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TRADE LIBERALIZATION WITH ENDOGENOUS EXCHANGE RATES

Barry Krissoff
Nicole Ballenger

Agriculture and Trade Analysis Division
Economic Research Service/USDA
1301 New York Ave., N.W.
Washington, D.C. 20005-4788

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Abstract

"Trade Liberalization with Endogenous Exchange Rates." Barry Krissoff and Nicole Ballenger (ERS, USDA).

Impacts of agricultural and nonagricultural trade liberalization on agriculture are assessed in a multi-commodity, multi-country framework. By modeling simulataneously all goods sectors of the economy, we evaluate the importance of (1) relative rates of protection between sectors and (2) exchange rate adjustments that follow trade liberalization in a world of floating rates.

TRADE LIBERALIZATION WITH ENDOGENOUS EXCHANGE RATES

Introduction

The United States and other members of the General Agreement on Tariffs and Trade (GATT) have recently begun to participate in an eighth round of multilateral trade negotiations (MTN) in which resolving agricultural issues is a top priority. The importance of agriculture in these negotiations is related to current problems in the international agricultural trade environment. Although many factors account for adverse agricultural market conditions, the agricultural policies of trading countries are thought to be important contributors to mounting surpluses, falling commodity prices, and declining agricultural trade values in the eighties. Trade barriers, price and income support programs, and other domestic agricultural policies buffer agricultural producers in many countries from world price movements and discourage supply adjustments.

Most analyses of agricultural protectionism are conducted using a partial equilibrium approach. For example, the OECD and World Bank studies examine a reduction in protection in a multi-agricultural commodity model but do not consider nonagricultural sectors. Yet a reduction in protection for the nonagricultural sector can cause changes in nonagricultural and agricultural prices, and changes in relative prices across countries via exchange rate movements. This would influence resource allocations across sectors and countries and thereby affect agricultural production, consumption and trade. The nonagricultural component of the economy may have even more influence on the sector than sector-specific policies.

In view of the potential importance of a broad-based framework, we develop a multi-commodity, multi-country static model and attempt to assess the effects of complete (agricultural and nonagricultural) trade liberalization on the agricultural sector. By modeling simultaneously all goods sectors of the economy, we are able to compare a total trade liberalization scenario in which exchange rates are endogenous--that is, they adjust until the value of the trade balance returns to its initial level--with a scenario in which only agricultural trade is liberalized and there are assumed to be no exchange rate effects.

To undertake the scenarios, we use a static world policy simulation model (SWOPSIM) (Roningen) which includes eight countries/regions [United States, European Community, Japan, Canada, Argentina, Brazil, Mexico, and rest-of-world (ROW)] and a breakdown of commodities for each country into agricultural goods (wheat, corn, soybeans, rice, sugar, dairy, beef and poultry), a composite 'other' agricultural good, a composite nonagricultural traded good and a composite nontraded good. A base level (1984) is established for consumption and production, consumer prices, producer prices, and world prices. For each country, producer and consumer prices (or the implicit per unit values) deviate from world price by the ad valorem rate of protection. The levels of government intervention in agriculture are measured by producer and consumer subsidy equivalents (ERS). For nonagricultural goods, ad valorem tariff and nontariff barrier tariff-equivalent rates are used for protection measures (Whalley; Anjaria, et.al.).

Analytical Framework

The framework for this analysis has its origins in studies by Valdez (1985) and Deardoff and Stern (1986). We set up a "more complete" partial equilibrium model with all produced and consumed goods specified in demand and supply functions. The model falls short of a general equilibrium characterization since factor markets are not explicitly described. However, our approach has the advantage over agricultural sector models of accounting for feedback from one sector to another as relative prices alter. Additionally, because all goods in the economy are accounted for and, hence, the total balance of trade, the exchange rate can be modeled endogenously and the effect of floating rates (or exchange rate liberalization) can be evaluated.

The model is developed for m countries/regions, i = 1 to m, producing and trading n goods, j = 1 to n, and producing additionally a nontraded good, k. The traded goods include agricultural goods (j = 1,...,n-2), a composite "other" agricultural good, (j = n-1), and a composite nonagricultural good (j = n).

The demand and supply functions depend on all prices as delineated below:

DAij = DAij(PAij, PTin, PHik) (1)

DTin = DTin(PAij, PTin, PHik) (2)

DHik = DHik(PAij, PTin, PHik) (3)

SAij = SAij(PAij, PTin, PHik) (4)

STin = STin(PAij, PTin, PHik) (5)

SHik = SHik(PAij, PTin, PHik) (6)

where D and S are demand and supply equations, respectively, P are prices, A denotes agricultural goods, T represents the nonagricultural traded products either exported or imported, and H represents the nontraded good. The model excludes wages, factor rental rates, and income. 1/ Farm input prices are included implicitly in the price of nonagricultural goods faced by agricultural producers; likewise, agricultural prices represent both prices of inputs and prices of alternative outputs to nonagricultural producers.

The domestic economy reaches an equilibrium when home goods have an excess supply (ES) equal to 0 and when net traded goods (including

1/ Efforts are now underway to model income endogenously in this framework.

agricultural goods) equal "net capital flows" (F). F is defined as including capital and service accounts and accommodating changes in international reserves. For country i,

$$ESHik = SHik - DHik = 0 \qquad (7)$$

$$\sum_{j=1}^{n} PijESij = \sum_{j=1}^{n} PijSij - \sum_{j=1}^{n} PijDij = Fi. \qquad (8)$$

World markets clear when excess supply of a good across all countries is equal to zero. For agricultural commodities, this occurs when

$$\sum_{i=1}^{m} ESAij = \sum_{i=1}^{m} SAij - \sum_{i=1}^{m} DAij = 0 \qquad (9)$$

for each j, j = 1 to n - 1. For the nonagricultural good that is traded, n, equilibrium occurs when

$$\sum_{i=1}^{m} ESTin = \sum_{i=1}^{m} STin - \sum_{i=1}^{m} DTin = 0 \qquad (10)$$

The traded price in each country's home currency is:

$$PTij = Ei\ PWTj \qquad (11)$$

where Ei equals home currency per U.S. dollar, PWTj is the world dollar price of good j for all traded j's. The exchange rate is assumed to be exogenously determined--an assumption to be relaxed later.

Various government policies can place a wedge between the world price of a traded good and the domestic price or implied per unit value of that good. (In the model, we assume no transportation costs or margin markups.) Consider the possibility that the home country affects traded prices (prices faced by producers and consumers) by either imposing an ad valorem subsidy or tax on exports or imports. This has the effect of modifing equation (11) to

$$PTij = Ei\ PWTj\ (1 + tij) \qquad (12)$$

where tij can be interpreted as an export subsidy or import tariff ($tij > 0$), or export tax or import subsidy ($tij < 0$) and is assumed to be exogenous. If the home country wants to encourage (discourage) exports, it can subsidize (tax) exports implying $t > 0$ ($t < 0$). If the home country wants to discourage (encourage) imports, it can tax (subsidize) imports implying $t > 0$ ($t < 0$).

A shock to the system--in terms of a change in protection in either sector of the economy, in any country or commodity market--leads to changes from base values in quantities produced, consumed, and traded and world and domestic prices. The system also determines either (1) changes in each country's balance of trade under the assumption of fixed exchange rates and the availability of external financing or (2) changes in each country's exchange rate under the assumption of floating rates which return all countries' trade balances to their initial equilibria. Thus, in the second case, we are assuming that changes in trade protection can change currency values depending on the elasticities of demand and supply for traded and nontraded goods. Since the elasticities approach does not consider a world with capital flows, we are implicitly assuming that the shock impacts only on the trade balance and does not induce changes in capital flows.

Through a series of differentiations and substitutions (see Appendix), we can obtain an expression for changes in balance of trade (which equals changes in net capital outflows) in terms of changes in protection and exchange rate policies, and changes in world prices of both agricultural and nonagricultural traded goods:

$$(\Pi 1 + \Pi 2)E^* + \Pi 1[PWA^* + (1 + tA)^*] + \Pi 2[PWT^* + (1 + tT)^*] = F^* \qquad (13)$$

where the *'s indicate percentage changes in variables and the Π's are parameters consisting of supply and demand elasticities and the shares of agriculture and nonagriculture in trade. (For the demand equations, the own price elasticities are negative and the cross price elasticities are positive or negative depending on whether the products are substitutes or complements. The reverse holds for the supply equations. Additionally, cross price effects are negative on goods that represent inputs into the production process, e.g.

the nonagricultural good price may represent the price of farm inputs as well as the price of alternative outputs.)

Under a fixed exchange rate system, E*=0, the balance of trade changes in response to changes in protection in the agriculture and nonagriculture sectors and changes in the world prices of traded goods. External financing is assumed to be forthcoming to balance the change in the value of net trade. 2/ In the small country case (unilateral changes in protection do not lead to world price changes) agricultural markets would be affected (a) directly by changes in the country's agricultural protection, and (b) indirectly by changes in prices of nonagricultural and nontraded goods resulting from changes in the country's nonagricultural protection. Additionally, when world prices and the trade balance both change following unilateral liberalization (the large country, fixed exchange rate case), the new world prices feed back to domestic prices in all countries and affect domestic production and consumption and, consequently, trade.

Under a floating exchange rate system, the country's currency would depreciate or appreciate following liberalization until the changes in the external imbalance are eliminated, that is, until F*=0. The change in protection and the ensuing exchange rate change both determine changes in domestic prices.

If the parameters of equation (13), Π1 and Π2, are positive, then a reduction in protection leads to a depreciation of the exchange rate which offsets, to some extent, the negative impacts on domestic prices of a reduction in protection levels. If the agricultural protection levels are initially negative and nonagricultural protection is initially positive, then a reduction of protection can lead to a depreciation which would reinforce the positive impacts of liberalization on domestic agricultural prices.

2/ Trade policy changes do not directly influence capital flows, but do so indirectly in order to balance the trade account.

The appendix differentiates the entire system of equations and derives reduced form equations for prices and exchange rates in terms of the exogenous variables, protection in the agricultural and nonagricultural sectors.

Simulation Results

Although there are many alternative scenarios which we could have simulated, we chose two cases: (1) a 100 percent multilateral liberalization of agriculture for all countries under the assumption of fixed exchange rates for all countries/regions in the model, and (2) a 100 percent multilateral liberalization of all sectors for all countries under the assumption of endogenous exchange rates for all countries/regions in the model. These scenarios were designed not to predict actual outcomes of trade negotiations, but to explore the bias in agricultural trade liberalization analyses which do not account for cross-sector linkages or exchange rate effects of changes in protection.

A summary of the simulation process is as follows. For each commodity within a country, the removal of any subsidy or tax induces changes in domestic production and consumption and, consequently, imports and exports. This, in turn, may influence world prices if the liberalizing country has a large enough share of the world market. Production and consumption in all countries respond to these new world price signals until a new equilibrium is obtained. (Clearly, the effects are more intertwined and more difficult to trace when all countries eliminate barriers to trade for all goods in the model.) In the exogenous exchange rate scenario, countries' trade balances continue to adjust until all world markets clear and domestic equilibrium conditions for the nontraded good are met. In the endogenous exchange rate case, movements in the trade balances (away from the initial equilibria) put pressure on the exchange rates which continue to adjust, influencing prices, production, and consumption, until the initial trade balances are restored and the other equilibrium conditions are met.

In tables 1 and 2, we report selected results focusing on the effects of liberalization on world agricultural prices, exchange rates, and trade. In tables 3 and 4A-C, we present measures of economic well being--domestic product and welfare gains or losses resulting from liberalization. Domestic product is computed by multiplying world prices (in local currency terms) times quantities supplied. The welfare measures are based on producer and consumer surpluses and government expenditures/revenues (not reported), the sum of which represents deadweight gains or losses. 3/

In both scenarios, world prices of all agricultural goods, except soybeans, rise. In percentage terms, sugar prices increase the most (33 percent in scenario 1 and 36 percent in scenario 2), followed by dairy prices (22 percent in scenario 1 and 25 percent in scenario 2), reflecting the relatively high levels of protection in these commodity markets. (Note, though, that the new domestic prices of the goods are often lower than initial domestic prices which included the trade barriers.) Soybean prices decline because of the increased Argentine and Brazilian exports following the removal of producer taxes and consumer subsidies in these countries (Krissoff and Ballenger).

The impacts on world prices are similiar in the two scenarios. However, it is interesting to note that total liberalization, and the resulting

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3/ The reduction of protection using tax and subsidy equivalents or nontariff barriers may not involve any actual government revenue loss or expenditure reduction. For instance, an import quota does not increase government revenue but, instead, allows the exporters to sell at a higher price in the import market and obtain economic rent. We implicitly assume that the government of the importing country is able to charge a quota fee to exporters and that the fee is equivalent to tax revenue. By making this assumption we are overstating the losses of government revenue when quotas are removed and, hence, may be distorting the welfare changes for the individual countries, although not for the world as a whole. The reader should be aware of this measurement problem in the discussion below. For details and limitations on the welfare measures see Haley, Dixit, and Roningen.)

exchange rate movements, tends to reinforce the price impacts of liberalization confined to the agricultural sector. The largest difference in price impacts is found in the rice market. This is driven by an appreciation in ROW's currency which reduces ROW's willingness to export rice at the lower domestic price (in comparision to the fixed exchange rate case). Combining this exchange rate effect with the elimination of the very high protection of Japanese rice places additional upward pressure on the world rice price. Another noticeable difference in price impacts is found in soybean markets. This is related to the depreciation of the Brazilian and Argentine currencies, which reinforces the export-stimulating effect of removing producer taxes.

Table 2 shows that in both scenarios there are substantial changes in foreign exchange earnings or costs from agricultural trade following liberalization. In the total liberalization scenario (case 2) Argentina and Brazil show gains in agricultural export revenues of 59 and 62 percent, respectively, as the volume of soybeans, sugar, dairy, and beef exports expands by a minimum of 50 percent. For Brazil particularly, this gain in agricultural export revenues is significantly larger than in the agricultural trade liberalization case. These results suggest that in these two countries, protection of the nonagricultural traded and non-traded sectors has represented a substantial bias against agriculture.

On the other side of the foreign exchange ledger, table 2 shows that Japan and Mexico purchase considerably more foreign agricultural goods following the removal of agricultural protection, particularly dairy for Mexico and rice, sugar, dairy, and beef for Japan. Mexico, though, does increase its "other agricultural" good exports (such as tomatoes and fresh vegetables), suggesting that the composition of Mexican agricultural production could change significantly following liberalization. When currency values vary, the Japanese yen declines slightly (3 percent) while the Mexican peso depreciates over 16 percent. As a result, increases in net expenditures on agricultural imports are smaller than in the fixed exchange rate case, particularly for Mexico. In case 2 Mexico registers a 350 percent rise in foreign exchange earnings from the "other agricultural" good over the base period.

In case 1, the European Community experiences an 82 percent increase in expenditures on agricultural imports, with sugar, dairy, beef and poultry becoming imported goods while wheat continues to be a net export commodity. Imports of the "other agricultural" good, however, continue to account for more than half of foreign exchange costs. A depreciation of the EC currency (4 percent) in case 2 mitigates somewhat the negative impacts of agricultural liberalization on the Community's agricultural trade balance.

For the United States and Canada, there are decreases in net agricultural exports of 14 percent each in scenario 1 and 13 percent each in scenario 2. In both scenarios, U.S. export values of wheat and soybeans fall, sugar and dairy import values increase, but the value of beef and poultry exports increase.

The rest-of-world improves its net export position in all agricultural goods except corn, soybeans and "other agriculture". This is not surprising since we assumed that ROW, on net, has no trade barriers. With agricultural prices generally rising and perfect price transmission assumed, ROW increases its production and decreases its consumption. In the total liberalization case, appreciation of the ROW currency causes its exports to be higher-priced in dollar terms and, therefore, less competitive relative to the fixed exchange rate case (table 2).

In countries which originally had low or negative protection rates, multilateral liberalization produces increases in agricultural production and value of production (table 3). This is the case in Argentina and Brazil, in particular: the values of their agricultural output (including "other agriculture") increase 17 and 7 percent, respectively, in case 1, leading to 3 and one percent increases in their total domestic products (table 3).

Much larger increases in total domestic product occur in the flexible exchange rate case (table 3). The appreciation of the dollar and ROW's currency relative to other countries' currencies lead to a expansion of total excess demand for both agriculture and nonagriculture from these countries. This places pressure on world prices to increase which influences quantities supplied by other countries. We observe domestic product increases, particularly in Brazil (11 percent) and Mexico (19 percent). In the EC, agricultural and nonagricultural product both rise (by 6 and 7 percent, respectively). Japan's total GDP increases by 5 percent despite a decline in agricultural GDP.

The other measures of economic well-being--producer and consumer surpluses, and net welfare changes--are reported in Tables 4A-4C. In case 1, the world welfare gain resulting from multilateral liberalization of the agricultural sector equals over $21 billion, almost all attributable to welfare effects in the agricultural sector (table 4A). With no protection barriers being removed in the nonagricultural sector, the only price and quantity adjustments in nonagriculture are due to cross price relationships with agriculture and these adjustments tend to be minimal.

Japan, with the largest average level of protection among the industrial countries, realizes the largest welfare gain ($7 billion) followed by the U.S. ($4.4 billion), the EC ($4 billion), and Mexico ($3.6 billion) (table 4A). Removal of the high Japanese protection on rice (nearly 5 times the world price) improves Japanese consumer welfare by nearly $10 billion and contributes $4 billion to the net welfare gain.

In the United States, the dairy sector experiences the largest changes, with consumers gaining and producers losing each about $11 billion. Given the total U.S. producer loss of under $16 billion, dairy comprises approximately two-thirds of producer losses (table 4B). Furthermore, the gain to consumers in dairy exceeds the total gain to consumers of $8.5 billion, indicating that consumers lose in the other agricultural commodities (largely beef) (table 4C). We should also note that there is a reduction in U.S. government expenditures of nearly $9 billion, particularly for grain programs, following liberalization.

Dairy and beef markets also play a large role in the welfare results for the EC and Mexico. Approximately 75 percent of the $4 billion welfare gain in the EC and over 90 percent of the $3.6 billion welfare gain in Mexico are attributably to welfare gains in the dairy and beef markets (table 4A).

The flexible exchange rate/total liberalization scenario produces a world welfare gain of $18.6 billion (table 4A). There are two counteracting forces which, on balance, produce the smaller efficiency gain in this case than in the case of agricultural liberalization with fixed exchange rates. First, as expected, liberalization of the nonagricultural sector combined with liberalization of the agricultural sector enhances the gains from trade liberalization. In other words, were exchange rates held fixed, all-sector liberalization would produce a larger efficiency gain than agricultural sector liberalization alone. 4/ However, the second force at work--the exchange rate adjustment--decreases the welfare gain by introducing greater flexibility into the system as it adjusts to relative price changes. The importance of this flexibility is easier to understand if we consider the case of imposing, rather than removing, a trade barrier. An imposition of a trade restriction alters relative prices and resource allocation. When exchange rates are

4/ A scenario encompassing an all sector multilateral liberalization assuming fixed exchange rates obtained a world welfare gain of approximately $25 billion.

allowed to change, the degree of change in relative prices is mitigated. Hence, the loss in welfare when protection barriers are put in place is also mitigated when exchange rates are allowed to alter. (The same concept would be important if we were to compare two fixed exchange rate models, one with an agriculture sector only and the other with agriculture and nonagricultural sectors. Liberalization of agriculture would produce smaller welfare gains in the model which includes both agricultural and nonagricultural sectors.)

Table 4A also reports that the efficiency gains in agriculture and nonagriculture are about $5 billion less and $2 billion more, respectively, in the total liberalization/flexible exchange rate case than in the agricultural liberalization/fixed rate case. Agriculture producers lose more and consumers gain less (approximately $2.5 billion) in case 2 than in case 1 (tables 4B and 4C). In case two, nonagricultural producers gain substantial producer surplus ($55.5 billion) with EC, Japanese, and U.S. producers being the big gainers ($24.7, $13.6, and $11.7 billion, respectively). Nonagricultural consumers also experience gains of $16 billion, with ROW's consumer surplus increasing by $26 billion, Canada, Argentina, Brazil and Mexico's increasing by $8 billion, while EC, Japanese, and U.S. consumer lose $18 billion in surplus. Finally, with the removal of nonagricultural protection, government revenues decline $70 billion.

Conclusion

The goal of this paper has been to compare the effects of liberalizing the agricultural sector with liberalizing agricultural and nonagricultural sectors under flexible exchange rates. In the second case, there are two additional factors which can influence agricultural markets, namely any cross price effects from price changes in the nonagricultural markets and changes in exchange rates (which occur due to changes in trade balances). In this model the cross price elasticities between the agricultural and nonagricultural sectors are very small and therefore there is little impact resulting from this linkage. Since we were only able to provide very rough estimates for these elasticities, this becomes a fruitful area for further research. The second channel of influence--exchange rate movements--does have significant impacts on the agricultural sector as well as on the general economies. Some of our main findings are:

- Simultaneous reductions in agricultural and nonagricultural protection, allowing exchange rates to vary, tends to reinforce the upward price pressure on agricultural goods that follows from agricultural liberalization. In most commodity markets, the reinforcing price effect occurs because the United States and the rest-of-world currencies appreciate relative to the other countries'. These two regions account for 70 percent of world GDP. The appreciation of their currencies and the resulting contraction of their net export volumes put upward pressure on world prices.
- For several countries--those that experience the largest exchange rate movements following total liberalization--the two simulations produce significantly different impacts on agricultural trade values. The net agricultural export positions of Argentina and Brazil are favored by currency depreciations; while the negative effects of reducing agricultural protection on Mexican and EC agricultural trade balances are mitigated by their currency depreciations.
- Total gross domestic product increases more for all countries except ROW in the total liberalization case than in the agricultural liberalization case. Total GDP and agricultural product benefit from the currency depreciations experienced by most countries because domestic production is valued in domestic currency terms at higher

prices than before liberalization. Higher world (dollar) prices and, in some cases, higher levels of production also translate into higher levels of GDP.

- Total world welfare gains are smaller with total trade liberalization and endogenous exchange rates than with agricultural liberalization alone. However, in countries with depreciating currencies, agricultural producer losses are typically lower (or gains are greater) in the total trade liberalization case than in the case of agricultural liberalization only.

The cross-sector issues developed in this paper illustrates the value of taking a more general equilibrium approach to analyzing agricultural trade liberalization issues. Substantial differences for individual countries arise when results of the total liberalization scenario are compared with the results of the agricultural liberalization scenario. This model indicates, however, that these differences are smaller for the United States than those that could arise for other countries, particularly developing countries where the protection of the nonagricultural sector remains relatively high. Our analysis is limited by its high level of aggregation, the lack of information on protection in ROW, and its consideration of a narrow set of macroeconomic factors. Additional studies may want to consider changes in other macroeconomic policies concommitant with trade liberalization as well as income effects.

APPENDIX

Derivation of Reduced Form Equations

To determine the impact of small changes in the system for a single country, eg. unilateral changes in protection, text equations (1) through (10) and (12) are differentiated. One agricultural good is assumed for purposes of exposition. Also, the country demarcation i is initially dropped for notational ease. The superscipt * indicates percentage changes.

$$DA^* = m_A PA^* + m_T PT^* + m_H PH^* \quad (A1)$$

$$DT^* = n_A PA^* + n_T PT^* + n_H PH^* \quad (A2)$$

$$DH^* = r_A PA^* + r_T PT^* + r_H PH^* \quad (A3)$$

$$SA^* = e_A PA^* + e_T PT^* + e_H PH^* \quad (A4)$$

$$ST^* = f_A PA^* + f_T PT^* + f_H PH^* \quad (A5)$$

$$SH^* = g_A PA^* + g_T PT^* + g_H PH^* \quad (A6)$$

where the m's, n's and r's represent demand elasticities and e's, f's and g's represent supply elasticities with respect to domestic prices. Differentiation of equation (12), an identity, yields

$$PT^* = E^* + PWT^* + (1 + tT)^* \quad (A7)$$

and

$$PA^* = E^* + PWA^* + (1 + tA)^* \quad (A8)$$

where we distinquish the nonagricultural good (tT) and the agricultural good (tA) policy wedges.

To determine changes in price of the home good, we substitute equations (A3), (A6), (A7), and (A8) into the differentiated equation (7), $SH^* - DH^* = 0$,

$$\begin{aligned} PH^* = & -[(r_A - g_A)/(r_H - g_H)]\ [E^* + PWA^* + (1 + tA)^*] \\ & -[(r_T - g_T)/(r_H - g_H)]\ [E^* + PWT^* + (1 + tT)^*] \quad (A9) \end{aligned}$$

The home good price, therefore, is influenced by changes in the exchange rate, trade policy, and world prices of agricultural and nonagricultural goods. More specifically, if the differences between the cross price elasticities of demand and supply [$(r_A - g_A)$ and $(r_T - g_T)$] are positive, then a depreciation of the home currency, an increase in world prices, or an increase in protection would place upward pressure on the price of the home good.

The next step is to differentiate the net trade equation (8):

$$\Theta 1(SA^* + PA^*) - \Theta 2(DA^* + PA^*) + \Theta 3(ST^* + PT^*) - \Theta 4(DT^* + PT^*) = F^* \quad \text{(A10)}$$

where Θ1 (Θ2) is the share of the value of supply (demand) for agriculture and Θ3 (Θ4) is the share of supply (demand) for nonagriculture relative to the value of net trade. By substituting from equations (A1), (A2), (A4), (A5), (A7) - (A9) into (A10), we obtain an expression for changes in balance of trade in terms of changes in trade and exchange rate policies, and changes in world prices of both agricultural and nonagricultural traded goods (equation 13 in text):

$$(\Pi 1 + \Pi 2)E^* + \Pi 1[PWA^* + (1 + tA)^*] + \Pi 2[PWT^* + (1 + tT)^*] = F^* \quad \text{(A11)}$$

where

$$\Pi 1 = \Theta 1(1+e_A) - \Theta 2(1+m_A) + \Theta 3f_A - \Theta 4n_A - [(r_A - g_A)/(r_H - g_T)] [\Theta 1e_H - \Theta 2m_H + \Theta 3f_H - \Theta 4n_H]$$

and

$$\Pi 2 = \Theta 1e_T - \Theta 2m_T + \Theta 3(1+f_T) - \Theta 4(1+n_T) - [(r_T - g_T)/(r_H - g_H)] [\Theta 1e_H - \Theta 2m_H + \Theta 3f_H - \Theta 4n_H]$$

Next, we relax the assumption of a representative country and, instead, we assume there are two countries and three goods (an agricultural good, a non-agricultural good, and a nontraded good). The following equations illustrate the implications of bilateral changes of protection in this framework.

For countries 1 and 2:

$$(\Pi 11 + \Pi 12)E1^* + \Pi 11(PWA^* + (1 + tA1)^*) + \Pi 12(PWT^* + (1 + tT1)^*) = F1^* \quad \text{(A12)}$$

$$(\Pi 21 + \Pi 22)E2^* + \Pi 21(PWA^* + (1 + tA2)^*) + \Pi 22(PWT^* + (1 + tT2)^*) = F2^* \quad \text{(A13)}$$

Again, we can examine the two extreme possibilities: allowing capital flows to change or allowing the exchange rate to float. In the fixed exchange rate case, with $F1^* + F2^* = 0$ by definition, equations (A12 and A13) reduce to:

$$1/2[\Pi 11 - \Pi 12)PWA^* + (\Pi 21 - \Pi 22)PWT^* + \Pi 11(1 + tA1)^* - \Pi 12(1 + tA2)^* + \Pi 21(1 + tT1)^* - \Pi 22(1 + tT2)^*] = F1^* \quad \text{(A14)}$$

If country 1 liberalizes relatively more than country 2, assuming no changes in world price, then country 1 experiences a deterioration of the trade balance and, consequently, requires larger capital inflows. In the floating exchange rate case, with $E2^* = -(1/E1E2)E1^*$ by definition, equations (A12 and A13) reduce to:

$$-1/\Gamma[\Pi 11 - \Pi 12)PWA^* + (\Pi 21 - \Pi 22)PWT^* + \Pi 11(1+tA1)^* - \Pi 12(1 + tA2)^* + \Pi 21(1 + tT1)^* - \Pi 22(1 + tT1)^*] = E1^* \quad \text{(A15)}$$

where $\Gamma 1 = \Pi 11 + \Pi 12 + (1/E1E2)(\Pi 21 + \Pi 22)$. Again, if country 1 liberalizes relatively more than country 2, assuming no changes in world prices, then country 1 experiences a depreciation of its currency relative to country 2's.

In equations (A14) and (A15) there are three unknown variables: changes in world prices of agricultural goods, changes in world prices of nonagricultural goods, and changes in the trade balance or exchange rate. To complete the system, the market clearing conditions (equations (9) and (10)) need to be differentiated:

$$SA1SA1^* + SA2SA2^* - DA1DA1^* - DA2DA2^* = 0 \quad \text{(A16)}$$

and

$$ST1ST1^* + ST2ST2^* - DT1DT1^* - DT2DT2^* = 0 \qquad \text{(A17)}$$

Substituting equations (A1), (A4), and (A7)-(A9) into equation (A16) and equations (A2), (A5), and (A7)-(A9) into equation (A17) yields

$$\Gamma 2E1^* + (\phi 11 + \phi 12)PWA^* + (\phi 21 + \phi 22)PWT^* + \phi 11(1 + tA1)^*$$
$$+ \phi 21(1 + tA1)^* + \phi 12(1+tT1)^* + \phi 22(1 + tT2)^* = 0 \qquad \text{(A18)}$$

and

$$\Gamma 3E1^* + (\Phi 11 + \Phi 12)PWA^* + (\Phi 21 + \Phi 22)PWT^* + \Phi 11(1 + tA1)^*$$
$$+ \Phi 21(1 + tA1)^* + \Phi 12(1 + tT1)^* + \Phi 22(1+ tT2)^* = 0 \qquad \text{(A19)}$$

where

$$\Gamma 2 = \phi 11 + \phi 12 - (1/E1E2)(\phi 21 + \phi 22),$$
$$\Gamma 3 = \Phi 11 + \Phi 12 - (1/E1E2)(\Phi 21 + \Phi 22),$$
$$\phi 11 = SA1(e_{A1} - e_{H1}(r_{A1} - g_{A1})/(r_{H1} - g_{H1})) - DA1(m_{A1} - m_{H1}(r_{A1} - g_{A1})/(r_{H1} - g_{H1})),$$
$$\phi 12 = SA1(e_{T1} - e_{H1}(r_{T1} - g_{T1})/(r_{H1} - g_{H1})) - DA1(m_{T1} - m_{H1}(r_{T1} - g_{T1})/(r_{H1} - g_{H1})),$$
$$\phi 21 = SA2(e_{A2} - e_{H2}(r_{A2} - g_{A2})/(r_{H2} - g_{H2})) - DA2(m_{A2} - m_{H2}(r_{A2} - g_{A2})/(r_{H2} - g_{H2})),$$
$$\phi 22 = SA2(e_{T2} - e_{H2}(r_{T2} - g_{T2})/(r_{H2} - g_{H2})) - DA2(m_{T2} - m_{H2}(r_{T2} - g_{T2})/(r_{H2} - g_{H2}))$$
$$\Phi 11 = ST1(f_{A1} - f_{H1}(r_{A1} - g_{A1})/(r_{H1} - g_{H1})) - DT1(n_{A1} - n_{H1}(r_{A1} - g_{A1})/(r_{H1} - g_{H1})),$$
$$\Phi 12 = ST1(f_{T1} - f_{H1}(r_{T1} - g_{T1})/(r_{H1} - g_{H1})) - DT1(n_{T1} - n_{H1}(r_{T1} - g_{T1})/(r_{H1} - g_{H1})),$$
$$\Phi 21 = ST2(f_{A2} - f_{H2}(r_{A2} - g_{A2})/(r_{H2} - g_{H2})) - DT2(n_{A2} - n_{H2}(r_{A2} - g_{A2})/(r_{H2} - g_{H2})),$$
$$\Phi 22 = ST2(f_{T2} - f_{H2}(r_{T2} - g_{T2})/(r_{H2} - g_{H2})) - DT2(n_{T2} - n_{H2}(r_{T2} - g_{T2})/(r_{H2} - g_{H2})).$$

Under the assumption of floating exchange rates, reduced form equations can be calculated from equations (A15), (A18), and (A19):

$$E1^* = \omega 1(1 + tA1)^* + \omega 2(1 + tA2)^* + \omega 3(1 + tT1)^* + \omega 4$$
$$(1 + tT2)^* \qquad \text{(A20)}$$

$$PWA^* = \omega 5(1 + tA1)^* + \omega 6(1 + tA2)^* + \omega 7(1 + tT1)^* + \omega 8$$
$$(1 + tT2)^* \qquad \text{(A21)}$$

$$PWT^* = \omega 9(1 + tA1)^* + \omega 10(1 + tA2)^* + \omega 11(1 + tT1)^*$$
$$+ \omega 12 (1 + tT2)^* \qquad \text{(A22)}$$

where Σ's are the reduced form parameters. Changes in the exchange rate, the world prices of agricultural goods, and the world prices of non-agricultural goods depend on the exogenous changes in protection. ω 1, ω 3, ω 5, ω 6, ω 11, and ω 12 are expected to be negative, while ω 2, ω 4, ω 7, ω 8, ω 9, and ω 10 are expected to be positive. Reducing protection relatively more in country 1 than in country 2 should cause a decline in the value of country 1's currency relative to country 2's and should have a postive effect on world prices.

Data Sources

Three types of data are needed to develop the empirical model: (1) base year data, including quantities supplied, demanded, and traded, prices, and exchange rates for 1984; (2) elasticities, including own- and cross-price elasticities of supply and demand for agricultural and nonagricultural composite goods; and (3) measures of protection for agricultural and nonagricultural goods.

Base year data for agricultural supply and demand were obtained from the Foreign Agricultural Service, USDA, supply and utilization data base. Country GDP data, used to calculate other agricultural supplies and nonagricultural supplies (traded and nontraded), were obtained from United National Monthly Statistics (Special Table I, Gross domestic product and net material product by kind of economic activity), Eurostat Review (National accounts, gross value added at current market prices), and International Financial Statistics, International Monetary Fund. Trade flow figures were obtained from International Trade 1985-86, published by the GATT, Food and Agricultural Organization's Trade Yearbook, and, for Latin American countries, from country statistical trade yearbooks. Net trade for each good was subtracted from supply in order to obtain demand. In cases where 1984 data were unavailable, estimates were made based on the latest information available.

Elasticities were obtained from several sources. Price elasticities for agricultural commodities were compiled, based on estimates from a number of existing studies, by the Economic Research Service (ERS), USDA, for the purposes of its agricultural trade liberalization modeling work. Elasticities for nonagricultural goods were obtained from Deardorf and Stern or were estimated by applying the homogeneity conditions to the equations. All the elasticities should be considered medium term estimates, that is, three to five years.

Ad valorem equivalent rates of protection for nonagricultural traded goods were obtained from Whalley for developed countries and from the IMF for the Latin American countries. Agricultural protection rates, producer and consumer subsidy equivalents (PSE's and CSE's), were developed by ERS. These measures include estimates of the subsidy equivalents of domestic agricultural policies, such as direct payments and input subsidies, as well as the effects of trade barriers (ERS). Where agricultural PSE's and CSE's were unavailable, estimates of agricultural commodity protection were obtained from Tyers and Anderson.

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Table 1--Changes in World Agricultural Prices

	(percent change) Case 1	Case 2
Wheat	7.4	10.0
Corn	6.2	7.1
Soybeans	-2.2	-3.2
Rice	8.3	14.4
Sugar	33.2	35.9
Dairy	21.7	25.3
Beef	15.8	15.6
Poultry	3.4	4.3

Table 2--Changes in the Value of Trade and Exchange Rates

(percent change)

	AGRICULTURE		NONAGRICULTURE		TOTAL		Exchange Rate
	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2	Case 2
US	-14	-13	0	0	-2	-1	--
EC	-82	-65	0	438	-96	0	-4.2
JA	-38	-37	0	13	-20	0	-2.7
CA	-14	-13	0	49	-11	0	-0.4
AR	55	59	0	-149	91	0	-1.0
BZ	23	62	0	-127	15	0	-8.4
MX	-1958	-1202	0	25	-42	0	-16.3
RW	369	201	0	-26	42	0	6.8

1/ A minus sign represents depreciation relative to the dollar.

Table 3--Changes in Economic Well Being: GNP 1/

	(percent change)					
	AGRICULTURE		NONAGRICULTURE		TOTAL	
	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
US	5	6	0	2	0	2
EC	-1	6	0	7	0	7
JA	-7	-5	0	5	0	5
CA	3	4	0	4	0	4
AR	17	19	0	1	3	5
BZ	7	20	0	9	1	11
MX	-3	20	0	19	0	19
RW	14	7	0	-4	1	-3

1/ Calculated in domestic currency.

Table 4A--Changes in Economic Well Being: Welfare Change

	(millions of dollars)					
	AGRICULTURE		NONAGRICULTURE		TOTAL	
	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
US	4,363	4,296	1	-8,917	4,364	-4,621
EC	4,040	2,186	0	-12,300	4,041	-10,114
JA	7,105	6,068	0	-3,380	7,105	2,688
CA	847	837	0	924	847	1,761
AR	700	808	-9	419	691	1,227
BZ	312	1,026	5	115	317	1,141
MX	3,691	2,434	1	1,168	3,692	3,602
RW	272	-980	0	23,932	272	22,952
Total	21,330	16,675	-1	1,961	21,329	18,635

Table 4B--Changes in Economic Well Being: Producer Surplus

	(millions of dollars)					
	AGRICULTURE		NONAGRICULTURE		TOTAL	
	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
US	-15,703	-15,334	0	11,662	-15,703	-3,672
EC	-17,291	-12,277	0	24,684	-17,291	12,407
JA	-14,745	-13,743	0	13,572	-14,745	-172
CA	-2,279	-2,206	0	3,235	-2,279	1,030
AR	3,474	3,653	2	-269	3,476	3,385
BZ	1,709	4,396	-1	1,672	1,707	6,068
MX	-5,992	-2,995	0	3,924	-5,992	929
RW	30,548	16,464	0	-2,945	30,548	13,519
Total	-20,280	-22,042	1	55,536	-20,279	33,494

Table 4C--Changes in Economic Well Being: Consumer Surplus

	(millions of dollars)					
	AGRICULTURE		NONAGRICULTURE		TOTAL	
	Case 1	Case 2	Case 1	Case 2	Case 1	Case 2
US	8,563	8,127	1	-2,977	8,564	5,151
EC	19,901	13,089	0	-11,972	19,901	1,117
JA	17,942	16,007	0	-3,827	17,942	12,180
CA	1,228	-2,762	0	2,299	1,228	3,451
AR	-2,690	-3,504	-11	2,292	-2,701	-470
BZ	-1,548	-1,152	6	3,503	-1,542	-6
MX	10,170	5,848	1	138	10,171	5,986
RW	-30,276	-17,444	0	26,877	-30,276	9,433
Total	23,289	20,507	-2	16,334	23,288	36,841