AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
http://ageconsearch.umn.edu
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

Gauging the Recent Effects of the North American Free Trade Agreement

Gary D. Thompson and Ricardo Cavazos Cepeda

The impacts of the North American Free Trade Agreement (NAFTA) on North American trade are described and analyzed using a variant of a gravity model. Controlling for the effects of real gross domestic product (GDP) and real exchange rates, the impacts of NAFTA on trade flows are statistically significant and positive in all but one case. Growth in real GDP has contributed to positive trade flows while real exchange rates have also affected trade flows in statistically discernible ways. In general, manufactured goods as well as machinery and transport equipment have benefited most from NAFTA while agricultural products have displayed less dynamic growth.

Bilateral and multilateral free-trade agreements have been promoted as one of the necessary conditions for stimulating world trade. Econometric analyses of aggregate trade patterns have detected a significant portion of growth in trade due to free-trade agreements (Baier and Bergstrand, 2001). Growth in disposable income and improvements in transportation technology have also contributed significantly to growth in aggregate trade. Free-trade agreements apparently lower tariff and non-tariff barriers sufficiently to allow changes in aggregate demand and supply in trading countries to affect trade patterns and growth.

The purpose of this analysis is to make an initial assessment of the effects of the North American Free Trade Agreement (NAFTA) on aggregate trade among its three constituent countries: Mexico, the United States, and Canada. With roughly five years of data since the signing of NAFTA in December 1993, some of the early effects of NAFTA on trade patterns should be now detectable. From this new "historical" perspective, the general patterns of trade among the three countries are first described. Then an econometric model of aggregate and disaggregate trade is specified and estimated in an effort to disentangle some of the causes of the changes observed in trade patterns.

The authors are a professor and graduate research assistant in the Department of Agricultural and Resource Economics, University of Arizona, Tucson. All correspondence concerning this manuscript should be addressed to Thompson at the Department of Agricultural & Resource Economics, University of Arizona, Tucson, AZ 85721-0023, garyt@ag.arizona.edu.
The authors would like to thank participants at the Food Distribution Research Society's Annual Conference at Mesa, Arizona, October 15, 2001.

Pre- and Post-NAFTA Trade Patterns

A naïve measure of the effects of NAFTA on trade patterns would be simply to compare the composition and growth of trade in various categories among the three trading partners before and after NAFTA. Pre- and post-NAFTA comparisons of trade would of course be naïve for several reasons. First, pre- and post-comparisons of trade would likely be blurred as many firms in the three countries anticipated the signing of NAFTA and commenced foreign investment. For example, in 1990, Sam Walton and Jeronimo Arango of Cifra, SA agreed to launch Wal-Mart's expansion in Mexico even though it was three years until NAFTA was signed (Luhnow, 2001). Now Wal-Mart is Mexico's largest retailer. Pre- and post-NAFTA comparisons may also be blurred for other reasons. Because the United States and Canada signed a bilateral free-trade agreement in 1989, the effects of NAFTA on U.S.-Canadian bilateral trade may be less prominent. Even with the advent of NAFTA, most tariffs have been progressively removed, some taking as long as fifteen years for complete removal.

Pre- and post-NAFTA comparisons may be naïve if changes stimulated by NAFTA represent shifts in production from trading partners outside NAFTA to NAFTA partners (Krueger, 1999). For example, Asian garment manufacturers might choose to relocate production facilities to Mexico to facilitate imports into the United States and Canada under the auspices of NAFTA. Rather than creating a net increase in trade, such relocation of manufacturing facilities would simply represent a shift in the source of exports. Trade patterns with countries outside of NAFTA signatories must be

considered when assessing the net impacts of NAFTA.

Finally, changes in aggregate supply and demand in Mexico, the United States, and Canada would have caused changes in trade patterns and growth with or without the presence of NAFTA.

For all these reasons, simple comparisons of pre- and post-NAFTA trade without accounting for underlying changes in aggregated supply and demand would lead to spurious conclusions about the effects of NAFTA. However, even though pre- and post- comparisons of trade patterns and growth may be naïve, such comparisons provide some background for understanding the nature of NAFTA's impacts on trade.

Changes in Aggregate Trade

Comparisons of aggregate trade between Mexico, the United States, and Canada before and after NAFTA can be gauged from Figure 1. Some general observations about aggregate trade patterns are useful. The magnitude of U.S.-Canada trade is appreciably larger than U.S.-Mexico trade. There was a noticeable increase in aggregate U.S. exports to Canada after passage of the Canadian-U.S. Free Trade Agreement in the late 1980s. Mexico-Canada trade is an order of magnitude smaller. Growth in imports and exports among all three countries has been sustained over the last decade and a half, with the United States as a notable net importer of goods and services from Mexico and Canada. Canada has also become an increasingly larger importer of Mexican goods although the absolute magnitude of those imports is still relatively small. The largest growth in trade has occurred with Mexican exports to the United States and Canada.

Some increases in the real value of trade after NAFTA become apparent when comparing aggregate imports and exports among the three countries before and after passage of NAFTA. When real imports and exports are regressed on a time-trend variable in the pre- and post-NAFTA periods, Chow tests with break points at the first quarter of 1994 indicate statistically significant increases in the rate of change of imports and exports.[1] Even in the case of Canadian exports to Mexico, which in Figure 1 appear relatively flat, the trend is statistically significantly greater in the post-NAFTA period for exports from Canada to Mexico than in the pre-NAFTA period. In the post-NAFTA period, aggregate exports and imports among the three countries have increased in statistically discernable ways. The causes of the increases, of course, cannot be discerned from the foregoing descriptive analysis.

Changes in Disaggregate Trade

Disaggregated import and export data for United States trade with Mexico and Canada were employed to gauge the composition and growth of sectoral trade pre- and post-NAFTA (Table 1).[2] Agricultural trade measured by categories *(0) Food and Live Animals*, *(1) Beverages and Tobacco*, and *(4) Animal and Vegetable Oils, Fats and Waxes* together account for 5 to 7 percent of trade; while that share remained static in the case of U.S. imports from Canada, it declined in the post-NAFTA period for all other trade flows. By far the most important category of U.S. imports and exports is *(7) Machinery and Transport Equipment*, which accounts for approximately half of all trade. Three categories—*(6) Manufactured Goods Classified Chiefly by Material*, *(7) Machinery and Transport Equipment*, and *(8) Miscellaneous Manufactured Articles*—jointly account for at least two-thirds of trade among the three countries. U.S. exports to Mexico and imports from Mexico in these three categories grew from 68 to 75 percent and 66 to 80 percent of total trade values, respectively. In general, U.S. trade with Canada appears to be slightly more diversified than U.S. trade with Mexico in the sense that no single category accounts for as large a share of trade.

Comparing average annual growth rates before and after NAFTA indicates that the U.S.-Mexico trade has been affected more than U.S.-Canada trade. High-growth sectors for U.S. exports to Mexico in the post-NAFTA period were *(0) Food and Live Animals* and *(3) Mineral Fuels, Lubricants and Related Materials*, with *(7) Machinery and Transport Equipment* and *(9) Miscellaneous*

[1] The results of the Chow test are available on request from the authors.

[2] The USITC data used to calculate the growth rates and shares in Table 1 were converted to real U.S. dollars. The USITC data were available from 1989 through 2000 whereas the aggregate trade data for trade among the three countries was available from 1984 on a monthly basis.

Figure 1. Aggregate Imports and Exports (Millions of 1982-84 U.S.$).

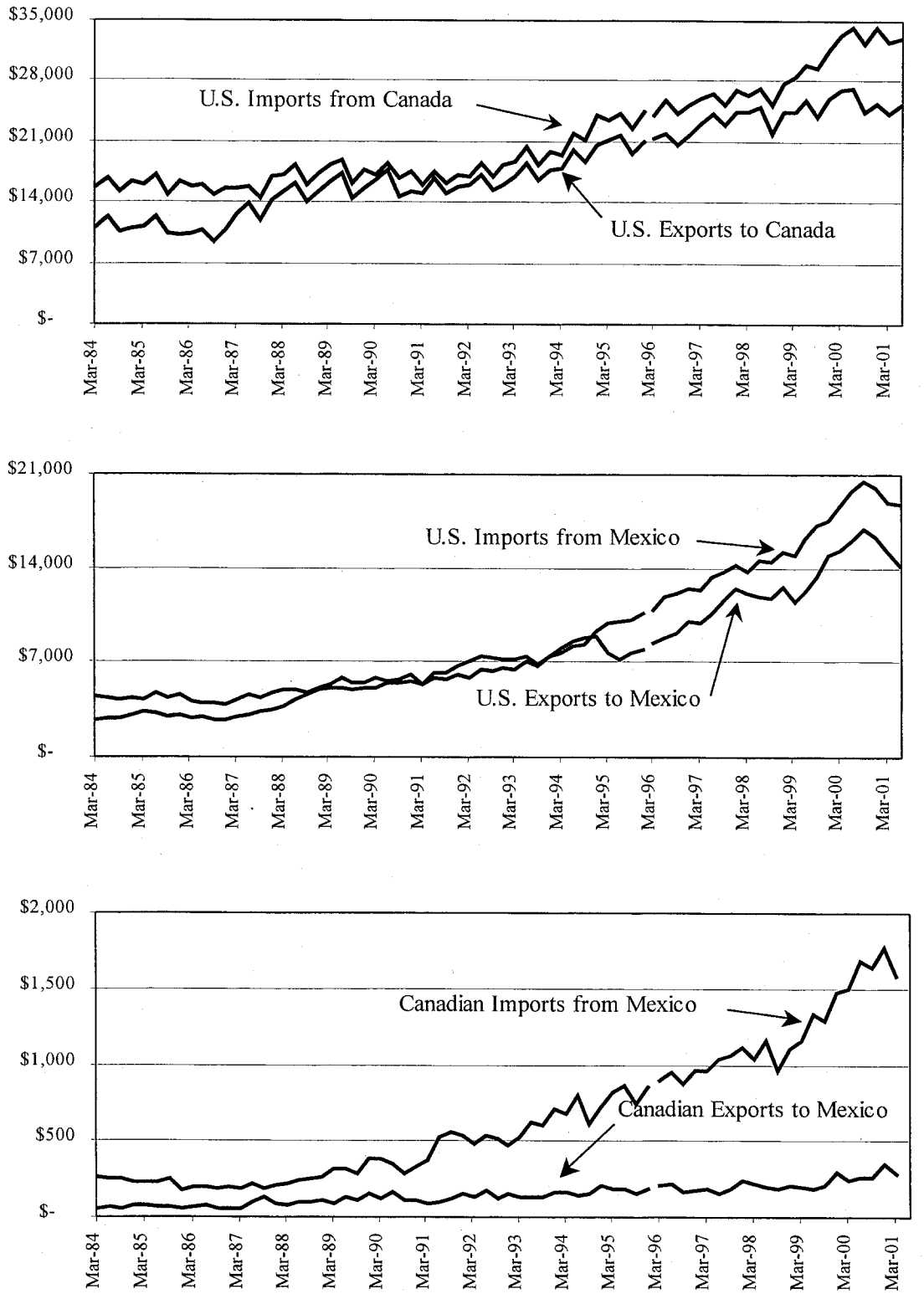

Table 1. United States Trade with Mexico & Canada, 1-Digit SITC Categories.

	Mexico				Canada			
	Exports		Imports		Exports		Imports	
1-Digit SITC	'89-'95	'96-'01	'89-'95	'96-'01	'89-'95	'96-'01	'89-'95	'96-'01
	Trade Shares							
0 Food & Live Animals	6%	5%	7%	4%	4.8%	4.6%	4.0%	4.3%
1 Beverages & Tobacco	0.2%	0.1%	0.7%	0.9%	0.1%	0.2%	0.6%	0.5%
2 Crude Materials, Inedible, Except Fuels	4%	3%	2%	1%	3%	3%	7%	6%
3 Mineral Fuels, Lubricants & Related Materials	2%	3%	12%	8%	1%	2%	10%	11%
4 Animal & Vegetable Oils, Fats & Waxes	0.5%	0.4%	0.03%	0.04%	0.1%	0.1%	0.2%	0.2%
5 Chemicals & Related Products, N.E.S.	8%	8%	2%	2%	7%	9%	5%	5%
6 Manufact. Goods Classified Chiefly by Material	12%	14%	7%	7%	11%	13%	16%	16%
7 Machinery & Transport Equipment	44%	50%	47%	57%	51%	55%	42%	43%
8 Miscellaneous Manufactured Articles	11%	12%	11%	15%	9%	10%	4%	6%
9 Commodities & Transactions, N.E.S.	4%	4%	4%	4%	7%	3%	6%	7%
Total	100%	100%	100%	100%	100%	100%	100%	100%
	Average Annual Growth Rates							
0 Food & Live Animals	0%	16%	5%	1%	18%	2%	4.6%	7.9%
1 Beverages & Tobacco	23%	8%	4%	24%	14%	10%	2%	4%
2 Crude Materials, Inedible, Except Fuels	3%	6%	8%	-8%	8%	-1%	3%	0%
3 Mineral Fuels, Lubricants & Related Materials	8%	28%	3%	19%	-3%	12%	6%	19%
4 Animal & Vegetable Oils, Fats & Waxes	13%	-4%	12%	26%	14%	8%	22%	-4%
5 Chemicals & Related Products, N.E.S.	8%	13%	12%	4%	13%	6%	9%	5%
6 Manufact. Goods Classified Chiefly by Material	10%	17%	9%	10%	16%	6%	4%	3%
7 Machinery & Transport Equipment	8%	20%	15%	16%	8%	4%	5%	6%
8 Miscellaneous Manufactured Articles	11%	15%	17%	17%	16%	5%	10%	12%
9 Commodities & Transactions, N.E.S.	3%	18%	8%	15%	-14%	-1%	7%	12%
Total	6.9%	15.7%	11.0%	12.8%	5.0%	3.4%	5.1%	6.1%

Source: USITC, World Trade, monthly data. Note '96-'01 represents months from January 1996 through July 2001.

Manufactured Articles experiencing substantial increases in growth rates from the pre-NAFTA period. Post-NAFTA imports from Mexico to the United States grew most rapidly in *(1) Beverages and Tobacco*, *(3) Mineral Fuels, Lubricants and Related Materials*, and *(4) Animal and Vegetable Oils, Fats and Waxes*. By contrast, the only categories of U.S.-Canada trade to display positive growth-rate changes in excess of 10 percent in the post-NAFTA period were *(3) Mineral Fuels, Lubricants and Related Materials* and *(9) Commodities and Transactions, N.E.S.*

As would be expected, some sectors of the three countries' economies have benefited enormously from North American trade in the post-NAFTA period while other sectors have not. Nonetheless, with a few exceptions—*(2) Crude Materials, Inedible, Except Fuels* and *(4) Animal and Vegetable Oils, Fats and Waxes*)—all sectors have continued to experience positive, though declining, annual growth rates. Three sectors stand out as the "engines" of growth in exports and imports: *(6) Manufactured Goods Classified Chiefly by Material*, *(7) Machinery and Transport Equipment*, and *(8) Miscellaneous Manufactured Articles*. Manufactured goods and machinery and transport equipment together have accounted for the largest share of U.S. trade with Mexico and Canada and have posted the largest increases in shares in the post-NAFTA period. Agricultural and food sectors have not gained any larger share of trade in the post-NAFTA period. For example, the share of U.S. trade in *(0) Food and Live Animals* with Mexico has declined over the post-NAFTA period, while the share of that category's trade with Canada has remained static.

Gravity Trade Model

The foregoing descriptive analysis suggests the effects of NAFTA on the real value of trade between Mexico, the United States, and Canada have been appreciable and that trade in some sectors has grown considerably. But descriptive analyses give little idea of what economic phenomena have caused those appreciable changes. The following exposition of the gravity model of trade provides some economic rationale for investigating the determinants of trade.

Gravity models have been widely used in empirical studies to measure the determinants of bilateral trade flows (Anderson, 1979; Bergstrand 1985,1989,1998; Sanso, Cuairan, and Sanz, 1993; Deardorff, 1998; Eichengreen and Irwin, 1998; Baier and Bergstrand, 2001). Gravity models continue to be popular for at least two reasons: many underlying structural models are theoretically consistent with the relatively parsimonious specification of the gravity model, and gravity models have performed well econometrically with a wide variety of data.

In most gravity models the value of exports from country i to country j, $T_{i,j}$, is expected to vary directly with aggregate income on both countries, Y_i and Y_j, and inversely with distance between the two countries, $D_{i,j}$. In its simplest form, the gravity equation is given by

$$(1) \qquad T_{i,j} = A\frac{Y_i Y_j}{D_{i,j}}$$

where A is a constant of proportionality. Aggregate income in both countries, often proxied with gross domestic product, serves as a measure of both supply and demand conditions. Aggregate income in country i reflects domestic production capacity capable of generating exports while income in country j indicates the level of demand for those exports. Distance between the two countries is a readily measurable proxy for the transportation costs of exporting goods.[3] In empirical applications of (1), indicator variables are typically added to reflect regional effects as well as the effects of tariffs and free-trade agreements.

Taking natural logarithms of (1) and appending a stochastic error leads to an easily estimated equation. Some researchers have estimated variations of (1) in the context of time-series data using first differences rather than levels (Baier and Bergstrand, 2001; Bayoumi and Eichengreen, 1997; and Eichengreen and Irwin, 1998). Others have investigated the role of functional form by estimating Box-Cox regressions (Sanso, Cuairan, and Sanz, 1993). Random versus fixed-effects models with pooled time series-cross section data have also been tested (Egger, 2000). The gravity model has been estimated as a single-equation, reduced-form model regardless of the particular empirical specification.

[3] For a comprehensive explanation of the various theoretical underpinnings of the gravity model, see Baier and Bergstrand.

Econometric Specification

The following econometric model is specified in the spirit of gravity models. The econometric model is essentially a reduced form for which there are several observationally equivalent structural models. The measures of proximity typically used in gravity models as an indicator of transportation costs are not included in the following model because the United States shares common borders with Mexico and Canada. Even though Mexico and Canada do not share a border there is a land bridge between the two countries with a well-developed transportation and communication infrastructure.

The econometric model linking exports and imports among the three NAFTA trading partners is specified as

$$(2) \qquad y_{ij,t} = \mathbf{X}'_{it}\beta_i + \varepsilon_{it} \quad i, j = 1,\ldots,m;\ t = 1,\ldots,T$$

where $y_{ij,t}$ denotes exports from country i to country j (or imports from country j to country i) in the t^{th} time period, $\mathbf{X}'_{it}$ is a row vector of relevant explanatory variables in the t^{th} time period, β_i is a conformable vector of coefficients to be estimated, and ε_{it} is an error term assumed to be distributed as follows $\varepsilon \sim N(\mathbf{0}, \Sigma \otimes \mathbf{I}_T)$. The explanatory variables in each equation include a constant, the level of real GDP, real GDP per capita, the real exchange rate, an indicator variable for the post-NAFTA period, and quarterly dummies. The specification in (2) does not include the same explanatory variables in each equation.

Both real GDP and real GDP per capita in each country are highly collinear; correlation coefficients between the two series are 0.991 for the United States, 0.977 for Mexico, and 0.679 for Canada. Despite the high degree of collinearity, estimation of the models as seemingly unrelated systems presents no difficulties. A number of hypothesis tests were performed to check for misspecifications. Wald and likelihood ratio tests for first-order vector autoregressive (VAR) error structures, $\varepsilon_t = \mathbf{R}\varepsilon_{t-1} + \mathbf{u}_t$, were performed with varying results (Guilkey, 1974). In general, the null hypothesis of a diagonal $\mathbf{R}$ could not be rejected.[4]

Rather than estimate the systems of equations in various steps as in Guilkey and Schmidt (1973), the parameters were estimated simultaneously with a nonlinear iterative-estimation procedure. With the maintained assumption that e is distributed normally, the procedure yields maximum likelihood estimates.

Data Considerations

Monthly observations on aggregate trade data for bilateral trade among all three countries were available from 1984 through the first six months of 2001. However, data disaggregated by sectors were not available for trade flows between Canada and Mexico. Although initial econometric estimates were obtained from the longer time series, they are not reported here for reasons of space. Instead, disaggregated data on trade flows between the United States and its two NAFTA partners were employed. Although monthly observations were available on disaggregated trade flows beginning in 1989, monthly population estimates for Mexico and Canada were not readily available. As a result, the data were aggregated temporally to quarterly observations. Hence, sample data consist of quarterly observations from 1989:I to 2001:I.

Estimation Results

Estimated values of the NAFTA indicator variables and their respective p-values are displayed in Table 2.[5] It is worth emphasizing that these indicator variables estimate the size of NAFTA impacts once the explanatory effects of real GDP, real GDP per capita, and real exchange rates have been taken into account. A number of salient patterns emerge from Table 2: all but one of the statistically significant indicator variables—U.S. exports of *(1) Beverages & Tobacco* to Mexico—is positive. Hence, where the effects of NAFTA are statistically discernable its effects are overwhelmingly positive. About half of the indicator variables (23 of 48) are statistically distinguishable from zero. Perhaps unexpectedly, the effects of NAFTA appear more frequently in U.S.-Canada trade (14 of 24) than in U.S.-Mexico trade (9 of 24).

[4] Estimation with $\mathbf{R} \neq \mathbf{0}$ with all ρ_{ij} potentially different from zero means that m^2 additional parameters must be estimated. The sample size is sufficiently large to permit estimation of m^2 additional parameters, but achieving convergence of the model is not always possible. For that reason, a diagonal $\mathbf{R}$ matrix was used.

[5] A full set of parameter estimates and descriptive statistics are available from the authors.

Table 2. NAFTA Indicator Variables, p-values in parentheses.

Group	U.S. Imp. from Mexico	U.S. Exp. to Mexico	U.S. Imp. from Canada	U.S. Exp. to Canada
0 Food & Live Animals[a]	-28.753 (0.391) -5%	54.119 (0.279) 11%	154.710 **(0.000)** 16%	-14.220 (0.767) -1%
1 Beverages & Tobacco	12.362 (0.267) 14%	-7.706 **(0.004)** -49%	16.847 (0.297) 13%	12.482 **(0.000)** 33%
2 Crude Materials, Inedible, Exc. Fuels	-12.701 (0.184) -9%	52.782 **(0.022)** 14%	188.575 **(0.061)** 12%	-47.873 (0.138) -8%
3 Mineral Fuels, Lubric. & Rel. Mat	230.609 (0.129) 22%	73.095 (0.184) 28%	1,092.744 **(0.000)** 45%	130.789 **(0.008)** 41%
4 Animal & Veg. Oils, Fats & Waxes	5.213 **(0.000)** 132%	12.183 (0.181) 28%	11.978 **(0.001)** 27%	18.711 **(0.000)** 87%
5 Chemicals & Rel. Products, N.E.S.	17.793 (0.155) 10%	46.699 (0.314) 6%	89.480 (0.110) 7%	78.299 **(0.030)** 5%
6 Manufact. Goods Class. by Mat.	105.207 **(0.003)** 13%	119.941 **(0.032)** 10%	107.778 (0.361) 3%	155.184 **(0.095)** 6%
7 Machinery & Transport Equipment	411.775 **(0.038)** 7%	706.576 **(0.002)** 16%	453.622 (0.325) 4%	574.388 (0.164) 5%
8 Miscellaneous Manufactured Articles	-23.245 (0.692) -2%	45.234 (0.338) 4%	197.350 **(0.000)** 15%	201.991 **(0.044)** 10%
9 Commodities & Transactions, N.E.S.	0.075 (0.998) 0%	28.646 (0.374) 7%	-11.651 (0.889) -1%	71.588 (0.872) 7%
Agriculture (0 + 1 + 4)	-20.531 (0.548) -3%	79.693 **(0.049)** 14%	192.834 **(0.000)** 17%	13.052 (0.799) 1%
Total	209.692 (0.583) 2%	1,000.119 **(0.012)** 11%	1,797.531 **(0.005)** 8%	1,203.161 **(0.030)** 6%

[a] Number below the p-value represents the estimated indicator value as a percentage of the sample mean of the respective import or export value.

The magnitudes of the statistically significant effects of NAFTA vary from relatively modest impacts, particularly for aggregate trade, to surprisingly large effects for U.S. imports from Mexico and U.S. exports to Canada of *(4) Animal & Vegetable Oils, Fats & Waxes* (U.S. exports of *4 Animal & Vegetable Oils, Fats & Waxes* account for less than 1 percent of exports). The categories of U.S.-Mexico trade that account for the largest share of trade have apparently been the beneficiaries of NAFTA: *(6) Manufactured Goods Classified Chiefly by Material* and *(7) Machinery & Transport Equipment* experienced increases between 7.2 percent and 15.8 percent due to NAFTA. U.S.-Canadian trade has benefited from NAFTA with detectable growth in at least half of the SITC 1-digit categories. U.S.-Canadian bilateral trade in *(3) Mineral Fuels, Lubricants & Related Materials* and *(4) Animal & Vegetable Oils, Fats & Waxes* increased by at least 25 percent due to NAFTA.

The uneven impacts of NAFTA on bilateral trade in various SITC categories are apparent in the disaggregated trade flows. Of the four aggregate import-export categories for U.S. trade with Mexico and Canada, only U.S. imports from Mexico registered no NAFTA-specific effects. Although the effects of NAFTA on aggregate trade were more modest than some of its effects on individual 1-digit categories, the effects vary in magnitude from 5.9 percent (U.S. exports to Canada) to 10.6 percent (U.S. exports to Mexico). Despite there being no statistically discernable effects of NAFTA on aggregate U.S. imports from Mexico, NAFTA did have a positive impact on the two categories with the largest shares of U.S. imports from Mexico *(6) Manufactured Goods Classified Chiefly by Material* and *(7) Machinery & Transport Equipment)*, which together accounted 64 percent of U.S. imports in the post-NAFTA period.

While NAFTA has had an undeniable positive impact on North American trade, the econometric model indicates another important source of growth in trade: real gross domestic product. Real GDP or "income" elasticities for imports and exports reported in Table 3 indicate statistically significant effects in 29 of 48 cases, with only five elasticities being negative.[6] The majority of the elasticities exceed unity suggesting that percentage increases in real income contribute importantly to growth in imports and exports. Perhaps not coincidentally, increases in real GDP contributed positively to U.S. imports from exports to Mexico and Canada in each of three important categories: *(6) Manufactured Goods Classified Chiefly by Material*, *(7) Machinery & Transport Equipment*, and *(8) Miscellaneous Manufactured Articles*. The magnitudes of the income elasticities in these three categories are mostly greater than one with the notable exception of U.S. exports to Canada, for which the elasticities tend to be smaller. As was noted above in the descriptive analysis, these three categories have been the engines of growth in trade. The econometric analysis suggests that increases in real GDP have been one of the principal sources of growth in trade in these three important categories; the sustained economic growth of the decade of the 1990s stimulated significant growth in North American trade in manufactured goods, machinery, and transport equipment.

Growth in trade in other sectors due to increased real GDP is less conspicuous. Food and agricultural categories—*(0)*, *(1)*, and *(4)*—and *(3) Mineral Fuels, Lubricants, and Related Materials* are two sectors for which increased real GDP either had no effect or negative effects. With the three food and agricultural categories taken jointly, the impacts of increasing real GDP only registered on U.S. imports from Mexico. The magnitudes of the income elasticities for *(0) Food and Live Animals* (2.285) as well as for food and agricultural categories as a whole (2.492) suggest that increases in real GDP in the United States had sizable impacts on growth in selected industries in the food and agricultural sector.

It is also important to account for the effects of real exchange-rate variations on North American trade flows. Over half of the real exchange-rate elasticities estimated (26 of 48) are statistically different from zero, indicating that real exchange rates exerted tangible effects on trade (Table 4).
The signs of the statistically significant real exchange-rate elasticities for U.S. imports from Mexico and Canada are all negative, as would be

[6] The marginal effect of real GDP on trade flows reflect two possible impacts of income on trade. The marginal effects are $\partial_{yij,t} / \partial GDP_{j,t} = \beta_{GDP,j} + \beta_{GDP\ per\ capita,\ j} / Population_{j,t}$. The first coefficient captures the impact of changes in market size while the second coefficient normalized by population reflects changes in individual purchasing power.

Table 3. Real GDP Elasticities Calculated at 1999:I-1999:IV Means (p-values in parentheses).

Group	U.S. Imp. from Mexico	U.S. Exp. to Mexico	U.S. Imp. from Canada	U.S. Exp. to Canada
0 Food & Live Animals	2.285 **(0.001)**	0.247 (0.657)	0.285 (0.265)	-0.492 (0.138)
1 Beverages & Tobacco	0.438 (0.694)	-0.784 (0.498)	-3.361 **(0.059)**	0.556 (0.169)
2 Crude Materials, Inedible, Except Fuels	0.647 (0.540)	0.277 (0.555)	0.050 (0.959)	0.945 **(0.005)**
3 Mineral Fuels, Lubricants & Rel.Mat	-5.038 **(0.016)**	1.226 (0.204)	-4.857 **(0.006)**	4.139 **(0.001)**
4 Animal & Veg. Oils, Fats & Waxes	-1.801 (0.473)	-1.986 **(0.054)**	-0.425 (0.778)	6.316 **(0.001)**
5 Chemicals & Related Products, N.E.S.	0.586 (0.450)	1.289 **(0.000)**	0.554 (0.384)	0.655 **(0.000)**
6 Manufact. Goods Class.Chiefly by Mat.	2.474 **(0.000)**	1.031 **(0.000)**	0.999 **(0.019)**	0.641 **(0.002)**
7 Machinery & Transport Equipment	1.911 **(0.000)**	1.974 **(0.000)**	0.787 **(0.081)**	0.375 **(0.077)**
8 Miscellaneous Manufactured Articles	0.827 **(0.088)**	1.042 **(0.000)**	1.640 **(0.000)**	1.062 **(0.020)**
9 Commodities & Transactions, N.E.S.	1.218 **(0.040)**	0.603 (0.125)	2.369 **(0.000)**	-26.378 **(0.004)**
Agriculture (0 + 1 + 4)	2.492 **(0.000)**	0.032 (0.944)	-0.127 (0.689)	-0.438 (0.182)
Total	1.714 **(0.000)**	1.507 **(0.000)**	0.296 (0.322)	0.341 **(0.031)**

Note: Standard errors of elasticities calculated by the delta method and p-values are based on two-tailed test. P-values in boldface are 0.100 or smaller.

Table 4. Real Exchange Rate Elasticities Calculated at 1999:I-1999:IV Means (p-values in parentheses).

Group	U.S. Imp. from Mexico	U.S. Exp. to Mexico	U.S. Imp. from Canada	U.S. Exp. to Canada
0 Food & Live Animals	-0.482 **(0.000)**	0.507 (0.373)	-0.243 **(0.000)**	1.200 **(0.001)**
1 Beverages & Tobacco	-0.281 **(0.093)**	2.766 **(0.026)**	-0.331 (0.485)	-0.262 (0.573)
2 Crude Materials, Inedible, Except Fuels	-0.307 **(0.076)**	-0.236 (0.644)	-0.779 **(0.015)**	-0.619 **(0.087)**
3 Mineral Fuels, Lubricants & Rel.Mat	-0.389 (0.185)	-1.371 (0.144)	0.243 (0.577)	-3.211 **(0.013)**
4 Animal & Veg. Oils, Fats & Waxes	-0.717 **(0.043)**	2.029 **(0.042)**	-0.385 (0.319)	-4.356 **(0.020)**
5 Chemicals & Related Products, N.E.S.	-0.328 **(0.007)**	-0.948 **(0.003)**	-0.238 (0.237)	-0.363 **(0.010)**
6 Manufact. Goods Class. Chiefly by Mat.	-0.182 **(0.006)**	-0.726 **(0.001)**	-0.208 (0.128)	-0.319 (0.219)
7 Machinery & Transport Equipment	-0.101 **(0.035)**	-1.532 **(0.000)**	-0.104 (0.534)	-0.231 (0.264)
8 Miscellaneous Manufactured Articles	-0.035 (0.430)	-0.665 **(0.002)**	-0.118 (0.406)	-0.511 (0.275)
9 Commodities & Transactions, N.E.S.	-0.069 (0.448)	-0.422 (0.256)	0.157 (0.345)	13.581 (0.133)
Agriculture (0 + 1 + 4)	-0.354 **(0.000)**	0.526 (0.281)	-0.326 **(0.000)**	1.068 **(0.004)**
Total	-0.165 **(0.002)**	-1.088 **(0.000)**	-0.183 (0.168)	-0.334 **(0.034)**

Note: Standard errors of elasticities calculated by the delta method and p-values are based on two-tailed test. P-values in boldface are 0.100 or smaller.

expected. However, positive and negative effects of real exchange rates on U.S. exports to both recipient countries are apparent. It should be noted that the real exchange-rate elasticities calculated in this study represent contemporaneous effects of real exchange-rate appreciation on trade flows; no lagged effects are measured. Hence, to the extent J-curve phenomena exist, the immediate effect of an appreciation in the real exchange rate on current exports may be positive or negative depending on the relative speed of adjustment of exports in a particular SITC category. With the relatively disaggregated data employed here, we would expect to observe some evidence of J-curve effects (Rose and Yellen, 1989). The few previous empirical studies employing relatively disaggregate trade data suggest there may be evidence of a J-curve in agricultural trade (Carter and Pick, 1989; Doroodian, Jung, and Boyd, 1999).

Real exchange-rate elasticities for U.S. exports to Mexico and Canada are negative, with only four exceptions. Three of the four exceptions occurred in agricultural categories: U.S. exports of *(0) Food and Live Animals* to Canada; and U.S. exports of *(1) Beverages & Tobacco* and *(4) Animal & Vegetable Oils, Fats & Waxes* to Mexico. The negative contemporaneous elasticities suggest a perverse initial impact of an increase in the real exchange rate for the majority of the SITC categories. Because over three-quarters of exports to Mexico and Canada are non-agricultural, the perverse impacts are in evidence in the export elasticities for total trade flows as well.

A slightly less obvious pattern in the magnitudes of the real exchange-rate elasticity values is that they tend to be smaller in absolute value for U.S. imports than for U.S. exports. This difference in absolute values suggests that the effects of exchange rates on the prices of goods imported into Mexico or Canada from the United States are more pronounced than for goods imported from those two countries into the United States.

Summary and Conclusions

Limited evidence from the second half of the 1990s indicates that NAFTA has had statistically discernible effects on trade between Mexico, the United States, and Canada. The effects of NAFTA have been overwhelmingly positive; the only trade flow with a statistically significant negative effect due to NAFTA was U.S. exports of beverages and tobacco to Mexico. Surprisingly, more statistically significant impacts were found with trade between the United States and Canada than for U.S.-Mexico trade. The magnitude of NAFTA impacts on trade in various sectors ranged from as low as 5 percent of average trade levels to as high as 130 percent for U.S. imports of Animal and Vegetable Oils, Fats, and Waxes.

In addition to the effects of NAFTA, growth in real gross domestic product (GDP) has fueled growth in trade between the three NAFTA trading partners. The largest magnitudes of real GDP elasticities have occurred in machinery and transport equipment as well as various types of manufactured goods. Interestingly, positive effects of GDP were registered on U.S. imports and exports to and from Mexico and Canada. The GDP-driven growth in these sectors is significant because jointly they account for between two-thirds and three-quarters of all bilateral trade flows between the United States and its partners.

Real exchange-rate movements have also affected trade flows. The magnitudes of the real exchange-rate effects are generally larger for U.S. exports to Mexico and Canada than for U.S. imports from those same two countries. Although the effects of real exchange rates are statistically significant in many cases, the elasticities for exchange rates tend to be smaller in absolute magnitude than GDP elasticities. There is some evidence of J-curve effects insofar as real exchange-rate appreciation does not provide immediate positive stimulus for U.S. exports in some sectors.

A number of caveats regarding this study are in order. Whether or not the predominantly positive impacts of NAFTA on North American trade flows constitute a net increase in trade is not answered, because trade between NAFTA partners and the rest of the world is not considered. Shift-share analysis like that conducted by Krueger (1999) would be one avenue for future research aimed at measuring the global impacts of NAFTA on trade.

The particular specification of the gravity model used here is likely more representative of the demand side of bilateral trade rather than the producers' side. Inclusion of aggregate GDP and GDP per capita in the destinations of trade flows

serves as a proxy for demand. Supply-side variables are absent in the model used here. Future efforts should focus on supply-related factors affecting trade flows. More refined measures of trade liberalization through time in specific sectors would also aid in estimating more accurately the specific effects of NAFTA; the use of indicator variables is an admittedly crude measure of post-NAFTA changes. Finally, more sophisticated econometric techniques such as switching regression models could be used to model institutional and structural changes occurring as the result of NAFTA.

References

Anderson, James E. 1979. "A Theoretical Foundation for the Gravity Equation." *The American Economic Review* 69:106-116.

Baier, Scott L. and Jeffrey H. Bergstrand. 2001. "The Growth of World Trade: Tariffs, Transport Costs, and Income Similarity." *Journal of International Economics* 53:1-27.

Bayoumi, T. and B. Eichengreen. 1997. "Is Regionalism Simply a Diversion? Evidence from the EU and EFTA," in T. Ito and A. Krueger (eds.) *Regionalism versus Multilateral Trade Arrangements*, Chicago: The University of Chicago Press.

Bergstrand, Jeffrey H. 1985. "The Gravity Equation in International Trade: Some Microeconomic Foundations and Empirical Evidence." *The Review of Economics and Statistics* 67:474-481.

Bergstrand, Jeffrey H. 1989. "The Generalized Gravity Equation, Monopolistic Competition, and the Factor Proportions Theory in International Trade." *The Review of Economics and Statistics* 71:143-153.

Bergstrand, Jeffrey H. 1990. "The Heckscher-Ohlin-Samuelson Model, The Linder Hypothesis and the Determinants of Bilateral Intra-Industry Trade." *The Economic Journal* 100:1216-1229.

Bergstrand, Jeffrey H. Comment on Deardorff, Alan V. 1998. "Determinants of Bilateral Trade: Does Gravity Work in a Neoclassical World?" in Frenkel, Jeffrey A. (ed) *The Regionalization of the World Economy*. Chicago: The University of Chicago Press, pp.23-28.

Carter, Colin and Daniel Pick. 1989. "The J-Curve Effect and the U.S. Agricultural Trade Balance." *American Journal of Agricultural Economics* 71:712-720.

Central Bank of Canada. 2001. http://www.bankofcanada.ca/

Central Bank of Mexico, Mexico, D.F. 2001. http://www.banxico.org.mx/

Deardorff, Alan V. 1998. "Determinants of Bilateral Trade: Does Gravity Work in a Neoclassical World?" in Frenkel, Jeffrey A. (ed) *The Regionalization of the World Economy*. Chicago: The University of Chicago Press, pp. 7-22.

Doroodian, Khosrow, Chulho Jung, and Boy Boyd. 1999. "The J-Curve Effect and US Agricultural and Industrial Trade." *Applied Economics* 31:687-695.

Egger, Peter. 2000. "A Note on the Proper Econometric Specification of the Gravity Equation," *Economics Letters* 66:25-31.

Eichengreen, Barry, and Douglas A. Irwin. 1998. "The Role of History in Bilateral Trade Flows," in Frenkel, Jeffrey A. (ed) *The Regionalization of the World Economy*. Chicago: The University of Chicago Press, pp.33-58.

Federal Reserve Bank of Saint Louis. 2001. http://www.stls.frb.org/

Guilkey, David K. and Peter Schmidt. 1973. "Estimation of Seemingly Unrelated Regressions with Vector Autoregressive Errors." *Journal of the American Statistical Association* 68:642-647.

Guilkey, David K. 1974. "Alternative Tests for a First-Order Vector Autoregressive Error Specification." *Journal of Econometrics* 2:95-104.

Instituto Nacional de Estadistica Geografia e Informatica. 2001. http://www.inegi.gob.mx/

International Monetary Fund. 1999. *International Financial Statistics Yearbook*. Washington, D.C.: International Monetary Fund.

Krueger, Anne O. 1999. "Trade Creation and Trade Diversion Under NAFTA," National Bureau of Economic Research Working Paper 7429, Cambridge, MA: http://www.nber.org/papers/w7429.

Luhnow, David. 2001. "Crossover Success: How Nafta Helped Wal-Mart Reshape The Mexican Market—Lower Tariffs, Retail Muscle Translate Into Big Sales; Middlemen Are Squeezed—'Like Shopping in the U.S.'" *Wall*

Street Journal August 31: A1.

Population Reference Bureau, 2001. http://www.prb.org

Rose, A.K. and J.L. Yellen. 1989. "Is There a J-Curve?" *Journal of Monetary Economics* 24 :53-68.

Sanso, Marco, Rogelio Cuairan, and Fernando Sanz. 1993. "Bilateral Trade Flows, The Gravity Equation, and Functional Form." *The Review of Economics and Statistics* 75:266-275.

Statistics Canada, 2001. http://www.statcan.ca/

United States Bureau of the Census 2001. http://www.census.gov/foreign-trade/balance/index.html

United States Department of Commerce, Bureau of Economic Analysis. 2001. http://www.bea.doc.gov/

United States Department of Labor, Bureau of Labor Statistics. 2001. http://www.bls.gov/

United States International Trade Commission. 2001. http://dataweb.usitc.gov/

World Bank. 2001. http://www.worldbank.org