An Export-Side Armington Model and Trade Liberalization in the World Wheat Market

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Abstract *This paper develops and applies an export-side international trade model to analyze economic gains resulting from trade liberalization in the world wheat market Major policy variables in the analysis include the removal of producer and consumer subsidy equivalents in industrialized countries Estimated gains are substantial for all exporting countries, ranging from $5 32 million for Argentina to $4 24 billion for the United States*

Keywords: *Export-side international trade model, producer subsidy equivalent, consumer subsidy equivalent*

Trade liberalization has become a major issue facing agricultural policymakers One of the primary concerns of the past several decades, shared among grain-exporting countries, has been access to import markets Today, circumstances have changed such that many grain-exporting countries are concerned not only with better access to markets but also with their own expansion in grain production associated with huge producer subsidies (*23*) [1] As a result, the United States and other members of the General Agreement on Tariffs and Trade (GATT) undertook the Uruguay Round of international trade negotiations in 1986, after the U S Congress passed the 1985 Food Security Act

Since most countries have adopted different types of trade barriers and domestic farm policies (*13*), a common basis for multilateral trade negotiations must be identified As a first step in generating this common basis, all tariff and nontariff trade barriers and domestic agricultural policies for major grain-trading countries were quantified in monetary terms by the Organization for Economic Cooperation and Development (OECD) and by the Economic Research Service (ERS) The concepts of producer subsidy equivalents (PSE's) and consumer subsidy equivalents (CSE's) were used to quantify the degree of protection by country and by commodity The PSE is the level of subsidy that would be necessary to compensate producers associated with removing all government support under current farm programs The CSE is the payment that would be necessary to compensate consumers upon removing all government support under current farm programs (*7*)

Even though PSE's and CSE's provide a common basis for determining the degree of trade protection, they may be insufficient as the basis for successful trade negotiation To reach an agreement in multilateral trade negotiations, governments must be convinced that many of their present trade barriers and domestic farm policies generate little benefit at enormous cost (*12*), and that the payoff on trade liberalization could be significant Our objective is to estimate the economic gains (or losses) from trade liberalization in the world wheat market, thus providing a basis for trade negotiations We reach that objective by developing an export-side international trade model The model is then used to measure the effect of removing PSE's and CSE's on trade patterns for major grain-trading countries, including the United States, the European Community (EC), Canada, and Japan

Trade Models and Data Requirements

A primary issue for international trade economists is to quantify the effects of policy change on trade patterns A number of different trade models have been developed and these are well documented by Thompson (*25*) However, the Armington model and a spatial equilibrium model, which was developed by Samuelson (*22*) and formulated by Takayama and Judge (*24*) as a quadratic programming model, have been most widely used in international trade to quantify the effects of policy change (*2, 3, 4, 5, 6, 10, 11, 16, 18, 19, 20*) The spatial equilibrium model assumes that the demand functions are integrable so that the Jacobian of the demand functions are symmetric Under this assumption, the spatial equilibrium model maximizes economic efficiency by reducing transportation costs of a homogeneous commodity Meanwhile, the Armington model assumes that the importer has a separable utility function, which is maximized through a two-stage optimization In the first stage, a country's budget is allocated across several sets of commodities in a way that will maximize the importer's utility function In the second stage, the utility associated with a subset is maximized subject to the budget allocated for commodities of this subset The Armington model differentiates commodities by country of origin, and therefore, commodities from different exporting countries are imperfect substitutes within an importing country's commodity market To reduce the number of parameters to be estimated, the Armington model assumes a constant substitution

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[1] Italicized numbers in parentheses cite sources listed in the References section at the end of this article

elasticity for each product pair in an importing country's commodity market

Even though both the Armington model and the spatial equilibrium model are theoretically sound, the lack of relevant price and transfer cost data discourages researchers from applying these models Researchers who have attempted to use these models in empirical studies recognize the difficulties associated with data collection, especially the availability of price data from all importing countries, and transfer costs connecting all exporting and importing countries These can be more clearly explained by considering the following Armington-type model

$$M_{ij} = b_{ij}{}^{zj} * M_j * (p^{ij}/PI_j)^{-zj}$$
$$= f_{ij} * (P^{ij})^{-zj} \quad (i = 1, 2, \quad m, j = 1, 2, \quad , n), \quad (1)$$

where $f_{ij} = M_j * (b_{ij}{}^{zj} * PI_j)^{zj}$, b_{ij} is constant, $-zj$ is the constant elasticity of substitution in the jth importing country between varieties of wheat, PI_j is the price index of a subset containing wheat in the jth importing country, M_{ij} is the import by the jth importing country from the ith exporting country, p^{ij} is the consumer price of M_{ij}, and M_j is the total wheat import by the jth importing country

In applying the Armington model, M_{ij} is frequently defined as an import from a region such as South America, the Middle East, Africa, or South Asia in order to reduce the size of a trade matrix Researchers recognize that reliable estimates of commodity prices and transfer costs are not available for all regions in any base year Therefore, most researchers use synthetic price and transportation cost data in the application of the Armington model and spatial equilibrium models Because of the nature of synthetic data, the resulting outcome may be viewed as polyester economics and therefore refutable

While we do not have reliable price information from most importing countries, we do have reliable information on quantities traded among all importing and exporting countries Therefore, this article develops the export-side international trade (ESIT) model, which connects spatially separated import and export markets through a quantity mechanism A similar concept was used in the work of Johnson and others (*15*) The ESIT model requires price information from all exporting countries and from only those importing countries that remove their trade barriers and domestic farm policies We will reveal that even though 18 importing countries/regions and 5 exporting countries are included in the analysis, price information is needed for only the 5 exporting countries and 1 importing country Other world trade models would require price information from all 23 countries/regions

An Export-Side International Trade Model

The ESIT model is based on a two-step procedure The first step links domestic commodity markets with an international commodity market The first step illustrates that the horizontal shift in the importing country's domestic commodity demand, or supply curve, to the right or to the left shifts the excess demand curve in the international commodity market to the right or to the left by the same amount Similarly, the horizontal shift in the exporting country's domestic supply curve or demand curve to the right or to the left shifts the excess supply curve in the international commodity market to the right or to the left by the same amount

The second step of the ESIT model links the international commodity market with export markets The export demand of an exporting country is derived by subtracting all other exporting countries' excess supply from the aggregate excess demand in the international market A market-clearing equilibrium is attained where the excess supply curve intersects the export demand curve for each exporting country

When an importing country removes its implicit tax on consumers so that its excess demand curve shifts to the right, the export demand curves of all exporting countries simultaneously shift to the right, while their excess supply curves remain unchanged For each exporting country, new equilibrium export price and quantity are attained where a new export demand curve intersects the unchanged excess supply curve for each exporting country

When an exporting country removes its subsidy to producers, its excess supply curve shifts to the left along the unchanged export demand curve For all other exporting countries, however, the export demand curve shifts to the right along the unchanged excess supply curve For an exporting country that removes its trade barriers, new equilibrium export price and quantity are attained where a new excess supply curve intersects the unchanged export demand curve For all other exporting countries, a new equilibrium is reached where a new export demand curve intersects the unchanged excess supply curve

A distinctive characteristic of the ESIT model compared with other existing international trade models, such as the Armington model and the spatial equilibrium model formulated by Takayama and Judge, is that the market-clearing equilibrium is attained through a quantity mechanism at the point where the excess supply curve intersects the export demand curve in each export market In the Armington model and the spatial equilibrium model, the market-clearing equilibrium is reached, through a price mechanism, at the point where excess demand equals excess supply So, the ESIT model substantially reduces data requirements from importing countries, such as transfer costs and import or consumer prices

The functional form of the demand and supply equations does not affect the magnitude of the horizontal

shifts of these demand and supply curves Therefore, let D = α – βP give the domestic demand When a government removes an implicit consumer tax (negative CSE), the magnitude of horizontal shift is estimated by –β*CSE Let the domestic supply curve be given by S = γ + δP When a government removes its subsidy to producers, the magnitude of horizontal supply shift is estimated by –δ*PSE

The next step is to estimate the horizontal distance of export demand shifts when an importing country or an exporting country removes the PSE and the CSE This can be accomplished by considering the following equations of export demand elasticity (*8*, *14*, *26*)

$$E_k = \sum_{i}^{m} \sum_{j}^{n} Ed_j(P^j)*T^j*M_{ij}/X_k(P_k)$$

$$- \sum_{i \neq k, j}^{m} \sum^{n} Es_i(p_i)*T_i*X_{ij}/X_k(P_k), \qquad (2)$$

where k = 1, 2, , m, where E_k is the export demand elasticity of the kth exporting country, Ed is excess demand elasticity, Es is excess supply elasticity, T is the price transmission elasticity, p^{ij} is the domestic price of the import from the ith exporting country in the jth importing country, P_i is the producer price of the ith exporting country, X_{ij} is the export by the ith exporting country to the jth importing country and equals zero if $X_{kj} = 0$, where $i \neq k$, and M_{ij} is the import by the jth importing country from the ith exporting country and equals zero if $X_{kj} = 0$, where $i \neq k$

In estimating the kth country's export demand elasticity with equation 2, we found that the excess supply of other exporting countries includes only that portion of their exports to countries to which the kth country exports Equation 2 includes the excess demand of importing countries to which the kth country exports For instance, Canada did not export to Korea in 1985, and therefore, all exports by other countries to Korea and Korea's imports must be excluded when estimating the export demand elasticity for Canada The export demand elasticity estimated with equation 2, consequently, is always less than or equal to export demand elasticity estimated with equations used by Bredahl and others (*8*), Johnson (*14*), and Tweeten (*26*)

By multiplying both sides of equation 2 by X_k/E_k, and using minor manipulations, we can rewrite equation 2 as

$$F_k = \sum_{j}^{n} X_k^j (a_k, p_k)$$

$$- \sum_{i}^{m} \sum_{j}^{n} M_{ij} (f_{ij}, P^{ij})*(Ed_j(P^j)*T^j/E_k)$$

$$+ \sum_{i \neq k, j}^{m} \sum^{n} X_{ij} (c_{ij}, P_i)*(Es_i(P_i)*T_i/E_k), \qquad (3)$$

where k = 1, 2, , m, where a, f, and c are intercept terms of the export demand, excess demand, and excess supply functions, respectively In equation 3, $M_{ij} = X_{ij}$ for all i and j

Since wheat is a differentiated product, it is assumed that the excess demand of the jth importing country from the ith exporting country is given by the Armington-type import demand in equation 1 Assuming that only h importing countries remove their trade barriers and domestic farm policies and the remaining (n-h) importing countries do not change domestic farm and trade policies, then the implicit function 3 can be rewritten as equation 4 by inserting equation 1 into equation 3

$$F_k = \sum_{j}^{n} X_k^j (a_k^j, P_k)$$

$$+ \sum_{i \neq k j}^{m} \sum^{n} (Es_i(P_i)*T_i/E_k)*X_{ij}(C_{ij}, P_i)$$

$$- \sum_{j}^{h} \sum_{i}^{m} (Ed_j (P^j)*T^j/E_k)*f_{ij}(P^{ij})$$

$$- \sum_{g}^{n-h} \sum_{i}^{m} (Ed_g (P^g)*T^g/E_k)*M_{ig}$$

$$= 0 \qquad \text{for } k = 1, 2, , m \qquad (4)$$

Since the excess demand has an Armington-type import demand function in equation 1, the implicit function 4 can be considered as the export-side Armington model The horizontal distance of the export demand shifts resulting from the horizontal shift of the excess demand and excess supply curves can be estimated by applying the implicit function theorem to the system of m-equations (*4*) Note that there are mn endogenous variables of a_k^j (k = 1, 2, , m, j = 1, 2, ,n) and m(n + h) exogenous variables, including c_{ij} ($i \neq k$) and f_{ij} for all i and j

By applying the implicit function theorem to equation 4, we determined that the horizontal distances of the export demand shifts resulting from removing the PSE and the CSE in the jth importing country are represented by the following equation

$$\begin{bmatrix} \Delta a_1^j \\ \Delta a_2^j \\ \\ \\ \Delta a_m^j \end{bmatrix} = \begin{bmatrix} \partial X_1^j/\partial f_{ij} & 0 & & 0 \\ 0 & \partial X_2/\partial f_{ij} & 0 & 0 \\ & & & \\ & & & \\ 0 & 0 & 0 & \partial X_m/\partial f_{ij} \end{bmatrix}$$

$$* \begin{bmatrix} (Ed_j * T^j / E_1) * \sum_1^m \Delta f_{ij} * (P^i)^{-z_j} \\ (Ed_j * T^j / E_2) * \sum_1^m \Delta f_{ij} * (P^i)^{-z_j} \\ \\ \\ (Ed_j * T^j / E_m) * \sum_1^m \Delta f_{ij} * (P^i)^{-z_j} \end{bmatrix} \quad (5)$$

The system of equation 5 can be compactly rewritten as

$$\Delta a_k^j = (\partial a_k^j / \partial F_k) * (Ed_j (P^j) * T^j / E_k) * \sum_1^m \Delta f_{ij} * (P^i)^{-z_j}$$

$$= (\partial a_k^j / \partial F_k) * (Ed_j (P^j) * T^j / E_k) * (-\beta^j * CSE^j + \delta^j * PSE^j), \quad (6)$$

where $k = 1, 2, \ldots, m$, $j = 1, 2, \ldots, h$, and where β and δ are the slope coefficients associated with the domestic commodity demand and supply functions, respectively

The price transmission elasticity T^j in equation 6 equals one when the importing country removes its trade barriers Note that the horizontal distance of the excess demand shift in equation 6 is replaced with the horizontal distance of the domestic commodity demand or supply shift The market-clearing condition is given by the following equation

$$\sum_j^n X_k^j(a_k^j + \Delta a_k^j, P_k^*) = \sum_j^n X_{kj}(c_{kj}, P_k^*), \quad (7)$$

where $k = 1, 2, \ldots, m$, and where the left-hand side and the right-hand side of the equality in equation 7 represent the export demand and excess supply, respectively, of the kth exporting country after trade liberalization The export price of the kth exporting country, P_k^*, is obtained from solving equation 7 for P_k Exports by the kth country to the jth importing country are obtained by inserting P_k^* into equation 7

The horizontal distances of the export demand shifts resulting from removing the PSE and the CSE in the ith exporting country, Δa_k^i, are given by the following equation

$$\Delta a_k^i = -(\partial a_k^j / \partial F_k) * (Es_i(P_i) * T_i / E_k) * (\delta_i * PSE_i - \beta_i * CSE_i), \quad (8)$$

where $k = 1, 2, \ldots, m$ and $k \neq i$, where δ_i and β_i are the slope coefficients associated with the ith exporting country's domestic supply and demand functions, respectively The price transmission elasticity T_i in equation 8 also equals one when the ith exporting country removes both the PSE and CSE

Market-clearing conditions are given by the following equations

$$\sum_j^n X_k^j(a_k + \Delta a_k^i, P_k^*) = \sum_j^n X_{kj}(c_{kj}, P_k^*), \quad (9a)$$

where $k = 1, 2, \ldots, m$ and $k \neq i$, and

$$\sum_j^n X_i^j(a_i, P_i^*) = \sum_j^n X_{ij}(c_{ij} + \Delta c_{ij}, P_i^*) \quad (9b)$$

where $i = k$

Export prices are then estimated from equations 9a and 9b Exports by the kth country to the jth importing country are obtained by substituting estimated P_k^* and P_i^* into equations 9a and 9b, respectively

Trade Pattern Effects of Industrialized Countries' Trade Liberalization in the World Wheat Market

Since the functional form of domestic demand and supply functions, the export demand function, and the excess supply function do not affect the magnitude of the horizontal shifts of these curves, we assumed that domestic demand and supply functions, the export demand function, and the excess supply functions are linear Domestic supply and demand equations are estimated for the United States, EC, Canada, Argentina, Australia, and Japan (tables 1-3) The domestic supply equations follow United States $Q = 56{,}494\ 4 + 93\ 53P$, EC $Q = 53{,}271\ 4 + 147\ 29P$, Canada $Q = 17{,}595\ 17 + 20\ 59P$, Argentina $Q = 11{,}968\ 0 + 13\ 06P$, Australia $Q = 16{,}799\ 4 + 12\ 44P$, and Japan $Q = 666\ 9 + 0\ 0756P$ Domestic demand equations are estimated as follows United States $Q = 37{,}306\ 0 - 32\ 2252P$, EC $Q = 70{,}590\ 0 - 68\ 4012P$, Canada $Q = 1{,}779\ 8 - 0\ 9246P$, Argentina $Q = 5{,}954\ 55 - 2\ 2684P$, Australia $Q = 3{,}779\ 6 - 2\ 2907P$, and Japan $Q = 7{,}786\ 8 - 3\ 6765P$

The per-unit PSE's and CSE's measure the magnitude of the vertical shifts of the domestic supply and demand curves (table 2) To use the ESIT model, the PSE's and CSE's must be converted into horizontal distances of domestic supply and demand shifts These conversions can be made with the slopes of the estimated domestic demand and supply equations

We used the Delphi method to estimate the constant elasticity of substitution (excess demand elasticity) for the jth country (table 3) Use of the Delphi method is well justified by Abbott (*1*) and McCalla and others (*18*), and more justifiable than using the same constant elasticity of substitution across all importing countries/regions The excess supply elasticity of the ith exporting country is also estimated with the Delphi method

The estimated excess supply equations follow Argentina $6{,}013\ 45 + 15\ 3244P$, Australia $12{,}643\ 8 +$

14 7347P, Canada 14,936 37 + 21 5179P, EC − 18,758 1 + 223 2330P, and United States 13,424 4 + 125 7589P The excess supply elasticity is perceived by all importing countries to be constant By using trade flows, we can estimate the excess supply equation for the kth country to the jth importing country for all k and j Price transmission elasticities (table 1) range between 0 and 1 However, the price transmission elasticity will equal 1 when all trade barriers are removed Export demand elasticities estimated with equation 2 are United States −1 275, Canada −2 932, EC −3 206, Australia −3 122, and Argentina −6 298 The estimated export demand equations Argentina EX = 57,868 2 − 399 51P, Australia, EX = 61,222 24 − 309 12P, Canada EX = 73,541 87 − 313 37P, EC EX = 66,635 658 − 327 69P, and U S EX = 73,741 85 − 273 69P Table 4 presents estimated trade flows and export prices under the conditions that the United States, EC, Canada, and Japan remove all PSE's and CSE's Results indicate that the volume of world wheat trade is expected to decline to 84 9 million metric tons (MT) from 89 7 million MT if major trading countries remove all PSE's and CSE's Canada's exports would decline slightly from 18 7 million MT to 17 9 million MT, while it's export price would rise from $175/MT to $178 76/MT U S exports would

Table 1—Wheat base-year data for simulation, 1984/85

Country/region	Production	Consumption	Net trade	e[3]	n[3]	T[4]
			1,000 metric tons			
Argentina	13,600	5,671	7,929	0 12	−0 05	0 50
Australia	18,666	3,436	14,854	10	− 10	90
Canada	21,199	1,618	18,702	17	− 10	1 00
European Community[1]	76,102	58,825	15,843	30	− 20	10
United States	70,618	32,440	32,414	20	− 15	1 00
European Community[2]	0	2,206	−2,206	0	− 20	10
Western Europe	16,627	16,240	−1,126	30	− 20	25
Eastern Europe	36,460	36,563	−1 856	20	− 10	40
USSR	68,600	94,531	−25,931	20	− 15	32
North/Central America	4,506	7,172	−2,666	15	− 17	52
Brazil	1,956	6,883	−4,927	15	− 12	20
South America	1,601	5,485	−3,884	15	− 12	1 00
Japan	741	6,489	−5,748	10	− 20	10
Korea	17	3,060	−3,043	10	− 20	60
China	87,820	94,994	−7,174	10	− 25	20
Indonesia	0	1,187	−1,187	0	− 20	40
Middle East	26,950	37,069	−10,119	04	− 12	40
South Asia	50,402	53,725	−3,323	10	− 20	20
East Asia	0	1,003	−1,003	0	− 15	60
Nigeria	45	1,845	−1,800	20	− 20	14
North Africa	3,494	9,090	−5,596	04	− 12	40
Egypt	1,875	6,732	−4,857	12	− 17	25
Other Africa	0	3,296	−3,296	0	− 25	40

[1]EC exporter
[2]EC importer
[3]Source (*21*)
[4]Source (*28*)

Table 2—Wheat average PSE's and CSE's during 1982-86

Country	Consumer price	Producer price	PSE/ metric ton	CSE/ metric ton	Horizontal distance PSE	Horizontal distance CSE
		U S dollars per metric ton			*1,000 metric tons*	
Canada	175	175	41	0	−848	0
European Community[1]	172	155	48	−37	−7,093	2 572
Japan	353	980	795	−116	−60	430
United States[2]	151	151	57	−0	1,562	0

[1]The subsidy equivalents represent a weighted average for durum wheat and soft wheat
[2]Acreage allocated for wheat production and for acreage reduction and conservation programs are 79 2 million acres and 18 3 million acres in 1984 respectively Production forgone from set-aside acreage was based on 50 percent of acreage slippage and yields, which were 85 percent of yields for planted cropland When the United States removes producers' subsidies the domestic supply curve initially shifts to the left by 5 3 million metric tons, but it shifts back to the right by 6 9 million metric tons due to a relaxed acreage reduction program

Source (*27*)

Table 3—Wheat base-year data for trade, 1984/85

Importing country/ regions	Exporting country/region						
	Argentina	Australia	Canada	European Community	United States	Subtotal	Ed_j[2]
	1,000 metric tons						
European Community	54	0	1,273	0	879	2,206	−0 20
Western Europe	31	0	96	345	654	1,126	−7 05
Eastern Europe	57	368	235	1,131	65	1,856	−5 80
USSR	4,057	2,040	7,633	6,078	6,123	25,931	−1 08
North/Central America	262	425	878	387	714	2,666	− 71
Brazil	660	0	1,185	51	3,031	4,927	− 23
South America	698	0	398	32	2,756	3,884	− 23
Japan	0	1,039	1,385	0	3,324	5,748	− 24
Korea	0	973	0	0	2,070	3,043	− 20
China	675	1,348	2,634	62	2,455	7,174	−4 53
Indonesia	74	502	200	0	411	1,187	− 20
Middle East	1,163	4,149	833	1,441	2,533	10,119	− 55
South Asia	91	1,282	129	359	1,462	3,323	−4 75
East Asia	12	105	124	0	762	1,003	− 15
Nigeria	95	0	21	18	1,666	1,800	− 21
North Africa	0	0	575	2,558	2,463	5,596	− 22
Egypt	0	2,168	443	1,450	796	4,857	− 28
Other Africa	0	455	660	1,931	250	3,296	− 25
Subtotal	7,929	14,854	18,702	15,843	32,414	89,742	
Es_i[2]	242	149	201	2 184	586		
Price ($/MT)	125	150	175	155	151		

[1] Ed_j is excess demand elasticity
[2] Es_i is excess supply elasticity

increase by 1 6 million MT to 34 1 million MT, and its export price would remain about the same EC exports would suffer the most, declining by nearly 6 million MT, from 15 8 million MT to 10 million MT, while its export price would rise to $172/MT from $155/MT Japan's excess demand curve would be expected to shift to the right as a result of trade liberalization, so that Japan's wheat imports increase at a higher price Results show, however, that imports by Japan would increase only slightly, by 112,000 MT, to 5 9 million MT, which may reflect the fact that the increase in imports resulting from the horizontal shift to the right of the excess demand curve is offset by reduced imports from the higher import price

While reduced exports by the EC and Canada would total 6 6 million MT, Argentina, Australia, and the United States would increase their exports by 1 7 million MT Therefore, the world wheat trade would decline by nearly 5 million MT to 84 8 million MT The increase in exports in Argentina and Australia would be only 28,000 MT Both the inelastic excess supply and the very elastic export demand for Argentina and Australia may be responsible for their sluggish increase in exports

Gains from Industrialized Countries' Trade Liberalization in the World Wheat Market

Trade liberalization affects not only trade patterns but the social welfare of all countries as well We used the partial equilibrium approach as a theoretical framework to estimate the effect of trade liberalization in the world wheat market on social welfare We estimated both consumers' surpluses (CS) and producers' surpluses (PS) with the following equations

$$\Delta CS = \int_0^{Qc'} (\alpha'/\beta - q/\beta)dq - \int_0^{Qc} (\alpha/\beta - q/\beta)dq - (P'Qc' - PcQc), \quad (10)$$

$$\Delta PS = \int_0^{Qs'} (-\gamma'/\delta + q/\delta)dq - \int_0^{Qs} (-\gamma'/\delta + q/\delta)dq - (P'Qs' - PsQs), \quad (11)$$

where α and α' are intercept terms for the domestic demand curve before and after trade liberalization, respectively, β is the slope coefficient of the domestic demand curve, γ and γ' are intercept terms for the domestic supply curve before and after trade liberalization, respectively, δ is the slope coefficient of the domestic supply curve, Qc and Qc' are domestic consumer demand before and after trade liberalization, Qs and Qs' are domestic supply before and after trade liberalization, respectively, Pc and Ps are consumer and producer prices before trade liberalization, and P' is domestic market price after trade liberalization Estimated domestic supply curves often intersect the horizontal axis For these cases, we employed the formula used by Kim and others (*17*) for estimating the changes of producers' surpluses Changes in con-

sumers' and producers' surpluses are estimated for the United States, EC, Canada, Argentina, Australia, and Japan Estimated changes in U S consumers' and producers' benefits resulting from trade liberalization in the world wheat market are –$19 3 million and $278 9 million, respectively (table 5) Even though the domestic supply curve shifts to the right by 1 6 million MT, the U S export demand curve also shifts to the right by 1 8 million MT, resulting in an insignificant increase Domestic consumption would decline slightly from 32 44 million MT to 32 42 million MT, while domestic supply would likely rise from 70 6 million MT to 72 2 million MT

Changes in Canada's consumer and producer benefits resulting from trade liberalization in the world wheat market would be −$6 1 million and −$779 2 million, respectively Domestic production probably would decline from 21 2 million MT to 20 4 million MT, while price would rise from $175 per MT to $179 per MT Meanwhile, consumer demand would fall slightly, by 3,000 MT (0 01 percent)

EC producers would expect to reduce their benefits substantially as a result of trade liberalization in the world wheat market, while EC consumer benefits would increase enormously Changes in EC consumer and producer benefits would be $2 3 billion and −$2 3 billion, respectively Domestic wheat consumption would likely increase by 2 6 million MT to 61 4 million MT, and the consumer price would rise slightly to just over $172 per MT Domestic supply would decline by 4 6 million MT to 71 5 million MT, but producer prices would rise substantially from $155 per MT to $172 per MT Gains to consumers resulting from trade liberalization are large enough to offset most losses to producers due to reduced production

Consumer demands for wheat in both Argentina and Australia would decline slightly as prices rise, while

Table 4—Estimated trade patterns after industrialized countries' trade liberalization in the world wheat market

Importing country/ region	Exporting country/region					
	Argentina	Australia	Canada	EC	United States	Subtotal
			1 000 metric tons			
European Community	54	0	1,221	0	923	2,198
Western Europe	31	0	92	218	687	1,028
Eastern Europe	57	368	225	714	68	1,432
USSR	4,061	2,043	7,320	3,837	6,432	23,693
North/Central America	262	426	842	244	750	2,524
Brazil	661	0	1,136	32	3,184	5,013
South America	699	0	382	20	2,895	3,996
Japan	0	1,040	1,328	0	3,492	5,860
Korea	0	974	0	0	2,175	3,149
China	676	1,350	2,526	39	2,579	7,170
Indonesia	74	503	192	0	432	1,201
Middle East	1 164	4,154	799	910	2 661	9 688
South Asia	91	1,284	124	227	1 536	3 262
East Asia	12	105	119	0	801	1,037
Nigeria	95	0	20	11	1,750	1,876
North Africa	0	0	551	1,615	2 587	4,753
Egypt	0	2,171	425	915	836	4,347
Other Africa	0	456	633	1,219	263	2,571
Subtotal	7 937	14,874	17,935	10,001	34,051	84,798
Price ($/MT)	125 53	151 37	178 76	172 13	151 60	

Table 5—Gains (or losses) from industrialized countries' trade liberalization in the world wheat market

Item	Argentina	Australia	United States	Canada	European Community	Japan
			Million dollars			
Changes in consumer surplus	−3 0	−4 7	−19 3	−6 1	2,252 9	72 4
Changes in producer surplus	7 2	25 5	278 9	−779 2	−2,290 0	−420 3
Net changes in surplus	4 2	20 8	259 6	−785 3	−37 1	−347 9
Savings in Government expenditure equivalent	1 12[1]	0	4,027 3	873 4	1,452 7	−169 5
Gains (or losses) to taxpayer	5 32	20 8	4,286 9	88 1	1,415 6	−544 1
Effectiveness ratio[2]	−3 75	0	− 06	90	03	− 2 05

[1]Export tax rate for 1985 was 21 5 percent
[2]Effectiveness ratio = Minus net changes in surplus/savings in government expenditure equivalent

producers in both countries would slightly increase their production Consumer demand in Argentina would decline slightly (1,000 MT, 0 02 percent), while producers would increase their wheat production by 7,000 MT (0 05 percent) to 13 61 million MT Consumers in Australia would reduce their wheat consumption by 3,000 MT (0 09 percent) and producer output would climb by 17,000 MT (0 09 percent) Wheat production in Japan would decline by 135,000 MT (18 percent) Consumer demand, however, would rise by 41,000 MT (6 percent), resulting in an increase in imports of 112,000 MT (1 9 percent)

We estimate net changes resulting from trade liberalization in the world wheat market at $4 3 billion for the United States, $88 million for Canada, $1 4 billion for the EC, $5 3 million for Argentina, $20 8 million for Australia, and −$517 million for Japan The magnitude of the net changes not only would be influenced by trade barriers and domestic farm policy but would depend on the magnitude of production levels Therefore, we estimated an effectiveness ratio of government intervention which is the ratio of welfare gains resulting from government subsidies compared with government expenditures that subsidize both consumers and producers The estimated effectiveness ratio is −0 06 for the United States, 0 90 for Canada, 0 03 for the EC, and −2 05 for Japan For example, when the United States spends 1 dollar to subsidize wheat producers, social welfare resulting from government subsidies would decline by 6 cents When the EC spends 1 dollar to subsidize producers or tax consumers, social welfare increases by 3 cents EC trade barriers and farm policy somewhat punish consumers while protecting producers in the EC As a result of trade liberalization in the world wheat market, EC consumer benefits would increase substantially by $2 3 billion, while producer benefits would decline by slightly more The EC spent $1 5 billion for subsidies, which generated just $37 million of social welfare enhancement

Canadian trade barriers and farm policy reallocated social benefits from taxpayers to producers When the Canadian Government spent 1 dollar to subsidize producers, their benefits increased by 90 cents

We did not estimate gains from trade liberalization for other importing countries because of limited information about domestic or import prices However, it is possible to provide a qualitative analysis of effects on trade patterns and gains from trade liberalization for these countries When all PSE's and CSE's in importing countries are removed, domestic demand increases and supply declines However, when all PSE's and CSE's are removed from all exporting countries so that export prices rise, domestic production increases and domestic demand declines Consequently, changes in social welfare in importing countries depend mainly on the relative size of PSE's, CSE's, and changes in export prices

Limitations and Conclusions

These results indicate that government subsidies to wheat producers and consumers do not generate an adequate level of social welfare Because members of GATT are currently negotiating for trade liberalization, this study offers the timely advice that trade barriers are unlikely to be beneficial to all exporting countries

Price elasticities of domestic demand and supply affect the magnitude of welfare effects of trade liberalization Domestic demand and supply equations, however, are synthesized by using secondary data in a crude manner Further econometric study is necessary for confirmation of elasticities used in this article Also, the foregoing analysis ignored the long run effect on domestic supply of trade liberalization in the world wheat and corn markets Producers are expected to react to changing prices and to increased uncertainty associated with market prices

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