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Effects of Tariffs and Nontariff Trade Barriers (NTBs) on the International Rice Trade:

A Reactive Programming Model*

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This paper presents the effects of tariffs and nontariff trade barriers (NTBs) on the competitive positions of the Southern U.S. rice industry and the other major rice exporting countries. The empirical results of the reactive programming model show that Pakistan and the Southern U.S. are the countries most serious affected by tariffs and NTBs.

The result also indicates that the competitive position of the Southern U.S. rice industry is relatively low in the world rice market. In contrast, the results strongly suggest that Thailand, China, and Burma would have relatively high competitive positions.

I. Introduction

As rice production expanded both in the U.S. and in foreign countries since the early 1970's, the increased supplies exerted downward pressure on export prices. With domestic farm programs supporting prices above the world levels, the U.S. rice exports decreased about 23.3 percent from 1980 to 1986, while rice

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exports from Thailand increased rapidly. Therefore, international trade has again emerged as a primary component for the U.S. rice industry.

A number of empirical studies have been conducted on econometric analysis to investigate the effects of trade policies on the world rice trade (Sangsiri; Wong). However, only one spatial equilibrium analysis for the world rice market was available to the author after 1960's (El-Amir). El-Amir developed spatial equilibrium model for international rice trade in order to analyze the effects of the U.S. PL-480 shipments on the patterns to world rice trade and to analyze the impacts of agricultural policy of the EEC. No empirical studies have been conducted using spatial equilibrium analysis to analyze the effects of tariffs, nontariff trade barriers (NTBs), and different types of flag vessels on the world rice market.

The objectives of this study are (1) to develop a spatial equilibrium model to estimate equilibrium trade volumes and trade prices for the Southern U.S. rice industry[1] and major rice exporting countries based on free trade conditions in the world rice market and (2) to analyze the effects of tariffs and NTBs on the competitive positions of the Southern U.S. rice industry and the other major rice exporting countries.

In order to accomplish the objectives of the study, a reactive programming model, within a spatial equilibrium analysis framework, is deveolped. The reactive programming is presented in section II. Section III presents data requirements and procedure. Section IV analyzes the empirical results generated by the reactive programming model and conclusions are presented in section V.

II. Reactive Programming

Reactive programming is a spatial eqilibrium computational procedure under perfect competition for solving a wide variety of interregional trade problems (Tramel and Seale 1959). This technique is more general than the procedure followed by Judge

[1] The major rice producing areas (states) of the U.S. are Arkansas, Texas, Mississippi, Louisiana, and California. In this study, California was excluded from the considerations.

and Wallace in that it is not necessary to assume fixed supplies in each region. Supply can be a funtional relationship as presented in the original Samuelson-Enke formulation (Enke; Samuelson) of the spatial equilibrium problems.

Reactive programming determines, simultaneously, the equilibrium quantities in each consuming area and the routes for satisfying this equilibrium from the supplies available in the producing area. Because of its flexibility, this technique is a useful tool for evaluating the effects of changes in certain variables on the complete system.

A. Mathematical Structure

The term "transportation problem" is used to refer to a special type of linear programming problem in which fixed supplies in each of *m* regions are to be allocated to meet fixed demands in *n* markets so as to minimize total transfer costs. Shipments from *i* to *j* are indentified as Q_{ij} and total transfer costs as $\sum_i \sum_j T_{ij} \cdot Q_{ij}$. Shipments from each region may not exceed the quantity supplied ($\sum_j Q_{ij} \leqslant S_i$) and receipts at each market must be at least equal to the quantity demanded ($\sum_i Q_{ij} \geqslant D_j$). No negative shipments are allowed ($Q_{ij} \geqslant 0$).

The dual of transportation problem can be written as follows:

(1) $\text{Max } R = \Sigma D_j V_j - \Sigma S_i U_i$

(2) $\text{S.T. } V_j - U_i \leqslant T_{ij}$

$U_i, V_j > 0$

Where, U_i: shipping point prices
V_j: market prices

That is, the objective is to maximize the difference between the value of market receipts and the cost of quantities supplied, $R = \sum_j D_j \cdot V_j - \Sigma S_i \cdot U_i$, subject to the restrictions that $V_j - U_i \leqslant T_{ij}$ and the above constraints on S_i and D_j hold.

Reactive programming is an extension of this dual transportation model that allows substitution of supply functions for the fixed supplies and replace the fixed demands with demand functions (King and Gunn). There is a price-dependent demand function in each market in which the price of the commodity in region j is a function of the total quantity received.

$$(3) \quad P_j = F_j(\sum_i Q_{ij}),\ i = 1, \ldots, m$$

Where, $\sum_i Q_{ij} = D_j$

The unit cost of production in the ith producing region is C_i.

$$(4) \quad C_i = G_i\ (\sum_j Q_{ij}),\ j = 1, \ldots, n$$

Where, $\sum_j Q_{ij} = S_i$

The net price for quantities shipped from region i to market j is $R_{ij} = P_j - C_i - T_{ij}$. The weighted average net price for all shipments from i is

$$(5) \quad R_i = \sum_j R_{ij} \cdot Q_{ij}\ /\ \sum_j Q_{ij}$$

Deviation of the net price for a given route, R_{ij}, from the weighted average net price for all shipments from that region, R_i, is D_{ij}, where $D_{ij} = R_{ij} - R_i$.

The reactive programming consists of solving the following m x n equations:

$$(6) \quad R_{ij} = F_j(\sum_i Q_{ij}) - T_{ij},$$
$$i = 1, \ldots., m$$
$$j = 1, \ldots., n$$

Subject to the following restrictions:

(i) Negative shipments are not permitted.

$$Q_{ij} \geqslant 0$$

(ii) a. Net prices for all routes used by region i must be non-negative and equal to each other

$$Q_{ij} \neq 0 \rightarrow \qquad R_{ij} = R_i \geqslant 0$$

b. Net prices for all routes not used by region i must be no larger than the net price for active routes.

$$Q_{ij} = 0 \rightarrow \quad R_{ij} \leqslant R_i \geqslant 0$$

(iii) Deviations from weighted average net prices are non-positive.

$$D_{ij} = R_{ij} - R_i \leqslant 0$$

a. Equality holds for active routes (see ii (a) above).

b. Either condition may hold for other routes (See ii (b) above).

(iv) Shipments from region i may not exceed supply.

a. $R_i > 0 \rightarrow \qquad \sum_j Q_{ij} = S_i$

b. $R_i = 0 \rightarrow \qquad \sum_j Q_{ij} \leqslant S_i$

Supply is fully allocated if the weighted average net price is positive but this is not necessary if net price is zero.

B. Scheme of Calculations: A Market Simulating Formulation

The algorithm operation of reactive programming is as follows. An initial set of supply and demand quantities is selected and a linear programming subroutine is used to allocate supplies among the markets. A market price is calculated from the demand function for each of the consuming areas. By substracting transportation costs from these market prices, net shipping point prices are obtained for the shipments in the initial allocation. A new level of output for the first shipping area is selected consistent with the net revenue received. This new quantity is then allocated among markets in such a way as to maximize net returns, given the market prices and previous shipping patterns of all other shippers.

The same process is repeated for the second shipping area given the behavior of all other shipping areas. The iterative routine continues until it is not profitable for any shipping area either to change the level of output or to reallocate supplies.

Several variations of the basis program are available. Supplies and/or demands may be treated as fixed or entered in functional form. Upper limits may be placed on one or more supply areas.

In this study, excess supplies (export volumes) and excess demands (import volumes) are entered in funtional form respectively. If funtional forms for supplies and demands are entered instead of fixed supplies in reactive programming, the equilibrium supplies and demands from the optimal solution of reactive programming would be varied from the initial supplies and demands. Since the objectives of this study are to analyze the effects of trade barriers on the equilibrium quantities and prices of trade in order to consider competitiveness of each country or region, it would be more reasonable to use functional forms which give different equilibrium quantities and prices of trade rather than fixed supplies and demands or fixed supplies and demand functions. For instance, if import tariffs are introduced in the free trade (base model), the trade volumes would decrease and the trade prices, on the other hand, would increase. Therefore, the functional forms for supplies (exports) and demands (imports) are used.

III. Data and Procedure

For convenience of handling data[2], the world rice market is partitioned into 8 exporting countries and 42 importing countries or regional groups. The countries or regional groups and their representative points are exhibited in Table 1.

The excess supply functions for each exporting country[3] and

2 The 1984 calendar year is selected as the data base for this study with some exceptions, such as tariffs and NTBs data used in 1982.

3 The procedure for calculating the linear excess supply functions ($Px = c + dQx_j$) for this study were derived from $c = Px - dQx_j$) and $d = (Px/Qx_j)$, $(1/Ees_j)$, where Ees_j is the elasticity of excess supply in exporting country j. In order to get the elasticities of excess supply (Ees_j), the following formula developed by Bredahl, Mayuers, and Collins was used:

$$Ees_j = (Es_j - Ed_j)(Q_{dj}/Q_{xj}) + Esj$$

the excess demand functions for each importing country[4] were derived indirectly. Data were gathered from published sources for the elasticities of domestic supply and demand in exporting countries and the elasticities of domestic supply and demand in importing countries (Grant; Rokjo; Ito; Liu).

Data pertaining to ocean freightshipments of rice and including rates in terms of U.S. dollars per metric ton, distances involved in each shipment, and nationality of vessel used in each shipment were obtained from Maritime Research Inc.[5] The data on the export taxes, import tariffs, and export and import NTBs imposed by exporting and importing countries were obtained from FAO publications.

In order to accomplish the objectives, two different models (scenarios) were examined as follows:

Model I (Base Model, Free Trade Model): The model which is assumed that there is no trade barriers in the world rice market.

Model II: The Base model with all taxes, tariffs, and NTBs together.

where, Es_j = elasticity of domestic supply in exporting country j
Ed_j = elasticity of domestic demand in exporting country j
Q_{dj} = jth exporting country's level of domestic demand
Q_{xj} = excess supply (exports) of exporting country j

4 The procedure for calculating the linear excess demand functions ($P_i = a + bQ_{mi}$) for this study were derived from $a = P_i - bQ_{mi}$ and $b = (P_i/Q_{mi})(1/Eed_i)$, where Eed_i is the elasticity of excess demand in importing country i. Eed_i were derived from the formular developed by Bredahl, Meyers, and Collins as follows:

$$Eed_i = (Ed_i - Es_i)(Q_{di}/Q_{mi}) + Es_i$$

where, Ed_i = elasticity of domestic demand in importing country i
Es_i = elasticity of domestic supply in importing country i
Q_{di} = ith country's level of demand
Q_{mi} = excess demand (imports) in exporting country i

5 Since there is significant difference between American flag shipments and other foreign flag shipments, a linear regression model of the following type included dummy variables was estimated using QLS as follows:

$$TC_{ij} = 24.0691 + .0022\ D_{ij} + 70.5555\ M_{ij}$$
$$(2{,}351) \qquad (10{,}416)$$

S.E. = 18.2047
R^2 = .8180

where, TC_{ij} = transportation cost from exporting country i to importing country j ($ per metric ton)
D_{ij} = distance between exporting country i to importing country j (miles)
M_{ij} = 0 if foreign flag vessels
1 if U.S. flag vessels

Table 1

RICE EXPORTING AND IMPORTING COUNTRIES OR REGIONS AND THEIR REPRESENTATIVE POINTS IN THIS MODEL

Countries or Regions	Representative Points (Ports)	Countries or States Included In the Region
Export		
U.S. Southern region	New Orleans	Arkansas, Louisiana Mississippi, Kexas
Thailand	Bangkok	
China	Sanghai	
Pakistan	Karachi	
Burma	Rangoon	
Australia	Sydney	
Italy	Venice	
Uruguay	Motevideo	
Import		
Brazil	Riode Janeiro	
Cuba	Havana	
Mexico	Tampico	
Peru	Callao	
South America (others)	Africa	Chile, Colombia, Bolivia, Venezuela, Ecuador, Paraguay
EC-9	Bordeaux	Belgium, Luxemburg, Denmark, France, West Germany, Greece, Ireland, Netherlands, United Kingdom
Portgual	Lisbon	
Spain	Bilbao	
Switzerland	Kiel	
West Europe (others)	Marseilles	Austria, Norway, Sweden, Finland
East Europe	Rejika	Bulgaria, Albania, Hungary, East Germany, Poland, Romania, Czechoslovakia, Yugoslavia
Iran	Abaden	
Iraq	Basrah	
Kuwait	Shuwaikh	

Table 1 (Continued)

Countries or Regions	Representative Points (Ports)	Countries or States Included In the Region
Saudi-Arabia	Jeddah	
Syria	Lattakia	
Turkey	Izmir	
U.A. Emirates	Abu Dhahi	
Middle East (others)	Jeddah	Jordan, Lebanon, Bahrain, Oman, Qatar, Yemen, Arab Republic, Israel, People's Democratic Republic of Yemen
Cameroon	Duala	
Ivory Coast	Abidjan	
Liberia	Monrovia	
Madagascar	Diego Suarez	
Mali	Conakry	
Mauritania	Port Etienne	
Mauritius	Mauritius	
Mozambique	Beira	
Nigeria	Lagos	
Senegal	Dakar	
South Africa	Capetown	
Africa (others)	Alexander	Algeria, Libya Morocco, Tunisia, Angola, Benin, Chad, Congo, Gabon, etc.
Bangladesh	Chittagong	
China	Shanghai	
Hong Kong	Hong Kong	
India	Bombay, Calcutta	
Indonesia	Surabaya	
Malaysia	Penang	
Philippines	Manila	
Singapore	Singapore	
Sri Lanka	Colombo	
Vietnam	Saigon	
Asia/Oceania (others)	Surabaya	Brunei, Papua New Guinea, New Zealand, Pacific Islands

IV. Results

An equilibrium or optimal solution, as the term as used in this study, is defined as "one set of exporting and importing countries, trade volumes, international prices, and international trade patterns among countries, which net profits or economic rents will be zero (Tramel and Seale 1963) and transportation costs will be minimized necessary to satisfy given excess supply schedules for exporting countries and excess demand schedules for importing countries under the assumption of perfect competition in the world rice market.

A. Base Model Results

Since the major assumptions of the base model are that free market conditions prevailed and trade restrictions are absent, transportation costs among countries given the excess supply functions of exporting countries and the excess demand functions of importing countries are considered to be the factors influencing the optimal solutions.

The results of the Base Model in terms of optimum export volumes for exporting countries are presented in Table 2. As trade theory suggests that if there is no trade barriers in the world market, the trade volumes would increase, the trade volumes of the Base Model (free trade model) were larger than the 1984 actual trade volumes, which were affected by trade barriers in the real world.

On a country or regional basis, the results indicate that the U.S. Southern region experienced the largest decline in exports. The proportion of the actual U.S. southern region exports in the world market was 2,032,000 M/T or 21.2 percent. However, the optimum volumes of the region exports were 838,000 M/T which was only 7.2 percent of the total volume of rice traded in the world market. In contrast, the optimum export volume for Thailand increased from 4,441,000 M/T to 4,803,000 M/T. Results from the base model also revealed that rice exports from China and Burma increased by 445.7 percent and 94.8 percent, respectively.

Although the export proportions of China and Burma were only 7.5 percent and 7.0 percent, respectively, in the 1984 world

Table 2

COMPARISON OF TRADE VOLUMES OF ACTUAL AND OPTIMAL SOLUTION FOR EXPORTING COUNTRIES, MODEL I (Free trade model) AND MODEL II

Exporting Countries or Region	Actual Exports (A)	Exports (Model I) (B)	Optimum Export Volume (Model II) (C)	Percentage Change From Actual Exports $\frac{B-A}{A} \times 100$	Percentage Change From Actual Exports $\frac{C-A}{A} \times 100$
	(1,000 M/T)			(%)	
U.S. Southern Region	2,032	838	724	-58.8	-64.4
	(21.2)*	(7.2)	(7.6)		
Thailand	4,441	4,803	4,546	8.2	2.4
	(46.4)	(41.3)	(47.5)		
China	715	3,902	2,580	445.7	260.8
	(7.5)	(33.6)	(27.0)		
Pakistan	1,006	220	0	-78.1	-100.0
	(10.5)	(1.9)	(0.0)		
Burma	669	1,303	1,173	94.8	75.3
	(7.0)	(11.2)	(12.3)		
Australia	302	257	246	-14.9	-18.5
	(3.2)	(2.2)	(2.6)		
Italy	258	168	160	-34.9	-38.0
	(2.5)	(1.4)	(1.9)		
Uruguay	155	137	134	-11.6	-13.5
	(1.6)	(1.2)	(1.2)		
Total	9,578	11,628	9,563	21.4	-.2
	(100.0)	(100.0)	(100.0)		

* The figures in parentheses are market shares.

rice trade market, their export shares increased to 33.6 percent and 11.2 percent respectively in the free trade model. The export volume of Pakistan decreased by 78.1 percent. However, the export volumes of Australis, Italy, and Uruguay decreased by around 15, 35, and 12 percent, respectively (Table 2).

These results indicate that in the free trade structure the competitive position of the Southern U.S. rice industry would be very weak. The competitive positions of Thailand, China, and Burma, on the other hand, would be very strong in the world rice market.

The equilibrium trade prices decreased as a whole, which were consistent with basic trade theory. The world average equilibrium price was \$323 per metric ton which was 6.9 percent lower than the actual world average import price of \$347 per metric ton (Table 3). Among the importing countries, the equilibrium import prices for Saudi Arabia, Middle East (others). U.A. Emirates, and Switzerland were relatively lower than actual levels. The equilibrium import prices for Cameroon, Senegal, Mauritius, Mauritania, and the Ivory Coast were relatively higher than actual levels.

These results indicate that actual import prices of African countries except Liberia, Nigeria, and South Africa were relatively low and those of Middle East countries execpt Syria were relatively higher than the equilibrium prices.

In order to investigate the competitive position of each exporting country in terms of unit transportation cost, the transportation cost per metric ton was calculated for actual and optimum trade flows in Table 4. The unit transportation cost of actual trade patterns was obtained by multiplying the actual shipments from each exporting country to all the importing countries by their corresponding transportation costs, then dividing by total export volumes of each exporting country. The unit transportation cost of optimal trade patterns was obtained by multiplying the optimal shipments from each exporting country to all the importing countries by their corresponding transportation cost, then dividing by total export volumes of each exporting country in the base model.

As shown in Table 4, the average unit transportation cost of 1984 trade flow patterns was \$38.67 per metric ton, but that of optimum flow patterns was \$36.10 per metric ton, or a decrease of 6.6 percent. The unit transportation costs of the U.S.Southern region, Pakistan, Thailand, Italy, and Uruguay in the base model were lower than those of actual trade pattern. Among those countries, Uruguay had the largest decrease in unit transportation cost of 36.0%; followed by Pakistan, 23.6%; Italy, 19.7%; the U.S. southern region, 15.1%; and Thailand, 0.1%. These results mean that the actual unit transportation costs of these exporting countries were relatively high.

However, the unit transportation costs of Australia, China,

Table 3

COMPARISON OF WORLD TRADE PRICES OF ACTUAL AND OPTIMAL SOLUTIONS FOR IMPORTING COUNTRIES, MODEL I (Free trade model) AND MODEL II

Importing Countries	Actual[1] Import Prices (A)	Equilibrium Import Prices		Percentage Change From A	
		Model I (B)	Model II (C)	$\frac{B-A}{A} \times 100$	$\frac{C-A}{A} \times 100$
	(CIF $ per M/T)			(%)	
Brazil	397	329	—	-17.1	—
Cuba	395	321	470	-18.7	19.0
Mexico	252	322	—	17.8	—
Peru	292	—	—	—	—
W. Hem.	416	327	393	-21.4	-5.5
EC-9	450	330	494	-26.7	9.8
Portugal	340	329	335	-3.2	-1.5
Spain	295	323	312	9.5	5.8
Switzerland	473	332	321	-29.8	-32.1
W. Europe (others)	433	327	316	-24.5	-27.0
E. Europe (others)	322	326	317	1.2	-1.6
Iran	420	320	479	-23.8	14.0
Iraq	412	321	356	-22.1	-13.6
Kuwait	440	321	310	-27.0	-29.5
Saudi Araia	542	322	311	-40.6	-42.6
Syria	297	324	374	9.1	25.9
Turkey	377	325	333	-13.8	-11.7
U.A. Emirates	486	320	309	-34.2	-36.4
M. East (others)	538	322	311	-40.1	-42.2
Cameroon	205	330	371	0	81.0
Ivory Coast	244	330	332	35.2	36.1
Liberia	400	331	340	-17.3	-15.0
Madagascar	248	—	—	—	—
Mali	297	330	334	11.1	12.5
Mauritania	257	329	319	28.0	24.1
Mauritius	226	320	309	41.6	36.7

Table 3 (Continued)

Importing Countries	Actual[1] Import Prices (A)	Equilibrium Import Prices Model I (B)	Equilibrium Import Prices Model II (C)	Percentage Change From A. $\frac{B-A}{A}\times 100$	Percentage Change From A. $\frac{C-A}{A}\times 100$
	(CIF $ per M/T)			(%)	
Mozambique	260	323	312	24.2	20.2
Nigeria	407	330	589	-18.9	44.7
Senegal	216	319	329	52.3	52.3
S. Africa	419	325	314	-22.4	-25.1
Africa (others)	302	324	313	7.3	3.6
Bangladesh	212	—	—	—	—
China	173	—	—	—	—
Hong Kong	346	310	299	-10.4	-13.6
India	300	—	—	—	—
Indonesia	319	313	319	-4.7	0
Malaysia	282	313	317	11.0	12.4
Philippines	310	310	330	0	6.5
Singapore	317	313	318	-1.3	.3
Sri Lanka	318	316	337	-.6	6.0
Vietnam	250	—	—	—	—
Asia/Oceania (others)	426	313	302	-26.5	-29.1
Average[2]	347	323	340	-6.9	-2.0

[1] Refer to note of Table 12.

[2] Weighted by import volumes as follows:

$$\text{Average price} = \frac{\Sigma P_i Q_i}{\Sigma Q_i}$$

Where P_i = import price in importing country i

Q_i = import volumes of importing country i

and Burma in the base model were higher than those for actual trade patterns. Especially, Burma, which had the largest increase in unit transportation cost, 16.1%; followed by Australia, 9.8%;

and China, 8.2%. This result means that actual unit transportation costs for Burma, China, and Australia were relatively low.

B. Effects of overall taxes, tariffs, and NTBs on 1984 trade situation

All of the trade barriers are included in the Model II in order to collectively examine their effects. Model II, in the author's opinion, would be the most similar to the actual trade situation. Therefore, the results of that model were compared with the actual trade situations (Table 2).

The optimum volumes of rice traded in Model II were reduced by only 0.2 percent of actual world trade volumes in the world rice market. However, the optimum volumes of trade for the U.S. southern region decreased by 64.4 percent from 2,032,000 M/T to 724,000 M/T. For Thailand, the optimum export volumes increased from 4,441,000 M/T to 4,456,000 M/T. The optimum export volumes from China increased by 260.8 percent. The export portion of China was only 7.5 percent in actual world market, but the market share increased to 27.0 percent in Model II.

The optimum export volumes for Pakistan decreased by 100.0 percent from 1,006,000 M/T to 0 M/T. In 1984, the export from Pakistan accounted for 10.5 percent of the total rice traded in the world market. The optimum export volumes from Burma increased from 669,000 M/T to 1,173,000 M/T. In 1984, Burma had only 7.0 percent of the market share in the world rice market, however, in Model II, its optimal export volume increased to 12.3 percent.

In summary, these results suggest that China, Burma, and Thailand would have strong competitive positions, while the U.S. southern region and Pakistan would have weak competitive positions in the world rice market.

The average equilibrium world trade price was $340 per metric ton which was slightly lower than the 1984 actual price $347 per metric ton (Table 3). On a country basis, there were large variations among import prices.

The results show that the actual import prices of Switzerland, Western Europe (others), Iraq, Kuwait, Saudi Arabia, U.A.

Table 4

COMPARISON OF UNIT TRANSPORTATION COST OF ACTUAL AND OPTIMAL WORLD TRADE PATTERNS FOR EXPORTING COUNTRIES — MODEL I (Free trade model) AND MODEL II

Exporting Countries	Unit Transportation Cost			Percentage Change From A	
	Actual[1] (A)	Model I[2] (B)	Model II[2] (C)	$\frac{B-A}{A} \times 100$	$\frac{C-A}{A} \times 100$
	($ per M/T)			(%)	
U.S. Southern Region	54.42	46.20	47.03	-15.1	-13.6
Thailand	35.13	35.11	35.19	-.1	.2
China	35.57	38.47	35.46	8.2	-.3
Pakistan	33.36	25.48	—	-23.6	—
Burma	29.32	34.05	36.59	16.1	24.8
Australia	36.35	39.91	40.13	9.8	10.4
Italy	30.31	24.35	24.35	-19.7	-19.7
Uruguay	41.19	26.37	30.67	-36.0	-25.5
Average[3]	38.67	36.10	36.21	-6.6	-6.4

[1] $UT_{ai} = \sum_j \frac{X_{aij} \cdot T_{ij}}{x_{ai}}$

[2] $UT_{oi} = \sum_j \frac{X_{oij} \cdot T_{ij}}{x_{oi}}$

where,

UT_{ai}	= actual unit transportation cost for exporting country i
X_{aij}	= actual export volumes from exporting country i to importing country j
T_{ij}	= transportation cost per M/T between exporting country i to importing country j
X_{oij}	= optimum export volumes from exporting country i to importing country j
UT_{oi}	= Optimum unit transportation cost for exporting country i
X_{ai}	= actual total export volumes for exporting country i
X_{oi}	= optimum total export volumes for exporting country i

[3] Weighted by X_{ai} or X_{oi}.

Emirates, Middle East (others), Liberia, South Africa, and Asia/Oceania (others) were relatively higher than the equilibrium import prices in Model II. In contrast, the actual import prices of Syria, Cameroon, Ivory Coast, Mauritania, Mauritius, Nigeria, and Senegal were relatively lower than the equilibrium import prices estimated in Model II.

The average unit transportation cost was $36.21 for the optimal trade pattern of Model II, which was about 6.4% lower than the actual average unit transportation cost, $38,67 (Table 4). However, by examing the unit transportation costs of each exporting country, there were some differences in unit transportation costs between the actual and optimal trade patterns. For example, the actual unit transportation costs of the U.S. southern region, Italy, and Uruguay were much higher than those of the optimal trade pattern. The actual unit transportation cost of China was higher slightly than that of Model II. The result would imply that if these countries can export rice to the world optimally or efficiently, they could reduce the unit transportation cost in the world rice market.

On the other hand, since the actual unit transportation costs of Burma, Australia, and Thailand were lower than those of Model II, the unit transportation costs can be increased more without adversely affecting the competitive position of those countries in the world rice market. This result means that even though there are some slight increases in transportation costs of these countries, the competitive positions would not be affected too much.

V. Conclusions

The empirical results of the study indicate that, in the free trade model (Base Model), the export volumes of the U.S.Southern region decreased by 58.8 percent comparing with the actual export volumes of that region. However, the export volumes for Thailand increased from 4,441,000 M/T to 4,803,000 M/T. Results from the Base Model also revealed that rice exports from China and Burma increased by 445.7 percent and 94.8 percent, respectively.

On the other hand, the world average trade price decreased from $347 to $323 per metric ton. Also, the results of free trade model indicate that one of the main differences between the actual and the base model results was that the major exporting countries except China shipped to a smaller number of countries in the base model than they did in 1948.

The results of all taxes, tariffs, and NTBs together were compared with the actual world rice market. The results indicate that Pakistan and the U.S. southern region were the countries most seriously affected by all tariffs and NTBs.

However, conclusion can be made that the competitive position of the Southern U.S. rice industry are relatively low in the world rice market. In contrast, the study results strongly suggested that Thailand, China, and Burma would have relatively high competitive positions.

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