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Effect of Trade Liberalization in the Short-Grain Japonica Rice Market: A Spatial-Temporal Equilibrium Analysis

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INTRODUCTION

Given current conditions in world food markets, there is serious concern on the stability of these markets in the 21st century. Real prices of many farm products have been subject to wide fluctuations with a long-term downward trend (Anderson and Tyers 1991), placing the state of food, income, and employment security in the international agricultural community at risk.

To stabilize prices, governments have increasingly resorted to interventions that nonetheless resulted in distortions in food prices. The public acceptance of these interventions has caused their numbers to rise to record levels. This increase has been particularly more rapid in Western Europe and Japan than elsewhere. In effect, this has further depressed and destabilized international food prices and thus worsened the food crisis (Anderson and Tyers 1991) since most of these policies extend price instability from the domestic to the world market jeopardizing world economic welfare.

The liberalization of agricultural trade continues to be slow. The Uruguay Round of Multilateral Trade Negotiations, which

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concluded in 1994, produced a number of important achievements including the adoption of new rules governing agricultural trade policy. However, this is only the first step in a lengthy process of reforming world agricultural markets.

Among agricultural crops, rice has the highest producer subsidy in total value and in per unit equivalent (OECD 1995). Rice, a major source of caloric supply and nutrition, is one of the most important food grains in the world. It is primarily produced and consumed in Asia with China, India, Indonesia, Bangladesh, and Thailand being the largest rice producers in the world (see Table 1). In 1991, these countries accounted for about 75% percent of global rice production.

Table 1. Principal rice producers of the world, 1987-1991 (in million metric tons)

Country	1987	1988	1989	1990	1991
China	174.3	169.1	180.1	189.4	185.0
India	85.3	106.4	110.3	112.0	110.9
Indonesia	40.1	41.7	44.7	45.2	44.3
Bangladesh	23.1	23.3	27.3	26.8	28.6
Thailand	18.4	21.3	20.2	17.3	20.0
Vietnam	15.1	17.0	19.0	19.2	19.4
Myanmar	13.6	13.2	13.8	14.0	13.2
Japan	13.3	12.4	12.9	13.1	12.0
Philippines	8.5	9.0	9.5	9.3	9.7

Source: UNCTAD (1993)

The objective of this paper is three-fold. First, a spatial-temporal equilibrium model is developed for short-grain japonica rice trade. Second, policy alternatives for free trade and improved trade are simulated to determine effects on policy changes. Third, implications of the results on the relevant countries, with special focus on the Philippines, are discussed.

The next section discusses the world rice market and the institutional framework of the General Agreement on Tariffs and Trade (GATT) and the World Trade Organization (WTO) as they relate to japonica rice. Following that is a section which describes the literature on spatial-temporal equilibrium modeling. It is followed by a presentation of the proposed spatial-temporal equilibrium model's specifications and data requirements. The next two sections meanwhile discusses the base period results and the results from alternative policy scenarios, respectively. These are followed by the implications of the study results on the Philippine economy. The last two sections summarizes the findings and conclusions of the study, the policy implications, and the limitations of the analysis.

WORLD RICE MARKET AND GATT

Most rice is consumed where it is grown so that very little of world rice production enters world trade. Less than 5 percent of the total rice production in the world enters into international markets (Efferson 1985). This renders the world rice market as thin and volatile with relatively few buyers and sellers.

The world market for japonica rice in various forms, varieties and qualities is even thinner and more volatile. The North East Asian countries of Japan, South Korea, China-Taiwan and China (Northern provinces) produce and consume japonica rice, while Australia, the United States and some countries in the European Union are the primary exporters of this rice variety.

Trade policies in major rice producing and consuming regions nations are largely protectionist. Because of restrictive trade policies such as price supports, import bans, and prohibitive tariffs, producer and consumer prices of rice in these countries are typically much higher than world prices. Domestic rice markets are heavily insulated and protected for various reasons, one of which is for national security. In many countries, rice is considered a sacred crop with deep historical and political underpinnings.

The Uruguay Round of the GATT was concerned with two aspects of trade in goods and services. The first goal was to increase market access by reducing or eliminating trade barriers through reductions in tariffs, reductions in nontariff support in agriculture, elimination of bilateral quantitative restrictions, and reductions in barriers to trade in services. The second goal was to increase the legal security of the new levels of market access, making trade and institutional agreements "binding" and enforceable. This latter goal led to the establishment of the World Trade Organization (WTO) in Geneva in 1995.

SPATIAL-TEMPORAL EQUILIBRIUM MODELS

Spatial-temporal price allocation (STPA) models are useful in enabling researchers to deal with situations where variables are dated and production, storage and pricing decisions are undertaken over finite periods of time. STPA models enable the researcher to evaluate not only pricing policies but also policies involving production and stock management. Several studies have applied these models and variants/extensions of STPA models to economic planning over space, over time, and over space and time. Examples of allocation studies are those done by Schmitz and Bawden (1973), Sasaki (1973), Zusman et al. (1973) and Koo (1984). Examples of allocation studies that focus only on the temporal dimension include Abe (1973), Pandey and Takayama (1973) and Singh (1973). Studies which consider both the spatial and temporal dimensions were done by Kottke (1973), Hashimoto (1977), Helmar (1984), Labys (1989), Takayama et al. (1989), Thompson (1989) and Cramer et al. (1991).

Cramer et al. (1991) conducted a key study on rice trade analysis using the spatial price equilibrium model. The researchers examined the world rice market in general while analyzing in detail rice quality and type differentiation and current price distortions. In this study, linear excess demand and excess supply functions were derived for both homogeneous and rice differentiated country importers and exporters. A General Algebraic Modeling System

(GAMS) solver (see Brooke et al. 1992) was used to approximate the 1986-1987 base year figures, as well as to simulate free trade and other policy scenarios. The primary results of the differentiated rice model indicate that if there were free trade in 1986-1987, overall world trade volume would:

(i) increase substantially by 104 percent;,
(ii) (as a percentage of world consumption) increase from 5.4 percent to 11 percent with high-quality indica exports increasing by 0.7 mmt, low quality indica by 0.004 mmt, and japonica exports by 0.64 mmt;,
(iii) increase world welfare by $12 billion;,
(iv) increase U.S. rice exports by 9.6 percent and U.S. total gross revenue by 89.5 percent, and;
(v) increase overall exports for all exporters.

While studies on the use of the spatial and temporal framework as applied to rice and other agricultural products exist, there has not been specific focus on high-quality, short-grain japonica rice trade. The spatial-temporal equilibrium framework provides an empirical methodology to analyze trade flows and an opportunity to evaluate effects from policy alternatives under various trade regimes on speculative stock levels which play a determining role in price stabilization.

PROPOSED SPATIAL-TEMPORAL EQUILIBRIUM RICE MODEL

The spatial and temporal equilibrium price framework developed by Takayama and Judge (1971) is used to construct a multi-region, two-period, single commodity spatial-temporal model for rice. The model utilizes excess demand and excess supply functions, equilibrium constraints, and conditions that link demand, supply, trade, and stock quantities. The model is essentially a trade problem taking the form of a welfare (or revenue) maximization approach. GAMS (Brooke et al. 1992) is used to approximate actual figures for the base years (1991/92 and 1992/93). The model is also used later to simulate different policy scenarios and examine policy effects on optimal trade quantities, prices and stock levels.

The proposed global market depicts the market for high-quality, milled, short-grain japonica rice as a unique market, apart from the markets for other varieties and qualities of rices. This model incorporates the major producers and consumers of short-grain japonica rice. The principal importing countries/regions include Canada (CAN), Japan (JPN), China-Taiwan (TWN), South Korea (SKR), Europe (EUR), Oceania (OCE), Middle East and South Asia (MESA), South America and the Caribbean (SAC), Other Asia (OAS), Other Africa (OAF), and the Rest of the World (ROW). The relevant countries in the European (EUR) region include Sweden, UK, France, Belgium, Spain, Switzerland, and the Netherlands. OCE consists of Australia, New Zealand, and Pacific Island countries. The MESA include the United Arab Emirates, Pakistan, and India while SAC include Panama, Brazil, Argentina, Turks and Caicos Islands and St. Christopher Island. Singapore and Hong Kong comprise OAS, while South Africa mainly accounts for OAF. Since a very large portion of short-grain rice exported by the US goes to the Middle East (Setia et al. 1994), the ROW is assumed to take after the characteristics of the MESA market and capture any residual trade quantities. The US is assumed as the sole exporter of high-quality, short-grain japonica rice[1]. The North East Asian countries of Japan, China-Taiwan and South Korea, and China are producers of this type of rice as well but are not exporters.

For the single-product, two-period case, the Marshallian market (or industry) demand function is to be maximized subject to a proper

[1] Australia, China, Spain and Italy are producers of japonica rices in both the medium- and short-grain variety. However, Australia largely produces and exports the medium-grain variety (Rice Growers Association of Australia 2000). China, on the other hand, produces short-grain japonica rice but exports little (Cramer et al. 1991). Spain and Italy are also, by and large, producers of the medium-grain japonica variety. Hence, the U.S. is assumed the sole exporter of short-grain japonica rice in the current study.

set of linear constraints. The objective function and constraints for this model are defined as follows:

$$MAX\ Z = Z_1 + Z_3 \tag{1}$$

where:

$$Z_1 = \Sigma_{I,1} (\alpha_{I,1} PD_{I,1} - 1/2\beta_{I,1} PD^2_{I,1}) - \Sigma_{E,1}(\gamma_{E,1} PS_{E,1} + 1/2\gamma_{E,1} PS^2_{E,1}) \ ;$$

$$Z_2 = \Sigma_{I2} (\alpha_{I,2} PD_{I,2} - 1/2\beta_{I,2} PD^2_{I,2}) - \Sigma_{E,2}(\gamma_{E,2} PS_{E,2} + 1/2\gamma_{E,2} PS^2_{E,2}) \ ;$$

$$\sigma^{t-1} = (1/(1 + r)) \ ; \text{ and}$$

$$Z_3 = \sigma^{t-1} * Z_2.$$

Subject to:

1) Spatial price equilibrium condition:
   $PD_{I,t} - PS_{E,t} = TC_{I,E,t}$, for all t, I and E.
2) Intertemporal price equilibrium condition:
   $\sigma^t * PS_{E,t+1} - PS_{E,t} = \sigma^t * SC_{E,t;E,t+1}$ for all t and E.
3) No excess demand for importing regions:
   $DCONS_{I,t} = STK_{I,t} + DSUP_{I,t} + IMP_{I,t}$ for all t and I
4) Excess supply possibility for exporting regions:
   $DSUP_{E,t} - STK_{E,t} = EXP_{E,t} + DCONS_{E,t}$ for all t and E
5) Excess demand function for importing regions:
   $IMP_{I,t} = \alpha_{I,t} - \beta_{I,t} PD_{I,t}$ for all t and I
6) Excess supply function for exporting regions:
   $EXP_{E,t} = \gamma_{E,t} + \delta_{E,t} PS_{E,t}$ for all t and E
7) Excess supply should at least satisfy excess demand:
   $\Sigma_I IMP_{I,t} = \Sigma_E EXP_{E,t}$ for each t and for all I and E
8) PS, PD, IMP, and EXP = 0,

where:

Z	is the value of world welfare or total gross revenue from trade (measured in US$);
PS, PD	are the supply price (FOB$ per MT) and demand price (CIF$ per MT), respectively;

α, β	are the excess demand intercept and excess demand slope, respectively;
γ, δ	are the excess supply intercept and excess supply slope, respectively;
TC	is the transportation cost;
SC	is the storage cost;
r	is the discount rate;
t	are the time periods (i.e., t = 1, 2);
E	is the set of exporters;
I	is the set of importers;
IMP, EXP	is the quantity of rice imported and exported respectively;
DCONS	is the domestic consumption of milled rice in important region at any time t;
DPROD	is the domestic supply of rough rice in importing/exporting region at any time, t; and
STK	is the domestic carry-over stocks of milled rice in importing/exporting region at any time, t.

Linear excess demand and excess supply functions are derived for all importing and exporting regions using actual data for domestic production, consumption, stocks, demand, supply and stock elasticities, milling rates, as well as exports/imports and supply/demand prices. These data are used to derive elasticities of excess supply and excess demand functions, which in turn are used to generate linear excess supply and excess demand functions for all the relevant regions. The general procedure for this derivation is taken from Cramer et al. (1991).

Table 2 shows the calculated linear excess demand and excess supply equations. In the case of China-Taiwan, the consumption data were estimated from a demand model formulated by Chang (1970) and updated using more recent data for explanatory variables (see Calaguas 1996).

A major constraint to spatial-temporal equilibrium is requiring prices at import and export points to differ in consideration of transportation cost. However, data on transportation costs for all relevant trade routes contemplated in this study are not available. Because of this data problem, Cramer et al.'s (1991) transportation model is used to derive ocean transportation costs. The estimated cost equation used in their study is as follows:

$$TC_{I,E} = \underset{(9.96)}{0.0124\, DIST_{I,E}} - \underset{(-6.07)}{0.000000875\, DIST^2_{I,E}} + \underset{(17.17)}{57.3648\, US} \qquad (2)$$

where $TC_{I,E}$ = transportation cost in US dollars/MT from exporter E to importer I,

$DIST_{I,E}$ = distance in nautical miles between exporter E and importer I,

US = dummy variable for shipments with U.S. flag vessels (i.e., 1 = shipment with U. S. flag vessels and 0 = without).

Data used to estimate transportation costs with the above equation were obtained from the U.S. Defense Mapping Agency (USDA). Storage cost data for the U.S. are rather difficult to obtain. Instead, a benchmark storage cost quote for 1992 was taken from a telephone conversation with Mr. Gene Rosera of the USDA Farm Services Agency on March 11, 1996. This figure was then adjusted for the U.S. rate of inflation to account for storage costs over the 1991-92 and 1992-93 period.

BASE MODEL RESULTS FOR 1991-92 AND 1992-93

The spatial-temporal equilibrium rice trade model was run using the General Algebraic Modelling System (GAMS) computer solver. Tables 3a, 3b, and 3c show the robustness of the model in approximating the 1991-92 and 1992-93 base periods actual values for quantities traded, prices, and stock levels. The evaluation results show that percentage errors (i.e., discrepancy between estimated and actual values) were not more than plus or minus 8 percent for equilibrium quantities traded, less than 11 percent error for

Table 2. Linear excess supply and excess demand equations, all regions, base scenario, 1991-92 (t_1) and 1992-93(t_2)

Regions/ Time period	Excess demand equations Intercept	Slope	Regions/ Time period	Excess supply equations Intercept	Slope
Importers:			Exporters:		
CAN			USA		
1991-92	977	-0.54	1991-92	- 9,052	26.77
1992-93	853	-0.43	1992-93	-14,470	34.00
JPN					
1991-92	146	0.00			
1992-93	119	0.00			
TWN					
1991-92	318	0.00			
1992-93	310	0.00			
SKR					
1991-92	47	0.00			
1992-93	19	0.00			
EUR					
1991-92	635	-1.03			
1992-93	520	-0.73			
OCE					
1991-92	98	-0.12			
1992-93	111	-0.12			
MESA					
1991-92	33	-0.02			
1992-93	33	-0.02			
SAC					
1991-92	685	-0.35			
1992-93	292	-0.20			
OAS					
1991-92	400	-0.26			
1992-93	200	-0.14			
OAF					
1991-92	11	-0.01			
1992-93	8	-0.01			
ROW					
1991-92	493	-0.33			
1992-93	845	-0.55			

equilibrium stock levels and less than 3 percent error for equilibrium prices. Table 4 shows the corresponding equilibrium values for the objective function. Table 5 indicates that when comparing the performance of the STPA equilibrium model with the spatial price equilibrium (SPA) model, the SPA model performs slightly better at predicting prices than the STPA model. However, the overall performance of approximating both equilibrium quantities and prices is generally the same for both models, with maximum percentage discrepancies of 7 percent to 8 percent.

These results and comparisons attest to the relative strength and robustness of the spatial-temporal equilibrium model in approximating actual values for the specified base period. From these results, one can expect that if the model were adjusted to reflect a particular trade policy scenario, the model should approximate

Table 3a. Spatial-temporal equilibrium model results, equilibrium trade quantities, base scenario, 1991-92 (t_1) and 1991-92(t_2)

Region	Actual export/import quantity		Estimated export/import quantity		% Discrepancy	
	t_1	t_2	t_1	t_2	t_1	t_2
Exporter						
USA	5,539	4,776	5,973	4416	8	-8
Importers						
CAN	1,303	1,083	1,313	1,118	1	3
JPN	146	119	146	119	0	0
TWN	318	310	318	310	0	0
SKR	47	19	47	19	0	0
EUR	1,308	962	1,305	992	0	3
OCE	175	186	178	190	2	2
MESA	45	45	46	46	0	0
SAC	907	522	917	524	1	0
OAS	571	312	573	292	0	-6
OAF	17	14	17	14	0	0
ROW	702	1,204	709	1,202	1	0

Table 3b. Spatial-temporal equilibrium model results, equilibrium prices, base scenario, 1991-92(t_1), 1992-93 (t_2)

Region	Actual CIF/FOB prices ($/mt)		Estimated CIF/FOB prices ($/mt)		Discrepancy (%)	
	t_1	t_2	t_1	t_2	t_1	t_2
Exporter (CIF$/mt)						
USA	545	566	561	556	3	-2
Importers (FOB$/mt)						
CAN	604	627	621	617	3	-2
JPN	641	664	658	654	3	-2
TWN	646	669	662	659	2	-1
SKR	643	664	659	656	2	-1
EUR	633	657	650	647	3	-2
OCE	643	670	663	660	3	-1
MESA	636	660	653	650	3	-2
SAC	644	668	661	658	3	-1
OAS	647	670	663	660	2	-1
OAF	619	642	636	632	3	-2
ROW	636	660	653	650	3	-2

Table 3c. Spatial-temporal equilibrium model results, equilibrium stock levels, base scenario, 1991-92 (t_1), 1992-93(t_2)

Region	Actual stock level ('000 mt)		Estimated stock level ('000 mt)		Discrepancy (%)	
	t_1	t_2	t_1	t_2	t_1	t_2
Exporter						
USA	3,805	8,199	3,366	8,559	-11	4
Importers	0	0	0	0		

Table 4. Spatial-temporal equilibrium model objective function values

Objective function	Value (in billion US$)
Z	9,564
Z1	3,938
Z2	5,449
Z3	5,625

Table 5. Spatial price equilibrium vs. spatial-temporal equilibrium model results, percentage discrepancies from actual values, base scenario, 1991-92 (t_1), 1992-93(t_2)

Region	Spatial price equilibrium model t_1 (%)	Spatial price equilibrium model t_2 (%)	Spatial-temporal equilibrium model t_1 (%)	Spatial-temporal equilibrium model t_2 (%)
Equilibrium quantities traded				
USA	0	2	8	-8
CAN	0	4	1	3
JPN	0	0	0	0
TWN	0	0	0	0
SKR	0	0	0	0
EUR	-1	4	0	3
OCE	3	6	2	2
MESA	4	4	2	2
SAC	4	1	1	0
OAS	0	-6	0	-6
OAF	7	7	0	0
ROW	0	0	1	0
Equilibrium prices (CIF and FOB)				
USA	0	1	3	-2
CAN	0	0	3	-2
JPN	0	0	2	-1
TWN	0	0	2	-1
SKR	0	1	3	-2
EUR	0	0	3	-1
OCE	1	0	3	-2
MESA	0	0	3	-1
SAC	0	0	2	-1
OAS	0	0	3	-2
OAF	0	0	3	-2
ROW	0	0	3	-2

equilibrium quantities, prices and stock levels with reasonable accuracy.

MODEL RESULTS UNDER ALTERNATIVE POLICY SCENARIOS

International trade theory and literature has shown that welfare is reduced by protectionism. This study examines whether the world rice economy, with particular respect to the market for high-quality, short-grain japonica rice, can gain from free or improved trade relations among regions. Departing from the base scenario, the intercepts and slopes of the excess demand and excess supply equations for each region are adjusted to reflect the policy regimes of free trade and improved trade (see Cramer et al. 1991 for further discussion of this procedure). The free trade scenario reflects total trade liberalization of the world short-grain japonica rice market. For the improved trade scenario, partial trade liberalization occurs; that is, all countries except Japan, South Korea and China-Taiwan espouse liberalized markets.

Table 6 summarizes the trade barriers that apply to all qualities and types of rice occurring in 1991-92 and 1992-93 for all regions covered in this study. Using this information, intercepts and slopes of the linear excess demand and excess supply equations are adjusted depending on the type of trade barrier (see Cramer et al. 1991). As shown in Table 6, common trade restrictions take the form of ad valorem taxes, per unit taxes, and tariffs for importers. However, for regions such as the European Community (EUR), the consumer subsidy equivalent in US dollars per metric ton is used to adjust its excess demand equation to reflect free trade. For producers such as the U.S., little or none is economically transferred from consumers of rice in the form of ad valorem taxes or per unit tariffs. However, rice producers are heavily subsidized (as measured by the PSE) so that this is taken into consideration when adjusting to a free trade regime. Under free trade, tariff walls come down and producer subsidies are eliminated. Linear excess demand and excess supply intercepts are adjusted following Cramer et al. (1991).

Tables 7a, 7b, and 7c show the free trade equilibrium quantities and prices for both periods and the corresponding percentage changes over base year values. These results show large increases in imports from the base year particularly for countries that are currently under heavy protectionist policies such as South Korea, Japan and China-Taiwan. Under free trade, trade expands 743 percent in period 1 and 727 percent in period 2, equilibrium prices rise to as much as $2,304 per metric ton. With increases in the trade price by an average of 25 percent from the base for both periods,

Table 6. Rice trade barriers, all types and qualities, all regions, 1991-92 (t_1) and 1992-93 (t_3)

Region	Ad valorem tax or producer subsidy (%)		Per unit tax/tariff or producer subsidy (US$/mt)	
	t_1	t_2	t_1	t_2
Exporter (Producer subsidy equivalent)				
USA	-	-	119	133
Importers				
CAN	1	1	-	-
JPN	-	-	3,179	3,711
TWN	-	-	1,219	1,198
SKR	-	-	565	603
EUR	-	-	223	227
OCE	-	-	0	0
MESA	10	10	-	-
SAC	58	58	-	-
OAS	0	0	0	0
OAF	-	-	50	50
ROW	10	10	-	-

Sources: OECD (1994); IRRI (1990)
Note: "-" means not calculated by sources or zero.

U.S. short-grain japonica production increases from the base by an average of 75 percent per year. Finally, stocks held by the U.S. increases by 30 percent in period 1 and increases by 2 percent in period 2 (see Table 7c).

Estimation results (see Table 8) indicate that under free trade in the short-grain japonica rice market, total world welfare, combining for both periods under consideration, would be US$80.6 billion, a 735 percent increase from US$9.6 billion of welfare under the current economic situation. World welfare due to increased trade would be US$41.3 billion for the first period and US$39.3 billion for the second period, representing increases from base year values by 949 percent and 598 percent, respectively.

The improved trade scenario is based on the premise that agricultural trade in agriculture, in general, will not likely be "free" but only "better" in the not-too-distant future. In this alternative trade policy regime, it is assumed that free trade will exist for all

Table 7a. Equilibrium trade quantities under free trade scenario, spatial-temporal equilibrium model results for periods t_1 and t_2

Region	Equilibrium export/import quantity ('000 mt)		Change over base year values (%)	
	t_1	t_2	t_1	t_2
Exporter				
USA	46,704	39,483	743	727
Importers				
CAN	2,185	1,612	68	49
JPN	16,332	14,265	11,086	11,887
TWN	6,065	5,030	1,807	1,523
SKR	15,003	13,310	31,821	69,953
EUR	3,225	2,008	147	109
OCE	380	336	117	81
MESA	75	67	67	49
SAC	1,226	623	35	19
OAS	999	455	75	46
OAF	33	26	94	86
ROW	1,181	1,752	68	4

Table 7b. Equilibrium prices under free trade scenario, spatial-temporal equilibrium model results for periods t_1 and t_2

Region	Equilibrium prices (US$/mt)		Change over base year values (%)	
	t_1	t_2	t_1	t_2
Exporter				
USA	2,202	1,720	304	204
Importers				
CAN	2,262	1,781	275	184
JPN	2,299	1,818	259	174
TWN	2,304	1,823	257	172
SKR	2,300	1,820	258	174
EUR	2,291	1,811	262	176
OCE	2,304	1,824	258	172
MESA	2,294	1,814	261	175
SAC	2,302	1,822	257	173
OAS	2,304	1,824	256	172
OAF	2,277	1,796	268	180
ROW	2,294	1,814	261	175

Table 7c. Stock levels under free trade scenario, spatial-temporal equilibrium model results for periods t_1 and t_2

Region	Equilibrium stock levels ('000 mt)		% Change over base year values	
	t_1	t_2	t_1	t_2
Exporter USA	4,935	8,372	47	-2
Importers	0	0		

Table 8. Objective function values under free trade scenario, spatial-temporal equilibrium model results

Objective function	Values (in billion US$)	% Change over base year values
Z	80.575	735
Z1	41.329	949
Z2	38.015	598
Z3	39.247	598

countries but for the heavily protected countries of Japan, South Korea and China-Taiwan, which have requested grace periods from the GATT provisions. In effect, this trade policy regime contemplates a scenario that is somewhere in between the base and the free trade situations and practically isolates the welfare foregone by the protectionist policies pursued by such countries. For this scenario, the set of adjustments will depend on policy adjustments that are partly based on the minimum access requirements stipulated under the GATT for Japan and South Korea. Under the Uruguay Round Agreement on Agriculture (URAA), Japan and South Korea each have expressed commitment to increase their minimum access opportunity for rice to 1,076 million metric tons by the end of the implementation period. Despite China-Taiwan's continuous bid for membership into the WTO, it is not covered by the GATT Agreement of 1993. However, with China-Taiwan anticipating membership and its agricultural economy already being prepped for the inevitable liberalization of the world agricultural trade arena, the study assumes Taiwan will eventually be part of this trading system. Like Japan and South Korea, China-Taiwan is opposed to the opening of the domestic rice market for reasons of national security. In 1991, the Taiwan Council of Agriculture adopted a policy that if the domestic rice market were opened to imported rice, a tariff rate not less than 134 percent or a maximum import quota of not more than 1.494 million metric tons would be imposed (Republic of China Council of Agriculture 1991).

Under the improved trade policy scenario, the derivation of linear excess demand and excess supply functions for each region is done in a fashion similar to deriving the functions under free trade. However, the excess demand functions for Japan, South Korea and China-Taiwan are different. Under the base scenario, Japan, South Korea and China-Taiwan take on zero slopes and intercepts equivalent to their imports. Under improved trade, these intercepts increases to the amount of the minimum access commitment under the URAA (for Japan and South Korea) or to the government-set import limits (for China-Taiwan) to reflect increases in imports, while maintaining zero slopes for these countries. Specifically, intercepts for the second time period reflects these policy limits, while the intercepts for the first time period reflects half of the intercepts of the second time period to accommodate an assumed gradual change toward the agreed limits.

Under the improved trade scenario, Japan, China-Taiwan, and South Korea face actual retail prices and hence no changes in domestic consumption. Moreover, for the minimum access agreement under the GATT, only the import quota increases for stockpiling purposes but no change in production is assumed (Nishimura and Mineshige 1994). Estimation results are shown in Tables 9a, 9b, and 9c. These results illustrate that the effects of an improved trade policy on regions are varied. South Korea has the largest increase in import quantity over the base year values for both periods with Japan and China-Taiwan trailing closely behind. U.S. exports increase as well by an average of 57 percent per period over base year values. CIF and FOB prices generally increase for all regions (note small increases in the first period and decreases in the second period for the South American and Caribbean [SAC] region). Buffer stock levels for the U.S. increase dramatically by 1,172 percent during the first time period and 373 percent for the second time period. As shown in Table 10, under an improved trade policy scenario, total world welfare increases by as much as 94 percent over the base year value by the end of the second period.

Principal findings of this study indicate that under free trade:

1. Average total volume of short-grain japonica rice traded is 43.3 million metric tons, an average increase of 733 percent over the base scenario.
2. World welfare increases to US$80.6 billion, rising 742 percent over the base year estimate.
3. Greater expansion in the trading environment is induced more than the improved trade policy.
4. Japan and South Korea will have the largest trade expansion.
5. Decreases in market shares, as experienced by regions such

Table 9a. Equlibrium trade quantities under improved trade scenario, spatial-temporal equilibrium model results for periods t_1 and t_2

Region	Equilibrium export/import quantity ('000 mt)		Change over base year values (%)	
	t_1	t_2	t_1	t_2
Exporter				
USA	8,836	7,330	60	53
Importers				
CAN	1,429	1,209	10	12
JPN	538	1,076	268	804
TWN	538	1,076	69	247
SKR	747	1,494	1,489	7,763
EUR	1,768	1,318	35	37
OCE	210	222	20	19
MESA	50	50	11	11
SAC	912	503	1	-4
OAS	631	323	11	4
OAF	20	17	18	21
ROW	757	1,279	8	6

Table 9b. Equilibrium prices under improved trade scenario, spatial-temporal equilibrium model results for periods t_1 and t_2

Region	Equilibrium prices (US$/mt)		Change over base year value (%)	
	t_1	t_2	t_1	t_2
Exporter				
USA	787	774	44	37
Importers				
CAN	847	835	40	33
JPN	884	872	38	31
TWN	888	877	37	31
SKR	885	874	38	32
EUR	876	865	38	32
OCE	889	878	38	31
MESA	879	868	38	32
SAC	887	876	38	31
OAS	889	878	37	31
OAF	862	850	39	32
ROW	879	868	38	32

Table 9c. Stock levels under improved trade scenario, spatial-temporal equilibrium model results for periods t_1 and t_2

Region	Equilibrium stock levels ('000 mt)		% Change over base year values	
	t_1	t_2	t_1	t_2
Exporter				
USA	42,803	40,525	1172	373
Importers	0	0		

Table 10. Objective function values under improved trade scenario, spatial-temporal equilibrium model results

Objective function	Values (in billion US$)	% Change over base year values
Z	18.579	94
Z1	7.046	79
Z2	11.171	105
Z3	11.533	105

as the EUR, can be attributed to cross-rice type or cross-commodity substitutions in demand.

6. Weighted average export price increases by 251 percent over the base period.
7. Equilibrium stock levels reflect an average increase of 12 percent over the base period.

Under the improved trade scenario, trade volume, world welfare, and equilibrium prices increase by smaller quantities than under the free trade case. However, improved trade results are substantially higher than the base scenario results. In comparing free trade with improved trade, it is interesting to note that there are less stock increases under free trade than under improved trade. This probably indicates that liberalized trade leads to more efficient markets and requires less stocks to 'control' price variability.

IMPLICATIONS ON THE PHILIPPINE RICE ECONOMY

Rice production is a major source of livelihood for a sizable number of farmers in the Philippines. However, production per capita has been stagnating due to declining hectarage devoted to rice and to various impediments to raise productivity levels (Lim 1996). Anti-GATT advocates argue that the stiff competition that will ensue from the GATT implementation will cause the further decline of the industry and displacement of many in the agricultural sector. Indeed, many miss the point that the GATT could provide an opportunity to increase competition, raise productivity in rice production, and foster efficiencies in production and consumption.

Rice production and productivity in the Philippines have degenerated because of both internal and external reasons. The skewed setup of markets, institutions and structures within the domestic agricultural economy have played a major role in sending incentives away from the efficient production of rice. Factors such as insecurity of tenure brought about by the failure of the government's agrarian reform program, obsolete technology and practices, poor agricultural infrastructure such as roads linking farms to markets, irrigation and postharvest facilities all have contributed to the decline in rice productivity (Lim 1996).

External factors, however, likewise contributed greatly to the worsening of the rice productivity problem. For a long time, protectionist policies in the world rice market have sent perverse signals and incentives to rice producing and consuming countries. This eventually warped the world rice economy away from potentially efficient production in several countries such as China, Thailand, or the Philippines.

It is not widely known that the Philippines produces 'koshihikari'[2] rice. Along with the internal factors in the domestic economy, the effect of protectionist policies in Japan, South Korea, and China-Taiwan may have influenced the under-production of such variety of rice in the Philippines. Hence, instead of destroying the domestic rice economy, the GATT may in fact provide pockets of opportunities for the Philippines to get into lucrative markets such as that for high-quality, japonica rice given potentially high prices. The objective of rice trade liberalization is not to raise prices per se, but to rationalize them in order to create efficiencies in production through specialization, and in consumption through the "right" market prices.

The implication for the Philippine economy is that it will make sense to face up to the challenges of trade liberalization as there are gains that could be derived from it. The results of the current study point to those gains.

However, such gains are not achieved easily, especially if domestic institutions are in shambles. To be able to benefit from free trade, Philippine policymakers must decide what system of incentives and institutional framework must be in place within the domestic economy so that rice farmers will reap what is due them.

[2] 'Koshihikari' is the name of a japonica rice variety that is preferred by most Japanese consumers. It is assumed similar to japonica rice although qualities may differ.

CONCLUSIONS

This study shows that a better trade environment in general brings about trade and income expansion. There are also shifts in market shares for imported high-quality, short-grain japonica rice under different scenarios. Under free trade, Japan and South Korea account for nearly 70 percent of the rice market while under an improved trade policy regime, the European countries, Canada and South Korea equally share 50 percent of the world short-grain japonica rice market. It is likely that these shifts in market shares are due to cross-commodity substitutions in demand for those regions.

It is interesting to note that although stock levels under both scenarios increase in general, stock levels under an improved trade policy regime increase more dramatically than under free trade. This is due to unmet and displaced demand in major consuming countries and excess supply in the U.S. in response to the large increase in trade price. Large buffer stocks under improved trade may be attributed to the U. S. production response and that producers might be more speculative than under a free trade scenario so that buffer stocks rise dramatically.

These spatial-temporal equilibrium short-grain japonica rice results are similar to the study done by Cramer et al. (1991). While the magnitudes of change in this study and in Cramer et al.'s study differ, the directions of change are the same. It is clear, from both studies, that there are significant potential gains from trade liberalization.

In the case of free and freer trade, the model results call for a significant increase in world prices. This increase may cause other liberalized countries such as China, Thailand, or the Philippines to enter the market and become new producers. By and large, the landscape of the world short-grain japonica market will experience dramatic changes. Such changes may create market expansion, increase competitiveness among suppliers, and therefore further benefit consumers in the long run.

LIMITATIONS OF THE STUDY

This study develops a spatial-temporal equilibrium model for high-quality, short-grain japonica rice trade for the purpose of analyzing the effects of trade policy changes on optimal trade quantities, prices, and stock levels from specified base scenarios. The current study is different from previous ones that analyzed trade policy impacts on the world rice economy for two reasons.

First, the study is focused on the single, unique market for high-quality, short-grain japonica rice. The study argues that this market is specialized where rice type and quality play an important role in determining demand and market structure. This suggests that cross-rice type substitution in this market may be irrelevant especially in the short-term. Hence, the assumption of no direct substitution may not be a limitation of the analysis but is consistent with the study's perception of market characteristics.

Second, the model provides critical estimates of stock levels, which are argued as essential in stabilizing prices in a partially liberalized trading environment. The role of buffer stock policy may be more desirable under an environment where countries pursue distortionary interventionist policies than under free trade. In fact, it is argued that in the absence of storage costs, buffer stock policies could even be an effective substitute for free trade (Devadoss 1992). However, storage costs are substantial, giving rise to the question of determining the marginal benefits and costs of storage activities and the institutional setup under which a buffer stock policy and its underlying activities are likely to achieve price stability.

While the study results provide some relevant inputs into the trade policy discourse, caution must be taken in interpreting them. The model used in the analysis utilized trade flows and prices that were influenced by 1992-93 agricultural policies in the relevant countries and the existing trade barriers at the time. Comparison of the current study with Cramer et al's alone shows that there are significant differences in trade flows and prices over just a few years. Further, the study has assumed no substitution between rice types and qualities as well as between consumption and production—which are all reasonable in the short- to medium-term and given the characteristics of the market. However, in the long run, such assumptions may no longer be valid. Hence, the perspective of the study is only of a short-term nature.

Moreover, the model used was not able to disaggregate total welfare into economic winners and losers among relevant countries and among consumers and producers within these countries. This is for the reason that it was not constructed to provide this information as part of the solution. Disaggregation of welfare is therefore a limitation of the study and may at best be only suggested for further study or research. In the context of the present study, welfare gained from free trade is still maintained as a Pareto optimal solution, whereby winners may outnumber losers or winners may compensate losers netting out positive outcomes.

Finally, the model assumed that the US would remain as the sole exporter of high-quality, japonica rice even after trade liberalization. The study has shown that the US was the only strong exporter of this rice in 1992-93. However, this may not hold true after liberalization when prices would have risen to signal potential producers to enter the market. Countries anticipated to enter the market such as China, Thailand, or the Philippines were not incorporated into the second time period. This is, therefore, a further limitation of the study.

REFERENCES

Abe, M. A. 1973. Dynamic Micro-economic Models of Production, Investment and Technological Change of the U.S. and Japanese Iron Industries, p. 345-367. In *Studies in Economic Planning Over Space and Time*, edited by T. Takayama and G. G. Judge. Amsterdam: North-Holland Publishing Company.

Anderson, K. and R. Tyers. 1991. *Global Effects of Liberalizing Trade in Farm Products.* London: Harvester Wheatsheaf.

Brooke, A. D. Kendrick K. and A. Meeraus. 1992. GAMS: A User's Guide. , Release 2.25, San Francisco: The Scientific Press.

Calaguas, R.A.S. 1996. Spatial-Temporal Equilibrium Analysis of Short-Grain Japonica Rice Trade. Department of Agricultural and Resource Economics, University of Hawaii at Manoa. Unpublished M.S. Thesis.

Chang, T. T. 1970. *Long-term Projections of Supply, Demand and Trade for Selected Agricultural Products in Taiwan.* Taipei, Republic of China: The Research Institute of Agricultural Economics, National Taiwan University.

Cramer, G. L. et al. 1991. The Impact of Liberalizing Trade on the World Rice Market: A Spatial Model Including Rice Quality. Arkansas Agricultural Experiment Station Special Report 153. Division of Agriculture, University of Arkansas.

Efferson, J. N. 1985. Rice Quality in World Markets. In *Rice Grain Quality and Marketing.* Los Baños, Philippines: International Rice Research Institute.

Food and Agricultural Organization. 2000. *FAO Database Results* [cited 27 January 2000]. Available from World Wide Web: (http://www.fao.org).

Hashimoto, H. 1977. World Food Projection Models, Projections, and Policy Evaluation. Department of Economics, University of Illinois at Urbana-Champaign. Unpublished Ph.D. dissertation.

Helmar, M. D. 1984. A Spatial and Temporal Forest Products Model. Department of Agricultural Economics, University of Nevada at Reno. Unpublished M.S. Thesis

IRRI (International Rice Research Institute). 1995. *World Rice Statistics, 1993-95.* Los Baños, Philippines: IRRI.

Ito, S., M. Rosegrant and M. C. Agcaoili-Sombilla. 1995. Quality-Equivalent and Cost-Adjusted Measurement of International Competitiveness in Japanese Rice Markets. EPTD Discussion Paper No. 12. Washington, D.C.: Environment and Production Technology Division, International Food Policy Research Institute.

Koo, W.W. 1984. A Spatial Equilibrium Analysis of the U.S. Wheat Industry. North Dakota Research Report 99. Agricultural Experiment Station, North Dakota State University, Fargo, North Dakota.

Kottke, M. W. 1973. Allocation of Milk Through Space and Time in a Competitively Mixed Dairy Industry, p. 557-578. In *Studies in Economic Planning Over Space and Time,* edited by. T. Takayama and G. G. Judge. Amsterdam: North-Holland Publishing Co.

Labys, W. C. 1989. Spatial and Temporal Price and Allocation Models of Mineral and Energy Markets, p. 17-47. In *Quantitative Methods for Market-Oriented Economic Analysis Over Space and Time,* edited by W. D. Labys, et al. Aldershot, England: Avebury.

Lim, J.Y. 1996. Issues Concerning the Three Major Agricultural Crops and GATT, p. 29-86. In *The General Agreement on Tariffs and Trade: Philippine Issues and Perspectives,* edited by J. Reyes. Quezon City, Philippines: Philippine Peasant Institute.

Nishimura, K. and M. Mineshige. 1994. Growing Pressure: Japanese Agriculture. *Look, Japan* 40(457): 6-8.

OECD (Organization for Economic Cooperation and Development). 1994 *Agricultural Policies, Markets, and Trade: Monitoring Outlook.* Paris: OECD.

————. 1995. *Agricultural Policies, Markets, and Trade: Monitoring Outlook.* Paris: OECD.

Pandey, V. K. and T. Takayama. 1973. Temporal Equilibrium Analysis of Rice and Wheat in India, p. 579-596. *Studies in Economic Planning Over Space and Time,* edited T. Takayama and G. G. Judge. Amsterdam: North-Holland Publishing Company.

Rice Growers Association of Australia. 2000. 'Corporate-Presidential Report [cited 31 January 2000]. Available from World Wide Web: (http://www.rga.org.au/industry/this_is.html).

Sasaki, K. 1973. Spatial Equilibrium Analysis of Livestock Products in Eastern Japan, p. 419-442. In *Studies in Economic Planning Over Space and Time,* edited by T. Takayama and G. G. Judge. Amsterdam: North-Holland Publishing Company.

Schmitz, A. and D. L. Bawden. 1973. A Spatial Price Analysis of the World Wheat Economy: Some Long-Run Predictions, p. 488-518. *Studies in Economic Planning Over Space and Time,* edited by T. Takayama and G.G. Judge. Amsterdam: North-Holland Publishing Company.

Setia, P., N. Childs, E. Wailes and J. Livezey. 1994. The U.S. Rice Industry. Agricultural Economic Report No. AER-700. Economic Research Service, U.S. Department of Agriculture, Washington, D.C.

Singh, I. 1973. Recursive Programming Models of Agricultural Development, p. 394-418. In *Studies in Economic Planning Over Space and Time,* edited by T. Takayama and G. G. Judge. Amsterdam: North- Holland Publishing Company.

Takayama, T. and G. G. Judge. 1971. *Spatial and Temporal Price and Allocation Models.* Amsterdam: North-Holland Publishing Company.

Takayama, T. et al. 1989. Application of the Spatial and Temporal Price and Allocation Model to the World Food Economy", p. 227-278. In *Quantitative Methods for Market-Oriented Economic Analysis Over Space and Time,* edited by W. C. Labys et al. Aldershot, England: Avebury.

UNCTAD (United Nations Conference on Trade and Development). 1993. *UNCTAD Commodity Yearbook, 1993.* New York: United Nations.

Zusman, P. et al. 1973. A Spatial Analysis of the EEC Trade Policies in the Market for Winter Oranges, p. 464-487. In *Studies in Economic Planning Over Space and Time,* edited by T. Takayama and G. G. Judge. Amsterdam: North-Holland Publishing Company.