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A Quantitative Model of the International Rice Market and Analysis of the National Rice Policies, with Special Reference to Thailand, Indonesia, Japan, and the United States

Hiroshi Tsujii

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INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE
1776 Massachusetts Avenue, N.W.
Washington, D.C. 20036

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A Quantitative Model of the International Rice Market and Analysis of the National Rice Policies, with Special Reference to Thailand, Indonesia, Japan, and the United States

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In Asia, rice is one of the most important commodities both economically and politically. From 1973 to 1975, 91 percent of the world total rice production was produced by the millions of farmers in Asia, and more than one billion people lived basically on rice. During the same period, 64 and 65 percent of the world total rice exports and imports, respectively, were done by Asian countries.

National and international rice markets consist of a system with very complex dynamic interdependencies among economic, institutional, technological, and environmental variables. The international market has oligopolistic characteristics regarding large rice exporters and importers with considerable product differentiation. The following points support this statement.[1] First, even though there are many small rice importers and exporters, the major rice importers and exporters in the international rice market are few in number. From 1970 to 1975, the three major rice exporters (United States, China, and Thailand) accounted for 62.5 percent of the world total rice export and the three major rice importers (Indonesia, Vietnam, and the Republic of Korea) demanded 33.4 percent of the world total rice imports. For example, Thailand and Indonesia had shares of 14.0 and 10.8 percent of the world total rice exports and imports, respectively, from 1970 to 1975. These shares are meaningful since separation of the domestic rice markets from the world rice market is done by government policies in most of the large rice trading countries. Secondly, the Department of Foreign Trade of Thailand, which is in charge of rice exports of that country, considers the maintenance of Thailand's share in the

world rice market important. They clearly recognize the competition for rice exports with other major exporting countries such as Burma, China, the United States, and Japan. This point is true in the case of the United States too. Finally, the Department of Foreign Trade of Thailand uses various rice export restriction policies in order to control the quantities and prices of rice exported. It is reported that when the rice supply in the world rice market is abundant, Indonesia can influence greatly the import price of rice.

Evidence for product differentiation is provided by the established reputation of good quality for Thai rice in the world and the continuation over many years of major importing countries as good customers for Thai rice.

In this paper, an econometric model of the dynamic interdependencies in the national and the international rice markets mentioned above was estimated with emphasis on Thailand. Only Thailand is explicitly incorporated in the model as a large exporter so the oligopolistic nature of the world rice market is not completely modeled. Two important rice policy issues — the rice premium policy issue of Thailand and the issues related to the rice export policy of the United States and Japan — are investigated by policy simulation with the estimated model.

In recent years, several quantitative models for the world food markets have been built and used mainly for projection purposes. FAO has conducted several world food projections.[2] But no coherent economic model has been used for the projections. Generally, commodity prices have been assumed to be constant, and the demand and supply of rice have been projected independently by extrapolating past trends. In 1971 the U.S. Department of Agriculture made a projection to 1980 of world grain markets. This model consists of a static equilibrium model and a linear programming (LP) model. The equilibrium model is comprised of regional demand and supply functions, a world market clearing equation, and the equations representing the price relationships between various marketing stages. The output of this model is an equilibrium set of prices and quantities demanded and supplied for each kind of grain included in the model. Then, given the regional quantities demanded and supplied, the cost minimizing trade flows are estimated with the LP model.

The Club of Rome's first project developed a dynamic long-run global model in which the interdependencies among population, land, food, resources, industrial production, and pollution were

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incorporated. This model shows that if population and industrial production grow geometrically along past trends, mankind faces limits of growth because of restrictive resources and will subsequently experience disastrous results of population decline due to starvation and/or pollution by the early period of the twenty-first century.

In 1974 the Ministry of Agriculture and Forestry of Japan developed a world model (hereafter the MAF model) for 10 agricultural commodities. This model consists of a dynamic equilibrium and trade matrix components. The basic framework is, therefore, similar to the U.S. Department of Agriculture's model mentioned above. The MAF model is a closer representation of the real world for the following three reasons: (1) the MAF model is dynamic with lagged relations among consumption, production, prices, and stocks; (2) livestock-feed interdependencies are explicitly included; and (3) the supply side is modeled by the production function approach, and some factor input determination functions are incorporated.

Since the FAO model is not a coherent economic model and the Club of Rome's model is a highly aggregated long-run global model, only the USDA and the MAF model will be discussed further. The MAF model has a more unrealistic price determination mechanism than the USDA model in the sense that the world equilibrium price of each commodity is determined first and then the domestic price in each country is determined as a linear function of the world price. It is more realistic for export, import, and domestic prices of a commodity to be determined first in each country as in the USDA model. A world price index for each commodity could then be calculated. The price determination mechanism of the USDA model permits one to more easily investigate effects of rice policies on the rice prices than is possible with the MAF model.

Both the USDA model and the MAF model determine domestic demand, supply, prices, and international trade and related prices in step-wise fashion. In reality the determination of these variables takes place simultaneously. Therefore, it is desirable that a commodity model conforms to this simultaneous determination process. And, since the international markets of rice and probably of other agricultural commodities are imperfectly competitive with some product differentiation, as mentioned above, it is more appropriate and realistic to formulate an international commodity model with an emphasis on bilateral relations between countries.

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The Wharton Agricultural Model has been briefly explained by Chen (1977). This is a large quarterly econometric model which includes 17 commodities or commodity groups and consists of four blocks of equations — the intercommodity block, the annual crop production block, the income-expenditure block, and the micro-macro linkage block. The first block simultaneously determines supply, demand, inventory, and price for each of the 17 commodities. A complex set of interrelated adjustment processes in the feed-livestock economy is modeled here as it was in the MAF model mentioned above. The second block is an annual and recursive model to forecast production of each crop and to evaluate the weather impact on crop production. The third block provides the main statistical identities relating the income and expenditure accounts for the agricultural sector of the U.S. economy. The fourth block links the agricultural sector model with the macro-model through a full feedback relationship. The model is based on the traditional microeconomics framework to determine supply-demand balances and complementary and substitution relationships among commodities. It describes a dynamic interdependent system in the agricultural sector of the United States. It does not include international interdependencies among agricultural sectors of various countries in the world.

Recently, two international models for rice were developed in Thailand by Olarn and Sayan (1976) and Phisit (1977). The model by Olarn and Sayan was based on the assumption of a purely competitive international rice market where 85 domestic demand equations for rice were estimated for various countries and a single world rice price was determined by equating world total rice production and demand. They used the FOB Bangkok export price of 5 percent brokens as the world price. Then, by subtracting (in the case of exporting country) or adding (in the case of importing country) "mark-up" consisting of export or import taxes and marketing costs, domestic rice prices were determined for each country. This price determination process was very similar to the process used in the MAF model. Thus, the same criticism made about the MAF model holds. Substituting the equilibrium domestic price into the domestic demand function, the equilibrium level of domestic demand for each country was determined. In a purely competitive environment as assumed, an individual rice exporting or importing country cannot influence the world price. An international rice market which is imperfectly or oligopolistically

competitive as discussed above seems more consistent with the real world situation.

Phisit (1977) formulated and estimated a three equation model which he designated "an oligopolistic model of Thai rice exports." I think he correctly assumed that the international rice market is an oligopoly. He asserts that these three equations form a system of equations. However, his third equation is completely separated from the first two and the first two equations were successively determined so the equations can be considered as three independent equations. The first equation which Phisit terms "the world demand function for Thai rice under the oligopolistic model," has the quantity of Thai rice exported specified as a function of its export price, quantities of American rice exported, and of Chinese rice exported. This is not a demand curve but a mixture of the reaction function of oligopolists and of the demand curve. Because of this incorrect specification, his estimate of price elasticity of world demand for Thai rice, which is a critical parameter regarding the rice premium issue, is biased. The domestic rice market, which is closely related to the exports of Thai rice, is not coherently modeled either. In conclusion, his model is both too simple to describe the oligopolistic international rice market, and it includes a few specification errors that make the results of not large value.

The author estimated a quantitative model of the international rice market in 1971 (Tsujii, 1972b) and its enlarged version in 1973 (Tsujii, 1973). As will be clear in the next section, the author's model also has the first and third advantages of the MAF model over the USDA model which were mentioned earlier. With respect to the price determination mechanism, the author's model is similar to the USDA model in the sense that export, import, domestic, and world rice prices are determined by a function for each price. The most important advantage of the author's model over both the USDA and MAF models is that the model handles the equilibrium and the trade flow simultaneously in the model with an emphasis on some bilateral trade relationships between countries.

The Estimated Model and Its Characteristics

The quantitative model of the international rice market is estimated for a sample period of the fifties and the sixties. The model consists of four submodels for the rice markets of Thailand, Indonesia, Japan, and the rest of the world. These three countries

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are closely related by rice trade and play important roles in both rice production and trade in the world. The number of countries included in the model could be increased without great difficulty if data were available. The data used for the estimation were annual time-series. The sources of these data[3] were the three governments and some of the international organizations. The OLS method was used for estimation of the model. Some Monte Carlo studies support the use of the OLS method in cases like the one of this study where the sample size is small and when measurement and specification errors are probable (Cragg, 1966; Cragg, 1967; Johnston, 1963; Wagner, 1958). The ability of the model to predict in the simultaneous simulation, orthodox statistical criteria, and the economic theory underlying the specification of each function of the model were criteria used in model specification. The Gauss-Seidel iterative method was used for the simulation.

The basic assumptions for the model are as follows: (1) internationl rice transactions are conducted by each government; and (2) various grades of rice in each country can be aggregated into one homogeneous commodity.

Effective government control of rice trade for the countries incorporated in the model makes the first assumption reasonable.[4] The second assumption is an inevitable consequence of the lack of more complete data. However, the common practice of sifting and mixing various grades of rice traded does make aggregation somewhat tenable.

The estimated model is as follows:

Thailand

$$(1)\quad O_y^t = \underset{(-4.24)}{-3778.6} + \underset{(3.51)}{2.1403}\, R^t_{-1}\, H^t_y/A^t_y + \underset{(14.60)}{2.1071}\,(A^t - R^t_{-1})\, H^t_y/A^t_y + \underset{(3.33)}{34.571}\, FN^t_{-1} + \underset{(1.58)}{121.42}\, W1_{-1} + \underset{(2.82)}{678.66}\, W3_{-1}$$

$R^2 = 0.9850 \qquad dw = 2.2404^{**} \qquad ss = 18$ ('51–'68)

$$(2)\quad A^t_y = \underset{(0.62)}{1334.8} + \underset{(1.51)}{13.137}\, P^{xt}_{-1} + \underset{(3.06)}{0.95951}\, R^t_{-1} + \underset{(1.33)}{1.4441}\, RF^t_{-1}$$

$R^2 = 0.4139 \qquad dw = 1.8003^{*} \qquad ss = 18$ ('51–'68)

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(3) $$FN^t = \underset{(-0.32)}{-5.1365} + \underset{(7.92)}{0.81870}\, FN^t_{-1} - \underset{(-1.81)}{0.24975}\, P^{fnt} + \underset{(2.21)}{0.31392}\, P^{dt}$$

$R^2 = 0.8873$ $ss = 18$ ('51–'68)

(4) $$C^t = N^t \cdot c^t$$

(5) $$I^t = O^t \cdot r^t - C^t - X^t$$

(6) $$S^t = S^t_{-1} + I^t$$

(7) $$P^{dt} = \underset{(1.82)}{38.432} - \underset{(-0.54)}{0.0024127}\, I^t_{-1} + \underset{(3.90)}{0.75499}\, P^{xt} - \underset{(-2.02)}{0.067516}\, PR^t_{-1}$$

$R^2 = 0.5173$ $dw = 2.2893^*$ $ss = 19$ ('51–'69)

(8) $$P^{xt} = \underset{(0.63)}{10.261} + \underset{(1.51)}{0.20205}\, P^{xt}_{-1} + \underset{(4.63)}{0.58117}\, P^{dt} + \underset{(4.44)}{0.10356}\, PR^t$$

$R^2 = 0.8296$ $ss = 19$ ('51–'69)

(9) $$X^t = M^{ti} + M^{tj} + M^{to}$$

Indonesia

(10) $$O^i = \underset{(-4.57)}{-4507.0} + \underset{(15.52)}{2.3704}\,(H^i - B_y) + \underset{(8.58)}{2.7997}\, B_y + \underset{(2.43)}{6.1710}\, FN^i_y$$

$R^2 = 0.9823$ $dw = 2.0699^*$ $ss = 20$ ('50–'69)

(11) $$H^i = \underset{(0.80)}{621.00} + \underset{(7.57)}{0.83008}\, H^i_{-1} + \underset{(1.99)}{8.1016}\, P^{dri}$$

$R^2 = 0.8158$ $ss = 18$ ('51–'68)

(12) $$FN^i_y = \underset{(1.29)}{44.855} + \underset{(2.81)}{0.50909}\, FN^i_{y(-1)} - \underset{(-2.42)}{0.93082}\, P^{fni} + \underset{(4.36)}{0.075550}\, B_y + \underset{(1.56)}{0.63631}\, P^{dri}_{-1}$$

$R^2 = 0.8910$ $ss = 19$ ('51–'69)

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(13) $$M^i = \underset{(3.20)}{969.64} + \underset{(3.02)}{0.51361}\, M^i_{-1} - \underset{(-2.63)}{5.1421}\, P^{mi} - \underset{(-3.84)}{789.14}\, DIM1$$

$R^2 = 0.7539$ $ss = 16$ ('53–'68)

(14) $$E^{ti} = \underset{(0.20)}{0.071062} + \underset{(0.75)}{0.16103}\, E^{ti}_{-1} - \underset{(-0.97)}{0.25317}\, P^{xt}/P^{mi} - \underset{(-1.22)}{0.00049342}\, PR^t - \underset{(2.92)}{0.00036811}\, X^t$$

$R^2 = 0.5047$ $ss = 18$ ('51–'68)

(15) $$M^{ti} = E^{ti} \cdot M^i$$

(16) $$C^i = N^i \cdot c^i$$

(17) $$I^i = O^i \cdot r^i - C^i + M^i$$

(18) $$S^i = S^i_{-1} + I^i$$

(19) $$P^{dri} = \underset{(3.18)}{131.98} + \underset{(0.60)}{0.15379}\, P^{dri}_{-1} - \underset{(-2.00)}{0.0074771}\, S^i_{-1}$$

$R^2 = 0.3332$ $ss = 18$ ('51–'68)

(20) $$P^{mi} = \underset{(-1.77)}{-32.204} + \underset{(4.13)}{0.51629}\, P^{mi}_{-1} + \underset{(4.64)}{0.85086}\, P^{xw}$$

$R^2 = 0.8385$ $ss = 18$ ('51–'68)

Japan

(21) $$O^j = \underset{(-5.71)}{-43724} + \underset{(1.76)}{1.2026}\, L^j + \underset{(7.17)}{11.991}\, D^j + \underset{(3.46)}{0.0320018}\, K^j + \underset{(1.64)}{327.22}\, W^j$$

$R^2 = 0.9440$ $dw = 2.1087^{**}$ $ss = 16$ ('53–'68)

(22) $$L^j = \underset{(7.89)}{4881.1} + \underset{(3.11)}{2163.9}\, P^{da}_{-1}/P^{aj}_{-1} - \underset{(-13.66)}{3103.1}\, WNA_{-1}/CPI^{fj}_{-1} + \underset{(1.56)}{720.75}\, P^{kj}_{-1}/P^{lj}_{-1}$$

$R^2 = 0.9395$ $dw = 1.8557^{*}$ $ss = 18$ ('52–'69)

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(23) $$D^j = \underset{(1.53)}{376.68} + \underset{(9.71)}{0.83959}\ D^j_{-1} + \underset{(2.08)}{271.20}\ P^{da}/P^{aj} - \underset{(-1.16)}{1.2001}\ P^{ij}$$

$R^2 = 0.8997$ $ss = 19$ ('51–'69)

(24) $$K^j = \underset{(0.17)}{2447.2} + \underset{(1.14)}{0.35602}\ K^j_{-1} - \underset{(-2.43)}{72149}\ P^{kj}/P^{ij} + \underset{(2.76)}{149069}\ WNA/CPI^{fj}$$

$R^2 = 0.9947$ $ss = 18$ ('52–'69)

(25) $$M^j = \underset{(2.84)}{955.27} + \underset{(2.99)}{0.51526}\ M^j_{-1} - \underset{(-2.66)}{0.084264}\ S^j_{-1} \cdot r^j_{-1}$$

$R^2 = 0.6728$ $ss = 20$ ('51–'70)

(26) $$E^{ij} = \underset{(0.56)}{0.39828} + \underset{(2.31)}{0.89513}\ E^{ij}_{-1} - \underset{(-0.62)}{0.40526}\ P^{xt}/P^{xw} + \underset{(2.86)}{0.0000013090}\ EMJ^i$$

$R^2 = 0.4422$ $ss = 19$ ('51–'69)

(27) $$M^{ij} = E^{ij} \cdot M^j$$

(28) $$C^j = CR^j + CU^j$$

(29) $$CR^j = \underset{(2.48)}{1614.8} + \underset{(14.87)}{0.96214}\ CR^j_{-1} - \underset{(-2.89)}{1579.9}\ P^{da}/P^{aj} + \underset{(6.42)}{1159.7}\ D3CR$$

$R^2 = 0.9495$ $ss = 19$ ('51–'69)

(30) $$CU^j = \underset{(11.93)}{9084.2} - \underset{(-6.96)}{4587.1}\ P^{du}/P^{bj} + \underset{(11.94)}{1.0533}\ Y^j$$

$R^2 = 0.9376$ $dw = 1.9756$ $ss = 19$ ('51–'69)

(31) $$I^j = O^j - C^j - CO^j - X^j + M^j/r^j$$

(32) $$S^j = S^j_{-1} + I^j$$

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$$(33)\quad P^{mj} = \underset{(2.48)}{21.287} + \underset{(1.50)}{0.14495}\, P^{mj}_{-1} + \underset{(7.82)}{0.57569}\, P^{xw} + \underset{(2.05)}{30.742}\, M^{j}/X^{w}$$

$$R^2 = 0.9176 \qquad ss = 19\ (\text{'51–'69})$$

The World

$$(34)\quad M^{to} = \underset{(1.90)}{1091.0} - \underset{(-1\ 71)}{391.71}\, P^{xt}/P^{xw} + \underset{(6.37)}{0.39387}\, MA^{o}$$

$$R^2 = 0.7211 \qquad dw = 2.4389^{*} \qquad ss = 20\ (\text{'50–'69})$$

$$(35)\quad P^{xw} = \underset{(1.20)}{52.011} + \underset{(3.25)}{0.67405}\, P^{xw}_{-1} - \underset{(-0.60)}{0.0024778}\, X^{w}$$

$$R^2 = 0.5542 \qquad ss = 19\ (\text{'51–'69})$$

$$(36)\quad X^{w} = X^{t} + X^{u} + X^{j} \cdot r^{j} + X^{o}$$

The figures in parenthesis under the estimated coefficients are t-values. The value of R^2 is the coefficient of determination. The letters dw mean the Durbin-Watson statistic, and ss is sample size. The asterisks, single or double, placed at the upper right-hand side of the values of the Durbin-Watson statistic indicate that at the two-tail 5 percent or 1 percent level of significance, respectively, the hypothesis that the first-order autocorrelation coefficient of the disturbance term is zero is accepted. The Durbin-Watson statistic is not presented for equations containing lagged values of the dependent variable among the regressors. Some variables in the estimated model have subscript y. This indicates that the data for these variables have the time reference of the crop year $(t-1)/t$. Because of these variables, other reliable variables in the model are lagged one period in order to attain empirically right time alignment in the data.

The notation used for model is as follows:

1. The subscript -1 to the variables in the model stands for the $(t-1)^{th}$ year. The subscript t for the tth year is, however, suppressed for the sake of simplicity of expression.

2. The superscript t stands for Thailand, i for Indonesia, j for Japan, and w for the world. The variables which appear without any country superscript in item 3 just below are common notations which can be applied to any of the countries involved in

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the model with an appropriate superscript unless specified otherwise.

3.

A : Total area planted to rice, 1,000 hectares, E^3

B : Area under BIMAS Biasa, Baru, and Gotong Rojong (G.R.) projects, 1,000 hectares, X

c : Per capita rice consumption, ton/man, X

C : White rice consumption, 1,000 tons, E

C^j : Total direct consumption of rice as food in Japan, brown rice 1,000 tons, E

CO^j : Amount of brown rice consumed other than directly as food, i.e., processing, feed, seed, and waste, 1,000 tons, X

CPI^{fi} : Price index of consumers' goods and services purchased by the farmers in Japan on yen basis, 1965 = 100, X

CR^j : Direct consumption of rice as food in the rural area in Japan, brown rice 1,000 tons, E

CU^j : Direct consumption of rice as food in the urban area in Japan, brown rice 1,000 tons, E

D^j : Total area planted to rice in Japan, 1,000 hectares, E

$D1M1$, $D3CR$: Zero-one dummies 0–1, X

E^{ti} : Share of Thai rice in the total white rice imports of Indonesia, E

E^{tj} : Share of Thai rice in the total white rice imports of Japan, E

EMJ^t : Deficit in the current accounts of balance of payments of Thailand with regard to Japan, $1,000, X

FN^i : Estimate of nitrogen fertilizer consumption in Indonesia, 1,000 tons, E

FN^t : Sum of nitrogenous fertilizer production and imports of Thailand, 1,000 tons, E

H^i : Harvested area of paddy in Indonesia, 1,000 hectares, E

H^t : Total rice area harvested in Thailand, 1,000 hectares, E

I : Inventory investment of white rice, 1,000 tons, E

I^j : Inventory investment of brown rice in Japan, 1,000 tons, E

K^j : Estimated real value of services derived from the agricultural machinery and implements used in rice production in Japan at 1965 prices, 1 million yen, E

L^j : Labor inputs into rice production in Japan, 1 million hours, E

M : Total white rice imports, 1,000 tons, E

M^{ti} : Imports of Thai rice by Indonesia, 1,000 tons, E

M^{tj} : Imports of Thai rice by Japan, 1,000 tons, E

M^{to} : Imports of Thai rice by all the countries of the world other than Indonesia and Japan, 1,000 tons, E

MA^o : Sum of total rice imports of the major Thai rice importing countries other than Indonesia and Japan, 1,000 tons, X

N : Population, 1,000 people, X

O : Paddy production, 1,000 tons, E

O^j : Rice production in Japan, brown rice 1,000 tons, E

P^{aj} : Farmers' selling price of agricultural products other than rice on yen basis, 1965 = 100, X

P^{bj} : Index of retail price paid for bread by urban families on yen basis, 1965 = 100, X

P^{da} : Index of farmers' average selling price of rice in Japan on yen basis, 1965 = 100, X

P^{dri} : Wholesale price index of rice (manufactured "bulu" B.A.) at Jakarta deflated by an estimated series of consumers' price index on the new rupiah basis, 1965 = 100, E

P^{dt} : Wholesale price index of 100 percent white

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rice in Bangkok on the U.S. dollar basis, 1965 = 100, E

P^{du} : Index of price paid for white rice by urban families in Japan on yen basis, 1965 = 100, X

P^{fn} : Average import price index of nitrogenous fertilizer on the U.S. dollar basis, 1965 = 100, X

P^{ij} : General price index of factors of agricultural production at the farm level in Japan on yen basis 1965 = 100, X

P^{kj} : Price index of agricultural machinery bought by the farmers in Japan on yen basis, 1965 = 100, X

P^{m} : Average rice import price index on the U.S. dollar basis, 1965 = 100, E

P^{xt} : Export price index of Thai white rice on the U.S. dollar basis, 1965 = 100, E

P^{xw} : World rice export price index, 1965 = 100, E

PR^{t} : Index of rice premium and other export levies on the U.S. dollar basis, 1965 = 100, X

r : Conversion ratio from paddy to rice, X

r^{j} : Conversion ratio from brown rice to white rice in Japan, X

R^{t} : Area irrigated in Thailand, 1,000 hectares, X

RF^{t} : Index of rainfall in Thailand, mm, X

S : Total quantity of white rice stock at the end of a year, 1,000 tons, E

S^{j} : Total stock of brown rice in Japan, 1,000 tons, E

W^{j} : Index of average temperature in August in Japan, degrees centigrade, X

$W1$: Maximum height of surface of the Chao Phraya at Ayutthaya in each year, meters above sea level, X

$W3$: Zero-one dummy used to explain the effect of flood control by Bhumipol Dam on rice production in Thailand, 0–1, X

WNA : Nominal wage index of regular employees in the nonagricultural sector in Japan on yen basis, 1965 = 100, X

X : Total white rice export, 1,000 tons, E

X^j : Total brown rice export of Japan, 1,000 tons, X

X^o : Total white rice export of all the exporting countries in the world other than Thailand, the United States, and Japan, 1,000 tons, X

X^u : Total rice export of the United States, 1,000 tons, X

Y^j : Real national income originating in sectors other than agriculture, forestry, and fishery, in Japan at 1965 prices, 10 billion yen, X

The model represents the dynamic interdependencies among the economic, technological, natural environmental, and institutional variables of the national and the international rice markets. Functions (1), (2), (3), (10), (11), (12), (21), (22), (23), and (24) indicate that supply conditions of rice in each country were represented by the production function and the factor input functions. By this approach, such things as technological and institutional changes can be handled more explicitly than when supply conditions are simply represented by supply functions. The domestic price, import and export prices, and the world price are determined simultaneously by the price functions, (7), (8), (19), (20), (33), and (35) in the model. Therefore, the price determination procedure is more realistic than that of the MAF model or Olam and Sayan's (1976) model as discussed in the first section. The model's simultaneous handling of the international rice trade and the determination of demand, supply, and prices is represented by the interdependencies among two groups of functions in the model, i.e., the group of functions (9), (13), (14), (15), (25), (26), (27), (34), and (36) and the group consisting of the rest of the functions. By this approach the unrealistic separation of market equilibrium and international trade in both the USDA and MAF model is avoided. The bilateral trade relations with an emphasis on Thai rice trade, which have

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substantive meaning in an imperfect market, are represented by functions (9), (14), (15), (26), (27), and (34).

The estimated model is linear in the parameters but nonlinear in variables. The two basic dynamic relations incorporated in the model are the price adjustment relation and the Nerlovian adaptive adjustment model (Nerlove, 1958). Supply and demand factors in the model can be explained as follows: In the submodel for Thailand the domestic supply side is represented by functions (1), (2), and (3), and the domestic demand side by (4), (5), and (9). The similar formulation for the domestic supply and demand exists in the other country submodels. In the international trade of Thai rice the demand side consists of the functions (9), (13), (14), (15), (25), (26), (27), and (34) which determine the demand for Thai rice by Indonesia (M^{ti}), Japan (M^{tj}), and by the rest of the world (M^{to}), and the world total demand for Thai rice (X^t). The supply side is represented implicitly by the functions (1), (4), and (5), and the export supply of Thai rice ($O^t \cdot r^t - C^t - I^t$) is equated to the total import demand for Thai rice (X^t) in function (5).

The world submodel has a much simpler structure than the country submodels. This simple structure reflects the international demand and supply situation concerning rice (functions (35) and (36)) and completes the world demand elements for Thai rice (function (34)).

Rice policies are incorporated in the model as policy instrument variables. These variables are as follows: The average rice premium index (PR^t), the irrigated area (R^t) for the Thai submodel, the area under the BIMAS program (B) for the Indonesian submodel, and the at-farm and the consumers' price indices of rice (P^{da} and P^{du}, respectively) for the Japanese submodel. Some natural and physical environmental conditions which affect rice production are also incorporated in the national rice production functions and in one, (2), of the factor input functions as explanatory variables.

The time series data of rice consumption, stock, and stock change (i.e., C, S, I) do not exist or exist only for partial years for Thailand and Indonesia. Consequently, rice consumption was estimated by per capita consumption (exists only for a few years) and population (functions (4) and (16)) and by interpolation and extrapolation. The stock and stock change were estimated mainly by intensive investigation of rice balance in each country. Some of the estimated functions such as the share functions and some of the price functions have rather low R^2 values. However, they were

believed to be the most acceptable of the specifications attempted from the economic theory point of view. The analysis suffered from severe limitations in the availability and quality of the data.

A block diagram of the estimated model is shown in Figure 1.

The model was validated with ex post simulation and actual values were tracked fairly closely (Tsujii, 1973).

Analysis of the Rice Policy Issues by the Estimated Model

In this section, the estimated model is applied to the analysis of issues concerning the rice premium policy of Thailand and rice exports by the United States and Japan. The policy simulation method with the estimated model was used for the analysis.

The rice premium policy which is a policy of a specific tariff on rice exports has been the most controversial economic policy in Thailand during the post-war period. During most of this period the premium amounted to about 20 to 35 percent or more of the export price of rice. The opponents (Aromdee, 1968; Behrman, 1968; Chuchart and Sopin, 1965; Krissanamis, 1967; Sanittonant, 1967; Usher, 1967) to the policy assume that the international and the domestic rice markets are competitive, and argue that the premium depresses the farm price of rice as much as the amount of the premium. This reduced farm price decreases rice production and exports and, consequently, foreign exchange earnings from the exports. The rice premium also decreases the consumers' price of rice in Thailand. Thus, the opponents regard the premium as an income transfer from the majority farmers to the minority city dwellers which has the effect of an unfair tax burden on the rice farmers. They also maintain that an alternative source of revenue to the premium can be found.

The proponents[6] of the rice premium policy assume that both the international and domestic rice markets are not competitive. Thus, they assert that some part[7] of the premium is borne by the Thai rice importers and that any decrease in the premium is absorbed by the rice middlemen. They also maintain that even if the premium depresses the farmers' price of rice, the government revenue from the premium policy is returned to the rice farmers by such government agricultural expenditures as irrigation facilities, road construction, and agricultural extension. They also argue that it would be very hard to find an alternative government revenue source to the rice premium. The proponents argue further that the rice

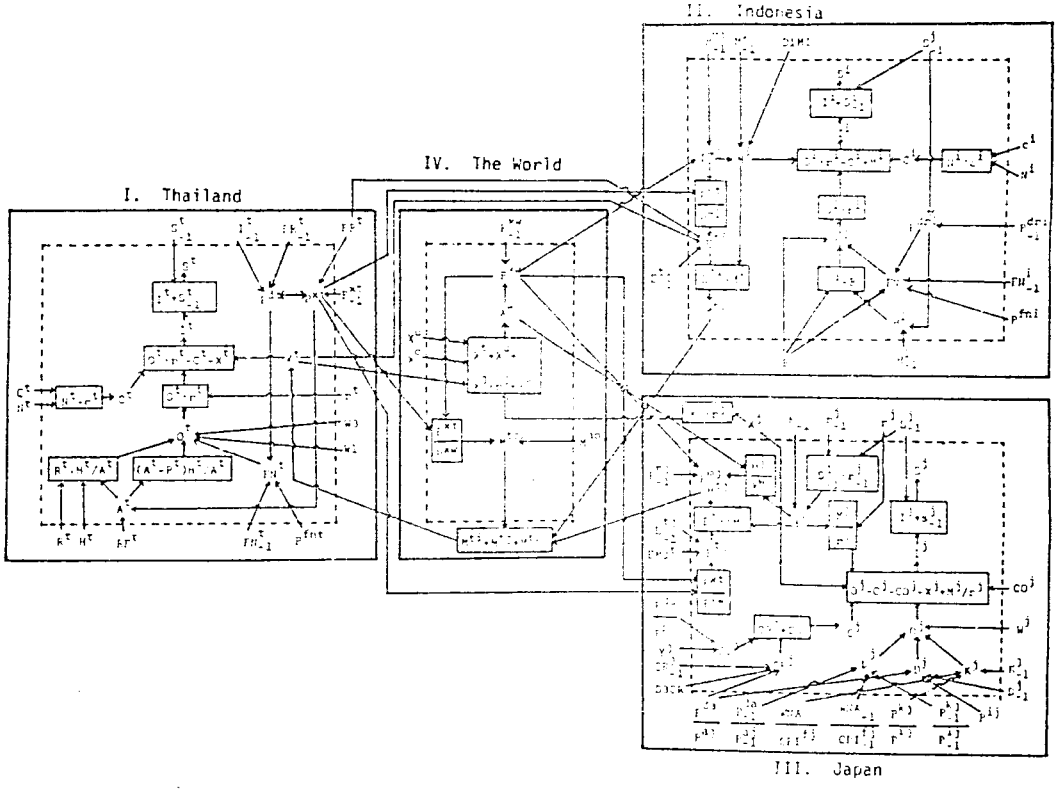

Figure 1. The Block Diagram of the Estimated Quantitative Model

premium keeps the domestic rice price lower and more stable than when the premium is not levied, and thus facilitates agricultural diversification and industrialization in Thailand.

A part of these issues are investigated by a policy simulation for a hypothetical 50 percent decrease in the rice premium every year using the estimated model. The major results are shown in Figures 2, 3, and 4 by the differences between the predicted value of the model (solid line) and the simulation results (dotted line).

The decrease of P^{xt} and the increase of X^t do not support the basic assumption of the competitive international rice market by the opponents. This result is compatible with the near unity price elasticity of world demand for Thai rice that is calculated from the model.[8] Consequently, the main argument of opponents (that the rice premium does not affect the export price of Thai rice but does affect the domestic rice price by as much as the value of the premium and, thus, affects the rice production and exports) is brought into question. On the contrary, the proponents' noncompetitive assumption of the international rice market and their consequent assertion that some part of the premium is borne by the importing countries are supported by the simulation results and by the estimated price elasticity of the world demand for Thai rice. If the price elasticity of the world demand for Thai rice is indeed near unity, the total foreign exchange earnings from rice export do not change much whatever the level of the rice premium might be. These simulation results and the estimated elasticity are consistent with an oligopolistic international rice market.

With regard to the effect of the rice premium on the domestic rice price, the simulation results shown in Figure 4 indicate that the rice premium does not depress the domestic price in the short run.[9] In the short run this result does not support the assertion of the opponents concerning the effect of rice premium on the domestic price. This result can be explained by a shift of the stock change function in the Thai submodel.[10]

In conclusion, we can say that the results of these analyses of some of the important rice premium policy issues by the application of the estimated model are, in general, in favor of the proponents' assertions.[11]

Now we turn to the analysis of policy issues concerning rice exports by the United States and Japan. The United States has been exporting considerable amounts of rice every year since the Second World War. It increased its exports very rapidly from 1960, and

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Figure 2. Export Price Index of Thai White Rice, P^{xt}

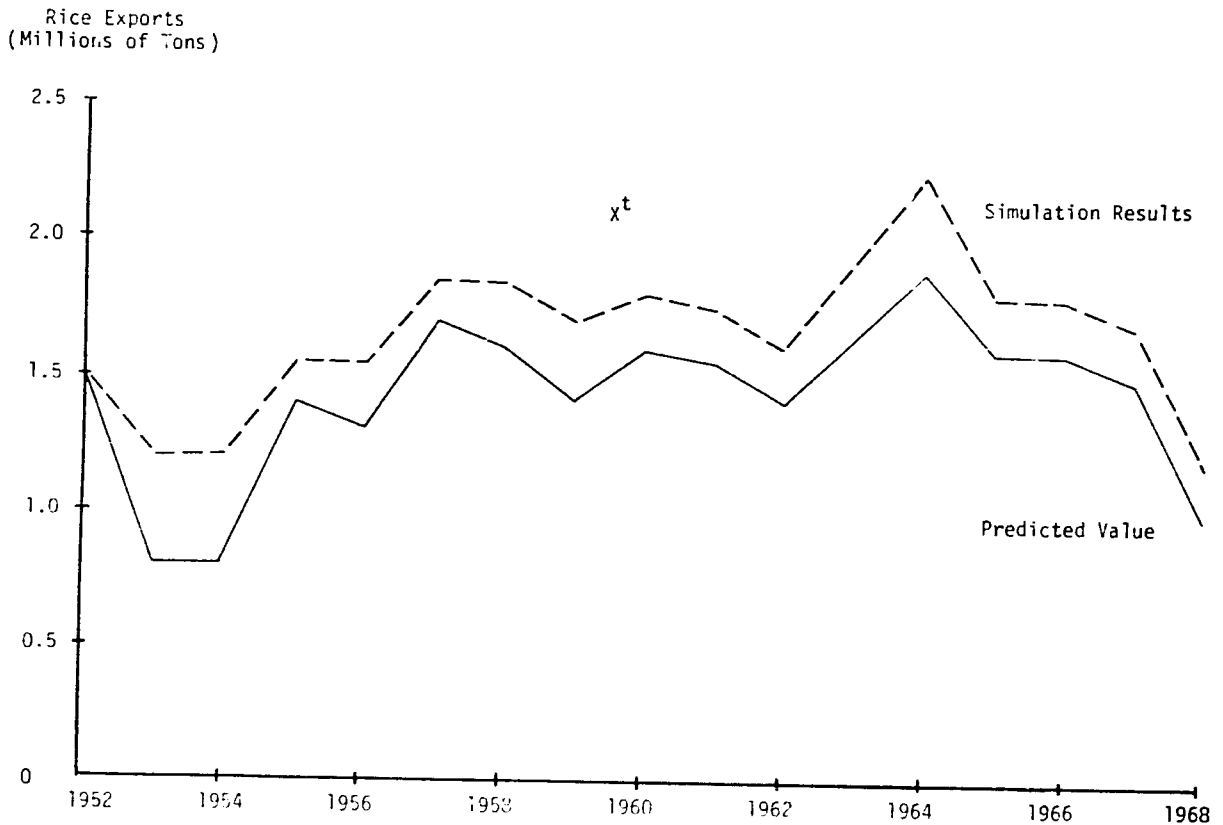

Figure 3. White Rice Exports by Thailand, X^t

Figure 4. Domestic Price Index of 100 Percent White Rice in Bangkok, Thailand, P^{dt}

became the world's largest rice exporter from 1967 to 1970. In 1971/72 and 1973/74 it was the second largest rice exporter next to Thailand and China, respectively. Japan, on the other hand, was one of the leading rice importers in the world until the mid-sixties. But because of the rapid increase of the government purchase and resale prices of rice under the near government marketing monopoly, surplus rice stocks accumulated very rapidly during the late sixties. Thus, Japan started exporting rice in 1969 and became one of the important rice exporters from 1970 to 1974. Most of the Japanese rice exports were for food aid on concessional terms or grants. The United States' exports were roughly half commercial. In 1970 the amount of rice exported by the United States and Japan accounted for 36 percent of the world's rice exports.

Strong accusations against rice exports by the United States and Japan were made by the traditionally less developed rice exporting countries — especially Thailand. These accusations were as follows: the large amount of rice exports by the developed countries takes away market share in the international rice market from the less developed rice exporting countries and thus restricts the rice exports by these countries. Moreover, the rice exports by the developed countries increase the total supply in the international rice market and thus depress the price level of rice. Consequently, the foreign exchange earnings of the less developed countries from their rice exports are decreased.

These accusations, in addition to the effect of rice exports by the United States and Japan on rice importing less developed countries, especially Indonesia, are to be investigated by a policy simulation with the estimated model. In the policy simulation model, a hypothetical policy of complete stoppage of rice exports by the United States and Japan is adopted. Major results of the policy simulation are presented in Figures 5, 6, and 7. The way of presentation of the results is the same as it was for Figures 2 to 4.

Figure 5 indicates that the increase in rice exports of Thailand caused by the hypothetical stoppage of the rice exports by the United States and Japan is very small. The resultant increase in the export price of Thai rice in the results of the present policy simulation was too small to be shown. However, the international price level of rice was increased considerably by the hypothetical stoppage of the rice export by the two developed countries as shown in Figure 7. All these results imply that (1) the accusation that the rice export of the developed countries deprives the less

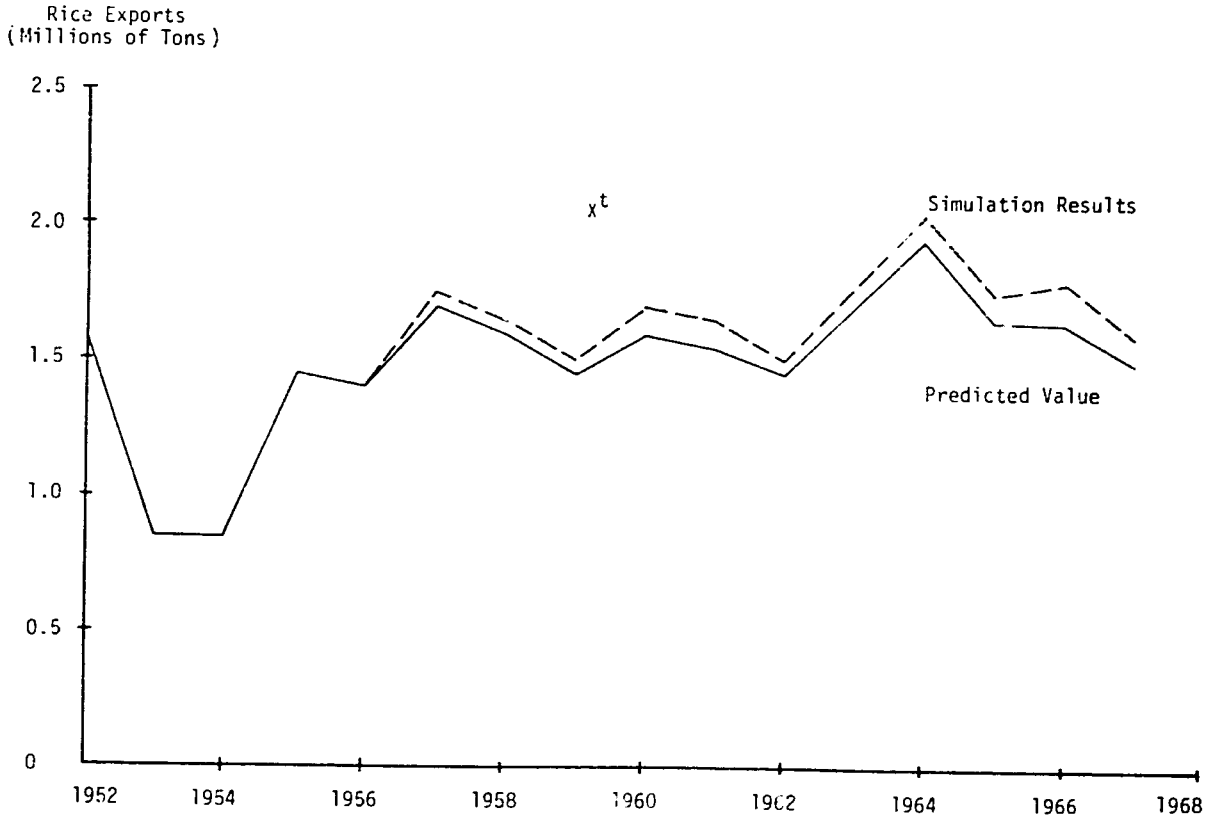

Figure 5. White Rice Exports by Thailand, X^t

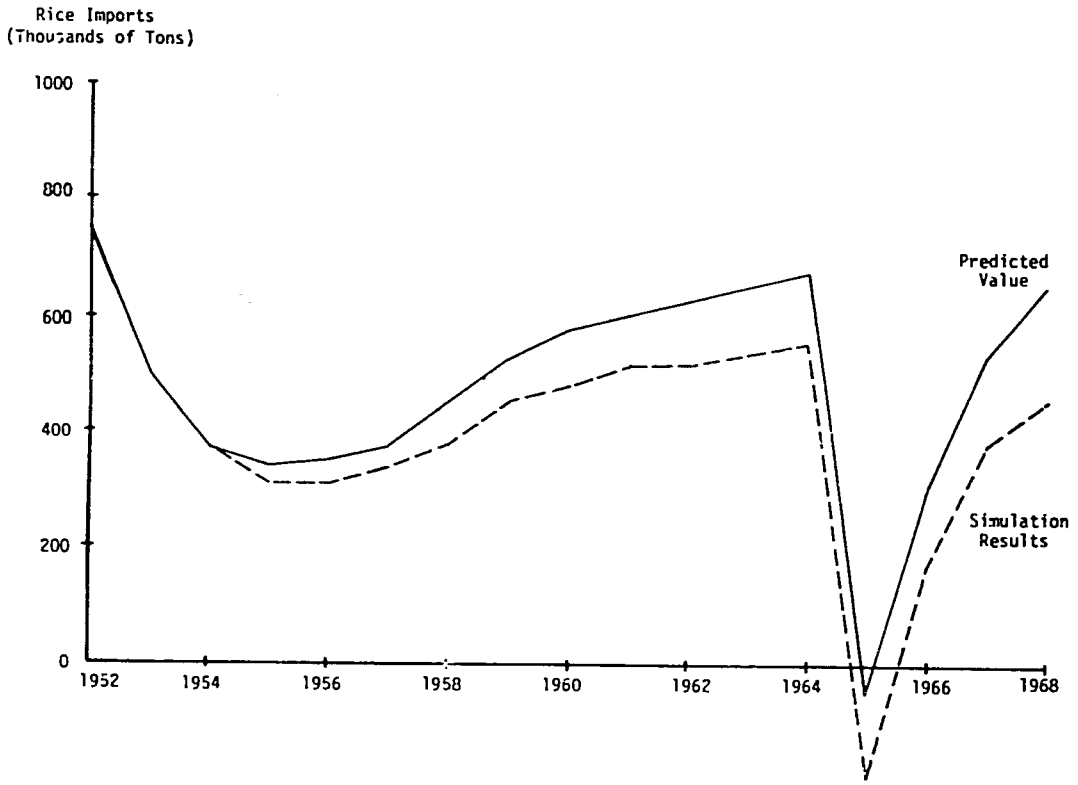

Figure 6. White Rice Imports to Indonesia, M^i

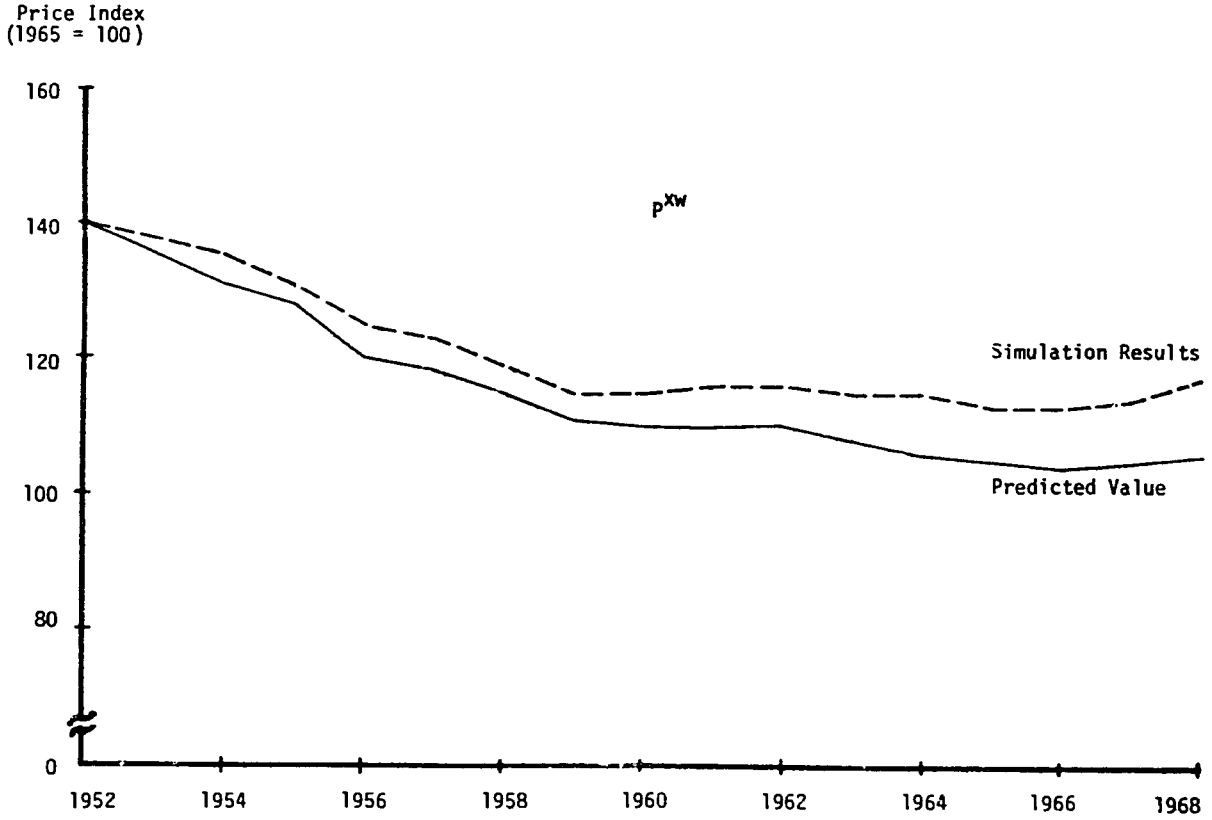

Figure 7. World Rice Export Price Index, P^{xw}

developed rice exporting countries of the latter's market shares and depresses the latter's rice export price does not quite hold as far as Thailand, a leading traditional rice exporter, is concerned; and thus (2) the accusation that foreign exchange earnings of Thailand from rice exports are decreased considerably by the rice export of the United States and Japan is questionable; also (3) the accusation that the rice exports of the developed countries depress the price level in the international rice trade holds true as shown in Figure 7.

These three implications further mean that the rice exports of the United States and Japan do not affect much the price and quantity of rice exports by Thailand, a leading rice exporter, but might affect considerably the smaller rice exporting countries. This independence of the behavior of Thai rice exports from the rice exports of the two developed countries can be explained as follows: (1) Thailand's position is that of an oligopolistic supplier of rice to the world rice market with a certain degree of product differentiation for Thai rice, and (2) the rice exports of the United States and Japan contain a large amount of food aid which goes to populations without the purchasing power to purchase rice on international markets.

Figure 6 shows the effect of rice exports by the United States and Japan on Indonesia, a traditional leading rice importing country. The stoppage of the rice exports decreases the total rice imports of Indonesia considerably because the stoppage increases the international rice price and thus the rice import price to Indonesia. Indonesia had a shortage of foreign exchange reserves during the simulation period. The results suggest that the rice exports by the United States and Japan benefit rice short Indonesia. This aspect should not be ignored in the accusations against rice exports by the two developed countries.

Conclusion

In this paper, the international rice market is characterized as a dynamic, interdependent, and imperfectly competitive system of economic, institutional, technological, and natural environmental variables. A model was developed and the simulation method used to analyze policy issues relating to the rice premium policy of Thailand and to rice exports by the United States and Japan. In the estimated model Thailand, Indonesia, and Japan were explicitly incorporated as submodels, and other countries were aggregated into a "rest of the world" submodel.

The results of the policy simulation regarding the rice premium policy issues in Thailand and the estimated near unity price elasticity of the world demand for Thai rice from the author's model deny the assumption of the competitive international rice market by the opponents of the policy, and thus do not support many of the opponents' arguments, but do support the proponents' arguments.

The results of another policy simulation suggest that the accusation that rice exports by the United States and Japan depress the export price and quantity of rice and thus foreign exchange earnings of Thailand is not valid. This result can be explained by Thailand's oligopolistic position as a large rice supplier in the world rice market with considerable product differentiation for Thai rice and by the high food aid content in the rice exports of the two developed countries. The results also indicate that rice exports by Japan and the United States result in a lower world price for rice which is beneficial to less developed rice importing countries like Indonesia.

NOTES

The author is with the Department of Agricultural and Forestry Economics, Faculty of Agriculture, Kyoto University, Kyoto, Japan.

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1. The second and third reasons are based on the author's theoretical and empirical analyses of rice exports and policies in Thailand in the past five years (Tsujii, 1977).
2. There were 1962-70, 1967-75, and 1970-80 projections by the FAO. The latest one was published as *Agricultural Commodity Projections, 1970-1980* in 1971.
3. The data and their sources, and the detailed discussion about them, are presented in Appendix B and Appendix C, respectively, of Tsujii (1973).
4. Rice exports from Japan and the United States are treated as exogenous policy instrument variables because the high percentages of these exports are in the category of food aid on concessional terms.
5. The first entry after the explanation of each variable stands for the unit or base year by which data for the variable are expressed. For the second entry, E stands for endogenous and X for exogenous variables.
6. Most of the proponents are government officers, some of whom are in charge of rice export policies. A survey team for the World Bank also

gave a supporting assertion (International Bank for Reconstruction and Development, 1959).

7. Some argue that all of the premium is borne by the importing countries.
8. By the comparative equilibrium analysis of the rice premium policy, we can show that the sum (this sum is a criterion of the welfare position for Thailand) of consumers' and producers' surpluses and the government revenue from the premium, when the premium is levied, is greater than the sum of these surpluses when the premium is not levied if the price elasticity of the world demand for Thai rice is unity. For more details refer to Chihiro Nakajima (1977).
9. By short run I mean several years during which a change in the rice premium in the first year might have effects on the rice markets.
10. This aspect was ignored in the discussion concerning the issues of the rice premium policy in the past. For more details refer to Hiroshi Tsujii (1972a).
11. Concerning the effects of stabilizing and lowering the domestic rice price by the rice premium, the actual management of the premium policy during 1967/68 and 1973/74 supported the existence of these effects. [For more details concerning this point refer to Hiroshi Tsujii (1973).] Consequently, rice became less profitable relative to the other agricultural crops in Thailand and agricultural diversification was facilitated. And since rice is the staple food and the most important wage good for the Thais, the wage rate can be kept low and stable and this can be a facilitating factor for the industrialization of Thailand.

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