Effects of Regional Trade Agreements on Trade in Agrifood Products: Evidence from Gravity Modeling Using Disaggregated Data

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Abstract

The recent proliferation of regional trade agreements (RTAs) has intensified the debate on their merits. A growing literature has addressed this policy debate, focusing on the welfare and trade effects of RTAs and their likely impacts on the multilateral trading system. Some view them as stepping-stones toward multilateral trade liberalization while others see them as stumbling blocks against free trade. The existing literature has neglected some important aspects of RTAs dealing with trade in agrifood products. This study analyzes trade creation and diversion effects of the North American Free Trade Agreement (NAFTA) on trade of six selected agrifood products from 1985 to 2000. The investigation estimates an extended gravity model using pooled cross-sectional time-series regression and generalized least squares methods. The result shows that the share of intraregional trade is growing within NAFTA and that NAFTA has displaced trade with the rest of the world. NAFTA has served to boost trade significantly among its members rather than with the rest of the world. Countries participating in NAFTA have moved toward a lower degree of relative openness in agrifood trade with the rest of the world.

Keywords: agrifood products, gravity model, NAFTA, North American Free Trade Agreement, regional trade agreements, trade creation, trade diversion.

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Introduction

The rapid spread of regional trade agreements (RTAs) has become commonplace in the global trading system in recent years. As a result, regionalism has emerged as a force potentially competing with multilateralism. The resurgence of new regionalism has brought back the old controversies about the welfare effects of RTAs.[1] The theoretical literature does not provide conclusive results on the net welfare effects of RTAs. Welfare effects depend on the relative magnitudes of trade creation and trade diversion effects and it is an inherently empirical issue. Net effects of trade creation and diversion may vary across the commodities within the same RTA, between RTAs, and over time.

The recent proliferation of RTAs has revived academic interest in the desirability of these agreements in themselves and vis-à-vis multilateral free trade. A growing literature addresses the debate based on the welfare effects of RTAs and their likely impacts on the multilateral trading system (Panagariya 2000; Krueger 1999). One school of thought views RTAs as reducing global welfare and creating "stumbling blocks" to multilateral free trade (Bhagwati 1998; Panagariya 2000). The other school of thought argues that RTAs are likely to raise global welfare and can act as "building blocks" to multilateral free trade (Summers 1991; Ethier 1998). Despite a number of empirical contributions in recent years, the effects of RTAs on trade in agrifood products have not been investigated rigorously. This void motivates our investigation, which focuses on the North American Free Trade Agreement (NAFTA) and its effects on trade of agrifood products in recent history.

The growing network of RTAs and five rounds of GATT/WTO (General Agreement on Tariffs and Trade/World Trade Organization) negotiations have served to reduce dramatically existing tariffs on industrial products.[2] However, the same is not true for agrifood products, as the treatment of agriculture within RTAs and the WTO is more complex and varies widely across agreements (Aksoy 2004). Following the Uruguay

Round Agreement on Agriculture (URAA), the treatment of agricultural trade protection has been slowly moving toward the way industrial products' protection is treated.[3] Yet, agricultural products enjoy a wide variety of exceptions incompatible with free trade, such as different provisions under the special safeguards, and amber-box and blue-box provisions of the URAA. The latter complicate agricultural trade liberalization because many countries rely on trade barriers to provide domestic support. Average preferential tariffs for agricultural products are still high in various RTAs. These conditions create a trading environment for agricultural products that is different from that for industrial goods. Some agreements, such as the Closer Economic Relations (CER) Trade Agreement between Australia and New Zealand, permit free trade in agriculture. Other agreements, such as NAFTA and Mercosur (the Southern Common Market), liberalize trade in agriculture but maintain trade barriers for sensitive products such as staples, sugar, and horticultural products.[4] At the other extreme, the South Asian Preferential Trade Agreement (SAPTA) excludes agriculture.

Some empirical studies show that intraregional trade in agrifood products has grown over time (dell'Aquila, Sarker, and Meilke 1999; Vollrath 1998; Hertel, Masters, and Gehlhar 1999). Diao, Roe, and Somwaru (1999) show that, on average, agricultural trade under NAFTA, the EU-15, Mercosur, and APEC (Asia Pacific Economic Cooperation) grew more rapidly than did total world agricultural trade. In particular, the growth in intraregional agricultural trade exceeded the growth in extraregional agricultural trade of the RTAs studied. These studies employ conventional descriptive statistical methods, which are not robust in identifying the trade effects of RTAs. While an RTA is formed to increase trade among members through preferential treatments, the question is whether it comes at the expense of the rest of the world. Despite a number of theoretical and empirical contributions in recent years, the effects of RTAs on trade in agrifood products are not evident in the existing literature. Most of the studies deal with merchandise trade (Clausing 2001; Krueger 2000; Gilbert, Scollay, and Bora 2001). While the trading pattern for agrifood products differs from that of general merchandise trade, it remains an open empirical question as to what extent agrifood trade among RTA partners increased and how much of the increase can be attributed to trade diversion.

Empirical studies have employed a range of techniques to investigate the effects of RTAs. There is a large body of empirical literature that uses economywide, multisectoral computable general equilibrium (CGE) models to analyze the welfare impacts of RTAs. Robinson and Thierfelder (2002) recently reviewed these studies and generated two general conclusions: (i) RTAs increase welfare of the member countries and the rest of the world, and (ii) aggregate trade creation is much larger than trade diversion. Although the CGE models have been influential in analyzing the welfare effects, their empirical limitations have been highlighted. First, the CGE studies have been prospective rather than retrospective (Krueger 1999). Second, the sectoral aggregation does not allow analysis of specific markets (e.g., all oilseeds are bunched into one sector). Policy information is often outdated, and baseline scenarios are unrealistic and based on older data (McKitrick 1998).[5] Hence, the results of CGE studies are sometimes questionable.

A descriptive approach is also followed in the literature to analyze the impacts of RTAs (Anderson and Norheim 1993; Yeats 1998; dell'Aquila, Sarker, and Meilke 1999). These studies use various indicators to measure the regional concentration of trade. A recent study by Yeats (1998) provides empirical evidences of trade diversion in Mercosur. The descriptive approach implicitly assumes that the share of trade occurring with partner countries would not have changed in the absence of the agreement. This method depends on a static framework and the results are dependent on the level of aggregation. Consequently, changes in the terms of trade due to changes in the relative trade importance of members and outsiders, as well as declines in the volume of trade for a single commodity included in the broader class, cannot be detected (dell'Aquila, Sarker, and Meilke 1999). In addition, the descriptive approach lacks the ability to analyze trade creation and diversion effects and, hence, the welfare implications of RTAs. Econometric techniques have seldom been used to study the effects of RTAs on trade in agrifood products. In particular, empirical researchers have paid little attention to the incorporation of the effects of RTAs into the specification of econometric models or to the estimation of the model by using pre- and post-RTA agrifood data, which we include in our analysis.

To assess the effects of NAFTA on trade in agrifood products, our investigation relies on a gravity model and disaggregated data. The study analyzes the effects of NAFTA on trade in six major agrifood commodities: red meat, grains, vegetables, fruits, sugar, and oilseeds. An extended gravity model is used to determine the extent of intraregional trade bias and potential trade diversion effects for the six commodities separately. A pooled cross-sectional time-series regression was estimated using the generalized least squares method for three-year intervals for each of the selected commodities from 1985 to 2000. The results suggest that NAFTA has served to boost significantly trade among its members rather than with the rest of the world. The results also suggest that the formation of NAFTA may have reduced the degree of relative openness to trade in agrifood products with the rest of the world. The next section will present the analytical framework with model specification and data description. Then we present the estimated results with a brief discussion. Finally, we offer concluding remarks and policy implications.

Analytical Framework

When a group of countries forms an RTA, there are two possible consequences. One is that higher-cost production within the union may displace lower-cost production in countries outside the union and divert trade from more efficient producers. The other possibility is that domestic production in one member country may be displaced by lower-cost imports from another member country and may create new trade among members. Furthermore, formation of an RTA may change the relative prices of members' imports and may lead to consumption expansion in the domestic market. Hence, trade creation can be viewed as having two composite effects: a production effect and a consumption effect. Since the Vinerian contribution in the 1950s, trade creation and trade diversion effects are being investigated in a static framework. A conceptual analysis of trade creation and diversion included in the Appendix provides more details.

The simple three-country analytical framework, illustrated in the Appendix, has been used in the literature to investigate trade creation and diversion effects. This framework does not fully represent the real-world situation. Most RTAs, such as NAFTA, the European Union, and Mercosur, include more than two countries. Nevertheless, the three-country framework is a natural starting point and an important step toward understanding the economics of regional integration. For ease of exposition, other partners are aggregated into the rest of the world. However, this framework can be extended empirically to many countries, including all major exporters and importers.

The behavioral relationships of excess demand and excess supply of countries for a particular commodity can be estimated by using a partial equilibrum framework. Price linkage equations can be specified to account for the transportation costs, exchange rate differences, trade policies, and so forth for a particular country. The price linkage equation links the domestic price to the world price. The world market equilibrium can be established by equating the net import demand of all the importers and net export supply of all the exporters. Then, the estimated excess supply and excess demand elasticities can be used to evaluate trade and welfare effect of RTAs (Francois and Shiells 1994; Rensik and Truman 1973).

Though conceptually this approach seems feasible, empirically this is a daunting task. Moreover, in practice, computational and data limitations rule out such an ideal approach, thereby forcing a trade-off between theory and econometric analysis. Besides these limitations, econometric models of international trade flows have a long history of yielding estimates of price and substitution elasticities of demand for imports with low magnitude, and frequently the estimates are statistically insignificant (Prais 1962; Goldstein and Khan 1985).

As an alternative, recent econometric studies have incorporated the effects of RTAs into the model specification and estimate models using pre-RTA and post-RTA data. The impact of RTAs on trade flows is captured through the use of dummy variables. This is known as the gravity model approach, which explains bilateral trade flows between trading partners over time. The gravity model has become an attractive technique for assessing the effects of RTAs. The application of the gravity model has long been controversial because it often lacks a coherent theoretical foundation. Estimated results of empirical gravity equations suffer omitted variable bias due to the lack of a strong theoretical foundation (Anderson and Wincoop 2003). As a result, the estimates cannot validly be used to draw comparative-static inference about the impacts of barriers on trade flows. This shortcoming has been addressed recently (Baier and Bergstrand 2001; Anderson and Wincoop 2003; and Feenstra 2002).

Anderson (1979) provided the first theoretical explanation for the gravity equation based upon the properties of expenditure systems. Since Anderson's synthesis, Bergstrand (1985, 1989), Helpman and Krugman (1985), and Deardorff (1998) have also contributed to improvements of the theoretical foundation of the gravity model. In these studies, the gravity equation is derived theoretically as a reduced form from a general equilibrium model of international trade in final goods. As a result, the theoretical underpinnings of the gravity model have become more transparent, better understood, and hence widely accepted in recent years. This new legitimacy for assessing international trade flows motivates our reliance on an extended gravity model in this study to analyze the trade effects of NAFTA.

Model Specification

The gravity model of bilateral trade postulates that the volume of trade between two countries is proportional to their gross domestic products (GDP) and inversely related to trade barriers between them. Empirical research has generated a number of alternative specifications for the gravity model. In the context of international trade, the basic formulation of the gravity equation is as follows:

$$T_{ijt} = a_0 Y_{it}^{a_1} Y_{jt}^{a_2} (Y_{it} / N_{it})^{a_3} (Y_{jt} / N_{jt})^{a_4} D_{ij}^{a_5} U_{ijt} \tag{1}$$

or, using natural logarithms,

$$\ln T_{ijt} = \ln a_0 + a_1 \ln Y_{it} + a_2 \ln Y_{jt} + a_3 \ln(Y_{it} / N_{it}) + a_4 \ln(Y_{jt} / N_{jt}) + a_5 \ln D_{ij} + \ln U_{ijt} \tag{2}$$

where

T_{ijt} = total bilateral trade between country i to country j in year t;

Y_{nt} = income of country n in year t and $n = i,j$;

N_{nt} = population of country n in year t and $n = i,j$;

D_{ij} = distance between countries i and j;

U_{ijt} = log normal error term.

By introducing regional dummy variables to estimate appropriate trade effects for NAFTA into equation (2), the basic formulation of the model can be extended as follows:

$$\begin{aligned} \ln T_{ijt} &= \ln a_0 + a_1 D_{t+1} + a_2 D_{t+2} + a_3 \ln GDP_{it} + a_4 \ln GDP_{jt} + a_5 \ln GDPPC_{it} \\ &+ a_6 \ln GDPPC_{jt} + a_7 \ln DIST_{ij} + \alpha_1 NAFTA_{ij} + \alpha_2 NAFTAO_{ij} + U_{ijt} \forall i < j \\ &\text{and } i = 1, 2, 3;\ j = 1, \dots, n \end{aligned} \tag{3}$$

where

NAFTA = 1 if j is a member of NAFTA
= 0 otherwise

NAFTAO = 1 if i is a net importer from a nonmember j
= 0 otherwise

In equation (3), T_{ijt} is the current U.S. dollar value of total bilateral trade (exports plus imports) between country i and country j in year t, D_{t+1} and D_{t+2} are dummies for the second year and third year, respectively (the first year is subsumed into the intercept). GDP_{it} and GDP_{jt} are nominal gross domestic products of country i and country j in year t in U.S. dollars, respectively, $GDPPC_{it}$ and $GDPPC_{jt}$ are nominal per capita GDP of country i and country j in year t in U.S. dollars, respectively. The latter variables are obtained by dividing GDP by midyear population (N) of the respective countries. Variable $DIST_{ij}$ is the direct air distance in kilometers between the capitals of country i and country j. The remaining variables included in equation (3) are dummy variables designed to capture the influence of other factors on trade flows.

Following Frankel and Wei (1998), we define two dummy variables for each regional bloc: (i) regional bloc dummy and (ii) an openness dummy. For example, $NAFTA_{ij}$ represents the existence of regional trade agreements between country i and country j in equation (3). If the estimated coefficient of the regional bloc dummy is positive and statistically significant in a particular estimation period, it implies that the intraregional trade has been stimulated by the formation of NAFTA. The estimated coefficient indicates that how much more trade had taken place among NAFTA members as a result of the formation of NAFTA. This reflects the sum of trade creation and trade diversion for NAFTA (e.g., Aitken 1973; Endoh 1999)

The $NAFTAO_{ij}$ dummy captures the degree of openness of NAFTA members' imports from the rest of the world. This dummy variable takes the value of one if a member is a net importer from the rest of the world (the importer is a member of NAFTA while the exporter is not in NAFTA) and zero otherwise. These dummy variables reflect any trade diversion occurring in the respective NAFTA member's import structure. If the coefficients of these variables are negative and statistically significant, then it can be stated that the total trade of the member (in the market where it is a net importer) with the rest of the world is less than relative to its net exports to a nonmember. More broadly, it implies that an RTA member has reduced its net imports from the rest of the world relative to its net exports to the rest of the world (Eichengreen and Irwin 1998; Frankel 1997). By combining the effects of the two dummy variables, we are able to separate cases where NAFTA is trade creating only (that is, it caused intrabloc trade to increase above average levels without changes in openness to nonmembers' trade) from those where NAFTA's increase in intrabloc trade comes at the expense of nonmembers' exports to the bloc countries. The latter effect can be identified as trade diversion.

Because of the double-logarithmic specification of the estimated function, the parameter estimates on the GDP_i, GDP_j, $GDPPC_i$, $GDPPC_j$, and distance variable can be interpreted as elasticities. For example, in equation (3), a_3 represents the percentage change in T_{ij} induced by a 1 percent change in GDP_i holding per capita GDP constant.[6] As dummy variables cannot be expressed in log form, the parameter estimates (α_k and β_k) should be interpreted with care. The percentage effect of the dummy variable is calculated following Halvorsen and Palmquist (1980).[7] Hence, for example, assume that the coefficient estimate of the NAFTA dummy variable in equation (3) is α_1. This shows that two NAFTA members traded an extra $\{\exp(\alpha_1)-1\}*100$ percent relative to the amount they traded with a non-NAFTA country. More precisely, the mean (or average) trade between two members is higher than their mean trade with the rest of the world by $\{\exp(\alpha_1)-1\}*100$ percent. Note that the benchmark is when a member country trades with a nonmember country (one bilateral partner is in the rest of the world). Similarly, the *NAFTAO* parameters (α_2) should be interpreted with care. For example, assuming that α_2 is negative, total trade of a NAFTA member (where the NAFTA member is a net importer) with a non-NAFTA country is $\{\exp(-\alpha_2)-1\}*100$ percent less than its net exports to nonmember.[8]

In the regression equation (3), expectations of the estimated sign for the explanatory variables are as follows. First, GDP_i and GDP_j would have positive coefficients because of the direct relationship between GDP and import demand. Moreover, we presume that larger economies trade more than do smaller economies. Similarly, $GDPPC_i$ and $GDPPC_j$ would possess a positive coefficient for normal final goods, as higher per capita income would induce higher import demand. Moreover, for a given size of the economy, as countries become more developed, they tend to specialize more in production and trade. In turn, richer economies tend to trade more than poorer economies. The GDP can be thought of as capturing the importance of size of the total economy or income as a determinant of trade, and the GDP per capita can be thought of as capturing the effects of the wealth of the economy on trade (Frankel and Wei 1998, Frankel 1997; Gilbert, Scollay, and Bora 2001).

The coefficients for $DIST_{ij}$ would likely have a negative sign, given that greater distances tend to increase transportation costs and information costs.[9] One would expect the estimated coefficient on the distance variable to be diminished in magnitude over the estimation period because of the recent developments in transportation technology. Frankel (1997) measured the distance by air routes in his study whereas Bikker (1987) measured distance by sea routes. Both of these studies report the estimated effect of distance on bilateral trade as negative and diminishing in magnitude over time. They also find a small though statistically significant difference in coefficient between the two.

Data Description

We concentrate on NAFTA from 1985 to 2000.[10] We selected this period to track the evolution of the trade pattern of NAFTA and to maintain comparability of the estimated coefficients. As its signatories implemented NAFTA in 1994, a comparison between pre-NAFTA and post-NAFTA econometric estimates will generate useful information about the trade effects of NAFTA. Hence we mainly focus on the magnitude and changes in estimated coefficients over the selected period. This study uses the International Trade by Commodities Statistics (ITCS) database developed by the Organization for Economic Cooperation and Development (OECD 2002). The ITCS provides yearly statistical data on imports and exports in quantity and value (thousand U.S. dollars) by commodities and by partner countries.[11] The ITCS, in its fullest detail, presents 2,582 different products that are classified according to the Standard International Trade Classification system (SITC-Revision 3).

In the present work, agrifood commodities are classified under six different categories according to the ITCS database. They are red meat, grains, vegetables, fruits, sugar, and oilseeds. Table 1 gives a complete description of the six commodities, with respective SITC codes. In each category, the study uses annual total bilateral trade (exports plus

TABLE 1. Description of commodities

Commodity	SITC Codes and Description
Red meat	0111: Meat of bovine animals, fresh, chilled, or frozen 0112: Meat of sheep and goats, fresh, chilled, or frozen 0113: Meat of swine, fresh, chilled, or frozen
Grains	041: Wheat 042: Rice 043: Barley 044: Maize 045: Cereals (no wheat, rice, barley, or maize)
Vegetables	054: Vegetables, fresh, chilled, frozen/preserved; roots, tubers 056: Vegetables, roots and tubers, prepared/preserved, n.e.s.
Fruits	057: Fruits and nuts (not including oil nuts), fresh or dried 058: Fruit, preserved, and fruit preparations
Sugar	06: Sugar, sugar preparations
Oilseeds	222 + 223: Ground nuts, Soya beans, Cotton seeds, Sunflower seeds, Sesame seeds, Rape, Colza, Mustard seeds, Linseeds, Palm nuts, Castor oilseeds

imports) for 59 countries, so that there are 1,711 data points (59*58/2) for a given year. The sample of countries accounts for at least 75 percent of world trade in a given year during the study period. GDP and per capita GDP data in current thousand U.S. dollars are taken from the Economic Research Service of the U.S. Department of Agriculture (USDA) (2003). The distance data is from the World Distance Tables produced by Hengeveld (1996). This database gives the direct air distance in kilometers between the capitals of selected countries.

Estimated Results

A pooled time-series, cross-section regression is estimated for three-year intervals from 1985 to 2000 for each of the six agrifood commodities.[12] The pooled data set allows better estimation of the influence of NAFTA when there are limited observations in each cross-section. For example, the NAFTA bloc dummy takes the value of one for only two bilateral pairs and takes the value of zero for the remaining 57 pairs per year. Notice that having this few observations may lead to an imprecise estimate of the NAFTA bloc effect, i.e., with a large standard error. Hence, we pooled data in three-year increments during the 15-year period, from 1985 to 2000 and estimate five separate regressions for each product. We also added time dummies for two of the three years (the third is, of course, rolled into the constant) to minimize the distortion of inflation on the estimates.[13] The year-specific intercept terms absorb the effects of global inflation and growth.

This dataset exhibits heteroskedastic error, as is frequently the case with cross-sectional data, based on the Breusch-Pagan and the White tests. Hence, generalized least squares are used to account for heteroskedasticity. We obtained the transformed variables in equation (3) by weighting each observation by the inverse of the square root of predicted squared residuals. The idea is that less weight is given to observations with a higher error variance.

Tables 2 through 7 report the estimated results for the selected commodities traded by NAFTA members. First we discuss standard gravity variables before turning to the bloc effects. The adjusted R^2 ranges from 0.4 for oilseeds to 0.7 for grains. The log of the two country GDP coefficients is always highly significant at the 1 percent level. These coefficients possess the expected positive sign in all estimated equations. In most cases, they are also less than 1. The estimated coefficients of GDP_i and GDP_j vary from 0.2 to 0.9 during the study period.[14] Hence, the result indicates that there is a statistically significant positive relationship between bilateral trade and incomes of partners. But trade increases less than proportionately with a country's size when per capita GDP is constant. This shows that large countries trade more than do small ones in the six commodities. These estimates are consistent with other studies such as Frankel (1997), Frankel and Wei (1998), and Gilbert, Scollay, and Bora (2001).

The parameter estimates of per capita income of NAFTA members and nonmembers on red meat trade are positive and statistically significant during the period of the study. They are also generally more than one for members and less than one for nonmembers. Hence, red meat trade increases more than proportionately with a member country's per capita income and less than proportionately with a nonmember country's per capita income. However, for the rest of the commodities, the per capita income coefficient shows mixed sign and magnitude. Hence, a general conclusion cannot be deduced. The

TABLE 2. Gravity model regression results of NAFTA trade in red meat (1985-2000)

	85-87	88-90	91-93	95-97	98-2000
Intercept	-40.65	-37.02	-31.44	-30.79	-23.33
	(-9.67)	(-6.44)	(-8.31)	(-10.25)	(-7.75)
D_{t+1}	0.02	-0.10	0.19	-0.45	-0.07
(Year dummy 1)	(0.05)	(-0.28)	(0.55)	(-1.38)	(-0.20)
D_{t+2}	0.12	-0.22	-0.01	-0.02	0.09
(Year dummy 2)	(0.35)	(-0.63)	(-0.03)	(-0.07)	(0.28)
GDPi	0.97	0.93	1.08	0.82	0.79
(Gross domestic product of i)	(6.40)	(6.36)	(7.51)	(5.84)	(5.24)
GDPj	0.35	0.10	0.33	0.32	0.28
(Gross domestic product of j)	(3.56)	(0.97)	(2.79)	(3.23)	(2.61)
GDPPCi	1.40	1.24	1.10	1.13	0.63
(Per capita GDP of i)	(4.04)	(3.43)	(3.02)	(4.33)	(2.12)
GDPPCj	0.93	0.91	0.45	0.50	0.49
(Per capita GDP of j)	(7.92)	(6.76)	(2.98)	(4.00)	(3.36)
DIST	0.01	0.34	-0.61	-0.06	-0.21
(Distance)	(0.02)	(1.12)	(-2.09)	(-0.19)	(-0.77)
NAFTA	1.78	2.91	2.45	3.07	3.76
(Regional dummy)	(3.37)	(5.22)	(3.72)	(5.19)	(7.65)
NAFTAO	1.91	1.92	2.10	0.60	0.56
(Openness dummy)	(6.12)	(6.14)	(6.46)	(2.00)	(1.50)
Adjusted R^2	0.55	0.49	0.44	0.48	0.36
Observations	243	229	309	343	357

Note: t-statistics are in parentheses. All variables except dummy variables are in logs. The dependant variable is total trade between country pairs.

TABLE 3. Gravity model regression results of NAFTA trade in grains (1985-2000)

	85-87	**88-90**	**91-93**	**95-97**	**98-2000**
Intercept	-22.39	-21.73	-26.08	-16.69	-12.98
	(-5.430)	(-6.85)	(-13.86)	(-10.21)	(-8.14)
D_{t+1}	-0.09	-0.04	0.24	-0.04	-0.17
(Year dummy 1)	(-0.26)	(-0.15)	(1.00)	(-0.17)	(-0.80)
D_{t+2}	-0.08	-0.13	0.04	-0.03	-0.31
(Year dummy 2)	(-0.25)	(-0.57)	(0.16)	(-0.12)	(-1.50)
GDPi	0.82	0.78	0.62	0.58	0.44
(Gross domestic product of i)	(5.83)	(7.75)	(7.63)	(6.93)	(5.42)
GDPj	0.76	0.74	0.79	0.83	0.92
(Gross domestic product of j)	(7.83)	(9.29)	11.58	11.11	11.89
GDPPCi	1.34	1.30	2.12	1.41	1.44
(Per capita GDP of i)	(3.18)	(4.46)	(9.03)	(7.91)	(8.01)
GDPPCj	-0.42	-0.53	-0.47	-0.47	-0.48
(Per capita GDP of j)	(-3.77)	(-5.60)	(-5.94)	(-4.33)	(-5.55)
DIST	-0.94	-0.74	-1.01	-1.23	-1.52
(Distance)	(-3.80)	(-3.70)	(-4.89)	(-7.28)	(-10.50)
NAFTA	-0.30	-0.10	0.51	0.61	0.34
(Regional dummy)	(-0.54)	(-0.14)	(1.43)	(1.95)	(1.28)
NAFTAO	-0.72	-0.87	-0.49	-1.18	-1.11
(Openness dummy)	(-1.84)	(-2.74)	(-1.58)	(-3.85)	(-4.95)
Adjusted R^2	0.53	0.66	0.62	0.61	0.61
Observations	234	238	405	421	437

Note: t-statistics are in parentheses. All variables except dummy variables are in logs. The dependant variable is total trade between country pairs.

TABLE 4. Gravity model regression results of NAFTA trade in vegetables (1985-2000)

	85-87	88-90	91-93	95-97	98-2000
Intercept	-15.44	-15.81	-23.57	-8.54	-8.10
	(-5.91)	(-4.62)	(-11.28)	(-5.41)	(-4.63)
D_{t+1}	-0.11	-0.05	-0.04	-0.25	0.01
(Year dummy 1)	(-0.49)	(-0.22)	(-0.160	(-1.30)	(0.06)
D_{t+2}	-0.20	-0.18	-0.23	-0.37	-0.29
(Year dummy 2)	(-0.79)	(-0.66)	(-0.99)	(-1.95)	(-1.69)
GDPi	0.60	0.81	0.61	0.26	0.19
(Gross domestic product of i)	(6.42)	(8.34)	(6.52)	(3.28)	(2.45)
GDPj	0.86	0.84	0.85	0.83	0.85
(Gross domestic product of j)	(12.98)	(12.24)	(14.67)	(16.32)	(17.49)
GDPPCi	1.04	0.61	1.63	1.37	1.32
(Per capita GDP of i)	(4.07)	(2.18)	(8.05)	(9.43)	(9.28)
GDPPCj	-0.07	-0.17	-0.18	-0.21	-0.38
(Per capita GDP of j)	(-0.80)	(-1.78)	(-1.97)	(-2.76)	(-6.08)
DIST	-1.59	-1.49	-1.27	-1.73	-1.42
(Distance)	(-8.17)	(-6.53)	(-6.56)	(-11.92)	(-10.52)
NAFTA	0.10	0.61	1.22	0.85	1.26
(Regional dummy)	(0.31)	(1.58)	(3.68)	(2.80)	(4.10)
NAFTAO	0.78	0.87	0.39	0.35	0.23
(Openness dummy)	(4.39)	(4.21)	(1.85)	(2.09)	(1.40)
Adjusted R^2	0.63	0.57	0.57	0.62	0.6
Observations	240	237	399	438	446

Note: t-statistics are in parentheses. All variables except dummy variables are in logs. The dependant variable is total trade between country pairs.

TABLE 5. Gravity model regression results of NAFTA trade in fruits (1985-2000)

	85-87	88-90	91-93	95-97	98-2000
Intercept	-26.35	-30.06	-35.82	-20.11	-18.30
	(-8.74)	(-9.31)	(-17.27)	(-11.45)	(-10.19)
D_{t+1}	0.08	-0.12	0.00	-0.11	-0.15
(Year dummy 1)	(0.32)	(-0.44)	(0.02)	(-0.45)	(-0.62)
D_{t+2}	0.01	-0.06	-0.17	-0.07	-0.06
(Year dummy 2)	(0.02)	(-0.20)	(-0.71)	(-0.33)	(-0.24)
GDPi	0.91	1.15	1.04	1.12	1.06
(Gross domestic product of i)	(7.27)	(9.60)	(10.22)	(10.51)	(9.11)
GDPj	0.59	0.66	0.75	0.69	0.90
(Gross domestic product of j)	(6.08)	(6.83)	(11.52)	(11.17)	(14.45)
GDPPCi	0.92	0.55	1.42	0.41	0.48
(Per capita GDP of i)	(3.93)	(2.54)	(6.53)	(1.99)	(2.17)
GDPPCj	0.15	0.13	-0.01	0.09	-0.07
(Per capita GDP of j)	(1.33)	(1.09)	(-0.14)	(0.94)	(-0.82)
DIST	-0.58	-0.50	-0.65	-1.45	-1.90
(Distance)	(-2.37)	(-2.14)	(-3.50)	(-8.36)	(-10.33)
NAFTA	0.64	1.06	0.82	0.39	-0.20
(Regional dummy)	(1.64)	(2.93)	(2.30)	(1.26)	(-0.58)
NAFTAO	1.18	1.52	1.84	1.34	1.16
(Openness dummy)	(3.89)	(4.64)	(7.26)	(5.66)	(4.71)
Adjusted R^2	0.56	0.57	0.62	0.56	0.54
Observations	235	240	394	419	435

Note: t statistics are in parentheses. All variables except dummy variables are in logs. The dependant variable is total trade between country pairs.

TABLE 6. Gravity model regression results of NAFTA trade in sugar (1985-2000)

	85-87	88-90	91-93	95-97	98-2000
Intercept	-7.53	-7.66	-14.65	-7.25	-5.42
	(-2.35)	(-1.96)	(-6.55)	(-3.78)	(-2.56)
D_{t+1}	0.01	-0.04	-0.31	0.32	-0.42
(Year dummy 1)	(0.03)	(-0.13)	(-1.07)	(1.30)	(-1.60)
D_{t+2}	-0.13	-0.05	-0.30	0.34	-0.39
(Year dummy 2)	(-0.45)	(-0.13)	(-1.06)	(1.45)	(-1.57)
GDPi	1.03	0.99	1.39	1.13	1.04
(Gross domestic product of i)	(8.30)	(7.03)	(11.51)	(10.38)	(9.40)
GDPj	0.52	0.51	0.69	0.66	0.63
(Gross domestic product of j)	(6.46)	(5.54)	(7.97)	(9.23)	(9.12)
GDPPCi	-0.38	-0.44	-0.18	-0.65	-0.58
(Per capita GDP of i)	(-1.33)	(-1.33)	(-0.76)	(-3.49)	(-2.76)
GDPPCj	0.07	0.11	-0.14	-0.19	-0.17
(Per capita GDP of j)	(0.51)	(0.81)	(-1.30)	(-1.86)	(-1.70)
DIST	-1.51	-1.40	-2.00	-1.59	-1.57
(Distance)	(-5.24)	(-4.13)	(-9.01)	(-8.74)	(-9.27)
NAFTA	-1.47	-0.56	-0.45	0.16	0.51
(Regional dummy)	(-2.26)	(-0.87)	(-1.00)	(0.59)	(1.79)
NAFTAO	1.32	1.11	0.60	0.83	0.74
(Openness dummy)	(4.34)	(2.82)	(2.12)	(2.90)	(2.79)
Adjusted R^2	0.48	0.34	0.48	0.49	0.4
Observations	227	232	377	449	436

Note: t-statistics are in parentheses. All variables except dummy variables are in logs. The dependant variable is total trade between country pairs.

TABLE 7. Gravity model regression results of NAFTA trade in oilseeds (1985-2000)

	85-87	88-90	91-93	95-97	98-2000
Intercept	-24.54 (-6.09)	-30.93 (-7.58)	-27.91 (-7.59)	-32.47 (-12.09)	-5.42 (-2.56)
D_{t+1} (Year dummy 1)	-0.04 (-0.10)	-0.38 (-1.15)	0.30 (1.09)	-0.15 (-0.52)	-0.42 (-1.60)
D_{t+2} (Year dummy 2)	-0.08 (-0.21)	-0.60 (-1.71)	0.20 (0.67)	0.02 (0.06)	-0.39 (-1.57)
GDPi (Gross domestic product of i)	1.14 (6.53)	1.29 (8.67)	1.24 (10.15)	0.89 (7.95)	1.04 (9.40)
GDPj (Gross domestic product of j)	0.94 (8.22)	0.86 (8.62)	0.94 (11.35)	1.15 (13.97)	0.63 (9.12)
GDPPCi (Per capita GDP of i)	0.34 (0.96)	0.23 (0.88)	-0.01 (-0.05)	0.86 (3.92)	-0.58 (-2.76)
GDPPCj (Per capita GDP of j)	0.10 (0.59)	0.08 (0.57)	0.05 (0.44)	-0.13 (-1.27)	-0.17 (-1.7)
DIST (Distance)	-1.45 (-4.75)	-0.85 (-2.63)	-1.03 (-4.00)	-0.86 (-3.38)	-1.57 (-9.27)
NAFTA (Regional dummy)	0.52 (0.48)	1.27 (1.41)	1.06 (1.72)	1.70 (2.69)	0.51 (1.79)
NAFTAO (Openness dummy)	-0.67 (-1.33)	-0.08 (-0.18)	0.87 (2.78)	0.45 (1.64)	0.74 (2.79)
Adjusted R^2	0.46	0.5	0.49	0.57	0.4
Observations	220	243	329	350	436

Note: t-statistics are in parentheses. All variables except dummy variables are in logs. The dependant variable is total trade between country pairs.

estimated coefficients for $GDPPC_i$ and $GDPPC_j$ can take either a positive or a negative sign. Commodities are revealed to be normal goods in consumption when the response of imports to per capita GDP is estimated to be positive and vice versa for inferior commodities.

Bilateral distance has a large effect on NAFTA trade. As expected, the parameter estimates of the distance variable are negative and statistically significant at the 1 percent level in NAFTA during the study period irrespective of the products. The negative sign on the distance parameter indicates that trade diminishes as distance increases. Note, however, that the elasticity estimates vary considerably across commodities and for the same commodity over time.

We use the log of air distance between the two major cities of the respective countries as the proximity measure.[15] The cities are usually the capitals of the two countries. But we substitute the capital for a major city in a few cases, as the major city seems to be the country's economic center.[16] For example, we use Shanghai for China rather than Beijing. We presume, as have many other studies on gravity, that the direct air distance is a reasonable proxy for transportation cost. However, it should be noted that transportation cost will not always increase monotonically with distance because transaction costs associated with many operations, such as loading, storage, and local distribution, are large compared with the small marginal cost per kilometer of distance traveled (Frankel 1997).

Our estimates for the effect of distance on bilateral trade in agrifood products confirm findings by Bikker (1987) and Boisso and Ferrantino (1994), who concentrated on total aggregated trade rather than on disaggregated products. Indeed, our distance coefficients seem to take a wider range for the six commodities. In general, we expect a higher distance effect for agricultural products than for manufactures, as agricultural products are relatively bulkier and perishable. Frankel, Stein, and Wei (1994) show that the negative effect of distance is more evident for agriculture than for manufactured products.[17] One might expect the distance effect to decline over time, as the average cost of transportation per kilometer has undoubtedly declined as a consequence of improved technology. But, there is no observable trend in the distance coefficient of NAFTA across the commodities during the entire sample period.

NAFTA Bloc Effect

Empirical results reported in Tables 2 through 7 suggest that there is a significant positive NAFTA bloc effect on vegetables and red meat trade during the study period. The calculated percentage change and dollar value equivalents of the estimated bloc and openness coefficients of NAFTA for the selected commodities are reported in Table 8.[18] In vegetable trade, the estimated coefficient of NAFTA is 0.1 (statistically insignificant) during 1985-87, rising to 1.26 (statistically significant) during 1998-2000. Beginning in 1991-93, it becomes more than one and statistically significant. This suggests that after

TABLE 8. Calculated percentage change and U.S. dollar (thousand) equivalents in the respective estimated bloc and openness coefficients of NAFTA (1985-2000)

Product	Variable	85-87	88-90	91-93	95-97	98-2000
Red meat	NAFTA	493*	1736***	1059**	2054***	4195***
		(185618)	(907532)	(696563)	(1431274)	(3293411)
	NAFTAO	575***	582***	717***	82**	75
		(216491)	(304253)	(471610)	(55745)	(58881)
Vegetables	NAFTA	11	84	239**	134**	253**
		(2174)	(24201)	(73179)	(52870)	(120968)
	NAFTAO	118**	139**	48*	42**	26
		(23329)	(40047)	(14697)	(16571)	(12431)
Grains	NAFTA	-26	-10	67	84*	40
		(16979)	(9607)	(53218)	(97738)	(36990)
	NAFTAO	-51*	-58**	-39	-69**	-67***
		(33305)	(55721)	(30978)	(80285)	(61959)
Sugar	NAFTA	-77**	-43	-36	17	67*
		(9521)	(6433)	(5266)	(3210)	(11662)
	NAFTAO	274**	203**	82**	129**	110**
		(33882)	(30370)	(11996)	(24365)	(19146)
Fruits	NAFTA	90	189**	127**	48	-18
		(43685)	(119160)	(79984)	(33076)	(13370)
	NAFTAO	225**	357**	530***	282***	219**
		(109213)	(225080)	(333791)	(194324)	(162679)
Oilseeds	NAFTA	68	256	189	447**	67*
		(25324)	(98618)	(74260)	(261261)	(33034)
	NAFTAO	-49	-8	139**	57	110**
		(18248)	(3081)	(54615)	(33315)	(54235)

Note: The estimated coefficients are reported in Tables 2 through 7 and corresponding percentage effects are shown here. The percentage effect is calculated by subtracting one from the exponent of the regression coefficient and then multiplying the result by 100. Generated thousand U.S. dollar equivalents are in parentheses.
*** denotes significant at the 1% level based on the estimated coefficients;
** denotes significant at the 5% level based on the estimated coefficients;
* denotes significant at the 10% level based on the estimated coefficients.

the NAFTA agreement, the regional trade bias for vegetables has increased. The estimates suggest that during the 1985-87 period, two members of NAFTA traded vegetables 11 percent (=exp(0.10)-1) more on average than they traded with the rest of the world. This increased substantially to 253 percent (exp(1.26)-1=2.53) during the 1998-2000 period. During the 15-year period, intra-NAFTA vegetable trade increased from U.S.$2 million to U.S.$120 million. This possibly reflects the effects of Mexican entry into

NAFTA in 1994. Mexico is a net exporter of vegetables and enjoys preferential access to larger Canadian and U.S. markets.

In red meat trade, the coefficient of NAFTA is positive and statistically significant during the entire period of this study. Interestingly, the red meat dummy has the most significant coefficients with larger magnitudes. The estimated coefficient is 1.78 during 1985-87 and is increasing up to 3.76 in 1998-2000. Red meat trade between NAFTA members ranges from 4 times to a staggering 42 times higher than it would otherwise be with the rest of the world. In terms of dollars, red meat trade among NAFTA members increased from U.S.$185 million to U.S.$3.3 billion during the study period. The bias is clearly significant even prior to the implementation of NAFTA in 1994.

In the case of grains, the estimated coefficient is -0.3 and statistically insignificant during the 1985-87 period (Table 3). It becomes 0.34 (but statistically insignificant) during the 1998-2000 period. However, only during the 1995-1997 period is it statistically significant, at 0.61. As indicated in Table 8, two NAFTA members traded 26 percent less than they traded with the rest of the world during 1985-87. But during 1998-2000, they traded with each other 40 percent (U.S.$36 million) more than they traded with the rest of the world. Hence, there is a clear upward trend in the bloc effect, even in trading grains. The coefficient for sugar trade increases from –1.47 (statistically significant) during 1985-87 to 0.51 (statistically significant) during 1998-2000. It turns out that two members of NAFTA traded sugar 77 percent less than they traded with the rest of the world during 1985-87 (U.S.$9.5 million), but they traded 67 percent (U.S.$11 million) more sugar relative to what they traded with the rest of the world during 1998-2000. Though not all coefficients are statistically significant, there is weak evidence of an intraregional trade bias for the grains and sugar in NAFTA.

In the case of oilseed trade, although estimates are positive and quite large, ranging from 0.57 to 1.7, except for the 1995-97 period, none is statistically significant. There is no clear trend in the estimated coefficients on oilseeds during the study period. In the case of trade in fruits, the NAFTA bloc effect is significant only during the 1988-90 and 1991-93 periods. Since the formation of NAFTA, this coefficient declines and even becomes negative during 1998-2000. Therefore, we cannot identify a strong bloc effect on oilseed and fruit trade.

We have seen that the relative magnitudes and trends of the estimated bloc effects are different for different commodities. Looking at explicit product categories, evidence of a significant regional trade bias is not found for oilseeds and fruits. However, in red meat and vegetable trade, a significant positive bloc effect is found during the sample period. The bias is strongest in red meat trade. We also find a positive bloc effect for grains and sugar. Thus, there is evidence to support that NAFTA has been successful in promoting trade in red meat, vegetables, sugar, and grains among its members. Can this success be attributed partially to trade diversion effects of NAFTA? We turn to this question in the following section.

Trade-Diverting Effects of NAFTA

Observing the level of changes in the degree of NAFTAO, the openness dummy, can give insights into the presence of trade diversion effects. This will tell us whether there are reductions in the level of imports by NAFTA members from nonmembers relative to the level of exports by NAFTA members to nonmembers over time. We are interested in both the level of the openness coefficient and its changes over time (i.e., during the pre- and post-NAFTA periods). The relevant results are reported in Tables 2 through 7. Table 8 presents calculated percentage changes and their dollar equivalents.

The estimated coefficients of red meat, vegetables, fruits, and sugar are positive and statistically significant but diminishing over time. The coefficients for red meat and vegetables become statistically insignificant, however, during the 1998-2000 period. There is a significant change in the openness coefficient for red meat, vegetables, fruits, and sugar after 1994 (post-NAFTA period). This reflects the effects of discriminatory preferential trade policies adopted by the NAFTA members after 1994.

The openness coefficient for red meat declines from 1.91 during 1985-87 to 0.56 during 1998-2000. Note that it increased from 1.91 in 1985-87 to 2.1 in 1990-93. After 1994, it declined to 0.6 and continues to drop even further. During 1985-87, net red meat imports of a country that later became a NAFTA member from the rest of the world was about six times (=exp (1.91)-1 =5.75) more relative to its net exports to a nonmember. However, during 1998-2000, net imports of a NAFTA partner from the rest of the world declined to only 0.75 times more (= exp(0.56) –1) relative to its net exports to a nonmember. In monetary terms, the NAFTA imports of red meat from the rest of the world relative to its exports of the same commodity have decreased from U.S.$225 million during 1985-87 to U.S.$58 million during 1998-2000.

In the case of vegetable trade, a similar pattern can be observed. The estimated openness coefficient declines from 0.78 during 1985-87 to 0.23 during 1998-2000. Once again, the magnitude of the estimated coefficient declines significantly after 1994. More precisely, total vegetable imports of a NAFTA member from the rest of the world (where the NAFTA member is a net importer) declined from U.S.$23 million to U.S.$12 million.

The openness coefficient for sugar fell from 1.32 during 1985-87 to 0.74 during the 1998-2000 period. The openness coefficient for fruits increased from 1.18 in 1985-87 to 1.84 in 1990-93, and then declined to 1.16 in 1998-2000. This indicates that, since the formation of NAFTA, members are importing relatively less fruits from nonmembers. Hence, the economies of NAFTA are becoming relatively less open to trade in red meat, vegetables, fruits, and sugar with the rest of the world over time. In particular, there is a significant reduction in trade (where a member is a net importer) after the 1994 period of the study.

In the case of trade in grains, the estimated openness coefficients are negative and statistically significant but increasing in absolute value after formation of NAFTA. The results show that NAFTA members imported 39 percent (or U.S.$ 30 million) less grains from the rest of the world during the 1991-93 period, and this declined even further to 67 percent (or U.S.$61 million) during 1998-2000. There is clear evidence of trade diversion in grains under NAFTA. This result reflects the fact that Mexico is the only NAFTA member importing a significant amount of grains. The other two members are net exporters of grains. Since 1994, Mexico is importing more grains from the United States and Canada than from other countries. The latter countries are competitive exporters while Mexican grain markets have been protected, especially coarse grains. Hence, the availability of cheaper imports from Canada and the United States does not constitute diversion in the Vinerian sense of importing from a less competitive source. The estimated openness coefficients for oilseed trade are negative but statistically insignificant during the first two periods. However, they become increasingly open since the formation of NAFTA in 1994.

Though the estimated coefficients of red meat, vegetables, sugar, and fruits are positive, they show a clear downward trend during the study period. The declining trend is very pronounced after formation of NAFTA in 1994. The results show that NAFTA members are becoming less open to trade in red meat, vegetables, sugar, grains (with the caveat) and fruits with the rest of the world. Only in case of oilseed trade does empirical evidence suggest that NAFTA members are becoming more open to trade with the rest of the world relative to NAFTA members.

Frankel (1997) applied the gravity model to total bilateral trade of NAFTA. Similarly, Gilbert, Scollay, and Bora (2001) and Krueger (2000) estimated the gravity model for nonfuel trade of NAFTA. These studies show that, in general, NAFTA tends to increase its openness to nonmembers' trade while increasing trade among its member countries. While the commodities considered in this study are different from those in previous studies, the results suggest that for five of the six commodities, NAFTA may have contributed to declining openness to trade with nonmembers relative to trade with members.

Concluding Remarks

We analyzed the effects of NAFTA on trade in six agrifood commodities for the period 1985-2000. The results suggest that there has been a significant increase in red meat, vegetables, grains, and sugar trade among the NAFTA members during the study period. A greater intraregional trade bias was found for red meat and vegetables than for the other commodities. NAFTA countries traded more with each other than they traded with a nonmember (either because the reduction of intra-NAFTA tariffs has created new trade or because trade has been diverted from the rest of the world to intra-NAFTA channels). While this study does not provide the precise magnitude of these effects, it provides insights into the presence of trade creation and trade diversion effects.

While red meat, vegetable, grain, and sugar trade have been reorienting significantly among members after the NAFTA agreement in 1994, the members seem to have reduced their imports from the rest of the world. The estimated coefficient of the openness dummy indicates that there is a decrease in red meat, vegetable, grain, sugar, and fruit imports by NAFTA members from the rest of the world since the formation of this regional agreement. This indicates that NAFTA preferential trade policies promote trade among members vigorously, while displacing trade with nonmember countries. Interestingly, NAFTA members seem to have traded more oilseeds with the rest of the world than with other members.

We investigated the extent to which NAFTA's preferential policies are influencing bilateral trade patterns for the six agrifood commodities, holding other economic determinants constant. The results suggest that intraregional trade of NAFTA was greater during the study period than what natural determinants can explain, i.e., the proximity of a pair of countries, their size, and the per capita GDP. The share of intraregional trade is growing within NAFTA. This does not necessarily mean that the members of NAFTA are undertaking explicit discriminatory trade policy measures against the rest of the world. This could be due to natural factors, e.g., rapid growth in per capita GDPs. However, the empirical results suggest that this has not been the case for NAFTA.

The major findings of the study are that NAFTA has reduced the degree of relative openness to trade in agrifood products with the rest of the world. NAFTA has served to boost trade significantly among its members rather than with the rest of the world. While this study does not generate specific information regarding the extent of trade creation and trade diversion for the six commodities attributable to NAFTA, the results do suggest the presence of significant trade creation and diversion effects. The empirical findings of this study can be considered as an intermediate step for addressing the relative trade creation and diversion effects. The results are informative and useful in identifying trade creation and trade diversion effects of NAFTA on the major agrifood products. Also, the study signifies the importance of analyzing the effects of RTAs for major commodities. The results based on aggregate data may not be revealing because the trade effects of an RTA may vary across agrifood commodities. This study is also helpful in identifying the existence of commodity-specific differences in agrifood trade patterns under NAFTA.

Although the research does provide valuable information for the agrifood sector, it does possess a number of limitations. We have not incorporated bilateral trade among nonmembers in our analysis because comprehensive bilateral trade data for all nonmembers were not available for the selected commodities. Therefore, our base in the analysis is the average trade between a member in the RTA and a nonmember. An ideal base would have been the average trade between two nonmembers. The dependent variable in our specification is total bilateral trade. We believe, as do many other analysts, that total trade ought not to be used as the dependent variable, as it imposes equality coefficients for imports and exports. Therefore, future research should estimate separate equations for exports and imports. Further, we pooled data for the member countries and then fit the same equation for all countries in the sample. This imposes identical coefficients across countries, and that may induce misspecification. As maintained by Egger (2002), traditionally estimated, time-averaged, cross-sectional gravity models have the potential to be misspecified because they ignore the presence of exporter and importer effects without testing for their relevance. Egger (2002) also argues against relying on a cross-sectional framework on the grounds that estimated coefficients are a composite of within and between effects. Rather, a panel framework is the most appropriate methodology for disentangling time-invariant and country-specific effects. Future research using panel analysis will certainly enrich our understanding of the impacts of RTAs on agrifood trade.

Endnotes

1. There were widespread RTA initiatives in the 1960s. That period has been called the First Regionalism, and more recent attempts to form RTAs have been categorized as the Second Regionalism (Bhagwati 1991).

2. A recent study (2002) by the WTO Secretariat (WT/REG/W/46) shows that existing tariffs on industrial products have been eliminated in most cases. Note, however, that the most-favored nation (MFN) tariffs on such products were already at low levels, especially in industrialized countries.

3. The Marrakesh Accord, creating the WTO and including the Agreement on Agriculture, was signed in 1994. The Agreement on Agriculture was a significant departure from the way agriculture had traditionally been treated in the international trading system. New rules and commitments were established in the areas of market access; export competition, and domestic support (OECD 1997).

4. Under NAFTA, all nontariff barriers to agricultural trade, except sanitary and phytosanitary (SPS) measures, between the United States and Mexico were eliminated. In addition, many tariffs were eliminated immediately, while others were phased out over periods of 5 to 15 years. All agricultural provisions will be implemented by the year 2008. For import-sensitive industries, long transition periods and special safeguards are allowed under NAFTA. The agricultural provisions of the U.S.-Canada Free Trade Agreement were incorporated into NAFTA. Under these provisions, all tariffs affecting agricultural trade between the United States and Canada were removed by January 1, 1998. However, there were a few exceptions for items covered by tariff-rate quotas. Mexico and Canada reached a separate bilateral NAFTA agreement on market access for agricultural products. The Mexican-Canadian agreement eliminated most tariffs either immediately or over 5, 10, or 15 years. Tariffs between the two countries affecting trade in dairy, poultry, eggs, and sugar are maintained. NAFTA allows parties to maintain special safeguards in the form of tariff rate quotas on many horticultural goods (Meilke and van Duren 1996).

5. In the model calibration phase, some parameters are determined based on surveys of empirical literature, some are chosen arbitrarily, and the remaining parameters are set at values that force the model to replicate the data of a chosen benchmark year (Shoven and Whalley 1992). This approach has also been criticized by Diewert and Wales (1988). These arbitrary measures undermine the ability of the model to represent the technology and tastes of the economy under study. Users of the simulation results have no way to assess the evidence supporting the choice of most parameters values (McKitrick 1998).

6. This should be interpreted with care. Note that, in equation (3), the exact income elasticity of trade is a_3+a_5. This implies that a percentage change in T_{ij} is induced by a 1 percent change in GDP holding the population constant.

7. If the estimated coefficient is α_1, we can calculate the relative change of expected value of total trade (T) for a change of dummy variable from zero to one with the following: $(T_1 - T_0)/T_0 = e^{\alpha_1} - 1$.

8. More broadly, we can state that net imports of a NAFTA member from the rest of the world is {exp(-α_3)-1}*100 percent less relative to its net exports with a non-member.

9. One can argue that climate differences in geographical regions would lead countries to specialize in different crop production and hence bilateral trade in some agrifood products does not depend on distance. However, this is one extreme case.

10. NAFTA members are Canada, the United States, and Mexico.

11. As the ITCS database does not provide figures for the bilateral trade of Mexico prior to 1990, we got relevant 1985-90 data for Mexico from the United Nations (2004) Comtrade database (http://unstats.un.org/unsd/comtrade/).

12. A pooled regression is commonplace in the gravity modeling literature. Such regressions are often estimated in cases where there are too few cross-sectional observations and a fairly good number of time-series observations. The three-year pooling follows Gilbert, Scollay, and Bora (2001) and Nilsson (2000). We implicitly assume that the regression parameters do not change over time (temporal stability) and that they do not differ between various cross-sectional units (cross-sectional stability).

13. This makes our model similar to Matyas' (1997) fixed-effects model, although he also included time-invariant fixed effects for each individual country.

14. However, there are deviations. Some coefficients of GDPi on sugar, oilseeds, and fruits show a value greater than 1.

15. Most of the gravity work uses the great-circle distance between the two latitude-longitude combinations. Similar straight-line measures are used by Linnemann (1966) and recently by Frankel (1997) and many others. Frankel distinguishes between land and sea distances and reports that it made little difference for the results. There are a variety of ways to measure transport cost than simply using the distance. Geraci and Prewo (1977) use the CIF to FOB ratio while acknowledging serious measurement errors.

16. We follow the procedure used by Frankel (1997) and many others in the literature.

17. We have not included controlling explanatory variables common border (adjacency) and cultural similarities (linguistic links) in the empirical specification. The studies

controlling adjacency such as Frankel (1997), and Gilbert, Scollay, and Bora (2001) show low coefficients on the log of distance.

18. We generate dollar-value equivalents of the estimated coefficients of NAFTA and NAFTAO by simply multiplying the mean value of the total trade by the percentage change.

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Appendix

Conceptual Analysis of Trade Creation and Trade Diversion

The analysis of the welfare effects of RTAs originated with Viner (1950). Two possibilities arise when a group of countries forms a union with a common tariff barrier against outside countries. One is that higher-cost production within the union may displace lower-cost production in countries outside the union. In effect, world output is reduced and some countries outside the union are made worse off. This occurs in the case of goods for which the union tariff is greater than the unit money-cost differences between the union and non-union sources. Second, lower-cost imports from one member may displace domestic production in another member country. In this case, world output increases, and the union members benefit without any loss to outside countries. Since both displacement and diversion can occur simultaneously when many goods are traded, one must examine each case in the union individually to determine the predominant effect on members and on world output (Viner 1950). Moreover, lower internal prices due to preferential policy induce an expansion in domestic consumption.

DeRosa (1998) extends the basic Viner model to a more general case with downward-sloping demand and upward-sloping supply functions in country *A*. The model considers two goods—good *X* and good *Y*—and three countries—*A*, *B*, and *C*. In Figure A.1, country *C* is assumed to be the most efficient producer of good *X*. Good *X* is imported by *A* after levying a specific tariff t_A on imports. Similarly, in Figure A.2, country *A* is assumed to be the most efficient producer of good *Y*. Country *B* imports good *Y* after levying a specific tariff t_B on imports. When a customs union is formed between A and B, country A eliminates tariff t_A on imports of good *X* from country *B*. This totally displaces exports of good *X* from country *C* to country *A* and now the entire import of *X* into *A* is supplied by country *B*. Table A.1 provides a summary of the welfare effects of hypothetical customs union considered in Figure A.1. The diplacement of exports from efficient producers in country C by exports from less-efficient producers in

B is considered a trade diversion. In Figure A.1, trade diversion resulting from the formation of a customs union is equal to the area *k.* For ease of exposition, the analysis here is conducted in terms of values rather than trade volumes. Trade creation corresponds to the expansion of country *A*'s imports of good *X*, represented by the area (e+j+g+l). Trade is created through a production effect (e+j) and a consumption effect (g+i). In Figure A.2, the hypothesized customs union has different effects on country *B*. Because country *A* is the least-cost supplier of good *Y*, elimination of country *B*'s tariff on imports of good *Y* from *A* results solely in trade creation. The expansion of exports of good *Y* from country *A* to country *B* leads to displaced production and an increase in consumption in country *B*. Country C neither gains nor loses from trade. Table A.1 provides a summary of the effects on trade and welfare of the customs union considered in Figure A.2.

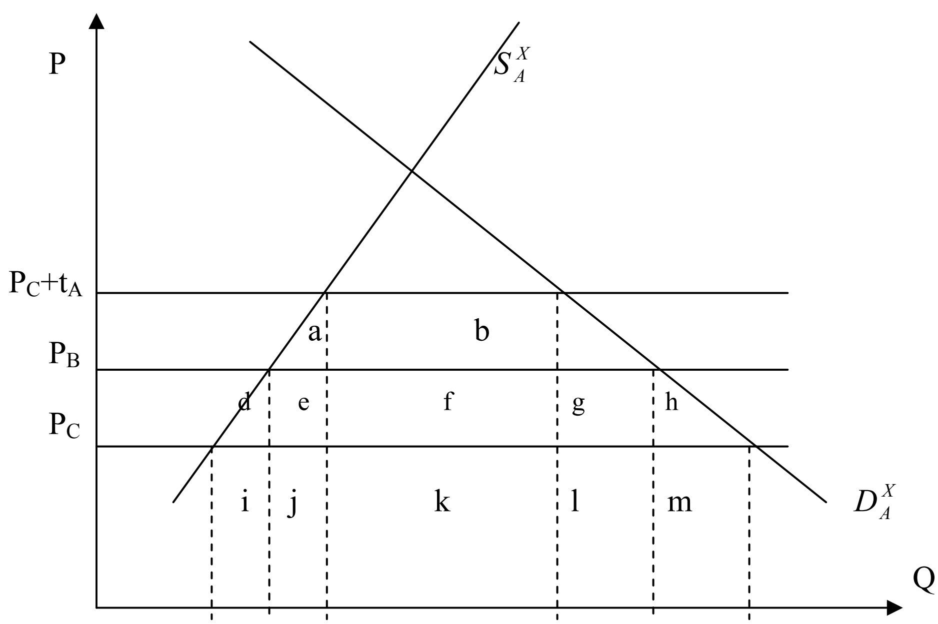

FIGURE A.1. Country A (least-efficient producer of good x)

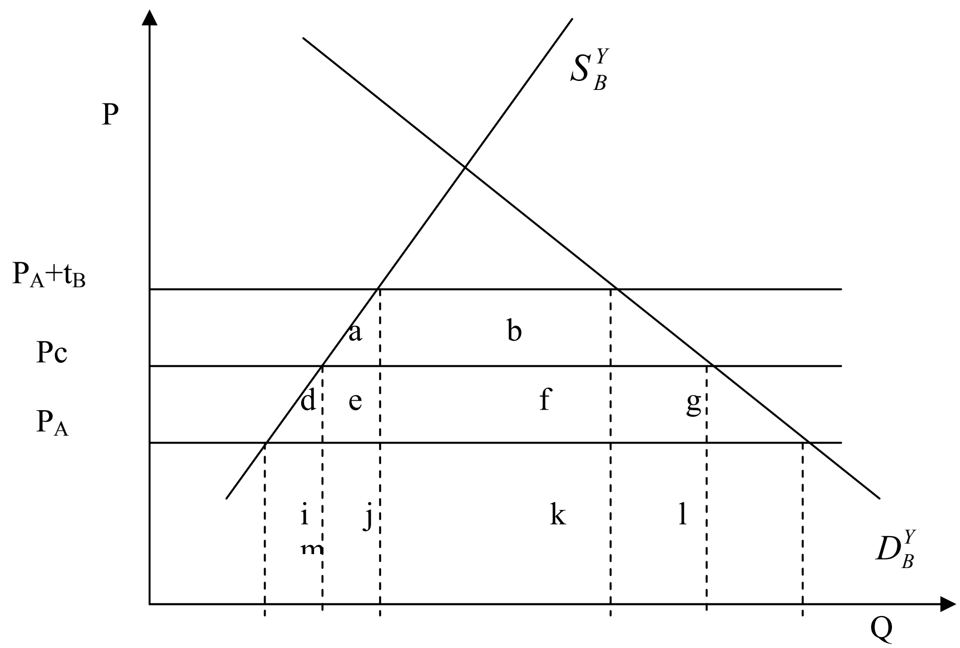

FIGURE A.2. Country B (least-efficient producer of good y)

As emphasized by Viner the trade effects illustrated in Table A.1 are not always unambiguous in sign. The customs union results in net trade creation for country *B* with respect to its imports of good *Y*. Nevertheless the union does not necessarily lead to net trade creation for country *A* with respect to its imports of good *X*. In general, the formation of a customs union results in ambigous net trade effects with respect to trade in both goods. These results are reflected in the changes in economic welfare for two countries. The economic welfare improves unambiguously for country *B* due to the dominance of consumption and production effects. The changes in economic welfare is uncertain for country *A* as the combined production and consumption effects (area *a*+*b*+*c* in Figure A.1) might not be sufficiently large enough to compensate the forgone tariff revenue of country *A* (area *b*+*f*). In turn, the changes in economic welfare is ambiguous for the customs union.

These trade and welfare results depend on the assumption illustrated in Figure A.1 and Figure A.2 regarding the relative efficiency of suppliers in *A*, *B*, and *C*. For country

B, the customs union gives rise to entire trade creation and greater welfare effects as country *A* is assumed to be the least-cost supplier of good *Y*. For country *A*, the welfare effects are uncertain as country *B* is assumed to be less efficient than country *C* in supplying good *X*. Generally, in a customs union under constant cost conditions, the welfare gain in the home country (*A*) due to trade creation will be partially, if not fully or more than fully, offset by added cost of imports from inefficient partner country (*B*) and forgone tariff revenues.

Two important implications emerge from the foregoing analysis. In particular, these implications are relevant for RTAs, formed among "small" countries (price-takers) exibiting constant cost of production. First, if member countries of an RTA are predominantly least-cost producers by international standards, the RTA will be trade-creating on a net basis and will increase welfare unambiguously. Second, if one or more member countries are inefficient producers by international standards, the RTA will give rise to ambiguous welfare effects. The net welfare effect depends on the positive gains resulting from trade creation and tariff revenue losses resulting from trade diversion.

TABLE A.1. Trade and welfare effects of a customs union between A and B

Customs Union	**Area in Figures A.1 and A.2**	**Sign**
Country A		
Trade effects		
Trade creation	(e + j) + (g + l)	Positive
Trade diversion	k	Positive
Net trade effects	(e + j) + (g + l)- k	Uncertain
Wefare effects		
Change in economic surplus	a + b + c	Positive
Production effects	a + e	Positive
Consumption effects	c + g	Positive
Change in tariff revenue	-(b + f)	Negative
Change in economic welfare	(a + c) - f	Uncertain
Country B		
Trade effects		
Trade creation	i + j + l + m	Positive
Trade diversion	--	–-
Net trade effects	i + j + l + m	Positive
Welfare effects		
Change in economic surplus	a + b + c + d + e + f + g + h	Positive
Production effects	(a + d + e)	Positive
Consumption effects	(c + g + h)	Positive
Change in tariff revenue	-(b + f)	Negative
Change in economic welfare	(a + d + e) + (c + g + h)	Positive
Customs Union (A+B)		
Net trade effects	(e + 2j + i) + (g + 2l + m) - k	Uncertain
Change in tariff revenue	-2(b + f)	Negative
Change in economic welfare	2(a + c) + (d + e + g + h) - f	Uncertain

Note: Welfare effects are measured based on the areas identified in Figure A.1 and A.2.