Bilateral Protection and Other Determinants of Trade:
A Gravity Model Approach

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Abstract

Border protection is thought to be a major impediment to trade, especially in agriculture. There are also many other forces shaping the global network of partner trade. This study uses the generalized gravity framework to distinguish among the different drivers of trade. The analysis focuses on dyadic determinants that either resist or aid partner trade in total merchandise and in selected agricultural markets. The global dataset used consists of bilateral trade among 70 countries in 1986, 1996, 2000, and 2004. Collectively, the 70 countries account for 85 percent of the world's cross-border trade in agriculture and 96 percent of its GDP. Empirical results lend support to the Heckscher-Ohlin explanation of trade, namely that relative factor endowments motivate cross-border trade. The results also show that tariff protection has not had an appreciable effect on either total merchandise or aggregate agricultural trade. However, trade in specific agricultural goods, such as meat and rice, was found to be severely constrained by the presence of bilateral tariffs.

Introduction

The WTO Doha Round was launched in 2001 with the aim of cutting tariffs, freeing up trade in industrial goods, and opening service markets. Initially, talks were scheduled to be completed by January 1, 2005. They remain, however, stalled after almost seven years of negotiations.

Presently, the prospects for a satisfactory resolution to the Doha Round are uncertain. The gap between the opposing WTO negotiators is wide, though members have recently acknowledged the need for greater flexibility on everyone's part if an agreement is to be achieved. The United States has been resistant to make concessions in the Doha negotiations, given insufficient offers of increased market access by its trading partners.. The Europeans have expressed some willingness to lower their agricultural tariffs. But they would like to spare many "sensitive" products, such as beef and poultry. Japan wants to continue excluding rice from competitive world market forces. Many developing countries desire greater access to foreign markets, but they are also interested in protecting their sensitive products. India, for example, has designated most of its major agricultural crops (i.e., grains oilseeds, fruit, dairy) as special products that will not be liberalized.

Belief in the benefits of more open markets, has led many countries to purse bilateral free-trade pacts as an alternative and/or complement to a new multilateral trade agreement. Since 2004, the United States completed agreements with Australia, Morocco, and Central America (including the Dominican Republic). More recently, agreements were negotiated with Panama, Peru, and South Korea.

This study uses the generalized gravity framework to gain a better understanding of the forces driving bilateral trade, including that of bilateral protection. The gravity model isolates the impact of any signal driver of trade by controlling for the influences of all other determinants.

The applied analysis focuses on trade for total merchandise, total agriculture, land-based commodities, processed foods, and specific product markets (namely, wheat, rice, red meat, and beer). It uses a dataset consisting of 70 countries trading with each other in four time periods, 1986, 1996, 2000, and 2004.

Evolving trade patterns

In the past decade global trade for all goods has grown faster than world GDP, increasing from 17 percent of world GDP to 23 percent in 2005. Agricultural continues to decline as a share of total trade. However, agricultural commodity and product trade has also grown substantially, increasing more than 50 percent since 2001. Trade growth is taking place at very different rates among trading partners and among the various agricultural goods. World fruit and vegetable trade has, for example, outpaced trade in traditional commodities such as cereals and livestock products (figure 1). Moreover, agricultural trade growth among NAFTA and the EU regions continues to outstrip world agricultural trade (figure 2).

Interestingly, the growth in total merchandise and agricultural trade has occurred despite the lack of progress negotiating lower tariffs. Agricultural trade between Canada and the United States became considerably larger in the past few years than what could have been predicted based upon tariff removal. The increase in regionalized agricultural trade is also surprising in view of the fact that the major free trade agreements were enacted decades earlier. Given the recent expansion of partner trade, the extent to which trade policies constrain trade is unclear.

Variations in ad-valorem tariffs

The lack of uniformity in tariffs across countries and commodities (table 1) and the multitude of factors driving agricultural trade complicate analysis of the impact that trade policy exerts. Supply and demand forces, such as relative costs of production, consumer income, and differential tastes and preferences costs operate throughout domestic and foreign markets and influence the direction, composition, and volume of trade. In addition to these fundamental market forces, both impediments and inducements, such as economic geography and the institutional environment help shape the global network of trade. The extent to which the various factors affect partner trade varies with time and over the spectrum of product trade. In this study, the generalized gravity framework is used to identify the drivers of trade and to isolate their impacts.

The study focuses on trade in the overall merchandise market, the aggregate agricultural market and two agricultural subsectors which comprise all farm-level commodities and all processed food and beverages. In addition, specific commodity/product markets are examined. Contrasts and comparisons are drawn that show the sensitivity of trade in the different markets to the factors that determine who-trades-what-with-whom.

The generalized gravity framework

The basic gravity equation, though the workhorse of empirical analysis of many years, lacks a theoretical foundation. Anderson (1979) was the first to draw linkages to economic theory. The generalized framework he developed incorporates the Armington assumption that goods produced by different countries are inherently imperfect substitutes by virtue of their provenance. This framework also assumes complete specialization in production and identical, homothetic preferences across regions approximated by a CES (constant-elasticity-of-substitution) utility function.

Anderson and van Wincoop (2003, 2004) enhanced the generalized gravity framework by incorporating an economic structure that addresses equilibrium of expenditures and production within and among trading countries. They assume that prices differ between regions due to trade costs—costs that are unobservable, but which can be inferred from instrumental variables. Anderson and van Wincoop (AvW) manipulate the CES expenditure system and derive an operational model that links trade costs to both bilateral and multilateral barriers. Market-clearing conditions are imposed to solve for general-equilibrium prices, prices that embody partner resistances confronting both the exporter and the importer with all of their trading partners. The partner-based prices are summarized in terms of multilateral trade resistances.

In this study, we adopt the AvW framework which imposes market-clearing conditions follows:

$$X_{ij} = \left(\frac{Y_i Y_j}{Y_w}\right)\left(\frac{T_{ij}}{P_i P_j}\right)^{1-\sigma} \tag{1}$$

subject to

$$P_i^{1-\sigma} = \sum_j P_j^{\sigma-1} \theta_j T_{ij}^{1-\sigma}, \forall i \tag{2}$$

$$P_j^{1-\sigma} = \sum_i P_i^{\sigma-1} \theta_i T_{ij}^{1-\sigma}, \forall j \tag{3}$$

where X_{ij} is value of exports from *i* to *j*; Y_i, Y_j, and Y_w are the outputs of country *i*, *j*, and the world (*w*), respectively; σ is the elasticity of substitution between the countries' goods; T_{ij} denotes bilateral trade costs; P_i capture "outward multilateral resistances" that depend on all bilateral resistances for origin *i*; P_j embodies "inward multilateral resistances" for destination *j*; and the θ's denote income shares.

The framework in (1-3) informs us that bilateral trade, after controlling for country size, is determined by what is often described as "trade barriers," but which includes inducements as well as impediments. The main insight from (1-3) is that partner trade depends not just on bilateral "trade barriers" (ie, drivers), but also on multilateral resistances. A negative relationship exists between the bilateral barrier and partner trade, but a positive relationship exists between multilateral barriers and partner trade.

The gravity equation that emerges from (1-3) is consistent with economic theory:

$$x_{ij} = y_i + y_j + \sum_{m=1}^{M} \beta_m \ln(Z_{ij}^m) - (1-\sigma)\ln(P_i) - (1-\sigma)\ln(P_j) + \varepsilon_{ij} \qquad (5)$$

where lower-case variables (i.e., x and y) refer to logarithms, ε_{ij} to the disturbance term (reflecting measurement error), Z_{ij}^m to the vector of *m* proxies denoting observable impediments and inducements to trade, normalized such that $Z_{ij}^m = 1$ denotes zero influence.

Equation (4) is derived from a general equilibrium view of world trade based upon utility- and profit-maximizing behavior. Generalization permits relaxation of certain assumptions underlying the basic model, such as perfect arbitrage. One advantage of the modern gravity model is that it mitigates omitted-variable bias, a problem that plagues atheoretical gravity equations. The problem of omitted-variable bias arises in traditional gravity analyses because the multilateral resistances--which are not included as independent variables but which are embedded in the error term--are correlated with the bilateral trade barriers contained in the estimating equation.

Statistical model specification

The statistical model is estimated using ordinary least squares. Model specification, with country fixed effects suppressed for notational simplicity, is as follows:

$$\ln(X_{ijs}) = \beta_{1s}\ln(Y_i) + \beta_{2s}\ln(Y_j) + \beta_{3s}\ln(D_{ij}) + \beta_{4s}\ln(DY_{ij}) + \beta_{5s}\ln(DT_{ij})$$

$$+ \beta_{6s}\ln(EM_{ij}) + \beta_{7s}(CB_{ij}) + \beta_{8s}(LS_{ij}) + \beta_{9s}(CH_{ij}) + \beta_{10s}(BP_{ijs}) + \varepsilon_{ijs} \tag{6}$$

where subscripts *s* refers to either a sector, subsector, or individual commodity/product, *i* to the exporting country, and *j* to the importing country. X_{ijs} is the value of the bilateral trade flow between *i* and *j* for *s*.[1] Y_i is exporter's GDP, denoting the size of the supplying market. Y_j is importer's GDP, signifying the size of the demanding market. D_{ij} measures the distance between the two trading partners, a proxy for transportation costs. DY_{ij} is the absolute difference in per-capita income between trading partners. DT_{ij} quantifies exporter-to-importer land/labor ratios. EM_{ij} is an indicator of exchange-rate misalignment. BP_{ijs} measures border protection (expressed in terms of 1 plus ad-valorem tariff equivalents), that confront exporter *i* in *j*'s market for *s*. BP_{ijs} captures all forms of applied interventions including specific, variable, and compound tariffs; tariff-rate quotas; as well as partner special preferences embodied in free trade agreements.[2]

Other observable determinants impeding or inducing bilateral trade include 1) common borders (CB_{ij}), a dummy variable which equals 1 when *i* and *j* share a contiguous border and 0 otherwise; 2) language similarity (LS_{ij}), a dummy variable which equals 1 whenever nine percent or more of the population in both countries share a common language and 0 otherwise;[3] 3) colonial heritage (CH_{ij}), a dummy variable which equals 1 if two countries have established colonial ties since 1945 and 0 otherwise. α_i and γ_j are exporter and importer fixed effects.

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[1] We follow common practice and drop observations when *i* does not trade with *j*. This convention, which may lead to biased coefficients, circumvents the problem that the log of zero is not defined. In future analysis, we intend to employ a balanced trade matrix, one which will include zero trade observations.

[2] BP_{ijs} is calculated using applied, rather than bound tariffs rates. Applied rates are the actual tariff rates charged at the border by an importing country. Bounds rates are tariffs resulting from WTO negotiations or accessions that are incorporated as part of a country's schedule of concessions.

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

The incorporation of the exporter dummy (α_i) and the importer dummy (γ_j) account for outward and inward multilateral prices, terms that Anderson and van Wincoop (2003) have shown to be central to specifications of gravity models that are consistent with theory. These fixed effects minimize statistical bias attributable to unobservable trade barriers affecting bilateral trade.

Capturing elusive economic concepts

The Linder effect

The DY_{ij} variable is designed to capture the Linder effect. Linder (1961) observed that suppliers of differentiated products produce primarily to satisfy the tastes of domestic consumers. This practice leads to trade among countries whose consumers have similar tastes. The null hypothesis that has been used to empirically test whether tastes and preferences affect the distribution of trade is that bilateral trade is a negative function of the absolute difference in per capita incomes in the two regions (Thursby and Thursby, 1987; Bergstrand, 1990).

Government border policies

Accurate quantification of tariffs, non-tariff barriers, trade preferences embodied in free trade agreements, and other border policies potentially affecting partner trade presents many challenges, especially given the variety and complexity of available policy instruments and their (uneven) use distribution. Protection and special preferences are best measured using ad-valorem subsidy and tariffs equivalents (AVEs), calculated at the specific commodity/importer level. AVEs enable analysts to compare the level of government policies across country/commodity markets.

The development of comprehensive measures of bilateral protection/preferences that cover the many products traded among the many trading partners in the world presents many challenges. For example, transforming partner-specific *non-ad-valorem* measures, such as compound tariffs, tariff-rate quotas, and preferential trading agreements, into AVEs is a non-trivial task. Moreover, there is the challenge of how best to summarize protection/preferences at sector/subsector and/or regional levels. Ideally, aggregate measures are derived from detailed product/country AVEs. However, even when detailed data are available, there remains the challenge of how best to develop aggregate measures of protection/preferences that are representative. .

The common practice is to use import-weighted averages to gauge protection at aggregate levels. This approach suffers from endogeneity bias because of the inverse relationship between import flows and tariffs, (eg., the higher the tariff, the lower the flow). Leamer (1974) used world imports as a weighting scheme to circumvent endogeneity. Leamer's approach does not, however, account for the importer's specific trade profile. Bouët *et al.* (2005) developed a weighting scheme designed to address both the problem of endogeneity and the need to consider aspects of importer specificity. Use can also be made of partner-specific commodity compositional export shares to weight border-policy metrics in each market. The use of partner-product weights has the advantage of characterizing the importance of actual bilateral trade profiles.

In this study, the MAcMap database[4] is the primary source from which we obtain measures of protection/preferences. This database contains consistent and exhaustive measures of government border policies among 163 reporting countries trading 5,111 products with 208 partners in 2001. The creators of MAcMap have developed a sophisticated methodology that addresses many of the complexities measuring partner protection/preferences (Bouët *et al.*). The methodology addresses endogeneity and aggregation bias that afflict conventional approaches. It also identifies ways to harmonize

[4] Note, the measures of applied protection used in the GTAP framework are derived from the MAcMap database.

different types of tariffs, including ad-valorem, specific, mixed, mega, and tariff-rate quotas (TRQ).[5]

Exchange-rate misalignment

Finally, we use a measure of exchange-rate misalignment (EM_{ij}) to determine how financial linkages among countries affect food trade. According to economic theory, domestic prices of foreign currencies are neutral. Consequently, exchange rates are not expected to affect domestic or foreign decisions affecting supply and demand. But, policymakers express concern from time-to-time about over- and under-valued exchange rates. Witness, for example, the current public debate about the appropriate foreign-currency value of the Chinese renminbi. Moreover, the economic literature is replete with empirical evidence showing that market-determined exchange rates are often out of equilibrium. Dornbusch (1976) and Bergsten and Williamson (2003) show that prolonged departures of actual exchange rates from purchasing power parity are not uncommon phenomena, even for the developed countries having flexible exchange rates.

To test whether EM_{ij} adversely affects food trade, we modify Perée and Steinherr's (1989) indicator of "exchange-rate uncertainty" (EU_{ij}) which captures both current and accumulated experience:

$$EU_{ij} = V_t^1 + V_t^2 = \left[\frac{\max Z_{ij,t-k}^t - \min Z_{ij,t-k}^t}{\min Z_{ij,t-k}^t} \right] + \left[1 + \frac{\left| Z_{ij,t} - Z_{ij,t}^p \right|}{Z_{ij,t}^p} \right]^2 \qquad (7)$$

where max (min) $Z_{ij,\,t-k}$ is the maximum (minimum) value of the absolute value of the exchange rate index over time interval of size *k.* past period. The central notion underlying

[5] Systemized rules were used to convert mixed and compound tariffs into representative measures of protection. To account for TRQs, applied tariff rates were calculated that reflect marginal levels of protection from tariff fill-rates and the imposition of set of procedures. Filters were applied to render prohibitive or "mega" tariffs that exceed the lowest rate that would drive imports to zero.

V_t^1 is that traders' uncertainty is conditioned by their memory of the high and low exchange rate over some relevant period, which we chose to be 10 years (the range that both Cho *et al.* and Perée and Steinherr also selected). V_t^2 adds more recent information. It puts the contemporaneous exchange rate into historical perspective. To calculate this second component, we follow the practice adopted by Rosenberg (2003) and take the mean of real exchange rates over a 30-year period (1975-2004) as the proxy measure for the purchasing-power equilibrium rate.

EM_{ij} differs from EU_{ij} in that the former is calculated using real (2000) exchange rates, while the latter is derived from nominal rates. Both are indicators that embody notions of volatility and uncertainty which can be described as approximating exchange-rate misalignment.

Data

We have assembled a cross-sectional data set for 70 countries for 1986, 1996, 2000, and 2004.[6] This data set includes all countries for which we could obtain reliable macroeconomic data on exchange rates and years for which both governance indicators and information about bilateral trade flows were available. The 70 countries accounted for 85 percent of the world's cross-border trade in agriculture and 96 percent of global GDP and in 2002.

Data sources:

- The data on bilateral trade were derived from *UN Comtrade* compiled at the United Nations by UN Statistical Office. We used WTO's definition of agriculture to base

[6] The 70 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, Zambia, and Zimbabwe.

our calculation of total agricultural trade. Agricultural subsector and commodity definitions are based on product classifications developed at the Economic Research Service, USDA.

- Distance between capital cities and/or the major commercial center closest between partner countries were calculated using the great circle method obtained from the Agricultural Research Service of USDA.
- Measures of border policies were derived from the MAcMap database and knowledge of the existence of free-trade agreements.
- The data on bilateral exchange rates, derived from information secured from International Financial Statistics of the International Monetary Fund and Financial Statistics of the Federal Reserve Board, came from the Economic Research Service, USDA.
- Information about arable land came from the United Nations, Food and Agricultural Organization's *FAOSTAT*.
- Data about colonial heritage and language similarity were obtained from Andrew Rose's website.
- All other data came from the *World Development Indicators* World Bank.

Empirical findings

Primary supply and demand determinants

Relative factor endowments

Heckscher-Ohlin (H-O) theory leads one to expect that agricultural trade would be positively related to the exporter-to-importer land/labor ratio because the production of agricultural goods requires relative intensive use of land. The theory also indicates that merchandise trade may be negatively related to the relative land/labor ratio factor endowments as most goods use more labor than land in production. Our empirical results--

with negative coefficients for total merchandise trade and positive coefficients for agricultural trade (whether the latter includes the entire sector, the land-based or processed food subsectors, or the individual agricultural product/commodities (i.e., wheat, rice, red meat, and beer)—lend support to the H-O explanation of trade (tables 2-9).[7]

At first blush, a simplified extension of H-O logic to trade in the processed-food subsector (as well as for beer) led us to hypothesis a negative relationship between trade and the exporter-to-importer land/labor ratio. We noted that the production of processed food products likely uses labor more intensively than land, favoring exporters who possess a greater supply of labor than land in comparison with their trading partners. Interestingly, the empirical results revealed a positive, not negative, relationship between trade in processed foods and DT_{ij}. This finding led us to a more sophisticated interpretation of the empirical results, one that focused on the *derived* demand for land in the case of processed food:

We recalled that primary commodities, such as grains, oilseeds, and other basic staples, are essential inputs in the production of processed foods; and reasoned that as these commodity inputs are used intensively in manufacturing food, they may be viewed as embodying the land resource base. Given this view, our empirical results suggest that the *derived* demand for land relative to the availability of the labor supply in exporter and importer markets is an important driver of trade in processed foods.

Income similarities/dissimilarities

Both positive and negative parameter estimates were generated for DY_{ij} --the variable denoting the absolute difference in per-capita incomes between trading partners. The

[7] Interestingly, the elasticities of DT_{ij} with respect to wheat and red meat are considerably larger than either the corresponding elasticities for aggregate agriculture or the two agricultural subsectors. These results show that the agricultural sector and the two agricultural subsectors contain products that are not as dependent on the relative availability of land as are wheat and red meat.

negative coefficients generated for processed foods, and also for beer, support the Linder hypothesis. These results show that two countries with similar tastes and preferences (proxied by comparable per-capita income), trade more with each other in differentiated products than with partners having dissimilar types of demand.

Positive DY_{ij} parameters demonstrate that as the value of DY_{ij} widens—that is to say, the per-capita income between two countries diverge—trade increases. Divergence in per capita income between trading partners is a proxy for partner disparity in their levels of development and differences in comparative advantage. Model results show that income dissimilarity increases partner trade in total merchandise and agricultural trade, a not unexpected finding given differences in production specialization patterns among countries within these aggregate sectors.

Geographical and cultural distance

Transportation costs

Transportation costs, proxied by physical distance, generally deter trade in total merchandise more than in total agriculture. Trade in processed foods, however, is constrained more by transportation costs than is total merchandise trade. The 1986-1996-2000-2004 average D_{ij} elasticity with respect to merchandise trade is -1.23, while the corresponding average elasticity for processed foods is -1.45. The average D_{ij} elasticity for wheat, rice, and meat over the same 4-year period is higher, equaling -1.00.

The distance elasticities with respect to trade of the basic commodities are less sensitive than is the corresponding elasticities of manufactured goods and processed foods. This finding provides support to the proposition that foreign manufacturers face greater competition from domestic sources of supply in the importing countries than do exporters of primary agricultural commodities. Given the substitutability between locally-produced and foreign supply sources for the raw agricultural ingredients used to manufacture processed foods, it is understandable why trade in these goods is more sensitive to transportation costs than are the primary agricultural commodities where the location of production is dependent upon the world-wide distribution of land.

In all the markets analyzed, transportation costs increased with time despite advances in technology. For example, the four individual agricultural commodity/product average fell steadily, decreasing from -0.78 in 1986 to -1.15 in 2004. Rising transportation costs are, no doubt, linked to the mounting world price for fuel.

Physical adjacency

The empirical results show no discernable impact whatsoever of common borders on merchandise trade in 1986, 1996, 2000, and 2004. In addition, CB_{ij} estimates were generally not significantly different from zero for processed agricultural products--foods that are more easily transported across long distances than unprocessed agricultural goods. Physical adjacency does, however, impart trade advantages in land-based agriculture and among the individual agricultural commodities examined.

To derive ad-valorem subsidy equivalents (ASE) for geographical contiguity from gravity-model parameters, it is necessary to make assumptions about the elasticity of substitution (σ). The elasticity of substitution is most assuredly smaller for aggregate sectors than for an individual commodity/product. Assuming that the σ for land-based agriculture is 5, ASE for sharing a common national border averages 7 percent (table 10). Assuming that the σ for an individual commodity/product is 10, geographic contiguity conveys trade advantages for countries sharing a common border that averages 14 percent for wheat, 13 percent for beer, 12 percent for red meat, and 5 percent for rice.

Cultural linkages

Cultural similarities/dissimilarities denote non-physical distance. Cultural ties lower the non-physical distance between two countries. In this study, cultural linkages are proxied by two variables, namely the ability of a significant proportion of the population in both countries to communicate in the same language and possession of a common colonial heritage.

Having the capability to converse in the same language facilitates communication and, therefore, is believed to foster commercial exchange. Indeed, the empirical results provide confirmation that language similarity bestows a trade advantage. Assuming that the σ for the aggregate sectors is 5, the ad-valorem subsidy equivalent for language provides a competitive advantage that averages 17 percent for total merchandise trade and between 18 and 19 percent for trade in the two agricultural subsectors. Interestingly, the ability to communicate in the same language does not generally have a discernable trade effect in the wheat and rice foodgrain markets. It does, however impart as much as a 6 to 8 percent advantage to partner trade in red meats and beer (under the assumption that the σ equals 10).

Model results show that the sharing of a common colonial heritage has a more pronounced impact on trade at the economy-wide and agricultural-sector levels than language similarity. The colonial-heritage ASE for total merchandise trade averages 24 percent for total merchandise trade and 32 percent for the agricultural sectors. These findings suggest that the motivation for trade during the colonial era, when the industrializing and the developing countries exchanged manufactured items for agricultural goods, established commercial networks that convey a trade advantage to this day.

Economic policies

Financial sector policies

Price distortions attributable to exchange-rate deviations from equilibrium values were found to generally lower trade. For example, when the U.S. dollar was undervalued in 1996, the exchange-rate-misalignment elasticity with respect to trade was -0.41 for the agricultural sector, -0.49 for land-based commodities, and -.62 for processed foods. Corresponding EM_{ij} elasticities were -0.64, -0.25, and -0.50 in 2000 when the U.S. dollar was overvalued.

Border protection

The generalized gravity model for total merchandise shows that the impact of applied protection on partner trade, after controlling for the influence of the other determinants, is not significantly different from zero. This finding is not surprising given the GATT/WTO liberalization that has lowered worldwide tariffs on most goods.

Government protection remains high in agriculture, in contrast to manufactured goods. Yet, model results for aggregate agricultural trade also show no statistically significant impacts of border policies. Given the skewed distribution of protection across the sector, with most products being freely traded among countries, this finding is also not surprising. Clearly, fundamental supply and demand determinants, such as relative factor endowments, transportation costs, and market size, are more important drivers of agricultural trade for the sector as a whole than are government border policies.

The impact of restrictive tariffs is best evaluated at the specific commodity/product level. In the case of wheat, the BP_{ij} elasticities are not significantly different from zero; again, a not unexpected finding given that wheat is a freely traded commodity. BP_{ij} parameter estimates are, however, consistently negative and statistically significant for rice and red meat. Bilateral protection elasticities with respect to rice trade (derived from mean BP_{ij} values) range from -0.4 to -0.5. Corresponding elasticities for red meat fall within the -1.0 to -1.3 range.

Conclusions

Economic theory informs us that at the individual country level, border protection raises domestic prices that harm local consumers and imposes losses on low-cost exporters that forego sales in the foreign market. At the global level, protection causes demand to contract and supply to expand, both of which distort price signals and lowers world welfare.

Theory also informs us that there are many other socio-economic and political-institutional determinants of cross-border trade, including market size, resource endowments, geographical proximity, tastes and preferences, cultural ties, and financial linkages. This paper used the generalized gravity framework to gauge the influence of the various factors driving the direction and volume of trade.

One noteworthy finding is that relative factor endowments matter. Parameter estimates for the exporter land-to-labor ratio relative to the importer land-to-labor were positive and statistically significant in all agricultural markets. By contrast, the relative-factor-endowment variable was negative and statistically significant for total merchandise trade in 1986, 1996, 2000, and 2004. These empirical results lend support to the Heckscher-Ohlin theory of comparative advantage.

Another important finding was that border protection was shown not to have had an appreciable effect on aggregate agricultural trade. The analysis established, however, that trade in specific agricultural goods has been severely constrained due to the presence of bilateral tariff protection.

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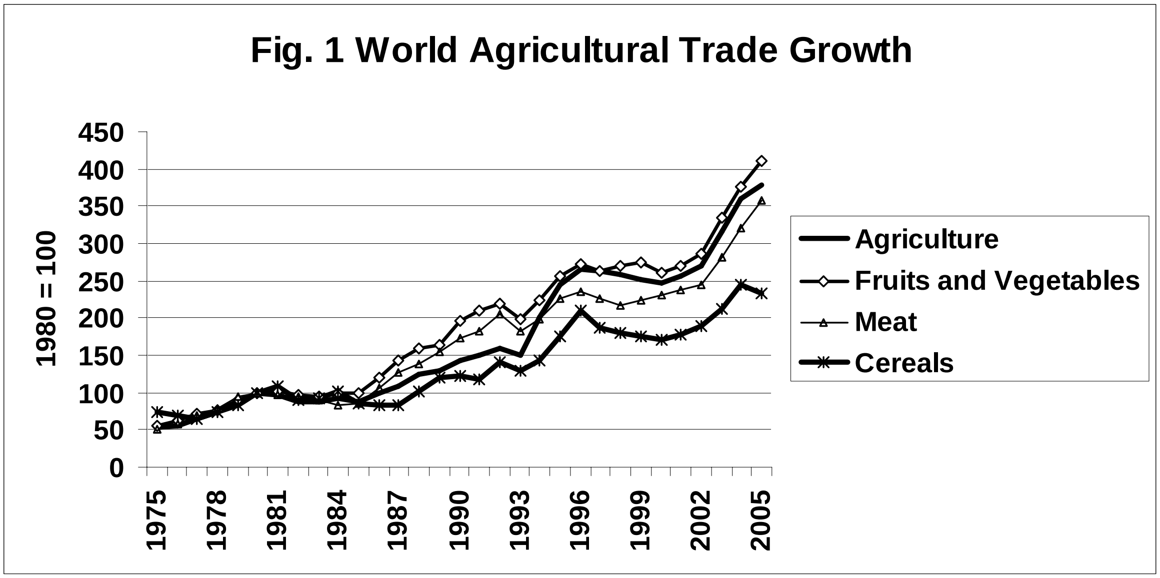
Fig. 1 World Agricultural Trade Growth
1980 = 100
450
400
350
300
250
200
150
100
50
0
1975
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005
Agriculture
Fruits and Vegetables
Meat
Cereals

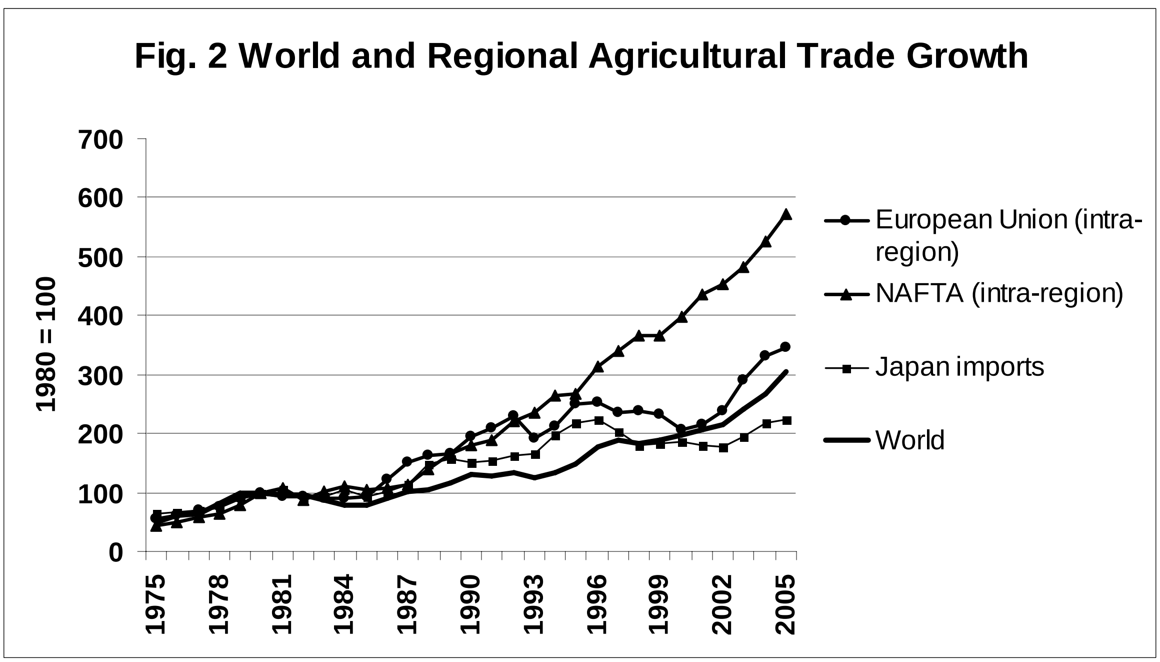
Fig. 2 World and Regional Agricultural Trade Growth
1980 = 100
700
600
500
400
300
200
100
0
1975
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005
European Union (intra-region)
NAFTA (intra-region)
Japan imports
World

Table 1: Agricultural Import Tariffs for Selected Importers (ad valorem rates)

	Australia	China	Japan	Philippines	India percent	Zimbabwe	Nigeria	Turkey	USA
Rice	0.0	0.4	796.0	24.7	25.0	0.0	37.4	31.8	5.1
Wheat	0.0	0.9	183.1	5.0	0.0	0.0	5.0	26.8	0.0
Coarse grains	0.0	87.7	38.6	28.1	0.0	0.0	0.0	56.6	0.0
Fruits and vegetables	1.1	24.8	14.0	9.3	40.2	25.0	75.0	37.1	0.6
Meat	0.0	15.0	46.8	21.3	44.0	8.3	31.3	39.8	1.7
Beer	9.7	41.4	15.1	5.8	125.9	60.0	120.5	15.9	1.4
Land-based commodities	0.3	27.8	197.7	14.8	33.3	10.3	29.4	35.9	3.6
Processed food	2.4	17.9	9.5	6.2	40.4	18.8	25.2	13.9	2.5

Source: MacMaps(2004) ad-valorem equivalent measures

Table 2: Total merchandise trade: Generalized gravity equation coefficients

Variables	Symbols	1986	1996	2000	2004
Exporter's income	Y_i	0.77*** (0.05)	0.91*** (0.04)	1.02*** (0.03)	1.02*** (0.04)
Importer's income	Y_j	0.79*** (0.04)	1.06*** (0.04)	1.00*** (0.03)	1.03*** (0.03)
Distance	D_{ij}	-1.19*** (0.04)	-1.24*** (0.04)	-1.29*** (0.04)	-1.21*** (0.04)
Income differences	DY_{ij}	0.10*** (0.02)	0.08*** (0.02)	0.07*** (0.02)	0.08*** (0.02)
Land/labor differences	DT_{ij}	-0.08*** (0.03)	0.00 (0.02)	-0.08*** (0.02)	-0.07*** (0.02)
Exchange-rate misalignment	EM_{ij}	-0.53*** (0.08)	-0.02 (0.11)	-0.37*** (0.11)	-0.24*** (0.08)
Language similarity	LS_{ij}	0.55*** (0.08)	0.71*** (0.07)	0.51*** (0.07)	0.69*** (0.07)
Colonial heritage	CH_{ij}	0.99*** (0.16)	0.76*** (0.15)	0.84*** (0.16)	0.80*** (0.17)
Common border	CB_{ij}	-0.13 (0.19)	-0.06 (0.16)	-0.06 (0.16)	-0.05 (0.16)
Bilateral protection	BP_{ij}	0.97 (0.96)	0.55 (0.81)	-0.67 (0.78)	-0.96 (0.79)
Adjusted R^2		0.74	0.80	0.81	0.81
Root mean square error		1.65	1.45	1.45	1.46
Number of observations		4200	4495	4651	4665

Parentheses denote t statistics based upon White's standard errors which are consistent and robust to heteroskedasticity. The * denotes the null hypothesis is rejected at the 0.10 significance level, ** at the 0.5 level, and *** at the 0.01 level.

Table 3: Total Agriculture trade: Generalized gravity equation coefficients

Variables	Symbols	1986	1996	2000	2004
Exporter's income	Y_i	0.74*** (0.04)	0.76*** (0.04)	0.82*** (0.04)	0.93*** (0.04)
Importer's income	Y_j	0.75*** (0.04)	0.86*** (0.03)	0.98*** (0.04)	0.92*** (0.03)
Distance	D_{ij}	-1.01*** (0.05)	-1.18*** (0.04)	-1.24*** (0.04)	-1.39*** (0.04)
Income differences	DY_{ij}	0.19*** (0.03)	0.13*** (0.02)	0.15*** (0.02)	0.08*** (0.02)
Land/labor differences	DT_{ij}	0.20*** (0.03)	0.13*** (0.02)	0.17*** (0.02)	0.16*** (0.02)
Exchange-rate misalignment	EM_{ij}	-0.56*** (0.07)	-0.41*** (0.12)	-0.64*** (0.13)	0.01 (0.10)
Language similarity	LS_{ij}	0.61*** (0.09)	0.66*** (0.08)	0.74*** (0.08)	0.74*** (0.08)
Colonial heritage	CH_{ij}	1.33*** (0.18)	1.19*** (0.17)	1.05*** (0.17)	1.06*** (0.18)
Common border	CB_{ij}	0.48* (0.21)	0.36 (0.18)	0.41** (0.18)	0.13 (0.18)
Bilateral protection	BP_{ij}	0.03 (0.27)	0.35* (0.21)	0.28 (0.23)	0.32 (0.23)
Adjusted R^2		0.67	0.71	0.73	0.73
Root mean square error		1.76	1.64	1.60	1.68
Number of observations		3509	3951	4117	4192

Parentheses denote t statistics based upon White's standard errors which are consistent and robust to heteroskedasticity. The * denotes the null hypothesis is rejected at the 0.10 significance level, ** at the 0.5 level, and *** at the 0.01 level.

Table 4: Trade in land-based agricultural commodities: Generalized gravity equation coefficients

Variables	Symbols	1986	1996	2000	2004
Exporter's income	Y_i	0.89*** (0.05)	0.78*** (0.04)	0.75*** (0.04)	0.85*** (0.05)
Importer's income	Y_j	0.95*** (0.04)	0.87*** (0.04)	0.90*** (0.04)	0.95*** (0.04)
Distance	D_{ij}	-0.96*** (0.05)	-1.08*** (0.04)	-1.14*** (0.04)	-1.30*** (0.04)
Income differences	DY_{ij}	0.16*** (0.03)	0.15*** (0.03)	0.15**** (0.02)	0.08*** (0.02)
Land/labor differences	DT_{ij}	0.27*** (0.03)	0.07*** (0.03)	0.08*** (0.02)	0.06*** (0.02)
Exchange-rate misalignment	EM_{ij}	0.02 (0.08)	-0.49*** (0.14)	-0.25* (0.15)	-0.14 (0.11)
Language similarity	LS_{ij}	0.56*** (0.10)	0.58*** (0.09)	0.71*** (0.08)	0.73*** (0.09)
Colonial heritage	CH_{ij}	1.16*** (0.21)	1.08*** (0.19)	0.90*** (0.18)	0.93*** (0.19)
Common border	CB_{ij}	0.61*** (0.21)	0.55*** (0.18)	0.51*** (0.18)	0.20 (0.19)
Bilateral protection	BP_{ij}	-0.32 (0.21)	0.01 (0.18)	0.23 (0.18)	0.20 (0.20)
Adjusted R^2		0.64	0.68	0.69	0.70
Root mean square error		1.83	1.76	1.68	1.82
Number of observations		3399	3843	3965	4073

Parentheses denote t statistics based upon White's standard errors which are consistent and robust to heteroskedasticity. The * denotes the null hypothesis is rejected at the 0.10 significance level, ** at the 0.5 level, and *** at the 0.01 level.

Table 5: Trade in processed foods: Generalized gravity equation coefficients

Variables	Symbols	1986	1996	2000	2004
Exporter's income	Y_i	0.32*** (0.05)	1.05*** (0.05)	0.82*** (0.05)	0.73*** (0.04)
Importer's income	Y_j	0.88*** (0.04)	0.78*** (0.05)	0.68*** (0.04)	1.03*** (0.04)
Distance	D_{ij}	-1.24*** (0.06)	-1.33*** (0.05)	-1.54*** (0.04)	-1.67*** (0.05)
Income differences	DY_{ij}	-0.02 (0.03)	-0.05** (0.03)	-0.03 (0.02)	-0.06*** (0.02)
Land/labor differences	DT_{ij}	0.26*** (0.03)	0.07** (0.03)	0.08*** (0.02)	0.19*** (0.02)
Exchange-rate misalignment	EM_{ij}	-0.51*** (0.08)	-0.62*** (0.16)	-0.5*** (0.14)	-0.02 (0.11)
Language similarity	LS_{ij}	0.65*** (0.11)	0.66*** (0.10)	0.72*** (0.09)	0.57*** (0.10)
Colonial heritage	CH_{ij}	1.18*** (0.23)	1.01*** (0.18)	1.05*** (0.16)	1.43*** (0.20)
Common border	CB_{ij}	0.27 (0.22)	0.40* (0.21)	0.19 (0.18)	0.15 (0.19)
Bilateral protection	BP_{ij}	0.02 (0.72)	0.28 (0.58)	-0.78 (0.52)	-0.41 (0.76)
Adjusted R^2		0.64	0.68	0.72	0.70
Root mean square error		1.73	1.63	1.56	1.71
Number of observations		2460	3109	3317	3503

Parentheses denote t statistics based upon White's standard errors which are consistent and robust to heteroskedasticity. The * denotes the null hypothesis is rejected at the 0.10 significance level, ** at the 0.5 level, and *** at the 0.01 level.

Table 6: Wheat trade: Generalized gravity equation coefficients

Variables	Symbols	1986	1996	2000	2004
Exporter's income	Y_i	1.15*** (0.14)	0.82*** (0.12)	0.91*** (0.13)	0.52*** (0.12)
Importer's income	Y_j	0.35** (0.17)	-0.14 (0.13)	-0.10 (0.13)	0.11 (0.15)
Distance	D_{ij}	-0.56*** (0.22)	-0.83*** (0.19)	-0.88*** (0.18)	-1.12*** (0.21)
Income differences	DY_{ij}	-0.14 (0.13)	-0.11 (0.11)	-0.19** (0.10)	-0.08 (0.10)
Land/labor differences	DT_{ij}	0.65*** (0.16)	0.23*** (0.12)	0.22** (0.11)	0.44*** (0.12)
Exchange-rate misalignment	EM_{ij}	0.85*** (0.26)	0.35 (0.49)	0.11 (0.45)	0.75 (0.48)
Language similarity	LS_{ij}	0.55 (0.37)	-0.49 (0.34)	0.48 (0.32)	-0.40 (0.38)
Colonial heritage	CH_{ij}	1.87** (0.86)	0.52 (0.73)	1.38** (0.69)	1.98*** (0.69)
Common border	CB_{ij}	1.00* (0.56)	1.17*** (0.44)	1.15** (0.45)	1.35*** (0.48)
Bilateral protection	BP_{ij}	0.30 (0.88)	-0.21 (0.92)	0.45 (0.80)	0.64 (0.70)
Adjusted R^2		0.50	0.50	0.43	0.52
Root mean square error		2.40	2.52	2.66	2.83
Number of observations		373	515	579	619

Parentheses denote t statistics based upon White's standard errors which are consistent and robust to heteroskedasticity.
The * denotes the null hypothesis is rejected at the 0.10 significance level, ** at the 0.5 level, and *** at the 0.01 level.

Table 7: Rice trade: Generalized gravity equation coefficients

Variables	Symbols	1986	1996	2000	2004
Exporter's income	Y_i	0.16** (0.08)	0.57*** (0.09)	0.56*** (0.09)	0.54*** (0.11)
Importer's income	Y_j	0.33*** (0.11)	0.47*** (0.10)	0.37*** (0.08)	0.39*** (0.12)
Distance	D_{ij}	-0.79*** (0.17)	-1.2*** (0.13)	-1.15*** (0.12)	-1.26*** (0.13)
Income differences	DY_{ij}	-0.25*** (0.07)	-0.24*** (0.07)	-0.11* (0.06)	-0.11* (0.06)
Land/labor differences	DT_{ij}	0.30*** (0.08)	0.30*** (0.05)	0.14** (0.07)	0.16** (0.07)
Exchange-rate misalignment	EM_{ij}	0.24 (0.28)	-0.50 (0.36)	-0.19 (0.40)	-0.26*** (0.32)
Language similarity	LS_{ij}	0.00 (0.29)	0.09 (0.25)	0.34 (0.25)	0.26*** (0.24)
Colonial heritage	CH_{ij}	-0.28 (0.59)	0.26 (0.54)	-0.36 (0.63)	-0.61 (0.50)
Common border	CB_{ij}	0.93** (0.42)	0.23 (0.35)	0.31 (0.37)	0.73** (0.34)
Bilateral protection	BP_{ij}	-0.95** (0.43)	-0.72* (0.42)	-0.70* (0.39)	-0.71* (0.40)
Adjusted R^2		0.43	0.47	0.39	0.48
Root mean square error		2.31	2.23	2.32	2.47
Number of observations		623	863	991	1118

Parentheses denote t statistics based upon White's standard errors which are consistent and robust to heteroskedasticity. The * denotes the null hypothesis is rejected at the 0.10 significance level, ** at the 0.5 level, and *** at the 0.01 level.

Table 8: Red meat trade: Generalized gravity equation coefficients

Variables	Symbols	1986	1996	2000	2004
Exporter's income	Y_i	0.05*** (0.07)	0.18** (0.08)	0.12* (0.06)	0.07 (0.06)
Importer's income	Y_j	0.65*** (0.08)	0.57*** (0.07)	0.58*** (0.07)	0.5*** (0.07)
Distance	D_{ij}	-0.85*** (0.09)	-1.18*** (0.07)	-1.04*** (0.07)	-1.20*** (0.08)
Income differences	DY_{ij}	0.01 (0.06)	0.04*** (0.05)	-0.02 (0.04)	-0.03 (0.04)
Land/labor differences	DT_{ij}	0.36*** (0.06)	0.38*** (0.05)	0.44*** (0.04)	0.44*** (0.05)
Exchange-rate misalignment	EM_{ij}	-0.19 (0.21)	-0.20*** (0.25)	0.27 (0.26)	-0.59*** (0.23)
Language similarity	LS_{ij}	0.49** (0.20)	0.71*** (0.16)	0.66*** (0.16)	0.24 (0.16)
Colonial heritage	CH_{ij}	0.84** (0.34)	0.77** (0.31)	0.21 (0.35)	0.26 (0.30)
Common border	CB_{ij}	1.02*** (0.31)	1.09*** (0.26)	1.02*** (0.27)	1.02*** (0.23)
Bilateral protection	BP_{ij}	-2.60*** (0.43)	-2.01*** (0.39)	-2.31*** (0.41)	-2.50*** (0.46)
Adjusted R^2		0.50	0.59	0.56	0.59
Root mean square error		2.19	2.06	2.10	2.20
Number of observations		1429	1692	1748	1804

Parentheses denote t statistics based upon White's standard errors which are consistent and robust to heteroskedasticity. The * denotes the null hypothesis is rejected at the 0.10 significance level, ** at the 0.5 level, and *** at the 0.01 level.

Table 9: Beer trade: Generalized gravity equation coefficients

Variables	Symbols	1986	1996	2000	2004
Exporter's income	$\mathbf{Y_i}$	0.22**	0.53***	0.36***	0.36***
		(0.09)	(0.11)	(0.07)	(0.07)
Importer's income	$\mathbf{Y_j}$	0.86***	0.76***	0.78***	0.68***
		(0.09)	(0.08)	(0.07)	(0.06)
Distance	$\mathbf{D_{ij}}$	-0.90***	-1.11***	-1.15***	-1.13***
		(0.10)	(0.08)	(0.07)	(0.08)
Income differences	$\mathbf{DY_{ij}}$	-0.19***	-0.10**	0.01	0.06
		(0.06)	(0.05)	(0.04)	(0.05)
Land/labor differences	$\mathbf{DT_{ij}}$	0.18***	0.14***	0.09**	0.01
		(0.07)	(0.05)	(0.04)	(0.04)
Exchange-rate misalignment	$\mathbf{EM_{ij}}$	-0.35**	0.15	0.23	-0.81***
		(0.18)	(0.24)	(0.26)	(0.21)
Language similarity	$\mathbf{LS_{ij}}$	0.20	0.15	0.51***	0.53***
		(0.20)	(0.16)	(0.15)	(0.16)
Colonial heritage	$\mathbf{CH_{ij}}$	-0.48	0.06	0.27	0.56*
		(0.36)	(0.33)	(0.30)	(0.29)
Common border	$\mathbf{CB_{ij}}$	1.08***	1.24***	0.81***	1.28***
		(0.34)	(0.26)	(0.25)	(0.27)
Bilateral protection	$\mathbf{BP_{ij}}$	-1.11	-1.09**	-0.40	-0.23
		(0.73)	(0.45)	(0.41)	(0.48)
Adjusted R^2		0.53	0.58	0.56	0.60
Root mean square error		1.77	1.77	1.78	1.89
Number of observations		800	1251	1346	1436

Parentheses denote t statistics based upon White's standard errors which are consistent and robust to heteroskedasticity. The * denotes the null hypothesis is rejected at the 0.10 significance level, ** at the 0.5 level, and *** at the 0.01 level.

Table 10: Ad-valorem tariff equivalent effects for language similarities, colonial heritage, and common border

	Symbols	1986	1996	2000	2004	1986	1996	2000	2004
			$\sigma = 5$				$\sigma = 10$		
Total merchandise	LS_{ij}	0.15	0.19	0.14	0.19	0.06	0.08	0.06	0.08
Total merchandise	CH_{ij}	0.28	0.21	0.23	0.22	0.12	0.09	0.10	0.09
Total merchandise	CB_{ij}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total agriculture	LS_{ij}	0.16	0.18	0.20	0.20	0.07	0.08	0.09	0.09
Total agriculture	CH_{ij}	0.39	0.35	0.30	0.30	0.16	0.14	0.12	0.12
Total agriculture	CB_{ij}	0.00	0.00	0.11	0.00	0.05	0.00	0.05	0.00
Land-based agric.	LS_{ij}	0.15	0.16	0.19	0.20	0.06	0.07	0.08	0.08
Land-based agric.	CH_{ij}	0.34	0.31	0.25	0.26	0.14	0.13	0.11	0.11
Land-based agric.	CB_{ij}	0.00	0.15	0.14	0.00	0.07	0.06	0.06	0.00
Processed foods	LS_{ij}	0.18	0.18	0.20	0.15	0.07	0.08	0.08	0.07
Processed foods	CH_{ij}	0.34	0.29	0.30	0.43	0.14	0.12	0.12	0.17
Processed foods	CB_{ij}	0.00	0.11	0.00	0.00	0.00	0.05	0.00	0.00
Wheat	LS_{ij}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wheat	CH_{ij}	0.60	0.00	0.41	0.64	0.23	0.00	0.17	0.25
Wheat	CB_{ij}	0.28	0.34	0.33	0.40	0.12	0.14	0.14	0.16
Rice	LS_{ij}	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.03
Rice	CH_{ij}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rice	CB_{ij}	0.00	0.00	0.00	0.20	0.11	0.00	0.00	0.08
Red meat	LSij	0.13	0.19	0.18	0.00	0.06	0.08	0.08	0.00
Red meat	CHij	0.23	0.21	0.00	0.00	0.10	0.09	0.00	0.00
Red meat	CBij	0.00	0.31	0.29	0.29	0.12	0.13	0.12	0.12
Beer	LS_{ij}	0.00	0.00	0.14	0.14	0.00	0.00	0.06	0.06
Beer	CH_{ij}	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.06
Beer	CB_{ij}	0.00	0.36	0.22	0.38	0.13	0.15	0.09	0.15

σ denotes the elasticity of substitution.
AVEs were assumed to equal zero when underlying parameter estimates were not statistically significant.