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Reciprocal Trade Agreements

Impacts on U.S. and Foreign Suppliers in Commodity and Manufactured Food Markets

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Reciprocal Trade Agreements: Impacts on U.S. and Foreign Suppliers in Commodity and Manufactured Food Markets

Thomas Vollrath, Jason Grant, and Charles Hallahan

Abstract

Reciprocal trade agreements (RTAs), which grant special preferences to members, affect the pattern and volume of bilateral trade in global markets. This study uses the gravity framework and panel data depicting annual trade between 69 countries over 31 years to examine how 11 RTAs have shaped U.S. and other suppliers' exports of commodity and manufactured foods. Empirical results show that joint RTA membership enabled exporters to increase their trade with member country importers in the two food markets. The few agreements that failed to have a positive effect on member trade in either commodity food or manufactured food involve developing countries that typically grant very limited cross-border trade preference to member countries. Interestingly, model results indicate that RTAs can be a vehicle to increase trade externally. Nine of the 11 RTAs also expanded exports externally to nonmember countries, albeit to a lesser degree than with member importers. In some cases, however, nonmember exporters of food bore the cost of the RTA-induced expansion of trade. Five RTAs lowered food imports from nonmember suppliers. The adverse effects on nonmember suppliers were more pronounced for the United States than for other competitors.

Keywords: Trade policy, reciprocal trade agreements, agricultural and food trade, gravity models

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Contents

Summary iv

Introduction 1

Theoretical and Applied Models 5

The Analytical Framework 5

The Benchmark and Generalized Food Models 7

Data 9

Empirical Model Selection 10

Trade Impacts of RTAs 19

Summary and Policy Implications 24

References 25

Appendix Table 32

Summary

What Is the Issue?

Reciprocal trade agreements (RTAs) between two or more countries offer an alternative approach to lower trade barriers than that provided through multilateral negotiations of the World Trade Organization (WTO). But because RTAs grant preferential cross-border treatment to member countries, they may distort markets and divert trade from nonmember exporters. This study focuses on two agricultural subsectors—commodity foods and manufactured foods—and quantifies the extent to which RTAs have expanded trade between member countries and altered trade between member and nonmember countries.

Most applied research on RTAs has examined the effects on intra-bloc trade, or trade between partners belonging to the same trading bloc. This study examines the impacts of 11 RTAs on both intra-bloc trade and extra-bloc trade, or trade between member and nonmember countries. The study also differentiates between the effects on the United States as a nonmember exporter and the effects on other nonmember competitors.

What Did the Study Find?

Given that international policy dynamics make negotiating a multilateral trade agreement difficult, countries have used RTAs as a practical and feasible route to gain greater access to foreign markets. These agreements have affected the pattern and volume of bilateral trade.

- RTA membership increased trade in most commodity and manufactured food markets during the 1975-2005 period. However, in some cases, the increase in intra-bloc trade came at the expense of a shift in imports away from nonmember food exporters.
- Not surprisingly, the rise in exports to partner markets was particularly pronounced when the exporter and the importer were members of the same RTA. For example, the formation of the European Union (EU) induced an expansion of intra-EU trade in manufactured foods and commodity foods of 93 and 95 percent, respectively, between 1975 and 2005. This growth equates to an average annual increase in food trade between EU countries of 3 percent per year.
- The rise in intra-bloc trade within the North American Free Trade Agreement (NAFTA) and the Closer Economic Relations (CER) agreement was, in contrast to that within the EU, substantially greater for manufactured foods than for commodity foods. Between 1989 and 2005, trade between NAFTA members expanded 6 percent per year, on average, in manufactured foods and 3 percent per year in commodity foods. Over the same period, trade between CER members Australia and New Zealand increased 14 percent per year in manufactured foods and 3 percent per year in commodity foods.

- Empirical results also show that bloc-member exports often expanded to nonmember markets following the start of the agreement. This finding supports the view that RTA liberalization often spills over into other markets, increasing member exports to nonmember importers. Given that RTAs grant preferential treatment to members, the rise in extra-bloc trade was understandably less than the increase in intra-bloc trade (with the exception being extra-bloc trade involving members of the Association of Southeast Asian Nations Free Trade Agreement, or ASEAN).
- In some markets, nonmember exporters of food bore the cost of RTA formation. Members of ASEAN, the EU, the Common Market for Eastern and Southern Africa (COMESA), the Greater Arab Free Trade Area (GAFTA), and the South Asian Preferential Trade Arrangement (SAPTA) were found to have lowered food imports from extra-bloc exporters following implementation of the agreements. The adverse effects of four of these RTAs were more pronounced for the United States than for other nonmember exporters. COMESA diverted trade in commodity foods away from non-U.S. exporters, but it did not curtail imports of food from U.S. suppliers.

How Was the Study Conducted?

ERS adopted the gravity framework and estimated benchmark and generalized equations to quantify the effects of 11 specific RTAs on intra- and extra-bloc trade in commodity and manufactured food markets. Data used in the applied analysis include 31 years of bilateral trade flows and selected socioeconomic characteristics of 69 countries and all partner pairs covering the 1975-to-2005 timeframe. To isolate the dimensions of trade creation and trade diversion attributable to each of the RTAs, the benchmark models accounted for such factors underlying trade as bilateral exchange rates, relative factor endowments, transportation costs, and membership/nonmembership in the various RTAs. The generalized models incorporated country-pair effects. By fixing these effects, the generalized equations embody nonobservable factors affecting trade. Both theory and statistical criteria were used to differentiate and identify the preferred analytical approach.

Introduction

Trade agreements are policy instruments used to reduce cross-border protection and to open markets. The primary goal of the World Trade Organization (WTO) and its predecessor organization, the Generalized Agreement on Tariffs and Trade (GATT), is to contribute to economic development and growth by reducing the obstacles to international trade and helping to ensure a level playing field for all member countries. The GATT/WTO provides a legal and institutional framework for governing cross-border trade between member nations. The "most-favored-nation" (MFN) principle in Article 1 is the centerpiece of the GATT/WTO. According to the MFN provision, each WTO member is to grant all members the same advantage, privilege, favor, or immunity that it grants to any other country. In other words, the provision implies that member countries are not to discriminate in their trade policy against other members.

A challenge facing the WTO and its member countries is reaching consensus about the rules governing international commerce, given the diversity of national sovereignty issues and vested interests. The current stalemate in the Doha Development Agenda (DDA) of the WTO reflects the difficulty of achieving agreement about trade policy reforms at the multilateral level. A former U.S. Trade Representative recently noted that the DDA may be doomed, but reciprocal trade agreements (RTAs) involving bilateral and regional groupings of countries are not (Schwab, 2011). According to Pascal Lamy, the Director-General of the WTO, these preferential agreements "will form part of the long-term tapestry of international trade relations" (World Bank, 2011).

RTAs offer an alternative approach to bargaining for mutual reduction of trade barriers within the framework of the WTO. It is easier for policymakers to reach agreement when there are relatively few countries engaged in negotiations. Still, RTAs may distort markets and divert trade away from efficient nonmember suppliers due to preferential cross-border treatment granted to member countries.

RTAs (i.e., free-trade agreements, customs unions, and common markets) are not consistent with Article I of the MFN provision. They are, however, allowed under Article XXIV. The key requirement of Article XXIV is that the exchange of preferences not be partial (i.e., the removal of duties and other restrictive regulations of commerce are to apply to "substantially all trade" in products between members). The meaning and interpretation of the word "substantial," however, is not clear (Crawford and Laird, 2000; WTO, 2000).

Economists began examining the implications of RTAs for the global trading system during the first wave of countries joining trading blocs in the 1990s. Some observers saw RTAs as "stumbling blocs" to freer trade RTAs, while others saw them as "building blocs." Bhagwati (1991; 1994; 1995), an ardent supporter of the GATT/WTO, repeatedly expresses concern that expansion in the number of RTAs was generating a "spaghetti bowl" of tariffs whereby countries subject the same product to different tariff rates depending on its ostensible origin. Bhagwati believes that RTAs are likely to spawn a complex web of protection across products and countries, reproducing the chaos of the 1930s protectionism. Bhagwati and Panagariya

(1996) are skeptical of the ability of RTAs to generate net welfare gains. Both clearly consider adherence to the MFN principle critical to the success of trade policy.

Bergsten (1996, 1998) questions whether the GATT/WTO provides the only, or even the most effective, way to open markets and promote trade liberalization. Bergsten coins the phrase "competitive liberalization" to describe "the overarching force" behind the proliferation of RTAs. According to Bergsten, the increase of global interdependence has induced countries to create RTAs to compete for footloose international investments. He argues that countries belonging to RTAs are better able and more willing to adopt bold trade liberalization reforms than are possible via multilateral trade negotiations within the GATT/WTO. Estevadeordal et al. (2008) show that some RTAs lower tariffs on imports from both member partners and nonmember partners.

Clearly, RTAs have become an increasingly prominent feature in the global marketplace in recent years. Vicard (2009) observes that 14 percent of country pairs trading in 2005 were members of RTAs, up from 4 percent in 1980. But trade flows between RTA partners represented one-third of world trade. This implies that countries belonging to RTAs trade intensively with each other. Crawford and Fiorentino (2005) note that the world has entered into one of the most prolific periods of RTA formations in history. Moreover, the post-1990 wave of RTA formation shows no sign of abating. As of July 2010, the WTO is monitoring 283 agreements, up from 180 agreements in 2003, less than 100 agreements in 1995, and just 40 agreements in 1990.

The rapid expansion of RTAs raises questions. U.S. policymakers have expressed concern, for example, that the large number of RTAs to which the United States does not belong may be eroding U.S. presence in foreign markets. Economists acknowledge that RTAs can provide "stepping stones" toward a more open world market or can, alternatively, be instruments that undermine global free trade and support for multilateral free trade (Krueger, 2000; Andriamananjara, 2003). Quantitative analysis is needed to provide empirical evidence that clarifies the benefits and costs of these agreements.

Econometric studies based on the gravity framework have been used to gauge the impact of RTAs on the volume of trade.[1] A principal objective of the majority of such gravity studies is to estimate intra-bloc trade expansion, often referred to as trade creation, of these agreements.[2] Intra-bloc trade involves trade between members of the same agreement. Perhaps the focus on intra-bloc trade creation stems from policymaker requests for information on the most tangible gains from RTAs.

Panagariya (2000) notes that there is a tendency to ignore possible welfare losses derived from RTAs, especially with respect to nonmember countries. He posits that the concepts of trade creation and trade diversion[3] are central to the policy debates about RTAs and that empirical analysis of these concepts are a challenging, albeit important, area for research. To infer the welfare effects of RTAs, Panagariya advocates applied analysis of trade creation and trade diversion by sector.

"Trade creation" occurs when products from low-cost producers in member countries displace high-cost domestic production. To date, relatively little

[1]The majority of gravity models focus on total merchandise trade. However, a growing number of applied studies published in recent years examine the impact of RTAs on agricultural trade (e.g., Zahniser et al., 2004; Clarete et al., 2003; Koo et al., 2006; Lambert and McKoy, 2009; Grant and Lambert, 2008; Jayasinghe and Sarker, 2008; and Vollrath et al., 2009).

[2]See Aitken, 1973; Sapir, 2001; Rose and van Wincoop, 2001; Cheng and Wall, 2005;Vollrath et al., 2006; Sandberg et al., 2006; Eicher and Henn, 2009; Subramanian and Wei, 2007; Baier and Bergstrand, 2007; and Baier et al., 2008.

[3]Viner (1950) was the first to define these terms.

attention has been given to the impact of RTAs on the reduction of trade between member and nonmember countries, often described as "trade diversion."[4] Trade diversion takes place when bloc countries reorient their trade away from low-cost, nonmember countries toward higher cost, bloc suppliers. Applied research that restricts attention to the intra-bloc impact of RTAs without also examining the extra-bloc trade effects (also known as third-country effects) does not fully examine the role of these agreements in shaping international trade patterns.

A recent ERS study deploys *generic* trade-creation and trade-diversion indexes in gravity equations to identify the impacts on agricultural trade of mutual as well as asymmetric RTA membership (Vollrath and Hallahan, 2011). Mutual RTA membership refers to cases where both the exporter and the importer belong to the same bloc agreement. Asymmetric membership is consigned to cases when the exporter is not a member of an RTA to which the importer belongs. Vollrath and Hallahan find that mutual RTA membership typically expands trade while asymmetric membership reduces partner trade in the world agricultural marketplace.

The current study uses gravity models to quantify the intra- and extra-bloc effects of *individual* RTAs on trade in agriculture. Intra-bloc trade refers to cases when trading partners belong to the same agreement. Extra-bloc trade is consigned to cases when either exporting partners or importing partners, but not both, belong to a common RTA. Unlike previously published research, this study controls for source-specific extra-bloc trade diversion. Moreover, it differentiates between the impacts of individual RTAs on U.S. and other competing suppliers who are not members of individual RTAs under consideration.

More specifically, this study quantifies the impacts of 11 RTAs on trade in the commodity and manufactured food markets. The 11 agreements examined are the Andean Free Trade Agreement (ANDE), the Association of Southeast Nations Free Trade Agreement (ASEAN), the Central American Common Market (CACM), the Closer Economic Relations (CER), the Common Market for Eastern and Southern Africa (COMESA), the European Union (EU), the Greater Arab Free Trade Area (GAFTA), the Southern Common Market (MERCOSUR), the Canada-U.S. Free Trade Agreement/ North American Free Trade Agreement (NAFTA), the South African Development Community (SADC), and the South Asian Preferential Trade Arrangement (SAPTA).

Collectively, the 11 agreements captured 78 to 92 percent of world agricultural trade during the 1975-2005 period. These agreements are widely distributed throughout the globe. The CER, EU, and NAFTA consist mostly of high-income, industrialized countries. The eight other agreements comprise developing countries. (See table 1 for more detailed information about the set of RTAs selected for this study.)

Commodity foods include raw ingredients (e.g., grains, nuts, fruit, and vegetables) as well as semi-processed products (e.g., preserved fruit and vegetables, meats, and dairy products). They are widely traded throughout the world because of the global distribution of relatively fixed land and labor supply (Regmi et al., 2005). Manufactured foods are highly processed

[4]Studies addressing trade diversion include those that have deployed generic indexes from which generalizations can be drawn about the RTA phenomenon (e.g., Koo et al. 2006; Magee, 2008; and Vollrath and Hallahan, 2011) as well as those that have focused on specific RTAs, enabling distinctions to be made among individual agreements with different trade-policy orientations (Frankel, 1997; Frankel and Wei, 1997; Wei and Frankel, 1997; Endoh, 1999; Cernat, 2001; Tang, 2005; Grant and Lambert, 2005; and Sarker and Jayasinghe, 2007).

Table 1

Reciprocal Trade Agreements

Acronym	Agreement name	Initial date	Country membership (1975-2005)*
ANDE	Andean Free Trade Agreement	1996	Bolivia, Colombia, Ecuador, Peru, Venezuela
ASEAN	Association of Southeast Asian Nations Free Trade Agreement	1993	Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Venezuela, Thailand
CACM	Central American Common Market	1991	Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua
CER	Closer Economic Relations	1983	Australia, New Zealand
COMESA	Common Market for Eastern & Southern Africa	1995	Angola, Burundi, Comoros, Democratic Republic of the Congo, Djibouti, Egypt, Eritrea, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Namibia, Rwanda, Seychelles, Sudan, Swaziland, Uganda, Zambia, Zimbabwe
EU	European Union	1975	Austria, Belgium, Czech Republic, Denmark, Finland, France, Malta, Netherlands, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, United Kingdom
GAFTA	Greater Arab Free Trade Area	1998	Egypt, Jordan, Kuwait, Morocco, Saudi Arabia, Tunisia
MERC	Mercosur Free Trade Agreement	1995	Argentina, Brazil, Paraguay, Uruguay
NAFTA	North American Free Trade Agreement	1989	Canada, Mexico, United States
SADC	South African Development Community	2001	Angola, Botswana, Lesotho, Malawi, Mauritius, Mozambique, Namibia, South Africa, Swaziland, Zambia, Zimbabwe
SAPTA	South Asian Preferential Trade Arrangement	1996	Bhutan, Bangladesh, India, Pakistan, Moldova, Nepal, Sri Lanka

*Country membership coded dynamically in the regression models as countries entered/exited from the agreements.

Note: Data on the 11 RTAs and their date of entry into force were compiled by scrutinizing previously published gravity studies and multiple websites, including the WTO homepage.

products (e.g., breakfast cereal, bakery products, pasta, candy, beer, soft drinks, soups, infant formula, and other food preparations). They are also extensively traded throughout the world even though the location of production of these foods is less dependent on the domestic availability of natural resources.

In today's globalized economy, manufacturing firms produce finished consumer foods in almost every country because raw agricultural inputs, such as grains, flour, and vegetables oils, can be easily sourced. If inputs are not available domestically, they can be readily imported from foreign suppliers—unless raw-material imports are constrained by cross-border trade barriers.

Theoretical and Applied Models

A recent study at the Organisation for Economic Co-operation and Development (OECD) examined a large number of RTAs and found evidence that they had contributed to agricultural trade liberalization (OECD, 2010). The empirical methodology adopted by OECD focused on the share of tariff lines that became zero as a result of RTAs.[5] It did not evaluate other modes of protection (e.g., regulatory mechanisms, technical barriers to trade, sanitary and phytosanitary measures). A methodology that does not quantify nontariff barriers is inherently limited, especially in view of the post-1995 shift toward such barriers following implementation of the Uruguay Round Agreement on Agriculture.

Gravity models provide a means to identify the extent to which RTAs affect trade and trade liberalization that go beyond the narrow focus on tariffs alone. Parameter estimates derived from gravity equations quantify positive/negative deviations in trade that characterize RTAs from hypothesized counterfactual levels in their absence—conditional on the other regressors in the estimating equations. These econometric models are, therefore, capable of isolating the impact of RTAs on trade flows, an issue that the authors of the OECD study explicitly acknowledge as one that merits further research.

In this study, the gravity framework is used in conjunction with panel data spanning trade between 69 countries from 1975 through 2005 to quantify how 11 RTAs have shaped the pattern of world trade in commodity and manufactured foods.[6,7] Benchmark and generalized models are estimated to measure the "treatment effects" of 11 RTAs on intra- and extra-bloc trade in the two food markets.[8]

The Analytical Framework

Gravity models have been widely deployed to gain a better understanding of the forces underlying trade. Tinbergen (1962) was the first to estimate such a model. He posited that the volume of trade between two countries was a function of their "masses" (proxied by Gross Domestic Product or population) and the distance separating them. Linnemann (1966) provided the first economic framework underlying the gravity model of international trade. He showed that the basic model could be derived from a four-equation partial equilibrium model of export supply and import demand.[9] Linnemann was also the first to include RTA membership as an explanatory variable.

Theoretical advances and improvements in model specification of gravity equations have been made since the pioneering work of Tinbergen and Linnemann. (See Anderson, 1979; Helpman and Krugman, 1985; Bergstrand, 1985, 1989, and 1990; Deardorff, 1998; Evenett and Keller, 2002; Anderson and van Wincoop, 2003 and 2004; Feenstra, 2002 and 2004; Baldwin, 2006; and Baier and Bergstrand (2007).)

In this study, all of the applied models are estimated using longitudinal rather than cross-sectional data. The employment of panel data creates greater efficiency, more variability, and less collinearity among the independent variables and is, therefore, generally preferred (Baltagi, 2001). Moreover, the use of panel data is particularly advantageous in estimation of econo-

[5]To be more precise, data are needed on duties collected under most-favored-nation (MFN) status and under preferential tariffs on imported goods from partner countries to assess the impact of RTAs on bilateral trade. Most countries simply do not provide public access to data on preferential tariffs.

[6]Panel data, unlike cross-sectional data, can disentangle time-specific from country- and partner-pair-specific effects.

[7]The 69 countries include Algeria, Argentina, Australia, Austria, Bangladesh, Belgium-Luxembourg, Brazil, Cameroon, Canada, Chile, China (mainland), Colombia, Costa Rica, Denmark, Dominican Republic, Egypt, El Salvador, Finland, France, Germany, Ghana, Greece, Guatemala, Honduras, Hong Kong, India, Indonesia, Ireland, Israel, Italy, Ivory Coast, Jamaica, Japan, Jordan, Kenya, Malaysia, Mexico, Morocco, Netherlands, New Zealand, Nicaragua, Nigeria, Norway, Pakistan, Panama, Paraguay, Philippines, Poland, Portugal, Saudi Arabia, Senegal, Singapore, South African Customs Union (Botswana, Lesotho, Namibia, South Africa, and Swaziland), South Korea, Spain, Sri Lanka, Sweden, Switzerland, Taiwan, Thailand, Trinidad-Tobago, Tunisia, Turkey, United Kingdom, United States, Uruguay, Venezuela, and Zambia.

[8]RTA-treatment effects relate to the partial effects of RTA-based binary variables on the continuous dependent variable, unidirectional trade flow. See Heckman (2001) and Wooldridge (2002). Countries signing an RTA are, for example, classified as the "treatment group," while country pairs that do not belong to the specific agreement are categorized as the "control group." Comparisons can then be drawn between the existing levels of partner trade that characterize the member countries trading with each other in the various RTAs to the hypothesized counterfactual levels in the absence of these agreements.

[9]In Linnemann's framework, markets cleared in response to the interaction between supply and demand forces, eliminating the need to include prices in applied analyses. His gravity model took the following reduced form:

$$X_{ij} = \beta_0 \frac{(s_i)^{\beta_1} (D_j)^{\beta_2}}{(R_{ij})^{\beta_3}}$$

where X_{ij} denotes the volume of trade from country i and country j, s_i represents factors affecting the potential

metric models that incorporate RTA dummy variables. Sohn and Lee (2006) contend that any empirical examination of the impacts of RTAs should incorporate longitudinal data rather than just a single point in time to allow for the phaseout of trade barriers. Baier et al. (2008) observe that "panel data offer an opportunity to better identify unbiased effects" of RTAs on trade flow than cross-section models because implementation of RTAs is typically slow moving, whereas changes in trade flows occur rapidly. Importantly, panel-based models enable the researcher to enrich model specification with fixed effects that potentially mitigate omitted-variable and heterogeneity bias. The statistical framework encompassing conventional gravity models using panel data is characterized as follows:

$$\ln(X_{ijt}) = \alpha_0 + \beta z'_{ijt} + \varepsilon_{ijt} \quad (1)$$

where X_{ijt} denotes trade from country i to country j in year t, z' is the vector of variables representing the export supply and import demand factors affecting partner trade, and ε_{ijt} is the idiosyncratic error assumed to have a distribution characterized by a mean of zero and a constant variance. The independent variables include country-specific characteristics, such as the GDP of each country in year *t,* and other factors common to both countries that affect bilateral trade, such as symmetric or asymmetric RTA memberships in time *t*.

Mátyás (1997) points out that model (1) imposes "unnecessary" restriction, namely that $\alpha_i = \alpha_j = \alpha_t = 0$ for all *i, j,* and *t*. He contends that the correct econometric specification takes the form of a triple-indexed model, with α_t capturing cyclic influences shared by all countries and α_i and α_j capturing exporter and importer fixed effects, respectively:

$$\ln(X_{ijt}) = \alpha_0 + \alpha_i + \alpha_j + \alpha_t + \beta z'_{ijt} + \varepsilon_{ijt} \quad (2)$$

Mátyás's three fixed-effect approach has been criticized for being a restricted version of a more general model. Egger and Pfaffermayr (2003) note that model (2) does not span the whole vector space explaining variations in bilateral exports. They posit that the proper specification of gravity equations includes exporter-to-importer fixed effects (a_{ij}), in addition to Mátyás's three-way effects:

$$\ln(X_{ijt}) = \alpha_0 + \alpha_i + \alpha_j + \alpha_t + \alpha_{ij} + \beta z'_{ijt} + \varepsilon_{ijt} \quad (3)$$

To circumvent perfect collinearity in the estimation of the above model, one α_i and one α_j must be set to zero. The removal of an exporter-fixed and an importer-fixed effect imposes a series of cross-pair restrictions on α_{ij}*'s*. Due to orthogonality, model (3) is equivalent to the following two-way model with time and country-pair fixed effects:

$$\ln(X_{ijt}) = \alpha_0 + \alpha_i + \alpha_j + \alpha_t + \alpha_{ij} + \beta z'_{ijt} + \varepsilon_{ijt} \quad (3')$$

The inclusion of α_{ij} in model (3`) mitigates heterogeneity bias by relaxing the restriction that the intercept of the gravity equation must be the same for all trading pairs. The α_{ij} vector accounts for the many variables commonly specified in gravity equations, such as distance, as well as the many difficult-to-quantify and/or unobservable variables that are specific to cross-sectional units over time.

supply of the exporting country, D_j denotes factors affecting the potential demand of the importing country, and R_{ij} consists of "resistance" factors that affect trade between the two countries, including impediments (such as transportation costs) as well as inducements (such as mutual RTA memberships).

The Benchmark and Generalized Food Models

Our "benchmark gravity model" is designed to capture the impact of specific economic factors commonly believed to drive commodity and manufactured food trade between countries. This model, which is consistent with the traditional gravity framework, contains (1) time-varying covariates (i.e., exporter and importer incomes, relative factor endowments, bilateral exchange-rate misalignments, and indicators of mutual and asymmetric RTA membership) and (2) time-invariant dyadic variables denoting transaction costs (i.e., distance, contiguity, common language, colonial heritage, and indicators of partner countries being landlocked). The basic model is expressed as follows:

$$\ln(X_{ijt}) = \alpha_0 + \alpha_i + \beta_1 \ln(Y_{it}) + \beta_2 \ln(Y_{jt}) + \beta_3 \ln(EM_{ijt}) + \beta_4 \ln(FE_{ijt}) \quad (4)$$
$$+\beta_5 \ln(DT_{ij}) + \beta_6(CB_{ij}) + \beta_7(LL_{ij}) + \beta_8(LS_{ij}) + \beta_9(CH_{ij}) + \sum_r \delta_1^r(ITC_{ijt}^r)$$
$$+\sum_r \delta_2^r(XTC_{ijt}^r) + \sum_r \gamma_1^r(MTD_{USjt}^r) + \sum_r \gamma_2^r(MTD_{OTHjt}^r) + \mu_{ijt}$$

X_{ijt} is the value of trade between exporter i and importer j in year t. GDP quantifies market size, with Y_{it} representing the potential supply of goods from exporter i in year t and Y_{jt} gauging the potential demand of goods being traded by importer j in year t. EM_{ijt} is an indicator of bilateral-exchange-rate misalignment. It is modeled after Perée and Steinherr's (1989) measure of exchange-rate uncertainty and Rosenberg's (2003) measure of the purchasing-power equilibrium exchange rate.[10,11] Relative factor endowments are captured by FE_{ijt}, a measure of exporter-to-importer arable-land/total-labor ratios in year t. The indicators for transportation costs include physical distance DT_{ij} and two indicator variables to reflect geographical characteristics, CB_{ij}, which equals 1 when i and j share a contiguous border and 0 otherwise and a landlocked variable LL_{ij}, which equals 1 when either i and/or j are landlocked and 0 otherwise. The measures for cultural proximity include language similarity LS_{ij}, an indicator variable which equals 1 whenever 9 percent or more of the population in both countries share a common language and 0 otherwise;[12] and colonial heritage CH_{ij}, an indicator variable that equals 1 if two countries have established colonial ties since 1945 and 0 otherwise. Time dummies (α_t) account for factors common to all countries, including worldwide inflation, increases in trade attributable to globalization, and general shocks affecting the world economy,[13] and μ_{ijt} is an idiosyncratic error.

The RTA bivariate variables in equation (4) enable different dimensions of trade creation/diversion to be quantified for each of the 11 RTAs.[14] They include (1) ITC_{ijt}^r, a dummy variable that equals 1 when i and j are both members of agreement r in year t and 0 when either i or j do not belong to r in year t; (2) XTC_{ijt}^r, a dummy variable that equals 1 when i is a member of agreement r and j is not a member of agreement r in year t and 0 otherwise; (3) MTD_{USjt}^r, a dummy variable that equals 1 when the United States, as an exporter, is not a member of agreement r to which j belongs in year t and 0 otherwise; and (4) MTD_{OTHjt}^r, a dummy variable that equals 1 when the non-U.S. exporter is not a member of agreement r to which j belongs in year t and 0 otherwise.

[10] EM_{ijt} controls for the influence of current and accumulated experience:

$$EM_{ij} = V_t^1 + V_t^2 = \left[\frac{\max Z_{ij,t-k}^t - \min Z_{ij,t-k}^t}{\min Z_{ij,t-k}^t}\right] + \left[1 + \frac{\left|Z_{ij,t-k}^t - Z_{ij}^p\right|}{Z_{ij}^p}\right]^2$$

where max (min) $Z_{ij,t-k}$ is the maximum (minimum) value of the exchange rate index over time interval of size k past period and Z_{ij}^p is the mean of the exchange rate between 1975 and 2005. The central notion underlying V_t^1 is that traders' uncertainty is conditioned by their memory of the high and low exchange rate over 10 years. V_t^2 puts the contemporaneous exchange rate into historical perspective. It captures nonlinear responses to departures of the current exchange rate from its longrun equilibrium rate.

[11] A reviewer suggested that we use an indicator of exchange-rate volatility rather than the exchange-rate misalignment variable. Others have noted that there is a certain amount of arbitrariness involved in choosing the appropriate exchange-rate variable to include in gravity models (Cho et al., 2002). We estimated the gravity models using Cho et al.'s measure of exchange-rate uncertainty in lieu of EM_{ijt}. The empirical results using our exchange-rate misalignment indicator and Cho et al.'s variable (calculated as a moving standard deviation of the first differences in the bilateral exchange rate over the prior 10 years) were very similar. All the RTA parameter estimates carried the same signs and were nearly identical in magnitude. Both types of exchange-rate variables carried the same sign and were statistically significant at the 0.01 level. Our comparative results are available upon request.

[12] The 9-percent threshold serves to denote the level at which the ability to communicate is viewed as not imposing substantial transaction costs.

[13] $\alpha_t = 1$ when year is equal to t and 0 otherwise.

[14] The RTAs are coded dynamically. Hence, the NAFTA-related dummies take the value of 1 for the United States and Canada between 1989 and 2005 and for the United States and Mexico and Canada and Mexico between 1994 and 2005. Moreover, each RTA dummy was constructed using "full-year" enforcement, with full year referring to at least 8 months of agreement implementation.

The variables of particular interest in this study are the intra-bloc (ITC^r_{ijt}) and three extra-bloc RTA-dummies ($ITC^r_{ijt}, MTD^r_{USjt}, MTD^r_{OTHjt}$). The hypothesized signs and descriptions of these covariates are as follows:

- $\delta^r_1 > 0$ denotes intra-bloc trade creation for agreement *r*.
- $\delta^r_2 > 0$ denotes extra-bloc trade creation for the set of countries belonging to agreement *r* exporting to partners not members of bloc *r*.
- $\gamma^r_1 < 0$ denotes import trade diversion adversely affecting the United States as a foreign supplier that lowers U.S. exports to trading bloc *r*.
- $\gamma^r_2 < 0$ denotes import trade diversion that lowers non-U.S.-foreign suppliers' exports to agreement *r*.

Clearly, factors other than those specified in the benchmark models are likely to influence both the level of partner trade as well as motivations for countries to enter into mutual RTAs. Examples include nontariff barriers, shipping regulations, antitrust rules, product standards, and other behind-the-border constraints.[15] Despite their potential importance, covariates denoting such factors are often not included in gravity equations as they are either not observable or are nearly impossible to quantify. Should the omitted factors be, in fact, correlated with countries' decisions to forge trading agreements, the generated RTA coefficients capture more than just the effects of these agreements. Hence, parameter estimates obtained from benchmark models may be biased and/or inconsistent due to omitted variable bias.

[15]Lawrence (1996) notes that RTAs provide a vehicle for achieving deeper integration precisely because of their ability to remove and/or mitigate domestic barriers that inhibit cross-border trade.

Another statistical issue of potential concern is endogeneity bias. Baier and Bergstrand (2007) posit that the primary source of such bias in the majority of applied econometric trade models is unobserved heterogeneity. The intuition behind their concern can be illustrated in the case of "natural trading partners." Consider the United States and Canada. Both countries are viewed as being natural trading partners. They share a common culture, speak the same language, have comparable institutional structures, and possess other affinities (e.g., similar values, tastes, and preferences). As a result, the United States and Canada are more likely to reach bilateral or regional trade agreements for reasons other than those captured by the variables specified in conventional gravity equations. Endogeneity bias is, therefore, likely to occur in such equations as the RTA dummy variables that denote joint or asymmetric RTA membership involving the United States and/or Canada and may be correlated with the error term. Hence, the absence of variables denoting affinity factors in estimating equations can lead to omitted-variable bias should they be systematically correlated with both bilateral trade and the RTA covariates.

The second type of gravity model used in this study mitigates both omitted-variable and endogeneity bias. It deploys exporter-to-importer fixed effects in lieu of the time-invariant variables in the benchmark model. Our "generalized gravity model" is expressed as follows:

$$\ln(X_{ijt}) = \alpha_0 + \alpha_t + \alpha_{ij} + \beta_1 \ln(Y_{it}) + \beta_2 \ln(Y_{jt}) + \beta_3 \ln(EM_{ijt}) + \beta_4 \ln(FE_{ijt}) + \sum_r \delta^r_1 (ITC^r_{ijt}) + \sum_r \delta^r_2 (XTC^r_{ijt}) + \sum_r \gamma^r_1 (MTD^r_{USjt}) + \sum_r \gamma^r_2 (MTD^r_{OTHjt}) + \varepsilon_{ijt} \quad (5)$$

The exporter-to-importer fixed effects (α_{ij}) generate country-pair intercepts. They isolate the trade creation/diversion impacts of each agreement *r* from the influence of other dyadic determinants, whether the latter are observable or nonobservable, by virtue of their ability to allow each unidirectional bilateral trade flow to have its own intercept. These country-pair fixed effects embody many difficult, if not impossible, to quantify factors, such as the natural-trading-partner phenomenon characterizing two countries (e.g., the United States and Canada) that induce in some partners trading proportionally more with each other than with others even in the absence of trade agreements (e.g., NAFTA). Hence, equation (5) accounts for heterogeneity more thoroughly than the *ad hoc* set of time-invariant variables (i.e., distance, physical adjacency, common language) in equation (4). Thus, the generalized gravity model enables the trade impacts of the individual RTAs to be separated from the unique bilateral relationships characterizing each country pair.

Moreover, the inclusion of the exporter-to-importer fixed effects allays concerns expressed by Bayoumi and Eichengreen (1997) that RTAs serve as "catch basins" for omitted variables in conventional econometric trade models. As Baldwin and Taglioni (2006) put it, the omission of country-pair fixed effects in gravity models, constructed to calibrate the integration effects of RTAs, is a classic example of the "gold medal" error. The country-pair fixed effects account for a range of socio/political/institutional factors that characterize each partner pair. Hence, the inclusion of these effects in estimating equations controls for the correlation between unobservable dyadic effects and the RTA binary variables.

We conclude that the generalized framework, with its exporter-to-importer fixed effects, is conceptually more appropriate than the benchmark framework. We also hypothesize that our generalized gravity equations for commodity and manufactured foods are likely to generate more reliable RTA parameter estimates than the corresponding benchmark equations.

Data

Annual bilateral trade data were obtained from the United Nations (UN) Commodity Trade Statistics (UN Statistical Office, 2007) database, UNComtrade, the primary international trade data source. The ERS panel dataset used in this study was compiled using UN-reported partner trade flows of commodity and manufactured foods among 69 countries from 1975 through 2005. Distances between capital cities and/or the major commercial center closest to partner countries were calculated using the great circle method obtained from USDA's Agricultural Research Service (2005). Data on common borders, language, and landlocked countries were taken from the website at the Centre d'Etudes Prospectives et d'Informations Internationales (2007). Information about arable land was obtained from the Food and Agriculture Organization of the United Nations (2008) FAOSTAT database. Data on reciprocal trade agreements and their date of entry into force were compiled by scrutinizing previously published gravity studies and multiple websites, including the WTO homepage (2011). All other data were obtained from *World Development Indicators* (see World Bank, 2008). Summary statistics for the variables in the panel dataset are shown in the appendix table.

Empirical Model Selection

In this study, the benchmark and generalized gravity equations are estimated for the commodity- and manufactured-food markets using alternative estimators and functional forms. The econometric results along with cluster-robust standard errors are presented in tables 2 and 3.[16]

Population-average (PA) and random-effects (RE) algorithms are deployed to estimate the benchmark equations, and the fixed-effects (FE) algorithm is used to estimate the generalized equations.[17] A statistical advantage of the PA and RE models is that all coefficients, including those for the time-invariant variables, can be estimated. A disadvantage is that their parameter estimates are inconsistent if the fixed-effects (FE) estimator is found to be appropriate.

All of our log-linear gravity models are estimated using ordinary-least-squares (OLS) techniques. A shortcoming of this approach is that OLS omits trade observations that are zero because the log of zero is undefined. Truncation of datasets used in empirical analysis may cause problems by deleting information that leads to bias estimates.[18] To address possible selection bias that may occur when not using the full panel dataset that includes both positive and zero trade flows, we estimate gravity equations using the Poisson-pseudo-maximum-likelihood (PPML) technique proposed by Santos Silva and Tenreyro (2006).

Diagnostic statistical tests are used to help identify the most appropriate empirical models to best gauge the RTA impacts on food trade. To evaluate the appropriateness of the RE estimator for our commodity and manufactured food trade models, we followed Egger and deployed the Hausman test, using the method of Wooldridge (2002).[19] The null hypothesis under the Hausman test is that the RE estimator is preferred to the PA alternative. This hypothesis is rejected in all cases at the .01 level of significance using Wald tests (see, column 2 in tables 2 and 3). The Hausman test results are consistent with Egger's empirical findings for total merchandise trade. We conclude that the PA estimator is the preferred approach to estimate the benchmark food equations.

The generalized gravity equations are estimated using the OLS and PPML techniques. The conventional practice is to use OLS. A shortcoming of this procedure is that information is lost whenever the trade matrix used does not include zero observations and is, therefore, unbalanced.

We used Stata's *areg* procedure, which absorbs the country-pair fixed effects via centering, to estimate the log-linear models and its *xtpqml* procedure to estimate the corresponding Poisson models. The PPML model for commodity foods did not converge.[20] Statistical criteria show that OLS is the most appropriate technique for estimating the generalized equation for processed food. Goodness-of-fit statistics clearly favor the OLS estimator. Witness the considerably larger Aikake information-criterion (AIC) penalty for the Poisson model vis-à-vis the AIC for the OLS model.

As a further check on the adequacy of the OLS in comparison with the PPML estimator, we performed heteroskedasticity-robust, regression-equation-specification-error tests. The null hypothesis for the Ramsey RESET test is

[16]Note, cluster-robust standard errors are reported in parentheses in these tables using White's (1980) corrective method, rather than the default standard errors. Default standard errors, which assume *i.i.d.* errors, are likely to be underestimated because gravity models using panel data are subject to (1) positive autocorrelation within each bilateral pair over time as each additional observation is not providing information independently, and (2) heteroskedasticity because the composite error is likely to be correlated over time for a given country pair.

[17]Both the PA and FE estimators assume that the covariates are exogenous. They use *between* (cross-partner pairs) and *within* (time series) variation in the data. The RE model, by contrast, makes the strong assumption that the intercept is uncorrelated with the regressors. In contrast to the PA and RE models, the FE framework uses the *within* transformation. The transformation eliminates the α_{ij}'s via centering. It permits arbitrary correlations between the omitted and the explanatory variables. This feature explains why the intercept varies over country pairs and over time in our generalized gravity equations.

[18]If the zeros are not randomly distributed, truncating the sample may generate a selection bias.

[19]Egger (2000) rejects the use of the RE estimator on both conceptual and empirical grounds in gravity models that are designed to gauge RTA treatment effects. He notes that in such models, "one is not interested in the estimation of typical trade flows between a randomly drawn sample of countries but between an *ex ante* predetermined selection of nations." Egger used the Hausman test to

[20]Convergence does not always occur with Poisson models because of their "sensitivity to small numerical problems," according to personal communication from Santos Silva.

Table 2

Benchmark and generalized models results for commodity foods

	Benchmark models		Generalized models		
	PA model	RE model	FE models		
Variables	LICs & HICs (1)	LICs & HICs (2)	LICs & HICs (3)	LICs (4)	HICs (5)
ln(Yi)	0.58**	0.45**	0.01	0.02	0.01
	(0.02)	(0.02)	(0.04)	(0.04)	(0.04)
ln(Yj)	0.76**	0.84**	0.81**	0.81**	0.80**
	(0.02)	(0.02)	(0.04)	(0.04)	(0.04)
ln(EMijt)	-0.06*	-0.09**	-0.09**	-0.09**	-0.11**
	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)
ln(FEijt)	0.18**	0.16**	0.04	0.06	0.05
	(0.01)	(0.02)	(0.04)	(0.04)	(0.04)
ln(DTij)	-0.83**	-0.95**			
	(0.04)	(0.04)			
CBij	0.47**	0.78**			
	(0.16)	(0.19)			
LLij	-0.36**	-0.55**			
	(0.08)	(0.09)			
LSij	0.48**	0.29**			
	(0.07)	(0.09)			
CHij	1.68**	2.00**			
	(0.19)	(0.23)			
ITC^{ANDE}	3.01**	1.47**	1.40**	1.38**	
	(0.49)	(0.09)	(0.09)	(0.09)	
XTC^{ANDE}	-0.08	0.11	0.08	0.04	
	(0.21)	(0.12)	(0.13)	(0.13)	
MTD^{ANDE_US}	1.76**	-0.33	-0.34	-0.34	
	(0.24)	(0.27)	(0.29)	(0.29)	
$MTD^{ANDE_non\text{-}US}$	-0.91**	0.01	0.11	0.11	
	(0.18)	(0.12)	(0.13)	(0.13)	
ITC^{ASEAN}	2.17**	0.24	0.21	0.19	
	(0.25)	(0.24)	(0.24)	(0.24)	
XTC^{ASEAN}	1.99**	0.31**	0.27**	0.23**	
	(0.11)	(0.08)	(0.08)	(0.08)	
MTD^{ANSEAN_US}	1.20*	0.04	-0.02	-0.01	
	(0.49)	(0.26)	(0.24)	(0.24)	
$MTD^{ASEAN_non\text{-}US}$	0.10	0.01	0.04	0.04	
	(0.12)	(0.09)	(0.10)	(0.10)	
ITC^{CACM}	3.18**	1.09**	0.95**	0.93**	
	(0.22)	(0.25)	(0.29)	(0.29)	
XTC^{CACM}	1.17**	-0.10	-0.17	-0.21*	
	(0.13)	(0.09)	(0.09)	(0.09)	

continued—

Table 2

Benchmark and generalized models results for commodity foods—continued

	Benchmark models		Generalized models		
	PA model	RE model	FE models		
Variables	LICs & HICs (1)	LICs & HICs (2)	LICs & HICs (3)	LICs (4)	HICs (5)
MTD^{CACM_US}	2.05**	0.28	0.14	0.16	
	(0.21)	(0.16)	(0.16)	(0.16)	
$MTD^{CACM_non\text{-}US}$	-0.56**	0.43**	0.58**	0.58**	
	(0.12)	(0.08)	(0.09)	(0.09)	
ITC^{CER}	2.90**	1.24**	0.63**		0.58**
	(0.18)	(0.05)	(0.08)		(0.08)
XTC^{CER}	2.38**	0.98**	0.47**		0.43**
	(0.16)	(0.13)	(0.16)		(0.16)
MTD^{CER_US}	0.35*	0.01	-0.42		-0.41
	(0.18)	(0.40)	(0.51)		(0.51)
$MTD^{CER_non\text{-}US}$	0.56**	0.30**	0.24		0.22
	(0.16)	(0.11)	(0.14)		(0.14)
ITC^{COMESA}	1.98**	1.77**	1.75**	1.74**	
	(0.57)	(0.32)	(0.37)	(0.37)	
XTC^{COMESA}	0.30	0.26**	0.27*	0.23*	
	(0.16)	(0.10)	(0.11)	(0.11)	
MTD^{COMESA_US}	0.96	-0.22	-0.30	-0.29	
	(0.56)	(0.28)	(0.28)	(0.28)	
$MTD^{COMESA_non\text{-}US}$	-0.25	-0.12	-0.13	-0.13	
	(0.15)	(0.11)	(0.12)	(0.12)	
ITC^{EU}	1.21**	0.86**	0.67**		0.56**
	(0.12)	(0.08)	(0.09)		(0.09)
XTC^{EU}	0.66**	0.20**	0.08		0.02
	(0.07)	(0.06)	(0.07)		(0.07)
MTD^{EU_US}	0.29	-0.63**	-1.08**		-1.10**
	(0.23)	(0.24)	(0.26)		(0.25)
$MTD^{EU_non\text{-}US}$	0.50**	-0.18**	-0.34**		-0.35**
	(0.09)	(0.06)	(0.07)		(0.07)
ITC^{GAFTA}	0.21	0.51	0.48	0.47	
	(0.36)	(0.27)	(0.29)	(0.29)	
XTC^{GAFTA}	-1.63**	-0.07	0.04	0.00	
	(0.13)	(0.09)	(0.09)	(0.09)	
MTD^{GAFTA_US}	0.91*	-0.69**	-0.74**	-0.74**	
	(0.41)	(0.12)	(0.12)	(0.12)	
$MTD^{GAFTA_non\text{-}US}$	0.35**	-0.34**	-0.36**	-0.36**	
	(0.11)	(0.07)	(0.07)	(0.07)	
ITC^{MERC}	3.43**	0.79**	0.62**	0.61**	
	(0.33)	(0.12)	(0.12)	(0.12)	

continued—

Table 2

Benchmark and generalized models results for commodity foods—continued

	Benchmark models		Generalized models		
	PA model	RE model	FE models		
Variables	LICs & HICs (1)	LICs & HICs (2)	LICs & HICs (3)	LICs (4)	HICs (5)
XTC^{MERC}	1.90**	0.45**	0.31**	0.27**	
	(0.11)	(0.09)	(0.10)	(0.10)	
MTD^{MERC_US}	-0.06	-0.26	-0.29	-0.28	
	(0.26)	(0.27)	(0.29)	(0.29)	
$MTD^{MERC_non\text{-}US}$	-0.59**	0.39**	0.46**	0.46**	
	(0.13)	(0.10)	(0.10)	(0.10)	
ITC^{NAFTA}	2.17**	0.63**	0.50**	0.48**	0.40**
	(0.42)	(0.13)	(0.12)	(0.12)	(0.11)
XTC^{NAFTA}	1.21**	0.47**	0.35**	0.30**	0.26**
	(0.12)	(0.08)	(0.09)	(0.09)	(0.09)
$MTD^{NAFTA_non\text{-}US}$	0.57**	0.15	0.12	0.12	0.09
	(0.13)	(0.08)	(0.09)	(0.09)	(0.09)
ITC^{SADC}	4.16**	0.89**	0.71*	0.71**	
	(1.16)	(0.34)	(0.28)	(0.27)	
XTC^{SADC}	0.75**	0.75**	0.68**	0.65**	
	(0.20)	(0.13)	(0.13)	(0.13)	
MTD^{SADC_US}	0.11	0.16	0.16	0.16	
	(0.37)	(0.53)	(0.57)	(0.57)	
$MTD^{SADC_non\text{-}US}$	-0.07	0.15	0.18	0.18	
	(0.18)	(0.14)	(0.14)	(0.14)	
ITC^{SAPTA}	2.15**	0.39	0.34	0.32	
	(0.63)	(0.31)	(0.33)	(0.33)	
XTC^{SAPTA}	0.43**	0.31**	0.31**	0.27*	
	(0.15)	(0.10)	(0.11)	(0.11)	
MTD^{SAPTA_US}	1.04**	-1.21**	-1.28**	-1.27**	
	(0.39)	(0.20)	(0.22)	(0.22)	
$MTD^{SAPTA_non\text{-}US}$	-0.55**	-0.13	-0.10	-0.10	
	(0.15)	(0.09)	(0.10)	(0.10)	
C	15.91**	16.98**	10.85**	10.82**	11.06**
	(0.37)	(0.38)	(0.32)	(0.32)	(0.32)
Observations	89,723	89,723	89,723	89,723	89,723
Number of xm pair		4529			
$\hat{\sigma}_u$		1.84			
$\hat{\sigma}_e$		1.26			
$\hat{\sigma}$		2.23			
ρ		0.681			
$\hat{\Theta}_{50}$		0.864			
R_w^2		0.115			

continued—

Table 2

Benchmark and generalized models results for commodity foods—continued

	Benchmark models		Generalized models		
	PA model	RE model	FE models		
Variables	LICs & HICs (1)	LICs & HICs (2)	LICs & HICs (3)	LICs (4)	HICs (5)
R_b^2		0.495			
χ^2		10357			
R_{adj}^2	0.47		0.83	0.83	0.83
AIC	3.99E+05		2.92E+05		
RESET	F = 27.33		F = 1.32		
RESET test p-values	0.0000		0.2512		
F (Hausman)		F = 128.38			
Prob> F		0.0000			

Notes: PA = population-average effects. RE = random effects. FE = fixed effects. LIC = low-income countries. HIC = high-income countries. The dependent variables and all time-varying independent variables are expressed in logarithmic terms. All regressions are estimated using annual panel data from 1975 through 2005. Time- and country-pair-dummy parameter estimates are not reported to save space. Standard errors are in parentheses. They are calculated using White's heteroskedastic robust-standard errors. * and ** denote that the null hypothesis is rejected at the 0.05 and 0.01 level, respectively.

Table 3

Benchmark and generalized models results for manufactured foods

	Benchmark models		Generalized models			
	LICs & HICs		FE (OLS)			FE (PPML)
Variables	PA (OLS) (1)	RE (OLS) (2)	LICs & HICs (3)	LICs (4)	HICs (5)	LICs & HICs (6)
ln(Yi)	0.83**	0.79**	0.29**	0.29**	0.30**	0.27*
	(0.02)	(0.02)	(0.05)	(0.05)	(0.05)	(0.11)
ln(Yj)	0.61**	0.67**	0.94**	0.95**	0.96**	0.82**
	(0.02)	(0.02)	(0.05)	(0.05)	(0.05)	(0.09)
ln(EMijt)	-0.25**	-0.13**	-0.11**	0.10**	0.11**	-0.07*
	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)
ln(FEijt)	0.04**	0.04*	-0.13*	-0.13*	-0.15**	-0.05
	(0.01)	(0.02)	(0.05)	(0.05)	(0.05)	(0.05)
ln(DTij)	-1.11**	-1.19**				
	(0.04)	(0.04)				
CBij	0.28	0.55**				
	(0.16)	(0.19)				
LLij	-0.11	-0.18*				
	(0.08)	(0.09)				
LSij	0.83**	0.70**				
	(0.07)	(0.08)				
CHij	1.26**	1.54**				

continued—

Table 3

Benchmark and generalized models results for manufactured foods—continued

	Benchmark models		Generalized models			
	LICs & HICs		FE (OLS)			FE (PPML)
Variables	PA (OLS) (1)	RE (OLS) (2)	LICs & HICs (3)	LICs (4)	HICs (5)	LICs & HICs (6)
	(0.21)	(0.26)				
ITC^{ANDE}	2.87**	2.52**	2.45**	2.40**		1.08**
	(0.39)	(0.07)	(0.06)	(0.06)		(0.28)
XTC^{ANDE}	0.46**	0.67**	0.62**	0.60**		0.04
	(0.17)	(0.15)	(0.16)	(0.16)		(0.18)
MTD^{ANDE_US}	0.14	-0.30	-0.23	-0.27		-0.30
	(0.24)	(0.16)	(0.16)	(0.16)		(0.24)
$MTD^{ANDE_non\text{-}US}$	-0.44*	0.20	0.36*	0.33		0.27
	(0.17)	(0.16)	(0.17)	(0.17)		(0.19)
ITC^{ASEAN}	1.59**	0.90**	0.80*	0.74*		0.05
	(0.32)	(0.33)	(0.34)	(0.34)		(0.22)
XTC^{ASEAN}	1.09**	0.54**	0.50**	0.47**		-0.15
	(0.10)	(0.09)	(0.10)	(0.10)		(0.18)
MTD^{ANSEAN_US}	0.95**	-0.21	-0.36*	-0.39*		-0.19
	(0.36)	(0.17)	(0.17)	(0.17)		(0.14)
$MTD^{ASEAN_non\text{-}US}$	0.62**	0.36**	0.32**	0.28**		-0.08
	(0.12)	(0.09)	(0.10)	(0.10)		(0.11)
ITC^{CACM}	3.20**	1.11**	0.79*	0.74*		0.55*
	(0.25)	(0.27)	(0.31)	(0.31)		(0.22)
XTC^{CACM}	0.24	-0.18	-0.32	-0.36		-0.60**
	(0.16)	(0.15)	(0.19)	(0.19)		(0.23)
MTD^{CACM_US}	0.67*	-0.03	-0.11	-0.13		0.05
	(0.27)	(0.09)	(0.11)	(0.11)		(0.09)
$MTD^{CACM_non\text{-}US}$	-0.10	0.24*	0.29*	0.25		0.27
	(0.11)	(0.11)	(0.13)	(0.13)		(0.21)
ITC^{CER}	2.63**	1.96**	1.29**		1.24**	1.66**
	(0.18)	(0.18)	(0.24)		(0.24)	(0.25)
XTC^{CER}	0.67**	0.36**	0.05		-0.02	-0.60
	(0.17)	(0.12)	(0.17)		(0.17)	(0.34)
MTD^{CER_US}	0.26	0.71**	0.50*		0.50*	0.60**
	(0.27)	(0.13)	(0.21)		(0.21)	(0.14)
$MTD^{CER_non\text{-}US}$	0.83**	0.69**	0.70**		0.70**	0.87**
	(0.14)	(0.13)	(0.16)		(0.16)	(0.16)
ITC^{COMESA}	1.84**	1.56**	1.71**	1.67**		3.30**
	(0.51)	(0.51)	(0.55)	(0.54)		(0.88)
XTC^{COMESA}	-0.01	0.01	0.04	0.02		0.19
	(0.16)	(0.16)	(0.18)	(0.18)		(0.21)

continued—

Table 3

Benchmark and generalized models results for manufactured foods—continued

	Benchmark models		Generalized models			
	LICs & HICs		FE (OLS)			FE (PPML)
Variables	PA (OLS) (1)	RE (OLS) (2)	LICs & HICs (3)	LICs (4)	HICs (5)	LICs & HICs (6)
MTD^{COMESA_US}	-0.53	-0.40	-0.36	-0.39		-0.87**
	(0.58)	(0.31)	(0.41)	(0.41)		(0.21)
MTD^{COMESA_non-US}	-0.71**	-0.41**	-0.42**	-0.44**		-0.56**
	(0.16)	(0.13)	(0.14)	(0.14)		(0.21)
ITC^{EU}	1.41**	0.83**	0.66**		0.56**	0.52**
	(0.13)	(0.09)	(0.10)		(0.10)	(0.09)
XTC^{EU}	1.14**	0.44**	0.18*		0.12	0.06
	(0.08)	(0.06)	(0.07)		(0.08)	(0.07)
MTD^{EU_US}	-0.08	-0.20	-0.28		-0.31	-0.05
	(0.27)	(0.24)	(0.30)		(0.29)	(0.14)
MTD^{EU_non-US}	-0.25**	0.04	0.15		0.15	0.04
	(0.08)	(0.07)	(0.09)		(0.09)	(0.09)
ITC^{GAFTA}	0.69*	0.39	0.34	0.30		0.38
	(0.32)	(0.23)	(0.25)	(0.25)		(0.25)
XTC^{GAFTA}	-1.56**	-0.19*	-0.03	-0.05		0.17
	(0.13)	(0.10)	(0.10)	(0.10)		(0.24)
MTD^{GAFTA_US}	0.03	-0.66**	-0.67**	0.69**		-0.42**
	(0.61)	(0.15)	(0.15)	(0.15)		(0.08)
MTD^{GAFTA_non-US}	-0.18	-0.25**	-0.24**	-0.26**		-0.37**
	(0.11)	(0.08)	(0.09)	(0.09)		(0.09)
ITC^{MERC}	2.81**	0.81**	0.67*	0.62		0.27
	(0.40)	(0.30)	(0.33)	(0.33)		(0.20)
XTC^{MERC}	1.00**	0.35**	0.20	0.16		-0.34
	(0.12)	(0.10)	(0.11)	(0.11)		(0.18)
MTD^{MERC_US}	0.81**	0.48	0.50	0.47		0.59**
	(0.24)	(0.27)	(0.27)	(0.26)		(0.18)
MTD^{MERC_non-US}	-0.41**	0.09	0.22	0.19		-0.08
	(0.13)	(0.11)	(0.11)	(0.11)		(0.20)
ITC^{NAFTA}	1.46**	1.46**	1.37**	1.31**	1.28**	0.72**
	(0.41)	(0.36)	(0.37)	(0.37)	(0.36)	(0.07)
XTC^{NAFTA}	0.29*	0.48**	0.37**	0.34**	0.29**	0.21**
	(0.11)	(0.09)	(0.10)	(0.09)	(0.09)	(0.08)
MTD^{NAFTA_non-US}	0.47**	0.08	0.04	0.01	0.02	-0.52**
	(0.12)	(0.10)	(0.11)	(0.11)	(0.11)	(0.13)
ITC^{SADC}	2.84*	0.21**	0.03	0.03		0.72**
	(1.30)	(0.05)	(0.14)	(0.14)		(0.16)
XTC^{SADC}	0.25	0.30	0.20	0.18		0.35

continued—

Table 3

Benchmark and generalized models results for manufactured foods—continued

	Benchmark models		Generalized models			
	LICs & HICs		FE (OLS)			FE (PPML)
Variables	PA (OLS) (1)	RE (OLS) (2)	LICs & HICs (3)	LICs (4)	HICs (5)	LICs & HICs (6)
	(0.19)	(0.16)	(0.17)	(0.17)		(0.28)
MTD^{SADC_US}	0.00	0.58	0.68	0.66		-0.05
	(0.39)	(0.59)	(0.65)	(0.66)		(0.05)
$MTD^{SADC_non\text{-}US}$	-0.27	0.13	0.21	0.20		0.26
	(0.20)	(0.16)	(0.17)	(0.17)		(0.21)
ITC^{SAPTA}	-0.05	0.88*	0.94*	0.89*		0.87*
	(0.67)	(0.41)	(0.44)	(0.44)		(0.43)
XTC^{SAPTA}	-0.15	0.29**	0.31**	0.28*		0.01
	(0.14)	(0.11)	(0.12)	(0.12)		(0.14)
MTD^{SAPTA_US}	-0.42	-1.01**	-1.04**	-1.08**		-1.25**
	(0.36)	(0.23)	(0.27)	(0.27)		(0.05)
$MTD^{SAPTA_non\text{-}US}$	-0.40**	-0.34**	-0.34**	-0.37**		-0.60**
	(0.13)	(0.10)	(0.10)	(0.10)		(0.12)
C	16.01**	16.07**	7.44**	7.35**	7.19**	
	(0.34)	(0.37)	(0.39)	(0.29)	(0.29)	
Observations	70,954	70,954	70,954	70,954	70,954	102,299
Number of xm pair		4,189				
$\hat{\sigma}_u$		1.62				
$\hat{\sigma}_e$		1.27				
$\hat{\sigma}$		2.06				
ρ		0.62				
$\hat{\Theta}_{50}$		0.83				
R_w^2		0.24				
R_b^2		0.54				
χ^2		17,542				
R_{adj}^2	0.52		0.81	0.81	0.81	
AIC	3.01E+05		2.31E+05			1.96E+11
RESET	F = 15.63		F = 0.48			$chi^2(1)$= 9.20
RESET test p-values	0.0001		0.4888			0.0024
F (Hausman)		F=187.63				
Prob> F		0.0000				

Notes: PA = population-average effects. RE = random effects. FE = fixed effects. LIC = low-income countries. HIC = high-income countries. All time-varying independent variables are expressed in logarithmic terms. All regressions are estimated using annual panel data from 1975 through 2005. Time- and country-pair-dummy parameter estimates are not reported to save space. Standard errors are in parentheses. They are calculated using White's heteroskedastic robust-standard errors. * and ** denote that the null hypothesis is rejected at the 0.05 and 0.01 level, respectively.

clearly rejected for the PPML estimator for processed foods but not for the OLS estimator in either the commodity food or the processed food equations (see column 6 in table 2 and columns 3 and 6 in table 3).[21] These findings suggest that omitted variables are a source of errors-in-variable bias in the PPML estimation, a problem that is not apparent in the OLS equation.

Summary statistics in tables 2 and 3 indicate that the OLS generalized equations are preferred to the benchmark models. Adjusted R^2s show that the generalized gravity models explain more variation than do the corresponding benchmark equations for both the commodity and manufactured food sectors. The overall measures of "goodness of fit" increased from 0.47 to 0.83 [0.52 to 0.81] when comparing the PA-model with the FE-model results for commodity [manufactured] foods (see column 1 and 3 in tables 2 and 3). Likelihood ratio and Akaike-information-criterion tests do not support the more restricted benchmark models in either food sector, adding further justification favoring the generalized model framework (see columns 1 and 3 in tables 2 and 3). Finally, RESET tests point to omitted-variable bias in the benchmark but not in the generalized equations. This finding addresses Bayoumi and Eichengreen's concern about errors-in-variable bias and Baldwin and Taglioni's intuition of the appropriateness of using country-pair effects when examining the effects of RTAs on trade.

Summary measures of overall statistical fit, information-criterion penalties, and both Ramsey RESET and Hausman tests provide support for the generalized gravity models vis-à-vis the benchmark models for both commodity and processed foods. Given our primary interest in this study to quantify the trade impacts of RTAs[22] as well as theoretical considerations and the results of the aforementioned diagnostic tests, we limit discussion in the next section to the RTA parameter estimates using the preferred analytical framework.

[21]The Ramsey RESET results for commodity and manufactured foods are not consistent with what Sun and Reed (2011) found when comparing OLS and Poisson models in their applied model for total agricultural trade.

[22]Our preferred PA benchmark models for food, though limited in their ability to diagnose the trade impacts of RTA, generate information about the fixed dyadic determinants that is not possible to obtain from the generalized models.

Trade Impacts of RTAs

The intra-bloc trade creation (ITC) parameters in table 4 from our preferred generalized gravity equations show that since the time of their inception, 10 of the 11 RTAs expanded trade in either the commodity and/or the manufactured food markets of member countries. The three RTAs that comprise mostly developed countries (i.e., the EU, NAFTA, and CER) increased member-country trade in both the commodity and manufactured food sectors. The formation of the EU increased intra-EU trade in the two food sectors during 1975-2005 between 93 and 95 percent, on average.[23] This translates into a fixed annual increase in food trade between EU countries of 3 percent (table 5).[24] The rise in intra-bloc trade within NAFTA and the CER was, in contrast to that within the EU, substantially greater for manufactured foods than for commodity foods. NAFTA caused trade between member countries to expand 8 percent per year on average in manufactured foods and 3 percent per year in commodity foods between 1989 and 2005. Results for the CER were similar in that the 6-percent annual increase of trade between Australia and New Zealand in manufactured foods was considerably greater than the 3-percent expansion of intra-CER trade in commodity foods.

[23]The percentage change in trade attributable to RTA formation is $(e^{\delta^{*}}-1)\times 100$.

[24]The formula to convert RTA coefficients into average annual percentage change is $\left(e^{\frac{\delta}{n}}-1\right)$, where n = the number of years the RTA is in force.

Table 4

Trade creation and trade diversion parameter estimates for intra- and extra-RTA blocs from the preferred gravity model

	Commodity foods				Manufactured foods			
Agreement	ITC (1)	XTC (2)	MTD^{US} (3)	$MTD^{non\text{-}US}$ (4)	ITC (5)	XTC (6)	MTD^{US} (7)	$MTD^{non\text{-}US}$ (8)
ANDE	1.40**	0.08	-0.34	0.11	2.45**	0.62**	-0.23	0.36*
	(0.09)	(0.13)	(0.29)	(0.13)	(0.06)	(0.16)	(0.16)	(0.17)
ASEAN	0.21	0.27**	-0.02	0.04	0.80*	0.50**	-0.36*	0.32**
	(0.24)	(0.08)	(0.24)	(0.10)	(0.34)	(0.10)	(0.17)	(0.10)
CACM	0.95**	-0.17	0.14	0.58**	0.79*	-0.32	-0.11	0.29*
	(0.29)	(0.09)	(0.16)	(0.09)	(0.31)	(0.19)	(0.11)	(0.13)
CER	0.63**	0.47**	-0.42	0.24	1.29**	0.05	0.50*	0.70**
	(0.08)	(0.16)	(0.51)	(0.14)	(0.24)	(0.17)	(0.21)	(0.16)
COMESA	1.75**	0.27*	-0.30	-0.13	1.71**	0.04	-0.36	-0.42**
	(0.37)	(0.11)	(0.28)	(0.12)	(0.55)	(0.18)	(0.41)	(0.14)
EU	0.67**	0.08	-1.08**	-0.34**	0.66**	0.18*	-0.28	0.15
	(0.09)	(0.07)	(0.26)	(0.07)	(0.10)	(0.07)	(0.30)	(0.09)
GAFTA	0.48	0.04	-0.74**	-0.36**	0.34	-0.03	-0.67**	-0.24**
	(0.29)	(0.09)	(0.12)	(0.07)	(0.25)	(0.10)	(0.15)	(0.09)
MERCOSUR	0.62**	0.31**	-0.29	0.46**	0.67*	0.20	0.50	0.22
	(0.12)	(0.10)	(0.29)	(0.10)	(0.33)	(0.11)	(0.27)	(0.11)
NAFTA	0.50**	0.35**		0.12	1.37**	0.37**		0.04
	(0.12)	(0.09)		(0.09)	(0.37)	(0.10)		(0.11)
SADC	0.71*	0.68**	0.16	0.18	0.03	0.20	0.68	0.21
	(0.28)	(0.13)	(0.57)	(0.14)	(0.14)	(0.17)	(0.65)	(0.17)
SAPTA	0.34	0.31**	-1.28**	-0.10	0.94*	0.31**	-1.04**	-0.34**
	(0.33)	(0.11)	(0.22)	(0.10)	(0.44)	(0.12)	(0.27)	(0.10)

Note: ITC (intra-bloc trade creation), XTC (extra-bloc trade creation), and MTD (import trade diversion) are variables. RTA-parameter estimates and robust standard errors replicated from the ordinary least squares generalized model for commodity (manufactured) foods in tables 2 and 3.

Table 5

RTA-induced average annual percentage change in trade induced by each agreement since inception

	Commodity foods				Manufactured foods			
	Trade creation		Trade diversion		Trade creation		Trade diversion	
Agreement	Intra-bloc (ITC)	Extra-bloc (XTC)	U.S. (MTD^{US})	Non-U.S. ($MTD^{non\text{-}US}$)	Intra-bloc (ITC)	Extra-bloc (XTC)	U.S. (MTD^{US})	Non-U.S. ($MTD^{non\text{-}US}$)
ANDE	0.15				0.28	0.06		0.04
ASEAN		0.02			0.06	0.04	-0.03	0.02
CACM	0.07			0.04	0.05			0.02
CER	0.03	0.02			0.06		0.02	0.03
COMESA	0.19	0.03			0.19			-0.04
EU	0.03		-0.03	-0.01	0.03	0.01		
GAFTA			-0.09	-0.04			-0.08	-0.03
MERCOCUR	0.04	0.02		0.03	0.05			
NAFTA	0.03	0.02			0.08	0.02		
SADC	0.15	0.15						
SAPTA		0.03	-0.12		0.10	0.03	-0.10	-0.03

Note:ITC (intra-bloc trade creation), XTC (extra-bloc trade creation), and MTD (import trade diversion) are variables. Percentage average annual change derived from parameter estimates in table 4 that are statistically significant at either the 0.01 or the 0.05 level of significance using the formula $\left(e^{\frac{\delta^k}{n}}-1\right)$, where n = the number of years the RTA is in force.

ANDE, CACM, COMESA, and MERC expanded trade with member countries in both food sectors. By contrast, GAFTA had no effect on internal bloc trade in either sector. However, SADC increased intra-bloc trade in commodity foods, and ASEAN and SAPTA augmented trade internally in the manufactured food sector. The finding that some RTAs have not increased cross-border trade with member countries in one or both food markets is not altogether surprising. Many countries, especially those in the developing world, grant limited tariff preferences in agriculture. The lack of statistical significance in commodity-based trade in ASEAN, GAFTA, and SAPTA could reflect the relatively small land bases from which to produce land-intensive commodities. The absence of empirical support for RTA-induced intra-bloc trade-creation could also indicate that food markets are not always well integrated within trading blocs.

Interestingly, model results reveal that not only did most of the RTAs create trade among member countries, but they also expanded trade externally to nonmember countries. Note the positive and statistically significant extra-bloc trade creation (XTCs) coefficients for the agreements that also augmented intra-bloc trade. These results may support Baldwin's (2002) hypothesis that trade liberalization, whether it originates from regional or multilateral agreements, "begets more liberalization." The results may reflect nondiscriminatory reduction in trade barriers to nonmember partners that took place as some of the RTA blocs were lowering barriers to member countries. They may also stem from increases in bloc-country competitiveness arising from spillover efficiencies caused by RTAs that enabled members to increase export sales to nonpartner importers.

Not surprisingly, the RTA-induced trade expansions with external partners were considerably smaller than sales to partner importers when the agree-

ments also augmented intra-bloc trade, except for trade in manufactured foods by ASEAN exporters. The ASEAN countries have little incentive to trade with each other in commodity and manufactured foods given similarities in their members' comparative advantages.

Overall trade creation induced by RTAs, denoted by positive and significant ITC and/or XTC coefficients, depicts most but not all of the agreements in the commodity and manufactured food sectors. Exceptions include nonsignificant parameter estimates for SADC in manufactured foods and for GAFTA in both the commodity and manufactured food sectors. The absence of any statistical significance of trade creation suggests that the set of GAFTA countries is not internationally competitive in either food sector and that the group of SADC countries is not competitive in manufactured foods.

The import-trade-diversion parameter estimates (MTD^{US} and $MTD^{non\text{-}US}$) reveal that 6 of 11 RTAs (i.e., ANDE, CACM, CER, MERCOSUR, NAFTA, and SADC) did not discriminate against outside suppliers.[25] However, both U.S. exporters and the composite foreign supplier in commodity and/or manufactured food markets were adversely affected by the formation of the EU, GAFTA, and SAPTA. The empirical results show, for example, that the EU reoriented imports of commodity foods away from both outside suppliers. The EU agreement effected a 66-percent decline in U.S. commodity food exports to EU members between 1975 and 2005. This drop is equivalent to an average annual proportional decline in U.S. exports to the EU of 3 percent. The EU had less of an impact on non-U.S. foreign suppliers of commodity foods, with exports falling 29 percent over the entire period, or 1 percent annually, on average. There is no statistical evidence that the EU discriminated against outsider suppliers of manufactured foods.

Results show that countries belonging to GAFTA reoriented imports from the United States and other foreign suppliers in both the commodity and manufactured food sectors. Parameter estimates show that the GAFTA countries lowered food imports from the United States by 8 to 9 percent per year, on average, since GAFTA's inception in 1998. In contrast, GAFTA curtailed imports from non-U.S. suppliers of commodity foods and manufactured foods at average annual rates of 4 percent and 3 percent, respectively.

SAPTA exhibited discriminatory patterns against both U.S. exporters and non-U.S. exporters of manufactured foods. In the manufactured food sector, SAPTA's imports from the United States fell by an annual average of 10 percent from 1996 to 2005, while its imports from the other foreign suppliers declined by 3 percent. In the commodity food sector, SAPTA curtailed its imports from the United States by 12 percent per year, on average. It did not, however, discriminate against non-U.S. foreign suppliers in this sector.

The ASEAN bloc also discriminated against the United States. On average, the ASEAN countries purchased 3 percent less manufactured food from the United States per year during 1993-2005 than would have been the case in the absence of this agreement. In sharp contrast to U.S. exporters, non-U.S. suppliers of manufactured foods to ASEAN actually increased their exports of manufactured foods to countries belonging to this bloc. This pattern suggests that ASEAN is a relatively open agreement overall, but not with respect to U.S. manufactured foods.

[25]There are a few instances where the gravity models generate negative MTD coefficients, but they are not statistically different from 0.

The United States also lost export market share to competitors due to the formation of CACM and MERCOSUR. While these two RTA blocs did not directly affect the volume of food imports from the United States, they adversely affected U.S. competitiveness vis-à-vis other suppliers.[26] In each case, bloc-member exporters and non-U.S. foreign suppliers increased sales of commodity and/or manufactured foods in the international marketplace.

COMESA is the only agreement that diverted trade away from non-U.S.-foreign suppliers but not against U.S. exporters. Since its inception in 1995, COMESA curtailed imports of manufactured foods from non-U.S. exporters by 3.5 percent annually. In contrast, imports from the United States did not drop below levels expected in the absence of this agreement.

U.S. food exports to the 10 foreign trading blocs did not increase as a result of RTA formation, except in the case of manufactured food exports to CER, which rose 2 percent per year on average. However, the 6-percent annual increase in trade between Australia and New Zealand and the 3-percent annual increase in non-U.S. suppliers' exports to CER exceeded the rise in U.S. exports of manufactured foods to the CER.

To examine the robustness of model specifications, ERS derived estimates using different combinations of RTAs (see columns 4 and 5 in tables 2 and 3). RTA parameter estimates using the OLS generalized gravity model for both bulk and manufactured foods are virtually identical when comparing food equations containing all 11 RTAs with corresponding regression models that included (1) the subset of RTAs comprising low-income members (i.e., ANDE, ASEAN, CACM, COMESA, GAFTA, MERCOSUR, SADC, and SAPTA) and (2) the subset of high-income RTAs (i.e., CER, EU, and NAFTA). Moreover, the statistical significance of 83 of the 86 parameter comparisons is the same.[27] The empirical results underscore model robustness to different combinations of RTAs.

To obtain information about how RTAs affect trade through time, comparisons are made of model estimations covering a 21-year period (1975-to-1994) with those spanning a 31-year period (1975-2005).[28] Not surprisingly, the intra-bloc trade creation coefficients for CACM, ASEAN, and NAFTA (i.e., ITC^{CACM}, ITC^{ASEAN}, and ITC^{NAFTA}) are not significantly different from zero for the 1975-94 period for either food sector. These three agreements entered into force near the end of the early period, in 1991, 1993, and 1994, respectively. Insufficient time elapsed for them to have had a discernable impact on food trade during the 1974-94 period.

As another example of estimated impacts over time, the intra-bloc trade-creation parameter estimates for the CER are positive and significantly different from zero for both the 21- and 31-year time spans. When the two-period ITC coefficients for commodity and manufactured foods (which, understandably, are smaller in magnitude for the shorter time frame) are converted into annual average percentage changes, they reveal that the CER induced greater change in intra-bloc trade creation in the early period—4 percent for commodity foods and 8 percent for manufactured foods—than for the 31-year period as a whole—3 and 6 percent for commodity and manufactured foods, respectively. These results are consistent with findings elsewhere in the literature that show that the impacts of RTA on trade are typically

[26] As an example, one reviewer pointed out that MERCOSUR increased Argentine exports of wheat to Brazil while the United States lost share as Argentina now had the advantage of not paying the 10-percent "common external tariff."

[27] The three exceptions include the XTC^{CACM} coefficient that is significant at the .05-level in the bulk equation, which excludes the high-income RTAs and the $MTD^{ANDE_non\text{-}US}$ and $MTD^{CACM_non\text{-}US}$ coefficients that are insignificant in the manufactured food equation, which also excludes the high-income RTAs.

[28] Empirical results are available from the authors upon request.

more pronounced during the first 10 to 15 years than afterward (Baier and Bergstrand, 2007; Grant and Lambert, 2008).

To examine more closely the diminishing effect of RTAs on trade through time, generalized gravity models are run covering the first 10 years of four agreements—ASEAN, CACM, CER, and NAFTA—and the 9-year period separating the EU12 from its expansion to the EU15 (following the accession of Austria, Finland, and Sweden). Results are compared with ITC parameter estimates taken from the 1975-2005 model runs. Table 6 shows RTA-induced effects on intra-bloc trade over two timespans for each of the aforementioned RTAs by converting ITC parameter estimates into average annual percentage changes.

In all cases, the empirical results depict larger impacts during the first decade than over the "life" of these agreements. For example, the average annual change of intra-NAFTA trade during the first 10 years of the agreement is 4 percent for commodity foods and 12 percent for manufactured foods. Corresponding figures for the 1975-2005 period as a whole are 3 percent for commodity foods and 8 percent for manufactured foods. In the case of the EU, the average annual percentage change of intra-EU trade through the EU12 period is 7 percent for commodity foods and 6 percent for manufactured foods. The corresponding EU figure for the 1975-2005 period is 3 percent for both commodity foods and manufactured foods.

Table 6
RTA-induced effects on intra-bloc trade over two time periods

Agreement	Commodity foods		Manufactured foods	
	First decade	Through 2005	First decade	Through 2005
ASEAN			0.08	0.06
CACM	0.08	0.07	0.07	0.05
CER	0.04	0.03	0.09	0.06
EU	0.07	0.03	0.06	0.03
NAFTA	0.04	0.03	0.12	0.08

Note: Percentage average annual change derived from parameter estimates that are statistically significant at either the 0.05 or 0.01 level using the formula $\left(e^{\delta \frac{1}{n}} - 1\right)$, where n = the number of years the RTA is in force.

Summary and Policy Implications

A primary motivation for countries to participate in trade agreements is to increase exports by reducing impediments to trade. Given that the international policy dynamics make negotiating a multilateral trade agreement extremely difficult, countries have resorted to the use of preferential agreements as a practical and feasible route to gain greater access to foreign markets. There are, however, tradeoffs in selecting this policy option. RTAs may become "stepping stones" that lead to more open world markets or "stumbling blocs" that discriminate against efficient suppliers and undermine support for multilateral trade liberalization. Empirical analysis can clarify these effects by gauging the actual impacts of individual agreements.

In this study, gravity models are estimated to identify the effects of 11 RTAs on intra- and extra-bloc trade in commodity and manufactured food markets. Empirical evidence reveals that most RTAs increased food trade in the international marketplace, but some also diverted trade away from more efficient suppliers. Not surprisingly, the rise in exports to partner markets was particularly pronounced when importers belonged to the same RTA as the exporter. The empirical findings also show that bloc-member exports often expanded to nonmember markets. Given the preferential treatment characteristic of RTAs, the rise in this extra-bloc trade was understandably less than the increase in intra-bloc trade, with ASEAN being the notable exception.

Empirical results show that since the time of its inception, the EU curtailed imports of commodity foods from the United States and from non-U.S. suppliers by an annual average of 4 percent and 1 percent, respectively. Such declines accumulate over time. For the 1975-2005 period overall, U.S. commodity food exports to the EU fell 66 percent while exports by non-U.S. suppliers declined 29 percent.[29]

The study also found that U.S. food exporters were more adversely affected than non-U.S. foreign suppliers by three other agreements; namely—ASEAN, GAFTA, and SAPTA. COMESA is the only agreement that diverted food trade from non-U.S. outside suppliers but not from U.S. exporters.

The majority of the 11 trade agreements examined in this study created trade in the commodity and manufactured markets while diverting comparatively little trade away from outside suppliers, with the exception of commodity food imports by the EU. This finding suggests that the benefits of RTAs generally outweigh costs in the international food marketplace. This inference is similar to the conclusion drawn by Vollrath and Hallahan (2011), a study of agricultural trade using generic RTA indexes.

[29]The United States promoted multilateral negotiations via the GATT during the 1960s and 1970s to counter discrimination inherent by the formation and expansion of the European Community (Bergsten, 1996). It is interesting that the concern about the erosion of exports by foreign suppliers due to the agreement uniting Europe proved to be prescient.

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Appendix table 1

Summary statistics for variables in the panel dataset

Variable	Mean	Std. deviation	Description
Xij_CF	53	(263)	Bulk commodity food trade between *i* and *j* (millions of U.S. dollars)
Xij_MF	131	(74)	Manufactured food exports by *i* to *j* (millions of U.S. dollars)
Yi	368	(1053)	Gross domestic product of importer *j* (billions of U.S. dollars)
Yj	362	(1055)	GDP of exporter *i* (billions of U.S. dollars)
EMij	5.19	(26)	Exchange-rate misalignment between *i* and *j*
FEij	23.85	(217)	Exporter-to-importer 0.1 hectare of arable land per worker in domestic labor force
DTij	7854	(4670)	Kilometers between the exporter *i* and importer *j*
CBij	0.0296	(0.1695)	Dummy: both countries share a common border
LLij	0.1243	(0.3299)	Dummy: If either or both countries are landlocked
LSij	0.2067	(0.4049)	Dummy: 9 percent or more of population in both countries sharing a common language
CHij	0.0144	(0.1192)	Dummy: existence of a colonial linkage after 1945
ITC^{ANDE}	0.0002	(0.0134)	Dummy: *i* and *j* in ANDE
XTC^{ANDE}	0.0091	(0.0947)	Dummy: *i* in ANDE, *j* outside of ANDE
MTD^{ANDE_US}	0.0002	(0.0133)	Dummy: U.S. as an exporter outside ANDE, *j* as an importer inside ANDE
$MTD^{ANDE_non\text{-}US}$	0.0094	(0.0966)	Dummy: non-U.S. exporter outside ANDE, *j* as an importer inside ANDE
ITC^{ASEAN}	0.0014	(0.0373)	Dummy: *i* and *j* in ASEAN
XTC^{ASEAN}	0.0285	(0.1663)	Dummy: *i* in ASEAN, *j* outside of ASEAN
MTD^{ANSEAN_US}	0.0005	(0.0215)	Dummy: U.S. as an exporter outside ASEAN, *j* as an importer inside ASEAN
$MTD^{ASEAN_non\text{-}US}$	0.0240	(0.1531)	Dummy: non-U.S. exporter outside ASEAN, *j* as an importer inside ASEAN
ITC^{CACM}	0.0027	(0.0517)	Dummy: *i* and *j* in CACM
XTC^{CACM}	0.0291	(0.1681)	Dummy: *i* in CACM, *j* outside of CACM
MTD^{CACM_US}	0.0007	(0.0259)	Dummy: U.S. as an exporter outside CACM, *j* as an importer inside CACM
$MTD^{CACM_non\text{-}US}$	0.0271	(0.1623)	Dummy: non-U.S. exporter outside CACM, *j* as an importer inside CACM
ITC^{CER}	0.0004	(0.0202)	Dummy: *i* and *j* in CER
XTC^{CER}	0.0260	(0.1592)	Dummy: *i* in CER, *j* outside of CER
MTD^{CER_US}	0.0004	(0.0202)	Dummy: U.S. as an exporter outside CER, *j* as an importer inside CER
$MTD^{CER_non\text{-}US}$	0.0234	(0.1512)	Dummy: non-U.S. exporter outside CER, *j* as an importer inside CER
ITC^{COMESA}	0.0005	(0.0225)	Dummy: *i* and *j* in COMESA
XTC^{COMESA}	0.0132	(0.1142)	Dummy: *i* in COMESA, *j* outside of COMESA
MTD^{COMESA_US}	0.0003	(0.0166)	Dummy: U.S. as an exporter outside COMESA, *j* as an importer inside COMESA
$MTD^{COMESA_non\text{-}US}$	0.0130	(0.1133)	Dummy: non-U.S. exporter outside COMESA, *j* as an importer inside COMESA
ITC^{EU}	0.0279	(0.1645)	Dummy: *i* and *j* in EU
XTC^{EU}	0.1615	(0.3679)	Dummy: *i* in EU, *j* outside of EU
MTD^{EU_US}	0.0028	(0.0531)	Dummy: U.S. as an exporter outside EU, *j* as an importer inside EU
$MTD^{EU_non\text{-}US}$	0.1555	(0.3623)	Dummy: non-U.S. exporter outside EU, *j* as an importer inside EU
ITC^{GAFTA}	0.0019	(0.0435)	Dummy: *i* and *j* in GAFTA
XTC^{GAFTA}	0.0171	(0.1297)	Dummy: *i* in GAFTA, *j* outside of GAFTA
MTD^{GAFTA_US}	0.0004	(0.0207)	Dummy: U.S. as an exporter outside GAFTA, *j* as an importer inside GAFTA
$MTD^{GAFTA_non\text{-}US}$	0.0217	(0.1457)	Dummy: non-U.S. exporter outside GAFTA, *j* as an importer inside GAFTA
ITC^{MERC}	0.0012	(0.0343)	Dummy: *i* and *j* in MERC

continued—

Appendix table 1

Summary statistics for variables in the panel dataset—continued

Variable	Mean	Std. deviation	Description
XTC^{MERC}	0.0216	(0.1455)	Dummy: *i* in MERC, *j* outside of MERC
MTD^{MERC_US}	0.0004	(0.0198)	Dummy: U.S. as an exporter outside MERC, *j* as an importer inside MERC
$MTD^{MERC_non\text{-}US}$	0.0181	(0.1333)	Dummy: non-U.S. exporter outside MERC, *j* as an importer inside MERC
ITC^{NAFTA}	0.0007	(0.0270)	Dummy: *i* and *j* in NAFTA
XTC^{NAFTA}	0.0267	(0.1613)	Dummy: *i* in NAFTA, *j* outside of NAFTA
$MTD^{NAFTA_non\text{-}US}$	0.0260	(0.1592)	Dummy: *i* outside of NAFTA, i inside NAFTA
ITC^{SADC}	0.0001	(0.0094)	Dummy: *i* and *j* in SADC
XTC^{SADC}	0.0042	(0.0644)	Dummy: *i* in SADC, *j* outside of SADC
MTD^{SADC_US}	0.0001	(0.0094)	Dummy: U.S. as an exporter outside SADC, *j* as an importer inside SADC
$MTD^{SADC_non\text{-}US}$	0.0044	(0.0659)	Dummy: non-U.S. exporter outside SADC, *j* as an importer inside SADC
ITC^{SAPTA}	0.0011	(0.0325)	Dummy: *i* and *j* in SAPTA
XTC^{SAPTA}	0.0189	(0.1360)	Dummy: *i* in SAPTA, *j* outside of SAPTA
MTD^{SAPTA_US}	0.0004	(0.0189)	Dummy: U.S. as an exporter outside SAPTA, *j* as an importer inside SAPTA
$MTD^{SAPTA_non\text{-}US}$	0.0166	(0.1278)	Dummy: non-U.S. exporter outside SAPTA, *j* as an importer inside SAPTA