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INTERNATIONAL TRADE IN RICE†

Few commodities are so heavily influenced by government policy as the international market for rice. Trade policies have often formed a cornerstone of national policies, and the resulting distortions in prices and commodity flows have obscured the importance of economic comparative advantage. Any realistic study of international market behavior, therefore, must be embedded firmly in the political economy tradition.

The focus of this essay, as in most commodity studies, is on the operation and effectiveness of the price mechanism. However, the key actors in the international rice market are governments rather than producers and consumers. The widespread use of concessional sales, government-to-government contracts, state trading agencies, and import-export barriers (described in the second section) mean that world prices have little direct relevance for production and consumption decisions in most countries. The most significant property of the international rice market is its use as a mechanism for resolving failures and conflicts among domestic policies. Although world prices still serve as the principal means for eliminating disequilibria, changes in export supplies or import demands are consequences of policy decisions rather than the actions of producers and consumers.

Students of the international market have long recognized the importance of policy in world rice trade (Wickizer and Bennett, 1941). The brief survey of econometric analyses presented in the third section indicates, however, that the market-surplus behavior characteristic of world trade has not been reflected adequately in the construction of economic models. Explanations of poor results have centered instead on inaccurate data, imperfect competition, differentiated products, or a lack of price responsiveness on the part of producers and consumers, rather than on the inadequacy of model structures. The fourth section develops a market-surplus model of international rice trade, in which changes in trade participation of eleven countries explain over 80 percent of the variation in world prices between 1961 and 1977. The subsequent section is concerned with the

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prevailing price level for this period. Additional data on domestic price policies of major consuming and producing countries are used to estimate the direction of bias in world rice prices relative to their free-trade level. The paper concludes with the prognosis that world rice prices will rise in real terms and will continue in their highly variable pattern.

THE TRADE

World trade in rice increased from 6.4 to 10.3 million metric tons (mmt) between 1961 and 1978, but never exceeded more than about 4 percent of total production. As Table 1 indicates, Asian countries are the dominant importers and account for 10 of the 12 countries which averaged more than 200,000 mt between 1961-78. Indonesia is by far the largest importer, and by the end of the 1970s Indonesian imports accounted for 15-20 percent of world import demand. Cuba, Hong Kong, Singapore, Malaysia, and Sri Lanka are another group of consistent importers, representing 15-20 percent of total trade. Finally, Table 1 demonstrates that the import side of the market has become less concentrated over time. The 12-country share declined from over 60 percent in the 1960s to 40 percent in 1978. This statistic reflects the increased importance of Middle Eastern and African importers and the diminished participation of India, Japan, and Vietnam.

Table 2 presents comparable data for exporters. Relative to importers, exporting countries are geographically more dispersed and smaller in number, although Asian countries still dominate. The 10-country list accounts for about 85 percent of total exports during the period 1961-78, with the United States, China, and Thailand representing 60 percent. Burma and Pakistan currently supply an additional 15 percent of the trade. Relative shares among the group changed during the period, as Burma's declined markedly, while those of the United States and Pakistan demonstrated the largest increases.

The general pattern of international rice price movements over the past two decades is well understood (Chart 1). World production increased gradually throughout the early 1960s, and international prices were stable. Bad weather and political turmoil in Asia caused prices to swing upward during the calendar years 1966-68. But with the return of more normal weather and the adoption of new rice varieties, particularly by importing countries, international prices trended downward. In 1972-73 an unprecedented series of poor global rice and wheat harvests resulted in large international price increases for both cereals. With improved production, prices fell sharply in 1975. By 1977, prices had increased due to production shortfalls among several prominent Asian importers and exporters, and fluctuated throughout the remainder of the decade. Between 1970-73 and 1974-77 there was a dramatic rise in the nominal price level, as indicated in Table 3. These data also demonstrate the large degree of variation in the qualities of rice traded internationally. Among importers, unit prices vary by 250 percent. Iran, Saudi Arabia, and Nigeria represent the high quality *indica* (long-grain) market supplied primarily by the United States, India, and Pakistan. Singapore, Sri Lanka, and Senegal import predominantly broken rice. Thailand, Burma, and China are the dominant suppliers of these qualities. South

TABLE 1.—RICE IMPORT STATISTICS, 1961-78*

Country	Million metric tons[a]							Percent of world imports						
	1961-78	1961	1966	1971	1976	1977	1978	1961-78	1961	1966	1971	1976	1977	1978
World	8.36	6.41	7.88	9.25	9.23	10.09	10.30	—	—	—	—	—	—	—
Cuba	.22	.19	.15	.28	.18	.14	.17	2.7	2.9	1.8	3.0	1.9	1.4	1.6
Bangladesh	.33	.49	.33	.35	.42	.10	.32	4.0	7.7	4.2	3.8	4.6	1.0	3.1
Hong Kong	.35	.34	.34	.35	.36	.34	.34	4.2	6.1	4.6	4.0	3.9	3.4	3.3
India	.52	.61	.97	.52	.41	.11	.06	6.2	9.5	12.3	5.8	4.4	1.0	0.6
Indonesia	.97	1.06	.31	.51	1.30	1.97	1.84	11.6	16.6	3.9	5.5	14.1	19.5	17.9
Japan	.44[b]	.14	.81	0	.02	.04	.06	5.3[b]	2.1	10.3	0	0.2	0.4	0.6
Malaysia	.32	.40	.30	.25	.18	.28	.41	3.9	6.6	4.3	2.7	2.0	2.8	4.0
Singapore	.20	.19	.16	.26	.22	.23	.19	2.4	5.2	3.3	3.3	2.4	2.3	1.8
Sri Lanka	.42	.47	.69	.34	.38	.54	.17	5.1	7.3	8.8	3.7	4.1	5.4	1.6
South Korea	.23	0	.01	.01	.18	.06	0	2.7	0	1.5	0	2.0	0.6	0
Vietnam	.73	-.17[c]	.44	1.38	.65	.30	.15	8.7	—	5.7	15.0	7.0	3.0	1.4
USSR	.27	.02	.27	.32	.32	.46	.41	3.2	0.3	3.5	3.6	3.5	4.6	4.0
Subtotal	4.75	3.74	4.78	4.57	4.62	4.57	4.12	57	58	51	49	50	45	40

*Data are from Food and Agriculture Organization of the United Nations (various years), *Trade Yearbook* and *Production Yearbook*, Rome. If yearbooks differ on estimates for any given year, the most recent estimate is utilized.

[a]Quantity data are net imports. Percentage calculations are based on gross imports.

[b]1961-68 only.

[c]Net exports.

TABLE 2.—RICE EXPORT STATISTICS, 1961-78*

Country	Million metric tons[a]							Percent of world exports					
	1961-78	1961	1966	1971	1976	1977	1978	1961-78	1961	1966	1971	1976	1977	1978
United States	1.68	.83	1.34	1.41	2.11	2.29	2.28	20.2	12.6	17.2	15.9	23.5	21.1	23.4
Italy	.26	.22	.08	.44	.39	.30	.44	3.1	3.3	1.0	4.7	4.3	2.8	4.5
Egypt	.36	.25	.35	.51	.21	.22	.14	4.3	3.8	4.4	5.5	2.3	2.0	1.4
Australia	.13	.06	.06	.10	.22	.25	.28	1.6	1.0	1.0	1.1	2.4	2.3	2.9
Burma	.81	1.59	1.13	.81	.63	.67	.35	9.7	24.0	14.4	8.7	7.0	6.2	3.6
China[c]	1.57	.39	1.34	2.15	1.45	1.15	1.60	18.9	7.7	17.8	23.2	16.1	10.6	16.4
Japan	.30[b]	0.00	0.00	.91	0.00	.02	.08[b]	3.8	0.0	0.0	9.8	0.0	0.2	0.8
Nepal	.19	.16	.27	.23	.18	.11	.06	2.3	2.4	3.4	2.5	2.0	1.0	0.6
Pakistan	.43	.17	.43	.18	.79	.96	.78	5.2	2.6	5.5	2.0	8.8	8.8	8.0
Thailand	1.51	1.57	1.51	1.59	1.92	2.93	1.57	18.1	23.8	19.2	17.1	21.4	27.0	16.1
Subtotal	7.11	5.25	6.53	8.33	7.90	8.90	7.58	85	81	84	90	88	82	78

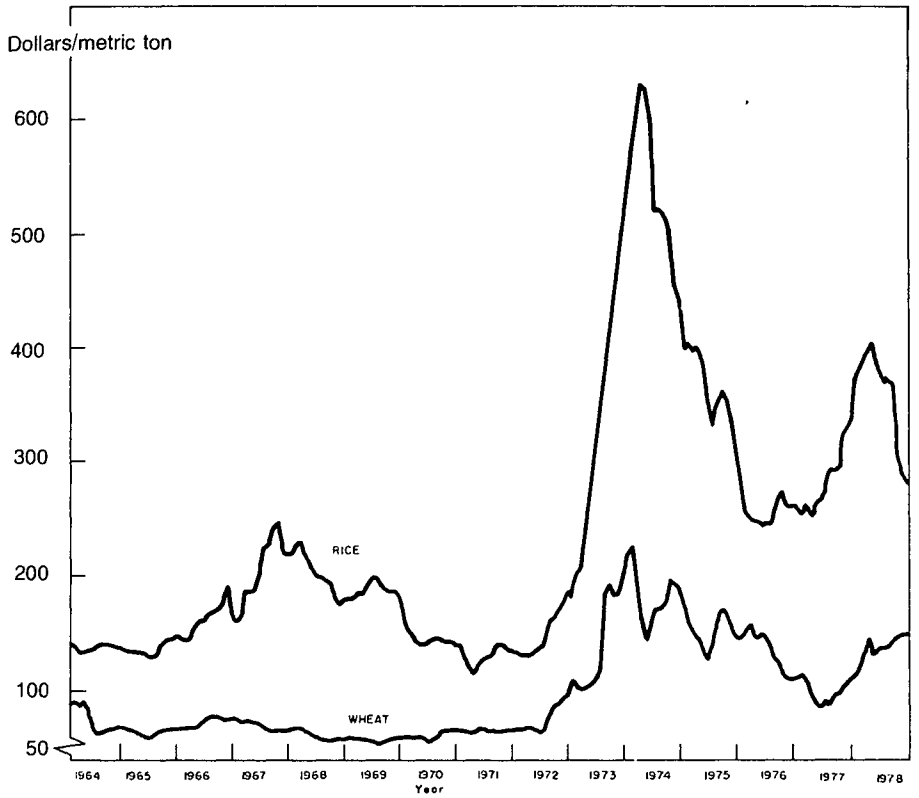
*Data are from Food and Agriculture Organization of the United Nations (various years), *Trade Yearbook* and *Production Yearbook*, Rome. If yearbooks differ on estimates, the most recent estimate is utilized. Average world exports were 8.323 mmt for the 1961-78 period. Margin differences between world import and export totals reflect stock changes.

[a]Quantity data are net exports. Percentage calculations are based on gross exports.

[b]1969-78 only.

[c]Food and Agriculture Organization estimates.

CHART 1.—EXPORT PRICES OF RICE (THAI 5S, F.O.B. BANGKOK) AND WHEAT (UNITED STATES HARD WINTER, F.O.B. GULF PORTS), 1964-78*



*Source: A.C. Palacpac (1980), *World Rice Statistics*, Department of Agricultural Economics, International Rice Research Institute, Los Banos.

Korea represents the major *japonica* (round-grain) market, whose prices appear somewhat below indica levels. Japonica varieties now compose less than 10 percent of world trade, primarily due to the reduced participation of Japan.

Among exporters, unit price variations are not as pronounced because most countries produce a mixture of qualities for export. Pakistan, Thailand, China, and the United States export significant quantities of both low-broken and high-broken rice. Among the major exporters of Table 2, Italy received the highest average price, reflecting the protection provided by the Common Agricultural Policy of the European Economic Community (EEC). The United States was also a relatively high-priced supplier while Burmese and Thai exports are dominated by the high-brokens market.

The prominence of government policy in international rice trade is rivaled by few other commodities. More than 50 percent of international trade is handled under direct government-to-government contracts and long-term agreements. Concessional sales by the United States, Japan, and Thailand have played a prominent, though irregular, role in rice trade in the past two decades, with Bangladesh, India, Indonesia, South Korea, and Vietnam the primary beneficia-

ries. Among importers, nearly all trade is government regulated, primarily through state trading agencies or the use of import quotas and tariff barriers.

Table 4 describes the trade policies of the countries listed in Tables 1 and 2. The dominant mechanism of interference involves the use of non-tariff barriers (NTBs). Government monopolization of foreign trade, or the imposition of import or export quotas, are the principal policies for control. The use of NTBs heightened the impact of government policies on the world market because quantitative control increased the flexibility of government responses to changes in domestic or world market conditions. Quantities proved easier to manipulate than prices and for most governments provided the most effective means of insulating domestic producers and consumers from the world market. Only the EEC and the United States differed from this pattern. The EEC utilized a variable levy and export restitution system, while the United States subsidized some exports through the provision of financing for Public Law 480 purchases, or provided direct producer payments when world prices fell below United States support price levels.

The heavy reliance on NTBs observed in Table 4 reflects the prevalence of these policies throughout the trade. Food and Agriculture Organization (FAO) surveys (FAO, 1973, 1977) of national rice policies in 83 countries (accounting for 88 percent of imports and 97 percent of exports) found only five nations—Austria, New Zealand, Norway, Saudi Arabia, and Sweden—with generally free trade policies. Among this group only Saudi Arabia is a significant participant in the rice trade. In total, 24 percent of world exports and 34 percent of world imports were subject to tariffs, and only 3 percent of imports were taxed at a rate above 10 percent of c.i.f. prices. On the other hand, NTBs affected 93 percent of imports and 76 percent of exports. For the vast majority of countries engaged in the trade, the volume of trade was directly determined by government policy.

The prominence of government policy and the wide variation in consumer preferences across countries have led many observers to question the existence of a coherent international rice market. But recent evidence provided in E. A. Monke (1980) and T.E. Petzel and Monke (1980) suggests that the world rice market is well integrated with respect to prices across countries, qualities, and time. Substitution across qualities in both consumption and production appear sufficiently rapid so that f.o.b. and c.i.f. prices for different countries and qualities cannot move independently for more than one or two months at a time.[1]

These results have two implications for the formulation of models of world rice trade. First, the price of any widely traded variety, such as Thai 5 percent brokens (Thai 5s) can serve as a reasonable indicator of movements in all world prices. Second, the presence of governments in the market, rather than producers or consumers, does not reduce the importance of the price mechanism as a means of equilibrating supply and demand on the world market. Government policies that affect trade participation, such as concessional and intergovernmental sales, have widespread rather than specific impacts on world prices.

[1] There are two minor exceptions to the generalization presented in the text. First, prices of japonica, which account for less than 10 percent of international trade, do not move in concert with indica prices in all markets. Second, the adjustments between the parboiled and raw rice markets are slow. Parboiling capacity at the mills has been limited, and expansion of capacity requires new capital investments (Petzel and Monke, 1979-80).

TABLE 3.—UNIT VALUES OF RICE IMPORTS AND EXPORTS*

Item	Average annual unit value of rice (US$/mt)		
	1970-73	1974-77	1978
Imports			
World	166	376	400
Nigeria	257	483	550
Saudi Arabia	237	634	495
Iran	221	540	500
Hong Kong	200	390	372
Indonesia	203	374	321
Bangladesh	106	257	230
Senegal	128	298	348
Singapore	154	331	344
Sri Lanka	108	283	255
South Korea	134	328	328
Exports			
World	158	332	372
Egypt	140	480	350
United States	218	378	408
Burma	91	244	251
China	140	332	399
Pakistan	176	357	331
Thailand	128	303	318
Italy	163	369	486
Australia	149	301	271

*Data are from the Food and Agriculture Organization of the United Nations (1972-78), *Trade Yearbook*, Rome.

EMPIRICAL STUDIES OF INTERNATIONAL TRADE

The most general and aggregate empirical study of international rice trade is that of F.G. Adams and J.R. Behrman (1976). They assert that developed, developing, and centrally-planned economies differ fundamentally in economic behavior and thus require separate supply-demand estimates. Trade is viewed by them as a residual of production and consumption in the three groups of countries. Production and per capita consumption serve as dependent variables, while an FAO world rice price index deflated by a world inflation index serves as the independent variable.

With the exception of the developed countries, the results show little evidence of price responsiveness. The explanatory variables for production and consumption in the centrally planned and developing economies (where over 90 percent of world production and consumption occur) are time trends, dummy variables for particular years, and lagged values of the dependent variables. The authors

TABLE 4.—GOVERNMENT POLICY AND RICE TRADE

Country	Trade policy
Bangladesh	Government monopoly
Burma	Government monopoly (Myanma Export-Import Corporation)
China	Government monopoly (China National Cereals, Oils, Foodstuffs Import-Export Corporation)
Cuba	Government monopoly (ALIMPORT, Ministry of Foreign Trade)
Egypt	Government monopoly (Rice Mills Organization, Foreign Trade Organization)
Italy	EEC variable levy and export restitution programs
Hong Kong	Importers are licensed and given quotas determined quarterly by government
India	Government monopoly (Food Corporation of India)
Indonesia	Government monopoly (BULOG)
Japan	Government monopoly
Korea	Government control (Ministry of Agriculture and Forestry)
Malaysia	Government control (National Padi and Rice Authority, NPCA). Private importers are licensed, granted quotas, required to purchase a proportion of Government-owned domestic rice.
Nepal	Information not availabile
Pakistan	Government monopoly of high-grade *basmati* rice (Trading Corporation of Pakistan). Government control of lower- grade rice exports through licensing of private traders; export taxes (since 1972).
Singapore	Information not available
Sri Lanka	Government monopoly
Thailand	Government control. Export permits required for private trade: use of rice premium and quotas dependent on domestic and world market conditions.
United States	No control over private trade. Before 1973, Commodity Credit Corporation provided export subsidies when wo prices fell below support prices plus marketing costs. Currently, intervention is limited to provision of financing for PL 480 United States Agency for International Development programs.
USSR	Government monopoly
Vietnam	Government monopoly

*Data are from the Food and Agriculture Organization of the United Nations (1973, 1977), Intergovernmental Group on Rice, "Compendium of National Rice Trade Policies," Rome.

conclude that the long-run price elasticities of supply are zero for the developing countries and 0.25 for the centrally planned economies (based on lagged price response of three to five years). Price and income elasticities of demand are non-zero only for the developed countries.

The studies of O. Chaipravat and S. Pariwat (1976) and W.R. Grant, T. Mullins, and W.I. Morrison (1975), represent extreme alternatives to the Adams-Behrman approach. The Grant et al. model, for example, includes 38 countries and regions and attempts to define production, consumption, and internal and external price relationships for each region. In addition, markets are differentiated by quality into high quality indica, high quality japonica, and broken rice. Exogenous variables include land, fertilizer, fuel, weather, population, incomes, tariffs, subsidies, research and extension programs, and agricultural development programs. However, errors in data, availability of data, and problems with degrees of freedom resulting from a short time series (often 15 years or less) with many exogenous variables result in an unwieldly model. The 154 equations contain tremendous variation in the use of explanatory variables and in significance levels of coefficient estimates. Moreover, the authors make no attempt to aggregate the results into a global equation system.

The studies of V. Arromdee (1968), H. Sarkar (1978), and H. Tsujii (1973) take an intermediate approach toward the aggregation problem and concentrate on important trading countries. The results of these studies are not very different from those mentioned above. The linkage of price and quantity remains elusive. Coefficients of quantity-price relationships have t-statistics well below the 95 percent significance level. Significant explanatory variables are simply lagged dependent variables or some transformations of the dependent variable.

Tsujii's study is perhaps the most detailed of this group and presents a 36-equation, 60-variable model with Thailand, Indonesia, Japan, and the rest of the world as components. His price relationship for Thailand shows domestic prices as a function of inventories lagged one year, f.o.b. prices, and the export tax, while export prices are a function of lagged export prices, domestic prices, and the export premium. The explanation of price movements relies heavily on the relationship between domestic and f.o.b. prices and the export tax. This relationship, however, is an identity (domestic price + tax = f.o.b. price). The only quantity variable in the price estimation is lagged inventories, and the coefficient on this variable is statistically insignificant.

In contrast to studies of international trade, the evidence on price responsiveness at the national level is substantial for both developing and developed countries. With respect to rice, two of the earliest papers were those of Behrman (1966, 1967). He examined rice supply in Thailand from 1940 to 1963 and found supply price elasticities small but significant—from .02 to 1.81 in the short-run and from .07 to 3.12 in the long-run, depending on geographical area. The distribution of elasticities, while broad, was skewed toward the lower end. Average short-run elasticities were .18, and long-run elasticities were .31. Furthermore, the elasticities depended on crop substitution possibilities and proximity to markets. Thus, both the magnitude of price response and the critical explanatory variables are similar to results for developed country producers.

Also important in this context is a study by C.P. Timmer and W.P. Falcon

(1973), which demonstrated the importance of relative prices and differences in agricultural infrastructure for rice production in nine Asian countries. They found that a Cobb-Douglas production function with harvested area, the ratio of domestic price of rice to that of fertilizer, and a separate intercept for each country as arguments, explained over 99 percent of the variation in output among the nine countries. The domestic rice-fertilizer price ratio varies across countries by a factor of ten, indicating large differences among countries in the economic environments in which rice is produced. While the specification of a consumption function was less successful than that for production, rice prices and incomes appeared as significant determinants of rice consumption in all countries.

The appearance of two such disparate sets of results suggests that an understanding of rice trade and of the role of price requires recognition of two distinct markets. World prices link supply and demand on the international market; internal prices perform a similar function on domestic markets. But the institutional structure of trade, dominated by government monopolies, often prevents variations in demand, supply, and prices on the international market from being reflected in domestic markets. The preference of governments for quantitative trade controls rather than tariffs isolates domestic price movements from world price movements, and fluctuations in world prices become largely irrelevant to the short-run production and consumption adjustment mechanisms within each country. The structure of trade causes the relationship between domestic and world price movements to be a function mainly of government policy, because the quantities of imports and exports, or at least the variations in these quantities over time, are largely determined by policy makers. Given this institutional context, it is understandable why past econometric studies of rice trade could not link production, consumption, and trade with world prices in a statistically significant manner.

PARTICIPANTS, POLICIES, AND PRICE VARIABILITY

The importance of government policy suggests that the appropriate functional form for a model of rice trade would use quantity as an independent variable and price as the dependent variable, a reversal of the formulation used in many previous trade studies. However, incorporating government policy into a model presents further difficulties. A fully explanatory trade model requires a national approach with hundreds of equations to capture both the complications of the market and the important political forces. But models of this magnitude are cumbersome and often beyond comprehension. Moreover, they generally cannot be implemented due to inadequate data. To be operational, therefore, a model of the role of government in the international market must be simplified by reducing the number of countries whose rice policies are to be examined.

The criterion for country choice in this analysis is variance in the quantity of imports or exports. Use of this criterion reflects the statistical requirement that policies and trade have indeed varied and the assumption that national deviations in demand or supply are transmitted to world markets and are the principal causes of world price variation. Simultaneity problems arise with the use of this criterion, because measures of variance identify countries that are highly respon-

sive to, as well as those which cause, world price movements. Fortunately, a substantial literature on national rice economies allows the identification of the few countries that do respond to world prices.

Variable behavior is defined formally as deviations of net trade positions from a time trend to allow for long-term changes in trade due to the growth of population or income, rural-urban migration, or increased investment. A time-series of net-traded quantities (N) is fitted to a time trend, T:

$$N_i = a + bT_i + u_i, \quad (1)$$

where i = 1961-77. The variance of trade participation can then be ranked by the values of the standard error of the estimate.[2] Table 5 presents the mean values of N, the standard deviation of N, and the standard error of estimate for all countries averaging at least 200,000 mt of imports or exports during 1961-77. In general, the time trends are not very pronounced, and the top half of a ranking of countries by the standard deviation of N would include virtually the same countries as the standard-error ranking.

The subsequent analysis focuses on government policy of the top 11 countries on the list. This group includes the five principal exporters (China, United States, Thailand, Burma, and Pakistan), five of the largest importers (Indonesia, India, Vietnam, Bangladesh, and South Korea), and Japan, which was both a major importer and exporter during the period under review.

Among the 11 high-variance participants, only China and the United States demonstrated a significant response to world price movements.[3] Grant and M.N. Leath (1979) have documented the importance of price in American production during 1950-76. They found harvested acreage to be significantly responsive to price. Estimates of short-run supply elasticities varied by state from 0.25 to 0.50. Exports also showed price responsiveness. Government-financed exports were significantly related to stocks, production, and the ratio of American to Thai prices, while commercial exports were related to production, government exports, and the same price ratio. Even though producer price support programs prevailed during much of this period, they did not substantially reduce the aggregate amount of domestic price variability relative to movements in world prices. Most of the variation in world prices (and domestic producer prices) occurred from 1965 to 1968 and from 1972 to 1977, when price-support programs were inoperative.[4]

[2] Because of inadequate stock data, annual carryovers were assumed constant. Due to first-order autocorrelation, all equations were estimated by generalized least squares.

[3] An exception to the above characterization is presented in 1974. Prices increased to roughly four times their 1972 level, and at these price levels the importers in this group showed negative price response. Imports declined by 1.5 mmt relative to their 1973 level. United States and Chinese performance in 1974 was also atypical in that their combined exports declined rather than increased, in part because of an "excessive" export response in 1973.

[4] While direct export subsidies have been relatively unimportant in rice trade, other government programs, most notably the concessional financing of Public Law 480 programs, were important in stimulating demand on the international market. Since 1972, however, these programs have played a diminished role (Mears, 1975), and cost-of-production analyses (Mears, 1976; Mullins, Grant, and Holder, 1978) suggest that producers are competitive on world markets at recent and expected international prices for rice.

In China the price-response mechanism is more complex. Timmer (1976) and D.L. Chinn (1979) suggest that the supply response occurs largely on the basis of trade flows, rather than of production. When rice prices are high relative to wheat prices, the government increases rice exports and wheat imports, resulting in short-run shifts in domestic consumption patterns between rice and wheat. Since wheat represents a lower cost source of calories, this policy amounts to an arbitrage between foreign exchange and sources of calories. Chinn has found statistical confirmation of this relationship.[5]

Among the remaining nine countries, trade variability has rarely been influenced by world prices. For many of the countries the importance of trade arises from its use as a mechanism for short-run quantity adjustments in domestic markets. Variability in trade reflects attempts by governments to offset short-run shifts in domestic production and thus to stabilize consumer prices and availabilities. Among the countries considered here, Bangladesh, India, Indonesia (Timmer, 1975a), South Korea (Moon, 1975), Thailand (Tsujii, 1977a), and Vietnam (Tsujii, 1977b) have all relied on variations in trade to maintain domestic consumption levels. Table 6 compares the coefficients of variation of domestic and world price series for a number of major trade participants. Although there is some cross-country variation in the length of the time series, domestic market prices vary less than world prices in all cases.

Inconsistency in the application of policies over time is also responsible for much of the variation in imports and exports among the nine countries. This effect has been most noticeable in the conduct of producer price policies. Erratic producer prices over time have resulted in equally erratic market responses. Given the desire to maintain levels of domestic consumption, successes or failures in production policies frequently translated directly into changes in imports or exports. In Burma, for example, procurements ranged from 18 to 67 percent of production during this period, reflecting variations in the size of the procurement fund as well as in producer prices (Palacpac, 1977). Pakistan's exports (FAO, 1976, 1977) varied by over 500 percent from 1970 to 1977 with nationalization of milling and marketing, changes in private exportation rights, and fluctuations in tariffs from 0 to 30 percent contributing to an unsettled institutional environment.

Changes in rice policies sometimes reflected changes in policy objectives. Japan (Hayami, 1975) provides the clearest example. During the immediate post-war period, Japan was one of the world's principal importers, reflecting the impact of rising labor costs on domestic production and the importance of rice as a low-price wage good in urban areas. By the 1960s, incomes had risen substan-

[5] Calories arbitrage appears to occur principally among urban consumers, since this is where most imported grains are directed (Timmer, 1976, p. 66).

Chinn's equation to predict rice exports is presented below:

$$X = -5823.55 + \underset{(2.29)}{949.77}(A)(P) + \underset{(8.41)}{59.34}(Q) \qquad R^2 = .85,$$

where X = rice exports, A = ratio of wheat calories to rice calories per kg, P = ratio of rice price to wheat price, and Q = rice production. A supply (arc) elasticity of 0.46 is estimated by using 1975 values for the dependent variables, and then simulating the effect of a 50 percent increase in rice price on exports. Estimates for 1975 are A = (330/363), P = (315/190), and Q = 119.

TABLE 5.—MEAN VOLUME AND VARIANCE OF TRADE PARTICIPATION, PRINCIPAL TRADING COUNTRIES, 1961-77*

Country	Mean annual trade[a] (*million metric tons*)	Standard deviation	Standard error of regression
China	1.648	.812	.546
Thailand	1.503	.550	.518
Indonesia	-.906	.508	.437
Vietnam	-.819	.682	.357
Japan	-.046	.500	.330
South Korea	-.256	.272	.259
Burma	.791	.518	.238
United States	1.695	.364	.214
Pakistan	.422	.244	.173
Bangladesh	-.320	.150	.155
India	-.542	.292	.140
Sri Lanka	-.436	.140	.134
Egypt	.381	.195	.130
USSR	-.270	.107	.108
Italy	.235	.131	.093
Malaysia	-.317	.093	.064
Nepal	.201	.070	.057
Cuba	-.217	.047	.048
Singapore	-.199	.046	.044
Hong Kong	-.349	.029	.028
Rest of world			
Exports	1.070	.331	.275
Imports	-3.180	.928	.547

*Data are from the Food and Agriculture Organization of the United Nations (various years), *Trade Yearbook*, Rome. Countries with average annual exports of 200,000 mt or more.

[a]Exports positive, imports negative.

tially, and diets had become more diversified. Consequently, the need for low consumer rice prices was eliminated. Income support for farmers became the principal objective of rice policy, and the substantial increases in government revenues during the 1950s eased budget constraints sufficiently to allow subsidization of production. Producer prices were doubled between 1958 and 1969, which together with declining trends in consumption effectively removed Japan from the import market. Producer prices, however, continued to increase. By 1978, producer prices reached $1100/mt rice, while export market prices were less than $300/mt. The result was an erratic pattern of concessional exports dependent largely on government willingness to subsidize trade and the size of domestic stocks. Exports varied from zero to 900,000 mt during the 1969-77 period, with no clear response to world prices.

Statistical linkages between trade policy and domestic prices are difficult to demonstrate. Trade is determined by a number of different policies, and these policies interact over time in an irregular manner. Shortfalls in domestic production might ordinarily be compensated by increases in rice imports, but changing priorities, perceptions of foreign exchange constraints by policy makers, and availabilities of alternative grains may modify this trend. The resultant need for many dummy and explanatory variables and the shortness of the time series available for most countries mean that estimated relationships between trade and policies are unlikely to produce satisfactory fits or significant coefficients.

For a few countries, however, the number of relevant policies are small and data availabilities are sufficient to allow estimation. Table 7 presents regression results of net traded quantities against a number of policy variables for Thailand, Indonesia, South Korea, and Burma. World prices are included in each equation to test for consumption or production responses (among importers and exporters, respectively). None of the price coefficients is significant, as the value of the largest t-statistic is only 0.66. In three of the four countries, however, deviation from trend in production appears to be a significant indicator of trade behavior. Indonesia and Thailand transferred about half of the deviation into changes in imports or exports. Trade policy consistently buffered domestic consumption from changes in domestic production in these countries. Foreign aid shipments appear important in South Korea, and the coefficient of 1.03 suggests that availability of aid played a major role in South Korea's trade variation.

The importance of the high variance participants in world rice trade means that shifts in their demand and supply functions for internationally traded rice have a major impact on world prices. Because the shifts in demand and supply are due principally to exogenous domestic policy actions, world price changes can be regarded as a function of changes in the quantities of exports and imports offered on the international market. If the changes in exports and imports of these countries are expressed in terms of excess demand, then a two-equation model composed of a price equation and the trade identity will allow the estimation of an excess supply curve. This curve measures the response of the international market to exogenously determined changes in excess demand.

In functional form,

$$\Delta P/P = f(\Delta T/T), \tag{2}$$

where $\Delta T = \sum_i (M^i_t - M^i_{t-1}) - \sum_i (X^i_t - X^i_{t-1})$, and $T = \sum_i M^i_t + \sum_i X^i_t$.

The variables are P = price, M = imports, X = exports, i = high variance trade participants (United States and China are excluded), and t = time.

By the trade identity, world imports must equal world exports and

$$(\sum_i \Delta M^i - \sum_i \Delta X^i)/T = (\sum_j \Delta X^j - \sum_j \Delta M^j)/T, \tag{3}$$

where j = all remaining trade participants ($i \neq j$).

Equations (2) and (3) form a model with two unknowns, $\Delta P/P$ and

$(\sum_j \Delta X^j - \sum_j \Delta M^j)/T$, and regression of $\Delta T/T$ on $\Delta P/P$ will thus trace out an excess

TABLE 6.—COEFFICIENTS OF VARIATION OF MARKET PRICES FOR RICE, VARIOUS PERIODS*

Country	Years	Retail prices	Thai 5 percent brokens
Importers			
Bangladesh,	1961-73	.23	.37
Orissa (Balasore)	1968-77	.26[a]	.50
India,	1968-77	.23[a]	.50
West Bengal (Sainthia)			
Indonesia	1968-77	26[b]	.50
Philippines	1961-75	.26	.51
South Korea	1961-74	.32	.58
Sri Lanka	1961-73	.30	.37
Malaysia	1961-71	.09[c]	.17
Exporters			
Japan	1961-73	.33	.37
Pakistan	1961-73	.29	.37
Thailand	1961-75	.23	.57

*All prices are from A. Palacpac (1977), *World Rice Statistics*, International Rice Research Institute, Los Banos, except as noted. Price series are generally taken in the capital city.

[a]Government of India, Directorate of Economics and Statistics (various issues), *Bulletin on Food Statistics*, New Delhi.

[b]D. D. Hedley (1971), "Rice Buffer Stocks for Indonesia: A First Approximation," Workshop on Rice Policy, Los Banos, mimeograph.

[c]Malaysia, Department of Statistics (various issues), *Monthly Statistical Bulletin of West Malaysia*, Kuala Lumpur.

supply curve. This curve is distinct from the familiar market supply curve, because the excess supply curve comprises both demand and supply responses. The United States and China comprise 62 percent of the remaining market supply (the six exporters together account for more than 85 percent of total exports), and extant data on their supply behavior allow a disaggregation of the excess supply curve into market demand and supply responses.

Equation (4) presents the results of a generalized least squares regression of the proportional change in the price of Thai 5 percent brokens against a time series of changes in exports and imports for nine of the 11 high-variance participants:[6]

$$\frac{\Delta P}{P} = .05 + 1.72\,\frac{\Delta T}{T} \quad .63\ \text{DUM68} + 1.15\ \text{DUM74} \qquad (4)$$

[6] The model is estimated for the years 1961-77, since data for 1978 were not available at the time of the estimation. Three adjustments are made to the data. First, the 1973 price for Thai 5s is not available, and a proxy price of $307/mt is generated by assuming the relationships of Thai 5s prices to the average unit value of exports was the same in 1973 as in 1971 and 1972 (Thai 5s prices were 45 percent above unit values in both years). The next two adjustments are to insert dummy variables for 1968 and 1974. In 1968 the trade was dominated by an increase in Vietnamese imports of about 1 mmt over the preceding year. Prices declined by about 3 percent in this year. In 1974, exports from China and the United States declined by about 400,000 mt, further aggravating the tight supply situation of 1972-73, and prices rose to nearly four times their 1972 level. At this point, importers demonstrated a clear price response and imports by the nine country group declined by nearly 1.5 mmt.

t-ratios (.91) (3.92) (-2.03) (4.22)

$R^2 = .61$ $F_{(3,11)} = 5.64$ DW = 1.92
DUM68 = 1 for 1968 and 0 elsewhere
DUM74 = 1 for 1974 and 0 elsewhere

The results show a strong association between behavior of this group of countries and variations in world prices. The estimates of the overall regression and the $\Delta T/T$ coefficient are both significant at the 99 percent confidence level, even though only 60 percent of the variation in prices is explained by this formulation. Variation in trade in other countries may have been important in some years and probably accounts for some of the unexplained variation.[7]

There is no reason to expect a simple linear functional form to fit changes in the dependent variable, particularly since the variation in trade of almost all market participants is policy-determined. Inclusion of a quadratic term in Equation (5) increases the significance level of all the estimated coefficients. The estimated value of the $\Delta T/T$ coefficient changes slightly, and the R^2 increases to 0.79. The second derivative of the equation is positive, and the constant term is not significantly different from zero. These features indicate that for a given absolute variation in trade, prices demonstrate more flexibility in an upward direction than in a downward direction. Arc elasticity estimates are 1.0 and 0.3 for increases and decreases in $\Delta T/T$ of .15 (about 1.0 mmt). This relationship is illustrated in Chart 2.

$$\frac{\Delta P}{P} = -.07 + 2.02\,\frac{\Delta T}{T} + 6.70\,\frac{\Delta T^2}{T} - 1.34\,\text{DUM68} + 1.13\,\text{DUM74} \quad (5)$$

(-1.67) (7.20) (3.59) (-4.76) (6.41)

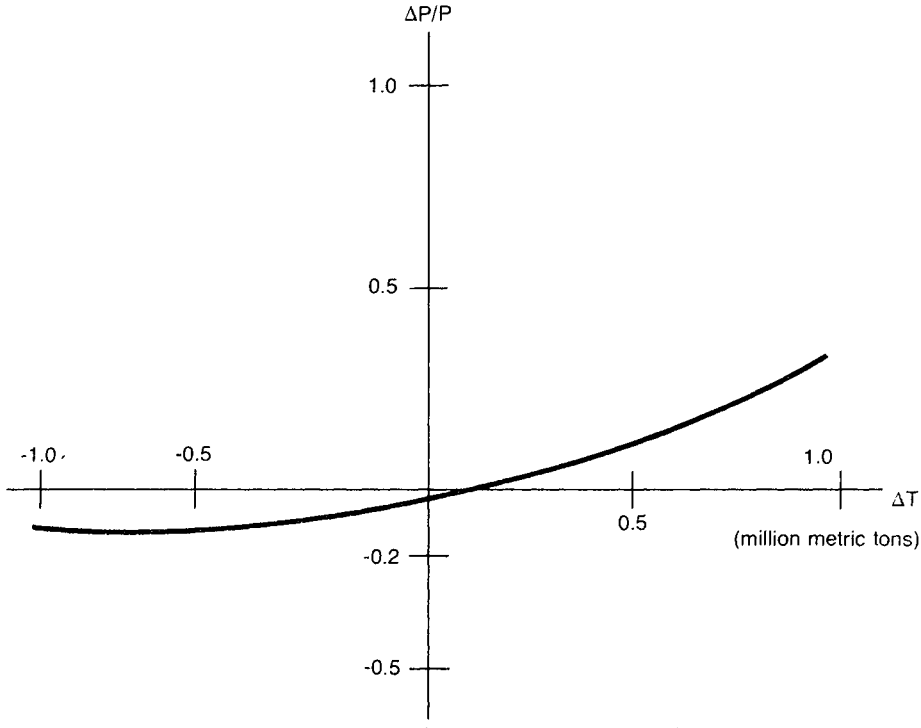
$R^2 = .82$ $F_{(4,10)} = 11.34$ DW = 2.26

Equation (5) is a more interesting formulation than (4) because it lends support to the observations of other researchers that demand elasticities for grain vary with price (Peck and Gray, 1980). Empirical studies (Chinn, 1979; Grant and Leath, 1979) suggest a price elasticity for Chinese and United States supplies of between 0.3 and 0.5. For the former figure, market demand elasticities become -0.2 for price increases and -1.3 for price declines. For a supply elasticity of 0.5, the demand estimates become -0.1 and -1.2. Hence, these results correspond to a market demand curve that is kinked around its long-run level, becoming less elastic as prices rise and more elastic as prices decline.

The preceding analysis has sought to demonstrate that short-run fluctuations in trade of a small group of countries caused, rather than resulted from, world price movements. The most important causes of trade variability involved government commitments to ensure domestic consumer availabilities (and stabilize domestic rice prices), fluctuations in producer price and procurement policies, and changes in the objectives of domestic rice policy. The aggregate impact of these policies on quantities traded caused world prices to fluctuate.

[7] The strict assumption underlying the model is that other exogeneous shifts in market supply and demand are offsetting. This appears reasonable, given the broad geographical dispersion of the remaining participants.

CHART 2.—WORLD PRICE RESPONSE TO CHANGES IN NET TRADE POSITIONS



There are important exceptions to the above characterization. The year 1974 was clearly atypical, and price-responsiveness of the United States and China has been important in reducing potential variability during this period. But for most countries and in most years, the world market was used to absorb the consequences of domestic policies.

POLICIES AND PRICE LEVELS

The previous section was concerned with the short-run variability in world prices. But an understanding of price level is equally important. Where trade barriers make world prices largely irrelevant to the private sector, expected world prices are still of concern to government policy makers, who must estimate taxes or subsidies on consumers or producers. If, for example, subsidization of domestic production is deemed necessary, the extent of consumer transfers through tariffs or tariff-equivalents or the magnitude of government budget outlays for producers depends ultimately on the c.i.f. price of rice. Moreover, the level of world prices is important in planning agricultural investment. Cost-benefit analysis is the principal technique for identifying investment opportunities, and most methodologies depend critically on the choice of an "appropriate" price for output. The fluctuations observed in the rice production investment patterns of many developing countries over the past two decades have frequently been associated with changes in project cost-benefit ratios due to fluctuations in world rice prices (Herdt, Te, and Barker, 1977).

TABLE 7.—RELATIONSHIP BETWEEN FOREIGN TRADE IN RICE AND RICE POLICIES OF SELECTED COUNTRIES, 1960s AND 1970s[a]

Thailand, 1961-77

$$TRADE = .05 + .45PROD._{-1} - .54QUOTA\ DUMMY - .20PRICE._{-2}$$
$$(.60)\quad (3.92)\quad (-2.88)\quad (-.66)$$
$$R^2 = .69 \quad F_{(3,12)} = 9.08 \quad DW = 1.54$$

Indonesia, 1966-77[b]

$$TRADE = -.41 + .55PROD._{-1} \text{ a } .36AID + .04PRICE._{-1}$$
$$(-.93)\quad (3.37)\quad (.38)\quad (.12)$$
$$R^2 = .66 \quad F_{(3,7)} = 4.47 \quad DW = 1.65$$

South Korea, 1962-77[b]

$$TRADE = -.01 - .03PROD._{-1} + .10PROC._{-1} + 1.03AID + .12PRICE._{-1}$$
$$(-.23)\quad (-.42)\quad (.23)\quad (4.12)\quad (.10)$$
$$R^2 = .72 \quad F_{(4,9)} = 5.88 \quad DW = 2.46$$

Burma, 1965-77

$$TRADE = -.02 + .16PROD_{-1} + .26PROC._{-1} - .18REV/DUMMY + .04PRICE._{-2}$$
$$(-.47)\quad (1.70)\quad (2.92)\quad (-1.78)\quad (.36)$$
$$R^2 = .86 \quad F_{(4,7)} = 10.72 \quad DW = 2.58$$

[a]The variables are:

TRADE = net traded quantities (*million metric tons*).
PROD.$_{-1}$ = deviations from logarithmic trend of domestic production, lagged one year (*million metric tons*).
QUOTA DUMMY = 1 for 1967-68, 1973-75, 0 elsewhere.
PRICE = annual average price of Thai 5 percent brokens, f.o.b. Bangkok (time lags indicated by subscripts). The equations are estimated in first differences, and price changes are expressed in relative terms.
AID = imports of rice under foreign aid programs.
PROC.$_{-1}$ = government purchases of domestic production, lagged one year.
REV DUMMY = 1 for 1967-68, 0 elsewhere. This dummy variable represents the effect of domestic unrest in Burma during this period.

[b]Cochrane-Orcutt estimation techniques.

Given the fluctuations of world prices over the past two decades, the estimation of a price level is not a simple task. Because prices are more flexible upward than downward, arithmetic averages of time series values overestimate the price level, even when the data are adjusted for inflation. Rather, the price level will be closer to the prices observed in years of weak demand than in years of strong demand. The average f.o.b. price of Thai 5s during the 1975-77 period was $296/mt, a 206 percent increase from the 1961-63 average price of $144/mt. This price rise is more reflective of the general inflation of the period than of changes in real prices. The index of unit values of agricultural products, for example, increased by 243 percent during this period, suggesting little change in the real price of rice.[8]

If the 1961-63 and 1975-77 periods can be considered "normal" marketing years, the finding of constant or slightly declining real prices is a remarkable result. For all the enormous changes in the rice economy during the interim—the Green Revolution and agricultural development programs, political disruption in southeast Asia, disastrous weather in 1972-73—rice price levels were surprisingly stable. A price of $300/mt for Thai 5s in 1976 prices is a reasonable estimate of the prevailing price level during this period. Since trade expanded from about 6.5 to 8.5 mmt, the long-run supply curve was essentially horizontal.

Government policy has undoubtedly affected the volume and patterns of trade over time, but its effect on world prices is unclear.[9] A downward bias on world prices will result from policies that reduce import demand or expand (subsidized) exports. Protection for domestic producers, for example, results in the removal of potential consumers from the world market and thus forces prices below their free-trade level. Alternatively, taxation of domestic production or subsidization of domestic consumption heightens reliance on international markets relative to a free-trade situation. Observed world prices will be above their free-trade level.

Detailed data on the extent of consumer subsidization and producer taxation are not available for most countries, but some simple assumptions applied to extant data suggest that consumer subsidization has been a dominant objective in most countries important in the rice trade. The ratio of fertilizer price to paddy price is frequently used as an indicator of producer price incentives, and a free trade ratio, based on a paddy equivalent price for white rice 25 percent brokens of $150/mt and a nitrogen price of $275/mt, was about 1.8 in 1976-77.[10] This price ratio is, at best, a c.i.f. port approximation. Transportation costs must be

[8] The World Bank international inflation index (based on prices of manufactured imports of less developed countries) increased by 246 percent during the same period.

[9] Timmer and Falcon (1975), for example, found that trade among southeast Asian countries differed markedly from observed patterns when a common rice-fertilizer price ratio was assumed to prevail in all countries. Japan became a major importer, while Indonesia substantially reduced imports.

[10] The paddy price is derived by discounting the Thai 5 percent brokens price of $300/mt by 15 percent to approximate an "ordinary" quality (25 percent brokens) price of $255/mt. Multiplying by a conversion factor of 0.60 yields a paddy-equivalent price of $153/mt. A urea price of $130/mt bagged, c.i.f. Asian ports, is based on FAO (1978) fertilizer price data for the 1976-78 period. Division by 0.47 yields a price for nitrogen of $276/mt. Bulk fertilizer prices are lower than bagged prices, and countries able to take advantage of lower cost fertilizer sources will face a ratio less than 1.8.

added to yield a ratio that reflects producer price or farm-gate incentives. Transport costs will increase farm-gate fertilizer prices and lower farm-gate paddy prices, thus increasing the world price ratio. An assumed transport cost margin of 25 percent on rice and fertilizer changes the ratio to 3.0.[11]

It will be assumed that a ratio of between 2.0 and 3.0 is a reasonable indicator of world price incentives at the farm-gate. Values greater than 3.0 suggest taxation of production, while values less than 2.0 suggest subsidization. Table 8 presents the value of this ratio for a number of major rice producers for the 1976-77 period. Among the countries listed in Table 8, only Japan, South Korea, Sri Lanka, and Taiwan appear to subsidize production. China, India, Pakistan, the Philippines, and Thailand appear to tax production, while values for Indonesia fall within the uncertain range.[12]

Comparison of consumer prices is more complicated, as prices must be adjusted for quality differences. Table 9 presents retail prices of "medium quality" rice for the dates and countries of Table 8. If these observed prices can be assumed equivalent in quality to the range represented by Thai A-1 Super 100 percent brokens and Thai 25 percent brokens, a world price range for medium quality rice in retail markets is $250-300/mt. At this price level, only South Korea, Taiwan, and Japan appear to tax consumers, with the remaining countries subsidizing or remaining neutral with respect to consumers.

Quantification of the aggregate impact of policy on prices is not possible without additional country-specific data on characteristics of supply, demand, market imperfections, and government incentives. But the direction of bias seems fairly certain; national policies have raised world rice prices. This result implies that changes in government policies to improve the allocation of resources within countries could moderate the rise in prices of grains predicted by projection analyses.[13]

PROGNOSIS

Few systematic changes are taking place in the world rice economy that indicate a substantial reduction in year-to-year price variation. Increases in irrigated area and the spread of new rice varieties more adaptable to fluctuations in day length and length of growing season may help to offset some of the short-run effects of weather on production, but these compensations are likely to be rather small. On the consumption side, increased substitution of wheat (or other grains) for rice might reduce rice price variability. The conventional wisdom that "rice eaters will eat only rice, irrespective of price," is being proven wrong by an accumulation of cross-price elasticities at the national level, and also in more aggregate data.[14] Substitution seems particularly relevant for Asia, where the preference for rice is strong. As Table 10 demonstrates, between

[11] Data for many less developed countries suggest total post-farm gate costs are often less than 25 percent, as demonstrated by the studies by L.A. Mears et al. (1974). The choice of a relatively high margin means that the "true" paddy-fertilizer price ratio is likely to be less than 3.0.

[12] The ratios appear low for Bangladesh and Burma also, but fertilizer supplies were limited. Paddy prices were $60-100/mt in Bangladesh and $20/mt in Burma, suggesting that most producers were taxed in those countries.

[13] See, for example, the United States Department of Agriculture (1978).

[14] See, for example, Timmer (1971).

TABLE 8.—RELATIVE FARM PRICES OF NITROGEN AND RICE, SELECTED COUNTRIES*

Country	Period	Price ratio ($/kg N) ÷ ($/kg Paddy)
Bangladesh	Jul-Aug 1976	1.93
Joydebpur	Feb 1977	1.97
Burma		
Rangoon District	Aug 1976	1.81
China		
Kwangtung	Oct 1976	5.90
India		
Coimbatore	Jul 1976	5.61
	Jan 1977	2.14
Orissa	Jul 1976	3.84
	Mar 1977	3.80
Thanjavur	Jan 1977	4.55
Waltair	Jul 1976	3.80
	Dec 1976	3.85
Indonesia		
Central Java	Jul 1976	2.48
	Mar 1977	1.97
Yogyakarta	Mar 1977	2.63
Japan		
Yatabe	Jun 1976	0.53
South Korea		
Hwaseong-gun	Jul 1976	1.51
Pakistan		
Islamabad	Apr 1977	3.77
Philippines		
Central Luzon	Jul 1976	3.55
	Mar 1977	3.21
Sri Lanka	Sept 1976	1.68
Kurunegala	Mar 1977	1.65
Taiwan		
Taichung	Jul 1976	0.78
	Feb 1977	1.34
Thailand		
Suphan Buri	Jun 1976	4.08
	Jan 1977	3.23

*Data are from A. C. Palacpac (1977), *World Rice Statistics*, International Rice Research Institute, Los Banos.

TABLE 9.—RETAIL PRICES OF MEDIUM QUALITY RICE, SELECTED COUNTRIES*

Country	Period	Retail price[a] ($/mt)
Bangladesh	Aug 1976	156
Dacca	Feb 1977	175
Burma	Aug 1976	37
Rangoon		
China	Oct 1976	153
Kwangtung		
India	Jul 1976	225
Coimbatore	Jan 1977	235
Orissa	Jul 1976	180
	Mar 1977	202
Thanjavur	Jan 1977	143
Waltair	Jul 1976	185
	Dec 1976	213
Indonesia	1976	282
Jakarta	1977	220
Japan	Jun 1976	837
Yatabe		
South Korea	Jul 1976	490
Hwaseong-gun		
Pakistan	Apr 1977	268
Islamabad		
Philippines	Jul 1976	284
Central Luzon	Mar 1977	318
Sri Lanka	Mar 1977	270
Kurunegala		
Taiwan	Jul 1976	438
Taichung	Feb 1977	355
Thailand	Jun 1976	193
Suphan Buri	Jan 1977	208

*Data are from A. C. Palacpac (1977), *World Rice Statistics*, International Rice Research Institute, Los Banos. Indonesian data are taken from D. D. Hedley (1979), "Rice Buffer Stocks for Indonesia," Yogyakarta, mimeograph.

[a]Conversion factors for national currencies were as follows:

Bangladesh	19.0	Taka/$US	South Korea	498	Won/$US
Burma	24.3	Kyat/$US	Pakistan	13.5	Rupees/$US
China	1.9	Yuan/$US	Philippines	7.4	Pesos/$US
India	8.9	Rupees/$US	Sri Lanka	8.1	Rupees/$US
Indonesia	414	Rupiah/$US	Taiwan	38	NT/$US
Japan	298	Yen/$US	Thailand	20.8	Baht/$US

1961-63 and 1972-74 per capita calorie consumption of wheat in Asia increased 46 percent, while consumption of rice was almost constant. The realized extent of substitution, however, depends first on changes in the import decisions of policy makers.

Barring major shifts in policy priorities, government policy will continue to magnify short-run price variations in the international market. Given the desire of most key trading countries to assure domestic per capita availabilities of rice at stable internal prices, the international market will continue to be a residual market. Much depends also on the consistency of conduct of government policy, as short-run fluctuations in domestic price and trade policy or changes in policy objectives will continue to affect trade participation and price variability. Finally, counter-cyclical actions by the United States and China will continue to be crucial helping to negate weather and policy-induced variations. If the United States retains flexibility in its rice production program, and if China continues to arbitrage rice for wheat when prices of rice are high relative to wheat prices, these countries can be important forces for increased market stability.

The countries responsible for future variability, however, may not be those identified in the previous section. Japan may not be a consistent exporter during the next decade given the relative inefficiency of domestic production and the government preference for acreage diversion rather than export subsidies. Among importers, Vietnam appears to have sufficient production potential to remove it largely from the international market, while the increased imports of Middle Eastern oil producers will give their policies increased influence over future rice prices.

The central issue concerning price levels is whether the price of $300/mt that prevailed in the 1960s and 1970s is an appropriate forecast for the 1980s and 1990s. A long-run estimate of international rice prices is essential to permit countries to plan their investment and policy strategies. Probably $300 is too low, and a planning figure of $350 (for Thai 5s in 1976 prices) is more appropriate. This assessment is based on several factors affecting rice production and consumption. Demand pressures stemming from growing populations and new demands for grain (usually for livestock feeding) in low- and and middle-income countries such as China, Korea, Nigeria, and the Eastern European countries, and rising real costs of production will generate upward pressures on the future level of rice prices. But the prospects for new rice production technologies, production and consumption opportunities in other staple food crops, and investments in production by a number of major importers may help to mediate substantial real price increases.

Developments in irrigated technologies are likely to provide a major source of increased rice production. While many areas have realized their initial Green Revolution potentials, further gains appear possible, primarily through better adaption of varieties to local environments. The International Rice Research Institute (1979) estimates that the yield potential of irrigated land can be increased by 1.1 mt per hectare (ha) by 1990. In addition, significant areas have not yet begun to realize their production potentials. In East India and Bangladesh, for example, which account for 40 percent of south Asian production, only 25 percent of the cultivated area is irrigated and modern varieties

TABLE 5.—PRODUCTION, CONSUMPTION, AND INTERNATIONAL TRADE IN RICE AND WHEAT, 1960S AND 1970S*

Annual growth of production, 1961-76 (*percent*)

	Rice production	Wheat production	Population
Far East	2.5	5.8	2.1
World	2.6	3.5	1.9

Per capita calorie consumption in the Far East (*kcal per day*)

	1961-63	1972-74
Rice	840	860
Wheat	209	305
Total	2,017	2,184

Net foreign trade (*million metric tons*)

	1961-65		1972-76	
	Wheat	Rice	Wheat	Rice
Far East	-13.0	+0.8	-17.2	+0.4
Near East	- 4.0	—	- 6.8	-0.7
Japan	- 3.1	-0.4	- 5.4	+0.2
North America	+31.8	+1.1	+42.8	+1.8

*Data are from the Food and Agriculture Organization of the United Nations (1977), *Intergovernmental Group on Rice Implications of Rice Production Trends for Food Security of Developing Countries*, Rome.

represent only 12 percent of production. Improved rainfed technologies also hold some promise. The estimated potential gains are only on the order of 0.6 mt/ha, but basic research has just begun. Even if the yield gains were small, the aggregate impact of such technological change would be substantial, since 35 percent of Asian and most of African rice production is rainfed (Barker and Herdt, 1979). The costs of expanded production, however, are expected to increase substantially relative to past levels. Irrigation costs in particular are likely to increase, because of rising input prices and because the transformation of most of the remaining irrigable land will be more difficult technically than past developments. A study by R.W. Herdt, A. Te, and R. Barker (1977), for example, suggests that the cost of new irrigation systems will average $1,000-1,300/ha (1975 prices), which is two to three times the cost of the previous decade.

Increases in export supplies will help moderate the price rise resulting from rising real production costs. The potential for expanded rice exports appears significant, particularly among the mainland countries of southeast Asia. An Iowa State University study of Thailand (Faber et al., 1978), for example, found a potential export surplus of 5 mmt at 1975 prices of $400/mt. Burma, Cambodia, and Vietnam have all been prominent, though intermittent, exporters since World War II. The resolution of political difficulties and the transmission of price incentive to producers remain critical parameters for the realization of these potentials. The United States also appears an important potential supplier if prices increase. While production from about 1 million ha is competitive at current prices, an additional 1 million ha (2.5 million mt of exports) appear profitable at 1975 prices of $400/mt (Mears, 1976).

The extensive interaction of domestic policies and the world market suggests that changes in policies, particularly with respect to domestic rice prices, offer the greatest potential for modification of the projected scenario of rising world prices and continued variability. Two facets of the conduct of government policy will influence future price levels. First, shifts in policy toward producer-oriented objectives will reduce upward pressure on international prices. Second, future increases in prices are likely to intensify pressure on governments to change policies which subsidize domestic consumers and tax domestic producers. In the short-run, causality flows from domestic rice policies to international prices. Over the longer run, however, government policies may be responsive to world price levels. Long-term subsidies imply continuing drains on the budget; both tax and subsidy policies reduce potential national income because of resultant distortions in resource allocation. Since price levels have been relatively constant in real terms over the past two decades, their effect on per unit revenue burdens and opportunity costs of resource misallocations has been constant. Thus changes in current policies in response to long-run levels of rice prices remain unknown.

The determinants of domestic policy, however, extend well beyond the world price of rice, and variation in price levels is not likely to facilitate statistical evaluation of the role of world prices in domestic policy. Policies influence world prices, and this essay suggested that appropriate recognition of the role of government policy lends much to an understanding of world price level and price variability. But domestic policies depend upon factors additional to world prices, such as government recognition of the importance for production of economic

incentives, priorities for growth and income distribution, and the balance of political power between rural producers and urban consumers. The importance of these factors ensures that policy will remain exogenous to economic models of the rice market, and that projections must necessarily contain substantial political as well as economic judgments about the future.

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