Quantifying the Effects of Mexico's Retaliatory Tariffs on Selected U.S. Agricultural Exports

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Introduction

From March 2009 to October 2011, the Mexican Government applied retaliatory tariffs to selected agricultural and nonagricultural products from the United States in response to U.S. noncompliance with the trucking provisions of the North American Free Trade Agreement (NAFTA). Imposition of these tariffs took place within the framework of NAFTA's dispute resolution process and eventually yielded a formal agreement in July 2011 to end the lengthy dispute about whether and how to implement NAFTA's trucking provisions. As part of the July 2011 agreement, the United States and Mexico agreed to create a new program for U.S. and Mexican carriers that want to provide cross-border, long-haul trucking services between the two countries. In addition, Mexico reduced its retaliatory tariffs by half and promised to eliminate the remaining half once the first Mexican carrier was approved under the new program. In October 2011, the first Mexican carrier was approved, and Mexico withdrew its tariffs.[1]

Mexico's retaliatory tariffs provide an unusual opportunity to consider the importance of trade liberalization to U.S. agriculture. In the absence of these tariffs, all of the targeted U.S. products qualify for duty-free treatment in Mexico as part of NAFTA. To estimate the tariffs' impact on the targeted agricultural commodities, we employ a fixed-effects gravity model of U.S. agricultural exports based on the Poisson distribution. This technique provides an econometrically sound and tractable method of estimating the tariffs' impact using monthly panel data on commodity- and country-specific export values that are highly skewed (many very large values for particular commodities and particular export destinations) and also have a large number of zero-valued observations. We estimate an aggregate model for the 34 U.S. agricultural products that were subject to the tariffs during the entire period from March 2009 to June 2011,

[1] Details of the emerging program may be found in U.S. Department of Transportation, Federal Motor Carrier Safety Administration (2011).

as well as a series of commodity-specific models. The 21 agricultural products that were added to the list of retaliatory tariffs in August 2010 are not included in our analysis since the number of monthly trade observations available since that point in time is still limited.

Background[2]

When NAFTA was signed in 1992, the United States and Mexico agreed to allow people from either country to obtain operating authority to provide cross-border, long-haul trucking services between the two countries by January 1, 2000, following a transitional period of about 4 years (December 18, 1995, to December 31, 1999). During this transitional period, such operating authority would be limited to the U.S. border states for people from Mexico and to the Mexican border states for people from the United States.[3] Neither the 1995 nor the 2000 deadline was met. Instead, implementation of NAFTA's trucking provisions was repeatedly delayed, as we shall discuss below.

Institution of cross-border, long-haul trucking between the United States and Mexico is expected to lower shipping and handling costs, shorten transit times, and reduce congestion and pollution (Haralambides and Londoño-Kent 2004; Fox, Francois, and Londoño-Kent 2003). While short-haul trucking across the U.S.-Mexico border is generally allowed within what is called the "border commercial zone" in the United States and the "northern perimeter" in Mexico,[4] cross-border trucking beyond these areas usually requires at least three vehicles: "a

[2] MacDonald (2010) provides a fascinating account of the many legal dimensions of the trucking dispute.

[3] NAFTA's cross-border trucking provisions do not apply to routes exclusively within the United States or Mexico. Indeed, the agreement preserves a U.S. moratorium on the provision of trucking services between points in the United States by persons from Mexico for cargo other than international cargo, and it reserves the transportation of cargo by truck between points in Mexico for Mexican nationals and Mexican enterprises [see the U.S. and Mexican schedules of NAFTA's "Annex I: Reservations for Existing Measures and Liberalization Commitments (Chapters 11, 12, and 14)"].

[4] In the United States, the border commercial zone usually extends 25-50 miles north of the U.S.-Mexico border (USDOT/FMCSA 2011) but is wider in some places. In Mexico, the northern perimeter for short-haul, cross-border

longhaul service that transports the cargo from Mexico/United States to a place near the border, a short-haul drayage truck that moves the goods across the border, and a third truck that delivers the cargo to its final destination beyond the U.S.-Mexico border commercial zone" (Prozzi et al. 2008: 1-2). Analysis by Texas A&M International University suggests that cross-border, long-haul trucking could reduce the travel time between Chicago, Illinois, and Monterrey, Nuevo Leon, by as much as 40 percent (Pacific Economic Cooperation Council 2004: 20). Cross-border, long-haul trucking is also likely to affect the relative attractiveness of trucking vis-à-vis other modes of cross-border transportation (i.e., rail and sea).

Some Mexico-domiciled carriers have already obtained limited authority to operate in the United States beyond the border commercial zone. Five Mexico-domiciled carriers received limited authority prior to 1982 and were "grandfathered in" when the U.S. Congress enacted the moratorium on Mexico-domiciled carriers in that year. In addition, a much larger number of majority U.S.-owned, Mexico-domiciled carriers received limited authority before the Interim Final Rules implementing NAFTA's motor carrier provisions were issued in March 2002 (USDOT/FMCSA, 2009b; Downey, et al. 2008; NAFTA Arbitral Panel, 2001). This latter group of carriers is referred to as "certificated" in reference to their Certificates of Operation. An independent evaluation panel (Downey, et al., 2008) concluded that a total of 861 grandfathered or certificated Mexican carriers with 1,749 trucks were operating in the United States beyond the border commercial zones in 2008. To the best of our knowledge, the economic impact of these operations on competing U.S.-domiciled truckers has not been documented.

Critics of NAFTA's trucking provisions have expressed concerns about the potentially negative impact of Mexican trucks on U.S. highway safety, the job security of U.S. truckers, and

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trucking generally extends 20 kilometers (about 12 miles) south of the border. (Secretaría de Comunicaciones y Transporte 2003).

efforts to thwart the illegal trafficking of arms, drugs, and people. Citing concerns about highway safety, President Clinton indefinitely postponed implementation of the trucking provisions starting in December 1995, just as it was time to begin phasing in cross-border, long-haul trucking. After consultations failed to resolve the dispute, the Mexican Government successfully contested the postponement using NAFTA's dispute resolution procedure. In February 2001, a NAFTA arbitration panel ruled that "the U.S. blanket refusal to review and consider for approval any Mexican-owned carrier application for authority to provide cross-border trucking service was and remains a breach" of U.S. obligations under NAFTA (NAFTA Arbitral Panel 2001: 83). Under NAFTA's dispute resolution procedure, this ruling allows Mexico to suspend U.S. trade benefits of "equivalent effect" to the trucking provisions until those provisions are implemented.

For nearly a decade, the Mexican Government opted not to suspend any U.S. trade benefits, as President George W. Bush tried to fulfill his campaign promise to implement NAFTA's trucking provisions. First, the Bush Administration surmounted a legal challenge that an environmental impact assessment was required before the provisions could be implemented (see the Supreme Court's decision in *U.S. Department of Transportation v. Public Citizen*). Then, it secured the cooperation of the Mexican Government to allow U.S. regulators to inspect Mexican motor carriers in Mexico, which was one of many safety requirements for cross-border, long-haul trucking enacted by the U.S. Congress in Section 350 of the Department of Transportation and Related Agencies Appropriations Act, 2002.

Finally, in December 2007, the Bush Administration implemented a demonstration project for NAFTA's trucking provisions that "allowed up to 100 Mexico-domiciled motor carriers to operate beyond the U.S. border commercial zones and the same number of U.S. carriers to operate in Mexico" (U.S. Department of Transportation, Federal Motor Carrier Safety

Administration, 2009a). This project, originally intended to have a one-year term, was extended for up to two more years "to ensure that it could produce sufficient data to evaluate its safety impact" (U.S. Department of Commerce, International Trade Administration, 2010).

Opposition to the demonstration project crystallized in the U.S. Congress in the form of legislative amendments that aimed to prohibit the project's establishment or end its funding. The Consolidated Appropriations Act, 2008, signed into law by President Bush in December 2007, included one such amendment, but the Bush Administration interpreted this restriction as applying to future demonstration programs and not the one that was already underway (MacDonald, 2011). A similar but more explicitly worded amendment was inserted into the Omnibus Appropriations Act, 2009, which President Obama signed into law on March 11, 2009. This time, the U.S. Department of Transportation immediately terminated the demonstration project, and a week later, on March 18, 2009, the Mexican Government unveiled its retaliatory tariffs, which took effect the following day. Appendix Table 1 lists the targeted agricultural commodities and the retaliatory tariff rates.

Retaliation and Resolution

The initial set of retaliatory tariffs issued in March 2009 covered 34 agricultural products and 43 nonagricultural products,[5] with rates ranging from 10 to 45 percent that generally corresponding to Mexico's most-favored-nation (MFN) tariff schedule. The tariffs covered about 5 percent of U.S. agricultural exports to Mexico in terms of value. During the 36-month period that immediately preceded the tariffs' imposition (March 2006 to February 2009), U.S. exports to Mexico of the targeted agricultural commodities averaged $887 million per year, compared with

[5] Although this paper does not consider the impact of the retaliatory tariffs on nonagricultural exports, our methodology is applicable to estimating that impact.

an annual average of $14.9 billion for the agricultural commodities that were not subject to the tariffs (see Table 4 in Zahniser and Roe 2011). While the tariffs largely avoided the leading bulk agricultural commodities exported to Mexico, such as corn, soybeans, beef, wheat, pork, and soybean meal, a number of processed products that are smaller but still prominent parts of agricultural trade were subject to the tariffs. The four largest examples (in terms of annual average exports to Mexico during March 2006 to February 2009) were:

- prepared soups and broths and preparations for such foods ($184 million);
- condiments other than soy sauce, ketchup, other tomato sauces, mustard, and mustard meal ($108 million);
- dog or cat food for retail sale ($93 million); and
- frozen potatoes ($81 million).

The initial set of retaliatory tariffs was imposed about five months after U.S. agricultural exports to Mexico experienced an overall decline due to the global economic downturn (fig. 1A). Nevertheless, the tariffs appeared to have had a marked impact above and beyond the effects of the downturn (fig. 1B), as exports of the targeted agricultural commodities declined more sharply than exports of the agricultural commodities that were not subject to the tariffs. During the period from March 2009 to February 2010, which roughly corresponds to the first 12 months of the retaliatory tariffs, Mexican agricultural imports from the United States not subject to the tariffs declined by 5.5 percent, while agricultural imports subject to the tariffs declined by 32.6 percent, compared with their annual average level from March 2006 to February 2009. Zahniser and Roe (2011: 19) offer the difference between the two percentages (27.1 percent) as a simple estimate of the retaliatory tariffs' impact on the targeted U.S. agricultural exports to Mexico.[6]

[6] The methodology used by Zahniser and Roe was suggested by Hui Jiang and Tony Halstead of USDA's Foreign Agricultural Service.

As U.S. and Mexican negotiators attempted to resolve the dispute, the Mexican Government raised the stakes for U.S. agriculture by expanding the retaliatory tariffs to cover an additional 21 agricultural products, effective August 19, 2010. The expanded list of products included pork (fresh, chilled, or frozen, bone-in) and fresh apples—two commodities that not only corresponded to much larger levels of trade ($334 million and $205 million, respectively) but also had been the subject of one or more antidumping cases since NAFTA's implementation in 1994. At the same time, Mexico lowered the retaliatory tariff rates on fresh grapes (from 45 to 10 percent) and frozen potatoes (20 to 5 percent). The initial retaliatory tariff on fresh grapes was 25 percentage points higher than the next largest retaliatory tariff, while frozen potatoes are an important processed food in many Mexican households.

With the implementation of the bilateral agreement to establish the trucking program, the end of this dispute appears to have arrived. As part of that agreement, Mexico reduced the retaliatory tariffs by half, effective July 8, 2011, and it eliminated the tariffs in their entirety on October 21, 2011 (Secretaría de Economía, 2011a), shortly after the first Mexican truck with operating authority under the new trucking program—carrying a shipment of industrial equipment to Garland, Texas—crossed into the United States (Watson, 2011).

Methods

To gauge the trade effects of Mexico's retaliatory tariffs, we estimate a series of fixed-effects gravity models of U.S. agricultural exports using the Poisson pseudo-maximum-likelihood (PPML) technique suggested by Santos Silva and Tenreyro (2006). We selected this technique because it provides a tractable, robust, and efficient alternative to the log-linear gravity models that are commonly estimated using ordinary least squares (OLS). Since some observations of our dependent variable (exports) equal zero, a logarithmic specification would

require us either to drop these observations or to substitute an arbitrarily selected small number in place of the zeroes; both of these approaches yield biased and inconsistent estimators. The Poisson (exponential) model resembles the logarithmic model in that it reduces the excessive influence of outliers in skewed datasets, but it differs from the logarithmic model in that the dependent variable is allowed to equal zero. The Poisson model has been shown to be a robust and efficient way to model data with these characteristics, and it has the additional advantage of allowing us to generate unbiased estimates of the tariffs' impact on the expected value of actual exports, not log exports, thus avoiding the so-called retransformation problem (Duan 1983, Manning 1998, Mullahy 1998, Ai and Norton 2000).

Our model is essentially a difference-in-differences equation. Looking only at commodities that were subject to the retaliatory tariffs, we compare the value of exports to Mexico with the value of exports of the same commodities to other countries, before and after the tariff. We also control for global economic trends, the effects of seasonality, and the GDP of the importing countries. Equation (1) summarizes the specification of our model:

(1)

In this equation, the dependent variable —the nominal dollar value of U.S. exports to country *i* in month *m* of year *t*—is regressed on an exponential function of the following explanatory variables:

- $MXTAR_{imt}$: the Mexico tariff variable—an indicator variable that equals one if Mexico is the importing country and the retaliatory tariffs are in effect and otherwise equals zero—to measure the impact of the tariffs on U.S. exports to Mexico;

- TAR_{mt}: the tariff period variable—an indicator variable that identifies the time period since the initial imposition of the retaliatory tariffs in March 2009—to enable the Mexico tariff variable to distinguish from factors that generally affected U.S. agricultural exports to all countries during the tariff period;
- GDP_{imt}: GDP of the importing country, in nominal U.S. dollars, to control for changes in the country's purchasing power;
- C_i: country-specific indicator variables (fixed effects), to distinguish among the importing countries, including Mexico;
- M_m: month-specific indicator variables, to capture seasonal patterns in exports to all countries;
- MXM_{im}: month-specific indicator variables for Mexico, to differentiate Mexico's seasonal patterns in its agricultural imports from the United States from those of other importing countries; and
- $YEAR_t$: year-specific indicator variables, to reflect overall global economic trends.

Unlike many specifications of the gravity model, ours does not include a measure of the distance between the exporting and importing countries. Instead, we use the country-specific fixed effects to capture the effects of distance from the United States and any other time-invariant variables (for instance, a common language or a shared geographic border with the United States) that distinguish among the importing countries. The use of indicator variables to identify pairs of exporting and importing countries (Cheng and Wall 2005) or specific importing countries (Zahniser et al. 2004) is a common alternative approach implemented by gravity modelers of international trade.

The PPML approach maintains the likelihood function derived from the Poisson distributional assumption but is consistent and asymptotically normal even if the data are over-dispersed compared with the Poisson, as is the case here. In such cases, standard errors must be calculated using the robust estimator (Cameron and Trivedi 2010). We also absorb the country fixed-effects using within-country differencing, implemented via Stata's *xtpoisson* command (StataCorp LP 2011).

We first estimate this model for the total exports of 34 agricultural commodities that were subject to the retaliatory tariffs, starting about 3 years prior to the tariffs' initial imposition in March 2009 and continuing through the end of our sample period in June 2011. We refer to this model as our aggregate model. In addition, we also estimate a set of 32 models of the exports of specific agricultural commodities to study the tariffs' impact on exports of particular products. We refer to these models as our commodity-specific models. As we shall discuss below, the U.S. and Mexican tariff schedules do not match each other exactly, so we estimate 32 commodity-specific models based on U.S. trade data that correspond with the 34 agricultural products targeted by Mexico's initial set of retaliatory tariffs. The commodities that we examine do not include the items that were added to the list of tariffs in August 2010.

Our data set covers the period from January 2006 to June 2011 and thus is several months shy of covering the entire period when the retaliatory tariffs were in effect. The export data were drawn from the *Global Agricultural Trade System* of USDA's Foreign Agricultural Service, which features detailed U.S. agricultural trade data obtained from the Census Bureau's *Foreign Trade Statistics*. The GDP data were calculated by multiplying nominal GDP, as expressed in the importing country's currency, from the *World Economic Outlook Database* of the International Monetary Fund (IMF) times the nominal exchange rate from the IMF's *International Financial*

Statistics and the Federal Reserve Board's *Financial Statistics*, as compiled by USDA's Economic Research Service in its *Agricultural Exchange Rate Data Set*.

Mexico's tariff schedule differs somewhat from the U.S. schedule, so a comparison of the two was required in order to match the commodities subject to the tariffs with the corresponding U.S. export data. For instance, the single U.S. tariff line for dates corresponds to two Mexican tariff lines, while the single Mexican tariff line for concentrates of juice from fruit or vegetables enriched with vitamins or minerals corresponds to two U.S. tariff lines. In the case of fresh Christmas trees, we use the U.S. export data for fresh foliage during the months of November and December, since U.S. export statistics do not include a specific category for Christmas trees and since Mexico rarely imports fresh Christmas trees during any other months of the year. Overall, the 34 tariff lines in Mexico's original set of retaliatory tariffs correspond to 32 tariff lines in the U.S. export data, so we estimate a total of 32 commodity-specific models, in addition to our aggregate model for these commodities. Table 2, which summarizes our model results, includes a concordance between the Mexican tariff lines subject to the retaliatory tariffs and the U.S. tariff lines associated with our models.

The number of importing countries in each model depends on the number of trading partners that the United States has for that commodity and ranges from 12 (sunflower seed meal and rapeseed meal with a high content of erucic acid) to 85 (aggregate model). Among the commodity-specific models, the median number of importing countries is 62.5, and the average number is 58.5.

Results from the Aggregate Model

Table 1 lists the parameter estimates and their significance levels from our aggregate model. Our main coefficient of concern—that of the Mexico tariff variable—has a negative sign and is statistically significant at the 99-percent level according to a two-tailed *z*-test. This means that exports to Mexico of these commodities fell in relation to exports to other countries during the tariff period, taking account of annual global trends, the GDP of each importing country, and seasonality. The next section discusses the tariff-effect estimates from the aggregate and commodity-specific models in greater detail.

The aggregate model reveals a strong and statistically significant seasonal pattern in the targeted U.S. agricultural exports, which peak in the fourth quarter of the calendar year as farm products enter the market after harvest. Mexico's seasonality pattern is significantly different from that of other countries, justifying the inclusion of the Mexico-specific month indicator variables in the equation. In particular, the difference between U.S. agricultural exports to Mexico during the fourth quarter and corresponding exports during the rest of the year is more pronounced for Mexico than for other importing countries.

The coefficients for the year-specific indicators confirm the presence of a growth trend in U.S. agricultural exports (to all countries) over the sample period—at least for the products that were subject to Mexico's retaliatory tariffs. These coefficients are all positive and statistically significant, demonstrating that exports in each year from 2007 to 2010 were higher on average than in 2006, the excluded year for purposes of comparison. Except for the year 2009, in which U.S. agricultural exports were negatively affected by the global economic downturn, the value of each successive year indicator is significantly larger than the previous one.

The parameter estimates for the other explanatory variables—the tariff period indicator and the importing country's GDP—are not statistically significant by conventional standards. The insignificance of the tariff period variable simply means that the year-indicators capture the bulk of the pre-tariff/post-tariff difference in total U.S. exports of these commodities. GDP's insignificance, however, is intriguing, since the GDPs of the exporting and importing countries are traditionally key explanatory variables in gravity models of international trade. Because our fixed effects for importing country broadly control for differences in GDP across importing countries, the insignificant coefficient for our GDP variable implies that within the relatively short time span (4-1/2 years) of our sample, either U.S. exports to a given country do not depend strongly on changes in that country's nominal national income, or there is simply not enough variation in GDP (or too much measurement error in the data) for that variable to have a statistically significant effect on those exports. To examine further the role of GDP in our specification, we re-estimated our models without the GDP variable, allowing the fixed-effects for importing countries to carry the full burden of accounting for the relative sizes of those countries' economies. This alternative specification generated similar parameter estimates for the Mexico tariff variable with similar levels of significance, which raises the question of whether GDP is indeed an indispensable variable in all gravity models of international trade, at least for panels covering a short period.

Estimates of Tariff Impact

The full effect of the retaliatory tariffs over the period examined is calculated by comparing the model's fitted values with its expected values, had those tariffs not been implemented. Figure 2 graphically represents the aggregate model's estimation of the targeted

U.S. agricultural exports to Mexico before and after the imposition of the tariffs. As one can see in the figure, the model does a good job of capturing the seasonal fluctuations in these exports. The fitted values (in red) move closely together with the actual values (in blue), usually reaching their highest values during the last quarter of the calendar year, when many U.S. farm products enter the market. Pears, onions, grapes, and Christmas trees are the principal products among the targeted commodities that are responsible for this pattern.

The green line in Figure 2 indicates the expected total value of the U.S. agricultural exports to Mexico subject to the tariffs during the entire period from March 2009 to June 2011, had the tariffs not been imposed. By subtracting the fitted values from the expected values, one can estimate the reduction in exports due to the tariffs. For instance, in October 2009, the fitted value of the targeted exports to Mexico was $51 million, and the expected value in the absence of the tariffs was $77 million, so the estimated reduction in exports was $26 million.

By summing up the estimated reductions for each month during the tariff period, one can calculate the total estimated reduction in exports. According to the aggregate model, the total reduction during the 28-month period equals about $635 million, or 33 percent.[7] This amount is nontrivial in size and indicative of the importance of duty-free access to the Mexican market to U.S. agricultural exporters. This estimated reduction of 33 percent is somewhat larger than the 26-percent estimate of Zahniser and Roe (2011).

Table 2 summarizes the findings from both our aggregate and commodity-specific models.[8] In 19 of the 32 commodity-specific models, the coefficient for the Mexico tariff variable is negative and statistically significant at the 99-percent level or better. Among these 19 models, the retaliatory tariffs reduced the value of three U.S. exports to Mexico during the 28-

[7] The figure 33% is identical to the value that is arrived at by converting the Mexico-tariff-period coefficient from Table 1 into a percentage: [exp(-0.4048)-1]*100 = -33.3%.
[8] The full set of results for the commodity-specific models is available from the authors upon request.

month period by more than $100 million each: prepared soups and broths and preparations for such foods; frozen potatoes; and dog or cat food for retail sale. When the estimated impacts from all the commodity-specific models are tallied, the total estimated impact of the tariffs during the sample period is $779 million (38 percent)—about 5 percentage points larger than the estimate obtained from the aggregate model.

Contrary to our central hypothesis, the Mexico tariff variable obtains a positive and significant coefficient in five of the commodity-specific models: prepared or preserved peanuts; soy sauce; concentrates of juice from more than one fruit or vegetable, enriched with vitamins or minerals; mineral water; and red, rose, claret, or white wine. These products make up less than 4 percent of the total value of the 32 targeted U.S. agricultural exports to Mexico between March 2009 and June 2011. While the positive and significant coefficients for these commodities suggest that omitted variable bias may be present in these models, the fact that these commodities account for a small share of the targeted agricultural exports implies that the impact of such bias on the aggregate estimate is probably small.

We can imagine a variety of market developments that might explain these positive coefficients. For example, further expansion of the Mexican supermarket sector could lead to greater supply of imported processed foods such as prepared and preserved peanuts, while increased preferences for imported wine in general could boost Mexican demand for U.S. wine. Similarly, in the commodity-specific models where the Mexico tariff variable garners a negative coefficient, it is possible that market developments unaccounted by the models cause some of the models to overstate the tariffs' impact, as the case of dog or cat food for retail sale illustrates. In 2008 (about a year prior to the imposition of the tariffs), the Mexican affiliate of the Mars Corporation opened a pet food plant in the State of Jalisco—a development that led to lower

subsequent levels of U.S. pet food exports to Mexico. If this plant had been in operation from the beginning of the sample period (January 2006), lower levels of exports of this commodity to Mexico during the pre-tariff period probably would have occurred, leading to a smaller estimate of the tariff's (negative) effect.

Conclusion

The retaliatory tariffs associated with the U.S.-Mexico trucking dispute adversely affected U.S. agricultural exports to Mexico. According to our aggregate model, the tariffs reduced exports of the agricultural commodities subject to these restrictions during the entire period from March 2009 to June 2011 by about $635 million (33 percent). Our commodity-specific models as a group provide a broadly similar finding: a $779 million reduction (38 percent) in the targeted exports. For three prominent U.S. agricultural exports to Mexico—soups and broths, dog or cat food, and frozen potatoes—the decrease in exports exceeded $100 million each. These results provide a strong indication of the importance of trade liberalization to U.S. agricultural exports to Mexico. With the removal of the retaliatory tariffs in October 2011, all of the targeted products once again qualify for duty-free treatment under NAFTA.

A fixed-effects gravity model based on the Poisson distribution was used to generate these estimates. Our simple specification, which relied primarily on country-level fixed effects and year and month indicator variables, enabled us to assemble the required data and estimate the models quickly—a plus for conducting trade policy analysis in an applied setting. This simplicity in specification, however, is likely to have resulted in some omitted variable bias, which would explain the five commodity-specific models in which the parameter estimates for the Mexico tariff variable carries a positive sign, opposite of our general hypothesis. At the same time, an

even simpler specification in which GDP was not included as an explanatory variable generated very similar results for the Mexico tariff variable, our main explanatory variable of concern. This outcome suggests that in some gravity models of international trade, a fixed effect for each pair of exporting and importing countries or, in our case, for each importing country—could be used in place of GDP variables, particularly when the level of trade does not vary greatly with GDP, or when GDP itself does not vary greatly over the course of the sample period.

In the future, an enhanced version of our gravity model could be used to examine the simultaneous effects of the retaliatory tariffs on trade volumes and unit values, thereby giving a more complete assessment of the impact on U.S. agricultural exports to Mexico. The impact on unit values is of particular interest, for it could offer insights into the welfare losses experienced by Mexican consumers in terms of higher prices and lower consumption levels of the targeted U.S. products, as well as the losses experienced by U.S. suppliers in terms of lower prices and lower sales volumes. Ideally, these models would include a more extensive set of explanatory variables that would account for commodity-specific market developments that influence U.S. agricultural exports to Mexico.

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Table 1--Parameter estimates from Aggregate Model

Variable	Coefficient	Standard error	*z* -score	Statistical significance
Tariff period for Mexico	-0.4048	0.0457	-8.86	***
Tariff period	0.0121	0.0275	0.44	
GDP	0.0001	0.0001	1.07	
Month-specific indicators				
January	-0.1239	0.0197	-6.27	***
February	-0.1112	0.0339	-3.28	***
March	-0.0191	0.0187	-1.02	
April	-0.0357	0.0136	-2.62	***
May	0.0340	0.0123	2.77	***
June [omitted reference]	--	--	--	
July	0.0424	0.0207	2.05	**
August	0.1173	0.0400	2.94	***
September	0.2071	0.0530	3.91	***
October	0.3638	0.0695	5.23	***
November	0.3126	0.0662	4.72	***
December	0.1582	0.0579	2.73	***
Month-specific indicators for Mexico				
January	0.2131	0.0238	8.97	***
February	0.0738	0.0337	2.19	**
March	0.1064	0.0196	5.42	***
April	-0.0019	0.0137	-0.14	
May	-0.0431	0.0123	-3.51	***
June [omitted reference]	--	--	--	
July	-0.0212	0.0191	-1.11	
August	0.0947	0.0387	2.45	**
September	0.0593	0.0520	1.14	
October	-0.0118	0.0673	-0.18	
November	0.0999	0.0652	1.53	
December	0.2120	0.0575	3.69	***
Year				
2006 [omitted reference]	--	--	--	
2007	0.0593	0.0293	2.03	**
2008	0.1352	0.0428	3.16	***
2009	0.1131	0.0656	1.72	*
2010	0.2151	0.0700	3.07	***
2011	0.2991	0.0735	4.07	***
Number of observations	5,610			
Number of importing countries	85			
Number of months	66			
Log pseudolikelihood	-1,382,024.80			

Results of two-tailed *z* -test on significance of parameter estimate:

***Significant at 1-percent level; **Significant at 5-percent level; *Significant at 10-percent level.

Table 2-- Mexico's Retaliatory Tariffs Had a Marked Impact on U.S. Agricultural Exports to Mexico

Mexican HS code	U.S. HS code in GATS	Commodity	U.S. exports to Mexico March 2009 - June 2011			
			Expected value without tariff (A)	Fitted value (B)	Estimated change due to tariffs (B - A)	
			Dollars (millions)			*Percent*
		Aggregate model	**1,907.1**	**1,272.3**	**-634.8**	**-33.3** ***
		Total from 32 commodity-specific models	**2,051.4**	**1,272.3**	**-779.1**	**-38.0**
0604.91.02	0604.91 (Nov. & Dec. only)	Christmas trees, fresh	20.6	17.3	-3.3	-16.0 *
0703.10.01	0703.10	Onions	85.4	34.1	-51.3	-60.1 ***
0705.11.01	0705.11	Iceberg lettuce	25.6	8.7	-16.9	-66.0 ***
0802.12.01	0802.12.0000	Almonds, shelled	62.9	56.2	-6.7	-10.6
0804.10.01 & 0804.10.99	0804.10	Dates, fresh or other	1.4	0.8	-0.6	-41.5 ***
0806.10.01	0806.10	Grapes, fresh	129.3	48.7	-80.6	-62.3 ***
0808.20.01	0808.20	Pears, fresh	161.1	111.8	-49.4	-30.6 ***
0810.10.01	0810.10	Strawberries, fresh	61.7	27.4	-34.4	-55.7 ***
0813.50.01	0813.50	Mixtures of dried fruit or nuts	9.4	8.9	-0.5	-4.9
1902.19.99	1902.19.2000	Pasta, not containing egg, not cooked, filled, or otherwise prepared	1.5	0.9	-0.6	-40.9 ***
2004.10.01	2004.10	Potatoes, frozen	235.5	107.8	-127.7	-54.2 ***
2005.40.01	2005.40	Peas, preapred or preserved, except in veinegar or ascetic acid, not frozen	1.0	0.2	-0.8	-80.9 ***
2008.11.01 & 2008.11.09	2008.11	Peanuts, prepared or preserved	14.5	20.4	5.9	40.7 ***
2008.19.01	2008.19.4000	Almonds, prepared or preserved	5.4	7.0	1.6	30.5
2008.19.99	2008.19 less 2008.19.4000	Nuts, prepared & preserved (includes mixed nuts but is separate from the categories for peanuts & almonds)	106.3	68.0	-38.4	-36.1 ***
2008.60.01	2008.60	Cherries, prepared or preserved	5.4	4.0	-1.3	-24.9 ***
2009.80.01	2009.80	Fruit or vegetable juice, other than orange, grapefruit, other citric fruit, tomato, apple, or grape	12.6	13.1	0.5	3.6
2009.90.99	2009.90.4000	Mixtures of fruit or vegetable juice, other than mixtures of vegetable juice only	19.8	14.3	-5.6	-28.0 ***
2009.99.01	2009.90.2000	Mixtures of vegetable juice only	1.2	0.9	-0.4	-30.9 ***
2103.10.01	2103.10	Soy sauce	9.8	11.9	2.1	21.5 ***
2103.90.99	2103.90	Condiments other than soy sauce, ketchup & other tomato sauces, mustard meal, & prepared mustard	208.9	197.0	-11.9	-5.7 *
2104.10.01	2104.10	Prepared soups & broths & preparations for such foods	538.5	332.2	-206.3	-38.3 ***
2106.90.06	2106.90.4800 & 2106.90.5200	Concentrates of juice from a single fruit or vegetable, enriched with vitamins or minerals	14.2	7.6	-6.6	-46.6 ***
2106.90.07	2106.90.5400	Concentrates of juice from more than one fruit or vegetable, enriched with vitamins or minerals	1.3	2.3	1.0	77.5 ***
2106.90.08	2106.90.6580	Food preparations not elsewhere specified or indicated, with a content of milk solid greater than 10% in weight	50.7	56.2	5.5	10.8
2201.10.01	2201.10	Mineral water	1.8	2.9	1.1	59.0 ***
2204.10.99	2204.10	Sparkling wine, other than champagne	2.9	1.5	-1.4	-48.4 ***
2204.21.02	2204.21.4000	Red, rose, claret, or white wine, whose alcoholic strength by volume is up to 14 percent at a temperature of 20 degrees Celsius (equivalent to 14 degrees on the Gay-Lussac hydrometer scale at a temperature of 15 degrees Celsius), in containers of clay, ceramics, or glass less than or equal to 2 liters	6.1	10.7	4.7	76.9 ***
2206.00.99	2206.00	Other fermented beverages or mixtures of fermented & non-alcoholic beverages, not elsewhere specified	25.6	13.6	-12.0	-46.8 ***
2306.30.01	2306.30	Sunflower seed meal and oilcake	1.4	1.1	-0.3	-22.3
2306.49.99	2306.49	Rape seed meal or oilcake with a high content of erucic acid	42.9	5.2	-37.7	-87.9 ***
2309.10.01	2309.10.0000	Dog or cat food, for retail sale	186.4	79.6	-106.8	-57.3 ***

Results of two-tailed *z* -test on parameter estimate for Mexico tariff variable:

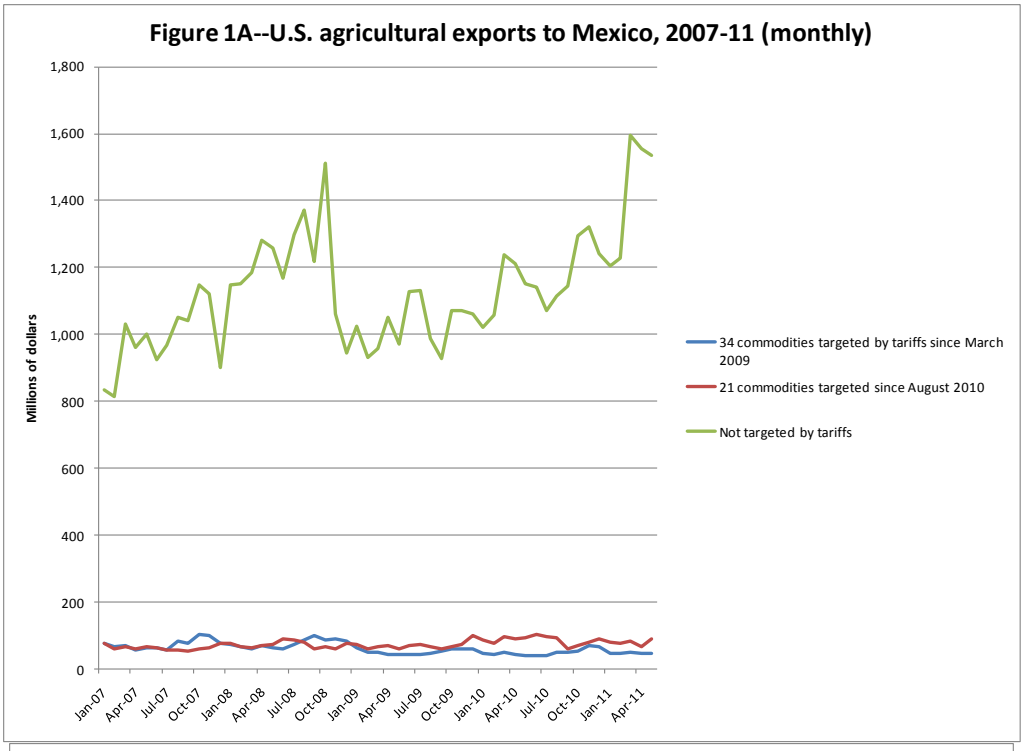
***=Significant at 1-percent level; *=significant at 90-percent level.

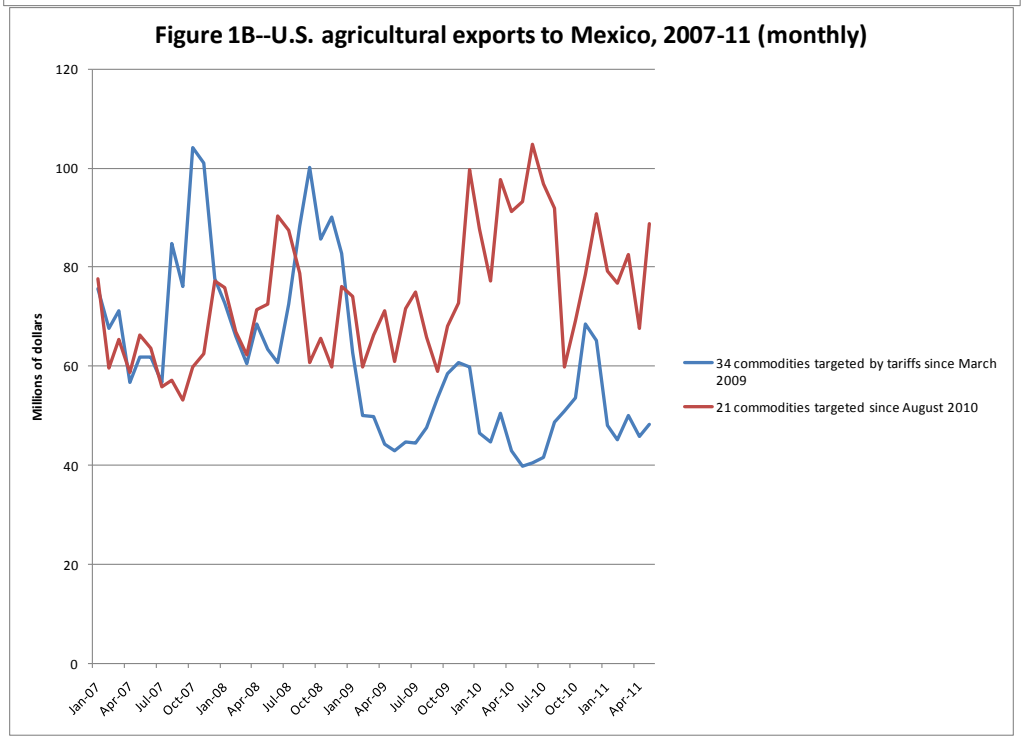
Note: Sum of actual values for period from March 2009 to June 2011 equals the sum of their fitted values.

Appendix Table 1--From March 2009 to October 2011, Mexico applied retaliatory tariffs on over 50 U.S. agricultural products

Tariff line	Description	Tariff rate, effective:		
		March 19, 2009, to August 18, 2010	August 19, 2010 to July 8, 2011	July 8 to October 20, 2011
		Percent		
0203.12.01	Meat of swine, legs, hams, and cuts thereof, bone-in, fresh or chilled	--	5	2.5
0203.22.01	Meat of swine, legs, hams, and cuts thereof, bone-in, frozen	--	5	2.5
0406.10.01	Fresh cheese (unripened or uncured), including that from whey cheese, and curd	--	25	12.5
0406.30.99	Processed cheese, not grated or powdered; excluding that product with a fat content less than or equal to 36 percent by weight and with an average fat content in dry extract greater than 48 percent, presented in packages larger than 1 kg.	--	25	12.5
0406.90.04	Grana o Parmigiano-Reggiano cheese, with a fat content less than or equal to 40 percent by weight, and with a water content, in nonfat material, less than or equal to 47 percent by weight; Danbo, Edam, Fontal, Fontina, Fynbo, Gouda, Havarti, Maribo, Samsoe, Esrom, Italico, Kernhem, Saint-Nectaire, Saint-Paulin, or Taleggio cheese, with a fat content less than or equal to 40 percent by weight, and with a water content, of nonfat materials, greater than 47 percent and less than 72 percent by weight.	--	20	10
0406.90.99	Cheese, not elsewhere specified or indicated.	--	25	12.5
0604.91.02	Christmas trees, fresh	20	20	10
0703.10.01	Onions	10	10	5
0705.11.01	Iceberg lettuce	10	10	5
0710.40.01	Sweet corn	--	15	7.5
0802.12.01	Almonds, shelled	20	20	10
0802.50.01	Pistachios, fresh	--	20	10
0802.50.99	Pistachios, other	--	20	10
0804.10.01	Dates, fresh	20	20	10
0804.10.99	Dates, other	20	20	10
0805.10.01	Oranges, fresh or dried	--	20	10
0805.40.01	Grapefruit or pomelos, fresh or dried	--	20	10
0806.10.01	Grapes, fresh	45	20	10
0808.10.01	Apples, fresh	--	20	10
0808.20.01	Pears, fresh	20	20	10
0809.10.01	Apricots, fresh	--	20	10
0809.20.01	Cherries, fresh	--	20	10
0810.10.01	Strawberries, fresh	20	20	10
0813.30.01	Apples, dried	--	20	10
0813.50.01	Mixtures of dried fruit or nuts	20	20	10
1104.12.01	Oatmeal	--	10	5
1602.49.01	Cooked pork rinds	--	20	10
1704.10.01	Chewing gum, including those coated in sugar	--	20	10
1806.31.01	Chocolate or other food preparations containing cocoa, blocks, tablets, or bars, filled, less than or equal to 2 kg in mass	--	20	10
1806.32.01	Chocolate or other food preparations containing cocoa, blocks, tablets, or bars, not filled, less than or equal to 2 kg in mass	--	20	10
1902.19.99	Pasta, not containing egg, not cooked, filled, or otherwise prepared	10	10	5
2004.10.01	Potatoes, prepared or preserved, frozen	20	5	2.5
2005.40.01	Peas, prepared or preserved (except in vinegar or acetic acid), not frozen	20	20	10
2008.11.01	Peanuts, prepared or preserved, shelled	20	--	--
2008.11.99	Peanuts, prepared or preserved, with shell	20	20	10
2008.19.01	Almonds, prepared or preserved	20	20	10
2008.19.99	Mixed nuts, prepared or preserved	20	20	10
2008.60.01	Cherries, prepared or preserved	20	20	10
2009.80.01	Fruit or vegetable juice, other than orange, grapefruit, other citric fruit, lime, pineapple, tomato, grape, or apple	20	20	10
2009.90.01	Mixtures of vegetable juice only	20	20	10
2009.90.99	Mixtures of fruit or vegetable juice, other than mixtures of vegetable juice only	20	20	10
2103.10.01	Soy sauce	20	20	10
2103.20.01	Ketchup	--	20	10
2103.90.99	Condiments, other than soy sauce, ketchup, other tomato sauces, mustard meal, and prepared mustard	20	20	10
2104.10.01	Preparations for soups, pottages, and broths; prepared soups, pottages, and broths	10	10	5
2106.90.06	Concentrates of juice from a single fruit or vegetable, enriched with vitamins or minerals	15	15	7.5
2106.90.07	Concentrates of juice from more than one fruit or vegetable, enriched with vitamins or minerals	15	15	7.5
2106.90.08	Food preparations not elsewhere specified or indicated, with a content of milk solids greater than 10 percent, in weight	15	15	7.5
2201.10.01	Mineral water	20	20	10
2204.10.99	Sparkling wine, other than champagne	20	20	10
2204.21.02	Red, rose, claret, or white wine, whose alcoholic strength by volume is up to 14 percent at a temperature of 20 degrees Celsius (equivalent to 14 degrees on the Gay-Lussac hydrometer scale at a temperature of 15 degrees Celsius), in containers of clay, ceramics, or glass less than or equal to 2 liters	20	20	10
2206.00.99	Other fermented berverages or mixtures of fermented and non-alcoholic beverages, not elsewhere specified	20	20	10
2306.30.01	Sunflower seed meal and oilcake	15	15	7.5
2306.49.99	Rape seed meal or oilcake, with a high content of erucic acid	15	15	7.5
2309.10.01	Dog or cat food, for retail sale	10	10	5

Sources: Unofficial author translation of Secretaría de Economía (2009, 2010, 2011ab).

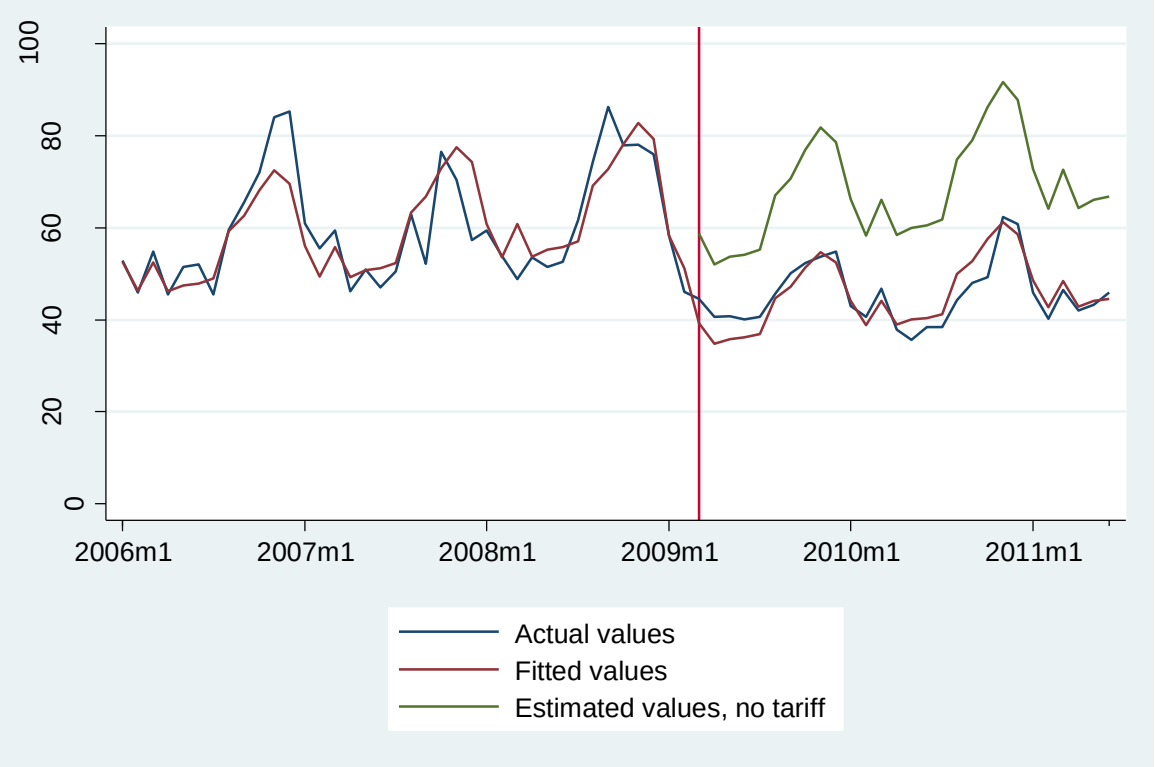




Notes: Trade values for the commodities targeted by Mexico's retaliatory tariffs are obtained from Mexican import data, while trade values for the agricultural commodities not targeted were calculated by subtracting the sum of the trade values of the targeted commodities, as reported by Mexican data, from the total value of U.S. agricultural exports to Mexico, as reported by U.S. export data.

Sources: Secretaría de Economía, as cited by Global Trade Atlas (2011), and U.S. Department of Agriculture, Foreign Agricultural Service (2011).

Figure 2—Mexico's Retaliatory Tariffs Have Had a Marked Effect on the Targeted U.S. Agricultural Exports to that Country



Blue line = Actual value of exports.
Green line = Expected value of exports in the absence of the retaliatory tariffs.
Red line = Fitted value of exports.
Vertical red line denotes March 2009, the month when the retaliatory tariffs were first imposed.