purposes. In addition, since the signing of NAFTA in 1994, exports of fruits and vegetables to the USA have increased from about 2.3 million tons in 1994 to about 3.8 million tons in 2005. Thus, my analysis takes into account not only the losses to producers related to decreases in the price of imports, but also the beneficial effects to producers as a result of increases in the prices of exports. This helps to achieve a more balanced understanding of the distributional impact originating from NAFTA and another large number of bilateral and multilateral free trade agreements that have come about since the 1990s.

One of the channels through which trade might affect inequality is through heterogeneous effects on agricultural producers of different wealth levels. I examine both the possible costs and benefits of NAFTA to Mexican cash-crop farmers by studying NAFTA's effect on the relative profitability of small and large farmers. I merge household data on income and cropping choices with border prices and trade restrictions at the crop level. In addition, Goldberg and Pavcnik (2007) highlight that the nature of Mexican trade liberalization facilitates a causal interpretation of the findings since the usual concern about the endogeneity of trade policy is less of a concern for Mexico.

I perform the analysis in two steps.[1] First, I measure the impact of a reduction in trade restrictions caused by NAFTA on the border prices of Mexico's main agricultural import from the USA (corn), and on its main agricultural exports (tomatoes and melons). I exploit the variation in the timing and degree of liberalization across products. Most previous studies, e.g. Chang and Winters (2002), Haskel and Slaughter (2003), Winters and Chang (2000), have not measured the effect of changes in trade barriers on border prices at a highly detailed level, but within categories. By using crop level data, I am able to overcome measurement problems related to trade restrictions. In particular, I am able to avoid measurement error owing to industry aggregation. Furthermore, my analysis considers all types of trade restrictions, whereas previous analyses have mostly been restricted to *ad valorem* tariffs. I find that reductions in trade barriers decreased the border price of grains and increased the border prices of fruits and vegetables.

Then, I determine the distributive impact of changes in border prices, triggered by NAFTA, on the income of small vs large cash-crop farmers. I do not restrain myself to corn producers, but consider all farmers who grow any crops for selling purposes. Using border prices of both imports and exports and considering all farmers, I am able to take into account both positive and negative effects of trade liberalization. I find that agricultural trade liberalization between Mexico and the USA has had a strong impact on the relative distribution of farm income. The results indicate that small farmers, for whom vegetables are more important, gain more from increases in the price of vegetable, whereas large farmers, for whom corn is more important, lose more from reductions in corn prices.

An important caveat is that the estimated effects obtained are not the total impact of price changes on any set of farmers that produce for selling purposes; rather, they reflect differential changes in income between small and large farmers. Thus, while agricultural trade liberalization may have had an overall impact on raising or lowering the inequality, this study captures the fact that the impact varied for cash-crop farmers of different land-size.

Finally, I also examine the impact of trade liberalization at the regional level. Most previous studies do not consider the fact that states far away from the border will be less affected by trade reforms.[2] Goods that are traded in well-connected regions could be nontraded goods in others. Hence, I perform the analysis by region, considering border, central and southern Mexican states separately. I find evidence of the impact of agricultural trade liberalization on cash-crop farmers belonging to the border and central states of Mexico, but there is no statistically significant effect for southern states.

2. Agricultural Trade between Mexico and the USA

The USA is Mexico's most significant agricultural trading partner, whereas Mexico and Canada are the largest agricultural trading partners of the USA. US–Mexican agricultural trade is largely complementary, meaning that the USA tends to export different commodities to Mexico than Mexico exports to the USA.

US exports of agricultural goods to Mexico are led by grains, with corn being the leading commodity. During the 1989–1993 period, corn shipments to Mexico were low whereas for the 1994–2004 period, US exports of corn soared to 6% per year.[3] As highlighted by Prina (2012), US corn exports to Mexico account for almost all Mexican corn imports.

The border price of US corn is regarded as the world's most representative price and its time series is used as reference for the international price of corn (Food and Agriculture Organization, 2012). In fact, as explained by Capehart (2009), while the US dominate world corn trade, their exports account for only a relatively small portion, about 15%. Consequently, corn prices are mostly determined by the domestic supply and demand in the USA, and the rest of the world adjusts to US prices. Corn prices were fairly stable in the period considered in this study (i.e. 1989–2005 for the analysis pertaining to border prices, and 1991–2000 for the analysis pertaining to farmers' income). It was only in 2006 that they started showing an increasing trend.

Mexican agricultural exports to the USA are led by vegetables and fruits. Vegetable exports increased at 0.8% annually during the 1989–1993 period. This is a very small rate compared with the 6.2% yearly increase in the period post NAFTA (1994–2004). Mexican vegetable exports to the USA account for about 65% of US vegetable imports, and Prina (2012) documents that tomatoes are the leading export crop. Fruit exports rose at 2.8% per year between 1989 and 1993, and at 4.8% after that. Mexican fruit exports to the USA account for about 20% of US fruit imports, and melons are the leading export crop.

3. Domestic Reforms, NAFTA, and Agricultural Trade Restrictions

Mexico's opening started in the early 1980s with a reduction of some trade restrictions on exports as a 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. Finally, while NAFTA took effect on 1 January 1994, several important domestic reforms were implemented before NAFTA.[4] These domestic policies aimed to reduce government participation and smooth transition to free trade. One of the main reforms in the agricultural sector that affected farmers most directly was the elimination of price supports to producers of basic crops through CONASUPO (Mexico's major state enterprise involved in agriculture, in charge of price supports). Another reform consisted in the implementation of direct income transfers via a transitional program called PROCAMPO initiated in 1993. The program granted income transfers to farmers based on the number of hectares allocated to barley, beans, corn, cotton, rice, sorghum, soy, sunflower, and wheat, in the three years before its start. Thus, productivity or the choice to switch to other crops did not affect the amount of the transfers farmers could receive. PROCAMPO was created to support domestic producers of basic staples to face the increased competition from farmers in the USA and Canada caused by NAFTA, and to help Mexican producers to switch to more competitive crops under a liberalized context.

With NAFTA, the structure of border protection for Mexico's agricultural sector was radically transformed. The aim of NAFTA was to eliminate all agricultural tariffs on trade between the USA and Mexico. Many tariffs were eliminated immediately with the others being phased out over periods of 5, 10, or 15 years.[5] This implies that agricultural products became duty-free on 1 January 1998, 2003, or 2008. Both Mexico and the USA have a limited number of products in the 15-year tariff phase-out category.

NAFTA eliminated all previous quantitative restrictions affecting US–Mexican trade in agricultural products. They were converted into either tariff-rate quotas (TRQs) or safeguards. The concept is simple. A so-called "under-quota" tariff is charged for imports below a certain threshold ("quota"), whereas an "over-quota" tariff is charged once the threshold is reached. NAFTA, thus, replaced quantitative restrictions with nonlinear tariffs. The difference between TRQs and safeguards is that for TRQs the under-quota tariff is set equal to zero.

This paper focuses on the major agricultural traded commodities: corn, tomatoes, and melon. Corn, which was heavily regulated before NAFTA implementation, is the main agricultural commodity imported by Mexico from the USA. Tomatoes and melons are the main agricultural commodities exported from Mexico to the USA.

Mexican imports of corn were subject to a TRQ with an *ad valorem* tariff, US imports of tomatoes were subject to a safeguard with a specific tariff, and US imports of melons were subject to a specific tariff. Trade restrictions for tomatoes and melons were monthly or seasonal whereas trade restrictions for corn were yearly.

4. Impact of Trade Liberalization on Border Prices

Data on Border Prices and Trade Barriers

I build a dataset of border prices and trade restrictions for the main agricultural goods exported from Mexico to the USA and for the main agricultural commodities imported by Mexico from the USA. The dataset spans the 1989–2005 period.

For monthly border prices, I use the unit values of imports or exports.[6] Unit values are computed as the custom values divided by quantities. These data are taken from the US Department of Agriculture, Foreign Agricultural Service.[7] The level of commodities aggregation is at the Foreign Agricultural Trade of the United States (FATUS) level, which aggregates Harmonized Systems (HS) 10-digit codes. The unit values, in US dollars, are deflated using the Producer Price Index at the farm level from the US Bureau of Labor Statistics and transformed into Mexican pesos using the monthly exchange rate from Banco de México.

I construct monthly time series of trade restrictions using the NAFTA (1993, Chapter 7), and the Economic Outlook Reports from the US Department of Agriculture. The official tariff schedules specify the trade restriction levied on each item of the Harmonized System.

Results

For commodities imported by Mexico from the USA, such as grains, I estimate: $\log P_{kmt}^{MEX} = \beta_0 + \beta_1 \tau_{kmt}^{MEX} + \zeta_{kmt}$ where τ_{kmt}^{MEX} is a function of the Mexican import tariff for good k. In the case of an *ad valorem* tariff, $\tau_k^{MEX} = (1 + t_k^{MEX})$, whereas $\tau_k^{MEX} = t_k^{MEX}$ in the case of a specific tariff. For commodities exported by Mexico to the USA, such as fruits and vegetables, I estimate: $\log P_{kmt}^{MEX} = \alpha_0 + \alpha_1 \log \tau_{kmt}^{US} + \varepsilon_{kmt}$ where k indicates the commodity, m the month and t the year. P^{MEX} is the Mexican border price in Mexican pesos. τ_k^{US} is a function of the US import tariff for good k. In the case of an *ad valorem* tariff, $\tau_k^{US} = (1 + t_k^{US})$ whereas in the case of a specific tariff, $\tau_k^{US} = t_k^{US}$. Finally, ε_{kmt} is an error term. Both equations are estimated with ordinary least squares (OLS) and robust standard errors.

Many shocks and events, other than changes in the agricultural trade policy between Mexico and the USA, could have affected the border prices over the period considered. For example, one important shock was the Mexican peso crisis in December 1994. Nevertheless, as shown by Prina (2012), we do not see a peak in Mexican exports to the USA, as Mexican commodities are cheaper, nor a decrease in Mexican imports from the USA, as US commodities are more expensive. I account for possible shocks in two different ways.[8] First, I introduce the Mexican price level as a control in the regressions, as in Haskel and Slaughter (2003).[9] Second, I remove all the macroeconomic effects by including year dummies. The main disadvantage of this last method is that, as the yearly time dummies take away part of the tariff variation, the identification comes from intra-year variation in tariffs. Hence, I estimate two different specifications: one with controls, the other with time dummies for each year. Finally, it is not possible to introduce yearly time dummies for corn that has a yearly tariff. In this case, only the first method is considered and agricultural GDP is added as a control.

Tomatoes and corn are subjected to yearly or seasonal safeguards and TRQs. NAFTA converted quantitative restrictions into nonlinear tariffs. A so-called under-quota tariff is charged if imports fall below a certain threshold whereas an over-quota tariff is charged once the threshold is reached. Since I analyze tariff rates at the margin, I consider the over-quota tariff for goods under these types of trade restrictions.[10] I introduce monthly dummies to correct for seasonality. Moreover, as the Durbin–Watson statistic indicates the presence of serial autocorrelation of order one, I compute Newey–West standard errors.

Table 1 reports the estimates of the equation for Mexican imports of corn from the USA and the estimates of the equation for Mexican exports of tomatoes and melons to the USA. The results follow the predictions of the model. Considering reductions in the Mexican over-quota tariff for corn imported from the USA, a 1% decrease in the tariff causes a statistically significant decrease in its border price of 0.20% when I control for the price level (consumer price index, CPI). Results do not change when the agricultural GDP is added as a control. Considering reductions in the US

Table 1. Regressions of Border Prices on Trade Restrictions

Corn	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
Tariff	–0.399***	0.200***	0.229***	0.231***	–0.399***	0.206***	0.237***	0.273***
	(0.077)	(0.059)	(0.053)	(0.054)	(0.081)	(0.060)	(0.053)	(0.065)
CPI		0.710***	0.805***	0.801***		0.717***	0.815***	0.791***
		(0.095)	(0.085)	(0.084)		(0.097)	(0.085)	(0.091)
Crisis dummy			0.254***	0.254***			0.258***	0.260***
			(0.063)	(0.062)			(0.064)	(0.063)
Agricultural GDP				0.037				0.391
				(0.131)				(0.434)
Constant	4.178***	–2.708***	–3.400***	–3.818**	4.225***	–2.772***	–3.494***	–8.009
	(0.362)	(0.799)	(0.698)	(1.659)	(0.397)	(0.812)	(0.703)	(5.036)
Monthly dummies	No	No	No	Yes	Yes	Yes	Yes	Yes
Obs.	144	144	144	144	144	144	144	144
R^2	0.312	0.680	0.743	0.743	0.317	0.707	0.751	0.753
DW test	0.096	0.222	0.288	0.287	0.086	0.201	0.266	0.262

Tomatoes	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*
Tariff	–0.195***	–0.312***	–0.049*	–0.049*	–0.047*	–0.225***	–0.315***	–0.042	–0.041	–0.052**	–0.042
	(0.019)	(0.017)	(0.028)	(0.027)	(0.027)	(0.019)	(0.018)	(0.028)	(0.026)	(0.025)	(0.028)
Quota dummy		1.100***	0.252**	0.235**	0.231**		1.089***	0.153	0.121	0.120	–0.013
		(0.097)	(0.108)	(0.103)	(0.103)		(0.098)	(0.118)	(0.114)	(0.108)	(0.133)
CPI			0.817***	0.826***	0.809***			0.851***	0.865***	0.966***	–1.179
			(0.088)	(0.086)	(0.087)			(0.084)	(0.080)	(0.095)	(0.830)
Crisis dummy				0.164**	0.166**				0.204***	0.201***	
				(0.082)	(0.080)				(0.072)	(0.080)	
Agricultural GDP					0.175					–1.089**	
					(0.188)					(0.568)	
Constant	4.439***	4.423***	–0.412	–0.460	–2.346	4.835***	4.607***	–0.407	–0.480	11.463*	11.944**
	(0.039)	(0.037)	(0.523)	(0.508)	(2.106)	(0.177)	(0.099)	(0.491)	(0.467)	(6.197)	(5.041)
Monthly dummies	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Yearly dummies	No	No	No	No	No	No	No	No	No	No	Yes
Obs.	204	204	204	204	204	204	204	204	204	204	204
R^2	0.295	0.696	0.828	0.830	0.831	0.381	0.713	0.848	0.852	0.856	0.871
DW test	0.305	0.710	0.833	0.841	0.841	0.297	0.644	0.842	0.863	0.893	1.055

Melons	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*
Tariff	–0.099**	–0.000	0.000	0.000	–0.532***	0.058	0.060	0.033	0.050
	(0.042)	(0.018)	(0.018)	(0.019)	(0.081)	(0.051)	(0.051)	(0.051)	(0.054)
CPI		0.895***	0.899***	0.968***		0.925***	0.930***	1.059***	0.169
		(0.046)	(0.046)	(0.059)		(0.050)	(0.051)	(0.101)	(0.690)
Crisis dummy			0.121	0.111			0.123	0.100	
			(0.086)	(0.099)			(0.116)	(0.110)	
Agricultural GDP				–0.605*				–1.304*	
				(0.313)				(0.708)	
Constant	3.156***	–1.651***	–1.678***	4.770	3.615***	–1.850***	–1.882***	12.346	2.701
	(0.097)	(0.248)	(0.252)	(3.359)	(0.134)	(0.286)	(0.296)	(7.620)	(4.201)
Monthly dummies	No	No	No	No	Yes	Yes	Yes	Yes	Yes
Yearly dummies	No	No	No	No	No	No	No	No	Yes
Obs.	204	204	204	204	204	204	204	204	204
R^2	0.040	0.738	0.739	0.747	0.265	0.776	0.777	0.783	0.812
DW test	0.325	1.188	1.194	1.172	0.656	1.179	1.187	1.127	1.448

Notes: OLS regressions. Newey–West standard errors in parenthesis, with one lag. ***,**,* denote significance at the 1, 5, and 10% level, respectively. All variables except dummies are expressed in logs. Mexican border prices are the prices at which the goods are sold at the Mexican border. They come from the Foreign Agricultural Service online dataset and are deflated by the US Producer Price Index at the farm level from the US Bureau of Labor Statistics. They have been converted to Mexican pesos using the official monthly average exchange rate. Mexican import tariffs for corn and US import tariffs for tomatoes and melons are from the NAFTA Outlook Reports (1994–2000). Mexican monthly CPI and agricultural GDP come from Banco de Mexico.

restrictions on imports of tomatoes and melons from Mexico, a 1% decrease in the tariff causes an increase in border price of 0.20% for tomatoes and 0.10% for melons when no controls are introduced. Furthermore, increasing the US import quota for tomatoes has a positive effect on the Mexican border price. Also, the effect on the border price is significant but reduced once the price level (CPI) is included in the regression. The coefficient for the US tariff for tomatoes remains significant when agricultural GDP and monthly dummies are added as controls. Hence, the evidence is consistent with the fact that reductions in the tariffs of goods exported by Mexico to the USA result in a statistically significant increase in the Mexican border prices of these commodities. However, once both yearly and monthly dummies are introduced in the regression, the tariff coefficients are not significant for the goods considered. This is explained by the fact that tariffs are seasonal and their reductions are done on a yearly basis. Therefore, once I include both dummies to control for seasonality and year fixed effects, I take away most of the tariff variation. Overall, Table 1 suggests that tariff reductions for corn imports from the USA caused by NAFTA forced down the Mexican border price of grains. These results are consistent with the findings of McMillan et al. (2007), which suggest that corn producer prices for Mexican farmers fell as a result of NAFTA.[11] However, there seems to be some evidence that NAFTA increased the border price of the agricultural exports from Mexico to the USA.

5. Impact of Trade Liberalization on Mexican Farmers

I examine the distributional impact of the price changes on the profits of small vs large Mexican landowners cultivating various crops.

Data

The household data come from the Mexican National Employment Surveys (*Encuesta Nacional de Empleo* (ENE)), collected in 1991, 1993, and 1995–2000, and the accompanying Agricultural Supplement carried out for those households participating in agricultural activities. The ENE surveys and their Agricultural Supplements contain information on land size and quality, on the three main crops cultivated for self-consumption and for selling purposes, on the total land allocated to the three crops jointly, on the amount produced of the most important crop, and on the level of technology used and hired labor. The dataset is not a panel, as each subject was interviewed only once, but a repeated cross-section.

I consider households participating in agricultural activities in which the household head declares that his primary occupation is the cultivation of crops. Furthermore, as I am interested in the impact of changes in the price of crops on agricultural profits, I select those that cultivate crops for selling purposes and discard those that cultivate for self-consumption.

Moreover, in the data there is no information about household consumption or expenditures. Thus, it is not possible to determine the implicit value of goods produced for own consumption. This implies I can only analyze the impact of farmers who are net sellers of agricultural goods because for this set of farmers the agricultural profits give me the value of the goods produced. NAFTA might have affected the household decision of whether to cultivate crops for sale or for self-consumption. However, there is no strong evidence that NAFTA changed the proportion of farmers producing crops for sale. On average 0.55% less farmers produced for selling purposes after NAFTA and this difference is not significant. If there was a change and assuming that the marginal farmers who dropped out were the least productive, then post-NAFTA the sample would be somewhat more biased towards more productive farmers.

Finally, I consider as farm profits the income from the cultivation of crops from the household head. In fact, the data show that when the household head indicates profits from crop cultivation as the primary source of income, the remaining employed household members would either have a missing source of income or income from wages. In the first case, they are "family labor;" in the second, they are working outside the household.

I merge the household data with the border price dataset. Because in the Agricultural Supplement the crops cultivated by each farmer are grouped into broad categories, I consider a unique border price for each group. In particular, for the categories "corn and beans," "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. 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 and households whose main source of income are profits from the cultivation of crops.

Empirical Strategy

I focus on the interaction between border prices and land cultivated by each household. The intent is to weigh common border prices using farm weights based on the farm level cropping patterns. The ideal farm weight for each border price would be given by the fraction of land allocated by the household to the production of each crop. Unfortunately, the information available for each farmer concerns the total amount of land allocated to the three most important selling crops. However, land size can be used as a proxy for farm-level cropping patterns. In fact, as shown in Table 2, small landowners make different cropping choices than do large landowners. Small

Table 2. Main Selling Crop Cultivated by Land Quartiles in Mexico

Variable		*1st Quartile 1 ha*	*2nd Quartile 2.25 ha*	*3rd Quartile 5 ha*	*4th Quartile >5 ha*
Obs.		3588	2598	3296	2889
Land	mean	0.767	1.831	3.670	15.084
	s.e.	0.005	0.005	0.015	0.405
Income	mean	241.740	319.904	465.905	904.705
	s.e.	5.606	9.493	14.240	25.249
Corn	mean	0.244	0.382	0.405	0.436
	s.e.	0.007	0.009	0.009	0.009
Fruit	mean	0.144	0.131	0.112	0.086
	s.e.	0.006	0.007	0.005	0.005
Vegetables	mean	0.089	0.053	0.047	0.038
	s.e.	0.005	0.004	0.004	0.004

Notes: Data from ENE datasets and Agricultural Supplement, 1991–2000. Income is in 1994 Mexican pesos per farmer per week.

farmers tend to cultivate fruit and vegetables whereas their large counterparts tend to cultivate corn, this is explained by the fact that fruit and vegetables tend to be labor intensive crops, while corn tends to be a capital intensive crop.

The equation I estimate is: $\pi_{ist} = \gamma_0 + \sum_k \gamma_2^k \text{defl}P_t^k L_{ist} + \delta Z_{ist} + \lambda_t + \lambda_k + \xi_{ist}$, where π_{ist} are the profits of farmer i in state s at time t, $\text{defl}P_t^k$ are deflated border prices for crop k at time t, L_{ist} is the land owned by farmer i in state s at time t, Z_{ist} are household characteristics. Year fixed effects, λ_t, control for inflation and other macro effects, such as global price trends and domestic trade policies, on the dependent variable π_{ist}. Also, crop fixed effects, λ_k, control for possible differential effects (e.g. of domestic trade policies) at the crop level. Finally, I use heteroskedasticity-robust standard errors to correct for heteroskedasticity.

The coefficients on the interaction between land cultivated and border prices, γ_2^k, are the primary coefficients of interest. They measure the impact on farmers' profits related to changes in crop prices for small vs large landowners. A positive (negative) value of the coefficient γ_2^k would suggest that an increase in the price of crop k is associated with a larger (smaller) increase in profits for large farmers with respect to small ones.

In the equation estimated above, border prices are explanatory variables measured at a higher level of aggregation than the dependent variable. Donald and Lang (2008) show that this problem is significant when the number of groups is small. Consequently, it is necessary to take into account errors that are common to observations sharing the same aggregate value. Not doing so it would be tantamount to assuming that the only factor that has an impact on land returns is the set of prices I have identified. In other words, I am not taking into account any changes in other macro variables, such as interest rate and fiscal policy, which could affect farmers with different land size differently. That is, I am not including a yearly error component such as $\varepsilon_t L_{ist}$, thus causing the estimated standard errors to be biased downward. The significant coefficients associated with the land–price interactions might not be significant once the common unmeasured yearly errors are considered.

The optimal way to adjust for common group effects, given the data (wherein the number of groups/years, t, is small, and the number of observations per year is large (700–2700 observations per year)), is to follow the two-step procedure as in Donald and Lang (2008). In the first step, I regress income on year dummies, λ_t, interacted with land and the additional regressors with OLS:

$\pi_{ist} = \sum_k \gamma_2^k \text{defl}P_t^k L_{ist} + [\cdot] + \varepsilon_t L_{ist} + \upsilon_{ist} = \lambda_t L_{ist} + [\cdot] + \upsilon_{ist}$ where $\widehat{\lambda_t} = \sum_k \gamma_2^k \text{defl}P_t^k + \varepsilon_t$ and $[\cdot] = \gamma_0 + \lambda_t + Z_{ist}\delta + v_{ist} + \lambda_k + \lambda_s + \lambda_{st}$. ε_t is an error term that is correlated within year t, and υ_{ist} is an individual-specific term that is independent of the other errors. In the second step, I regress the estimates of the coefficients of the interaction between year dummies and land on the year prices, $\widehat{\lambda_t}$, with OLS: $\widehat{\lambda_t} = \beta_0 + \sum_k \beta_1^k \text{defl}P_t^k + \varepsilon_t + \left(\widehat{\lambda_t} - \lambda_t\right)$. Therefore, I am estimating the effect of having more/less land each year on income separately and then regressing these on the crop prices.

Results

The results from the estimate of the one-step procedure are presented in Table 3. I obtain a positive and significant coefficient for the price of corn interacted with farmsize whereas the coefficient for the price of tomatoes interacted with farmsize is negative and significant. This indicates that small farmers gain more from increases in the price of vegetables than do large ones. Furthermore, large farmers lose more from

Table 3. Farmers' Profits and Land–Border Price Interactions in Mexico

Dep. var. profits	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
$P^{corn} \times$ Land	0.358***	0.273**	0.437***	0.467***	0.414**	0.311*
	(0.135)	(0.137)	(0.164)	(0.167)	(0.169)	(0.179)
$P^{tomato} \times$ Land	−0.311***	−0.259***	−0.367***	−0.397***	−0.365***	−0.305***
	(0.082)	(0.084)	(0.099)	(0.102)	(0.103)	(0.110)
$P^{melon} \times$ Land	0.119	0.115	0.156	0.175	0.233	0.187
	(0.141)	(0.143)	(0.174)	(0.177)	(0.177)	(0.192)
Household controls	yes	yes	yes	yes	yes	yes
Crop dummies	yes	yes	yes	yes	yes	yes
Year dummies	yes	yes	no	no	no	no
State dummies	no	yes	no	no	no	no
Year–state dummies	no	no	yes	yes	yes	yes
Crop–year dummies	no	no	no	yes	yes	yes
Crop–state dummies	no	no	no	no	yes	yes
Crop–year–state dummies	no	no	no	no	no	yes
Obs.	7922	7922	7922	7922	7922	7922
R^2	0.34	0.40	0.44	0.44	0.46	0.49

Notes: OLS regressions with robust standard errors (in parenthesis).***,**,* denot significance at the 1%, 5%, and 10% levels, respectively. All variables except dummies are expressed in logs. Crop dummies take the value one for the main crop cultivated by the farmer and zero for the remaining crops. *P* stands for border price. Mexican border prices come from the Foreign Agricultural Service online dataset and have been converted to Mexican pesos using the official average exchange rate. Household controls include cultivated land, years of schooling of the household head, hours worked weekly by the household head, number of household members, irrigation infrastructure, machineries, and animals. Household data come from the 1991–2000 ENE surveys.

reductions in corn prices relative to small farmers. This is consistent with the information about cropping patterns shown earlier in Table 2. Finally, there is no statistically significant difference in agricultural profits from changes in the prices of fruits between large and small landowners.

The results are robust to the introduction of state–year dummies to control for possible time-varying state-level shocks. Furthermore, since Mexican states differ in their soil quality, geography, accessibility, and distance from the border, and all of these attributes are potentially correlated with cropping patterns and farmers' profits, I control for time-invariant state characteristics with state fixed effects. The results do not change.

As the elimination of trade restrictions following NAFTA was phased over more than a decade, producers might have adjusted their production bundles accordingly during time. In particular, farmers could have switched a fraction of their production from corn into fruit and vegetables, expecting a decrease in the price of corn and an increase in the price of fruit and vegetables, owing to changes in trade restrictions.[12] This would have been more likely to happen for large farmers who were possibly better informed about the expected changes in crop prices. Because of the lack of a panel dataset, I am not able to take into account such possible adjustments in production. However, if large farmers switched a fraction of their production from corn into fruit and vegetables, my estimates are a lower bound of the loss large farmers would have had relative to small farmers, had large farmers not switched. That is, without switching large farmers would have been hurt more relative to small farmers.

Table 4 presents the estimates of the two-step procedure. The first step regression results allow me to estimate the overall yearly effect for small vs large farmers of NAFTA and global price trends combined, controlling with year and crop dummies (and their interactions) for the effects of domestic reforms. The results from the second step regression, (i.e. equation (10)) show estimates of the effect of crop prices on small vs large farmers. These estimated effects might be a combination of NAFTA and global price trends. However, given that, for the period considered in the study, global prices were fairly stable, the magnitude of the effect can be attributed largely to NAFTA.

Adjusting for common group effects increases the size of the standard errors with the effect that no coefficient is statistically significant despite magnitudes similar to the previous estimates presented in Table 3. Two of three coefficients, the ones for corn and tomatoes, have the expected sign.

I perform the same analysis at the regional level, dividing Mexican states into three groups: border, central, and southern states.[13] Regional differences in the quality of soil and distance and connection to the US border are crucial. 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 owing to the radial structure of highways and railways in Mexico. In fact, all commodities coming from the south and directed to the US border must pass through the center of Mexico. Finally, ferry transportation, which would allow for a more rapid connection, is not well developed.[14] Thus, one might 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.

Table 5 reports the estimates from the second step for the three regions after adjusting for common group effects.[15] The results reflect the expectations. For central states, the coefficients associated with the price of corn and tomatoes are still statistically significant. Border states show some impact on the price of corn, while there is no statistically significant effect for southern states.

6. Conclusion

The findings tend to suggest that agricultural trade liberalization between Mexico and the USA affected border prices and the relative profitability of small and large cash-crop farmers. Tariff reductions caused by NAFTA increased the border prices of tomatoes and melons (Mexico's main agricultural export) and decreased the border price of corn (Mexico's main agricultural import). Border price changes affected the relative distribution of farm income: small farmers, for whom vegetables are more important, gain more from increases in the price of vegetables whereas large farmers, for whom corn is more important, lose more from reductions in corn prices. As NAFTA raised the prices of fruit and vegetables, and fruit and vegetables are important crops for small farmers whereas corn is important for large farmers, these findings tend to indicate that NAFTA has had a more favorable impact on small Mexican cash-crop farmers than on large ones.

These results are of much wider interest than the impact of NAFTA itself. Agriculture has often been a major stumbling block in trade negotiations. The recent collapse of the World Trade Organization global trade talks is one of many examples. Similar

Table 4. Two-Step Procedure for Mexico

Dep. var. profits	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Year 1991 × Land	0.2182***	0.2159***	0.2097***	0.2155***	0.2067***	0.1985***
	(0.0458)	(0.0482)	(0.0514)	(0.0512)	(0.0519)	(0.0533)
Year 1993 × Land	0.3625***	0.3289***	0.2765***	0.2856***	0.2635***	0.2891***
	(0.0450)	(0.0482)	(0.0610)	(0.0632)	(0.0622)	(0.0628)
Year 1995 × Land	0.695***	0.6431***	0.5654***	0.593***	0.6331***	0.6257**
	(0.1238)	(0.1168)	(0.1533)	(0.1620)	(0.1659)	(0.2601)
Year 1996 × Land	0.5557***	0.5233***	0.5174***	0.5059***	0.5147***	0.5155***
	(0.0290)	(0.0296)	(0.0330)	(0.0334)	(0.0337)	(0.0355)
Year 1997 × Land	0.4764***	0.4531***	0.4578***	0.461***	0.4282***	0.3982***
	(0.0537)	(0.0556)	(0.0732)	(0.0753)	(0.0761)	(0.0843)
Year 1998 × Land	0.6404***	0.5914***	0.6134***	0.621***	0.6188***	0.6061***
	(0.0338)	(0.0342)	(0.0395)	(0.0409)	(0.0414)	(0.0418)
Year 1999 × Land	0.6522***	0.6241***	0.6452***	0.6428***	0.6535***	0.6510***
	(0.0344)	(0.0343)	(0.0399)	(0.0412)	(0.0416)	(0.0453)
Year 2000 × Land	0.5622***	0.5459***	0.5072***	0.5021***	0.5107***	0.5373***
	(0.0309)	(0.0310)	(0.0368)	(0.0377)	(0.0375)	(0.0388)
Household controls	yes	yes	yes	yes	yes	yes
Crop dummies	yes	yes	yes	yes	yes	yes
Year dummies	yes	yes	no	no	no	no
State dummies	no	yes	no	no	no	no
Year–state dummies	no	no	yes	yes	yes	yes
Crop–year dummies	no	no	no	yes	yes	yes
Crop–state dummies	no	no	no	no	yes	yes
Crop–year–state dummies	no	no	no	no	no	yes
Obs.	7922	7922	7922	7922	7922	7922
R^2	0.35	0.4	0.44	0.44	0.46	0.49

Land–year dummies coeff.	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Price of corn	0.4872	0.4129	0.4098	0.4265	0.4095	0.3354
	(0.4346)	(0.4134)	(0.4494)	(0.4233)	(0.4630)	(0.4820)
Price of tomatoes	–0.4305	–0.3836	–0.3785	–0.3980	–0.3997	–0.3624
	(0.2452)	(0.2333)	(0.2536)	(0.2389)	(0.2613)	(0.2720)
Price of melons	0.0761	0.0848	0.0610	0.0895	0.1858	0.1712
	(0.3744)	(0.3562)	(0.3872)	(0.3647)	(0.3989)	(0.4153)
Constant	0.4832	0.4685	0.5952	0.4563	–0.0957	0.1572
	(2.3457)	(2.2314)	(2.4256)	(2.2850)	(2.4992)	(2.6015)
Obs.	8	8	8	8	8	8
R^2	0.50	0.47	0.42	0.48	0.48	0.41

Notes: OLS regressions with robust standard errors (in parenthesis). ***,**, * denote significance at the 1%, 5%, and 10% levels, respectively. All variables except dummies are expressed in logs. Crop dummies take the value one for the main crop cultivated by the farmer and zero for the remaining crops. "Land" is the omitted category. Household controls include cultivated land, years of schooling of the household head, hours worked weekly by the household head, number of household members, irrigation infrastructure, machineries and animals. Household data come from the 1991–2000 ENE surveys. *P* stands for border price. Mexican border prices come from the FAS online dataset (USDA) and have been converted to Mexican pesos using the official average exchange rate.

Table 5. Second Step for Mexican Border, Central, and Southern States

Land–year dummies coeff.	*Border States* (1)	(2)	(3)	(4)	(5)	(6)
Price of corn	0.526*	0.2515	0.6293**	0.028	–0.0752	–0.1526
	(0.2314)	(0.2448)	(0.2141)	(0.9324)	(0.9719)	(0.9701)
Price of tomatoes	–0.1447	–0.0425	–0.1891	0.2308	0.3126	0.3117
	(0.1306)	(0.1381)	(0.1208)	(0.5262)	(0.5485)	(0.5475)
Price of melons	–0.2642	–0.1408	–0.4575*	–1.3611	–1.2358	–1.1441
	(0.1994)	(0.2109)	(0.1845)	(0.8034)	(0.8374)	(0.8359)
Constant	0.2051	0.1927	1.2721	7.7272	6.8086	6.6534
	(1.249)	(1.3212)	(1.1556)	(5.0329)	(5.2461)	(5.2367)
Obs.	8	8	8	8	8	8
R^2	0.63	0.33	0.74	0.52	0.48	0.45
Land–year dummies coeff.	***Central States* (1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Price of corn	0.7302*	0.7107*	0.8095	0.6184	0.6217	0.7370
	(0.3586)	(0.3773)	(0.4767)	(0.4288)	(0.4484)	(0.5143)
Price of tomatoes	–0.5517*	–0.5579*	–0.6591*	–0.5277*	–0.5543*	–0.6500*
	(0.2024)	(0.2129)	(0.2690)	(0.2420)	(0.2530)	(0.2903)
Price of melons	0.0416	0.0532	0.3504	0.0835	0.1824	0.4110
	(0.3090)	(0.3251)	(0.4107)	(0.3694)	(0.3863)	(0.4432)
Constant	0.2321	0.2926	–1.5903	0.3472	–0.1393	–1.6320
	(1.9357)	(2.0368)	(2.5732)	(2.3145)	(2.4203)	(2.7764)
Obs.	8	8	8	8	8	8
R^2	0.69	0.68	0.71	0.60	0.63	0.68
Land–year dummies coeff.	***Southern States* (1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Price of corn	–0.3719	–0.2321	–0.0695	0.1196	0.0626	–0.0994
	(0.7071)	(0.7478)	(0.6644)	(0.5272)	(0.5342)	(0.5963)
Price of tomatoes	–0.0089	–0.0829	–0.1563	–0.2681	–0.2235	–0.1119
	(0.399)	(0.422)	(0.375)	(0.2975)	(0.3015)	(0.3365)
Price of melon	0.1646	0.1433	0.0339	0.132	0.1688	0.0305
	(0.6092)	(0.6444)	(0.5725)	(0.4542)	(0.4603)	(0.5138)
Constant	1.671	1.5362	1.9272	1.0151	0.7509	1.7851
	(3.8168)	(4.0367)	(3.5865)	(2.8457)	(2.8838)	(3.2188)
Obs.	8	8	8	8	8	8
R^2	0.19	0.15	0.17	0.3	0.26	0.15

Notes: OLS regressions.***,**,* denote significance at the 1%, 5%, 10% levels, respectively. All variables are expressed in logs. *P* stands for border price. Mexican border prices come from the FAS online dataset (USDA) and have been converted to Mexican pesos using the official average exchange rate.

trade reforms in other developing countries will trigger distributional problems similar to those encountered with NAFTA. Among other contributions, this paper has stressed the importance of taking into account the consequences of a bilateral trade agreement on both the import and the export side to get a balanced perspective.

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Notes

1. Nicita (2009) and Porto (2006) follow a similar methodology connecting trade policies to prices, then connecting prices to wages, and household welfare.

2. Chiquiar (2008), Hanson and Harrison (1999), and Robertson (2000, 2004) find that wage differentials in border states are much more affected by trade reforms than the rest of Mexico.
3. US exports of corn to Mexico account for 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.
4. For an excellent review of agricultural policy reforms in Mexico see Yunez-Naude (2002).
5. Changes in trade restrictions during the entire phase-out period were dictated by Chapter 7 of NAFTA signed in 1993.
6. 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, measured at the farm gate level. An implicit border price may be calculated as the unit value of imports or exports (Glossary of Agricultural Terms, OECD).
7. These data are originally collected by the Census Bureau, US Department of Commerce.
8. This issue is also discussed in Chang and Winters (2002).
9. Although border prices have been deflated using the Producer Price Index at the farm level in the USA, I control for the Mexican price level as inflation patterns are very different in the two trading countries and border prices might be affected by both.
10. For both the USA and Mexico, imports of most of the goods subject to TRQs or safeguards were always almost double the quota.
11. Fiess and Lederman (2004) and Yunez-Naude and Barceinas Paredes (2004) found no clear effects.
12. If farmers expected a decrease in the price of corn and an increase in the price of fruit and vegetables, it is not reasonable to assume that they would have switched into corn.
13. I use the same definition of border, central, and southern states as in Prina (2012).
14. A detailed description of regional differences can be found in Levy (2004).
15. Given the importance of adjusting for common group effects, I do not report the one-step OLS estimates for the three regions.