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RICE IN ASIA: IS IT BECOMING AN INFERIOR GOOD?

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Abstract

Empirical results using time-series and cross-sectional data indicate that rice in Asia is becoming an inferior good. Steady declines in rice consumption per capita are occurring, as income levels rise. Accordingly, Asia should have an increasing rice surplus, putting more pressure on international rice markets in the future.

Key Words: Asia, rice, income elasticity, inferior good.

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INTRODUCTION

Background of Asian Rice Economies

The importance of rice for Asians has been well recognized in the literature (Barker et al, Coyle, Chen et al, Mears, Moon). While world rice production is approximately 300 million metric tons (MT), Asians both produce and consume approximately 90% of the world's rice. Their per capita annual consumption at around 100 kilograms (kg) compares with 3 to 4kg per person in the western world.

Although the importance of rice has not changed much in recent years, rice consumption levels have tended to decrease as income increase. This tendency is observed in Japan and other countries in Asia. Per capita rice consumption in Japan, for example, decreased from 125kg in the early 1960's to 85kg in the mid-1980's, while per capita real gross domestic product (GDP) increased by 2.8 times during the same period. As income increased, Japanese had access to more varieties of food, and consequently, their diet changed from the traditional rice diet to a more western diet of bread, red meat, and dairy products.

If such a tendency exists across Asian countries, Asia potentially holds excess supply in the future placing tremendous pressure on international trade for rice. This paper investigates the relationship between rice consumption and income level, seeking income elasticities in Asian countries.

Studied in this analysis are fourteen Asian countries where rice is the staple food.[1] They are Bangladesh, Burma, the People's Republic of

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[1] Because data from the International Monetary Fund (IMF) were used, Asian countries that are not members of IMF were basically excluded due to insufficient data.

China (P.R.C.), India, Indonesia, Japan, South Korea, Malaysia, Nepal, the Philippines, Singapore, Sri Lanka, Thailand, and Taiwan. The outlook for rice economies of these countries varies. Per capita rice consumption decreased by more than 10% in Japan, Malaysia, Nepal, Singapore, Thailand, and Taiwan, changed less than ± 10% in Bangladesh, India, S. Korea, and Sri Lanka, and increased by more than 10% in Burma, the P. R. C., Indonesia, and the Philippines during the studied period, basically 1961 through 1985 (Table 1). Growth in per capita real GDP in the domestic currencies was the highest by 417% in S. Korea, followed by Singapore's 278%, Taiwan's 251%, Sri Lanka's 162%, Indonesia's 152%, the P. R. C.'s 140%, Japan's 139%, Malaysia's 135%, and Thailand's 121% (Table 2). In terms of annual per capita GDP converted to the U.S. Dollars, Japan, Singapore, Taiwan, Malaysia, and S. Korea averaged more than US$2,000 per person in the mid-1980's. These countries are relatively wealthy countries in Asia (Table 3); Thailand, the Philippines, and Indonesia are middle-class countries producing between US$1,000 and US$500; and the rest of the countries such as Sri Lanka, India, the P. R. C., Burma, Bangladesh, and Nepal are low-income countries. Nepal had the lowest per capita GDP, US$138.

Traditional net rice exporters are Thailand, Burma, the P. R. C., Taiwan, and Nepal (USDA, 1986). India exported limited amounts after the late 1970's. The Philippines also exported small quantities but was classified as an importer. Bangladesh, Indonesia, S. Korea, Malaysia, Singapore, and Sri Lanka are net importers. Indonesia and S. Korea, however, are almost self-sufficient today, partly due to Government policy.

Literature Review and Justification

There are few reports on income elasticities of rice in Asia. The

Food and Agriculture Organization of United Nations (FAO) in 1971 estimated Asian income elasticities of rice at .10 for Burma, .40 for the P.R.C., India, Kampuchea, Laos and Sri Lanka, .70 for Indonesia, -.10 for Japan, .20 for Malaysia, the Philippines, and Thailand, and .30 for Pakistan and Taiwan based on 1960's data. In the FAO report, Japan was the only country, where rice was estimated to be an inferior good. Daly *et al.* (June 1973) reported a negative income elasticity for the rural area in South Vietnam. They show income elasticities of rice ranging from -.1 to -.15 for the rural area and from .25 to .35 for the whole nation.

Income elasticities for S. Korea, estimated by Moon (1975), were .124 for urban areas and .329 for rural area. Korea Rural Economics Institute (KREI, 1984) estimated -.245 and .263 in the S. Korean urban and rural areas, respectively. Wong (1976) showed income elasticities in Thailand at .0559 and .0613 for the shortrun and the longrun, respectively. Wong's elasticities were much more inelastic than the elasticity estimated earlier by FAO for the nation. More recently, an income elasticity estimated by Mann (1982) for Thailand was negative, -.024, indicating that rice in Thailand is now an inferior good.

Mears (1981) suggested income elasticity for rice in Indonesia being "not larger than .35" and estimated income elasticity to be .319, less elastic than the .70 estimated by FAO earlier. Chen's (1980) income elasticity of -.44 for Taiwan was even lower than FAO's .30. Ito, Wailes, and Grant (1985) reported inelastic or negative income elasticities for Asian countries; i.e., -.218 for Burma, -.079 for India, .308 for Indonesia, -.189 for Japan, .102 for S. Korea, -.534 for Pakistan, .243 for the Philippines, -.131 for Thailand, and -.081 for Taiwan. All these reports seem to be suggesting in general that income elasticities for rice in Asian countries are becoming smaller over time and that rice is changing from a normal good to an inferior good.

Unfortunately, however, none of them explicitly analyzed change in income elasticities, particularly change in sign of the elasticitites, over time in their quantitative methods. Barker *et al.* suggest that specific rice consumption patterns among Asian countries are "unique for each country" and also that demand increases for cereal grain vary depending upon income level. Thus, they state that one should estimate "different income elasticities for different countries and expect them to change over time," (pp.166-7).[2] It is necessary, therefore, to investigate Asian rice consumption patterns among countries using a time-series and cross-sectional analysis method. Because rice consumption patterns in Asia seem to be continuously changing even in the 1980's, it is essential to include the recent data in the analysis. The results from such analyses would provide more specific information on Asian rice consumption, and subsequently, their rice excess supply and export potential for the future.

METHODOLOGY

The assumpton is that per capita rice consumption in Asian countries holds a positive relationship up to a certain level then turns to hold a negative relationship with their income level; i.e., consumption increases up to a saturated point then decreases as income levels increase. A model that fits this assumption is Log-Inverse-Log model (FAO, 1972):

(1a) $Q = EXP(a - bY^{-1})Y^{-c}$, namely

(1b) $\ln Q = a - b\, Y^{-1} - c \ln Y, \quad (b > 0, c > 0)$

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[2] Barker *et al.* estimated income elasticities for total cereal using a functional form: $\ln Q = a + b \ln Y + c (\ln Y)^2$, where Q = grain consumption, Y = per capita gross domestic product transformed to US$, and a, b, and c are estimated coefficients. The dependent variable includes all grain consumption; therefore, the estimated elasticities may be "under- or over-" estimated for rice (p. 167).

where,
Q = consumption,
Y = income,
a = intercept,
b = coefficient of Y^{-1},
c = coefficient of lnY.

In this model, the derivative of Q with respect to Y is:

(2) $\partial Q/\partial Y = (b/Y^2 - c/Y)Q$. Thus,

(3) $\partial Q/\partial Y > 0$, if $b/Y > c$, and

(4) $\partial Q/\partial Y < 0$, if $b/Y < c$.

Equations (3) and (4) indicate that if b/Y is greater than c, consumption is increasing and reaching its maximum at b/Y=c as income increases, and that consumption begins to decrease as b/Y gets smaller than c due to increases in Y. If the situation in Equation (3) holds, the commodity is a normal good, and if the situation in Equation (4) holds, it is an inferior good.

The second derivative of Equation (1) is:

(5) $\partial^2 Q/\partial Y^2 = EXP(a - bY^{-1})Y^{-2-c}[b^2Y^{-2} - (bc + c + 2)bY^{-1} + (1 + c)c]$

The whole Equation (5) is positive, if its [·] portion is positive. Multiplying the [·] portion by Y^2 produces the following equation.

(6) $b^2 - (bc + c + 2)bY + (1 + c)cY^2$ >/=/< 0

The left-hand side of Equation (6) changes from negative to positive as Y increases. This indicates that once Q has reached its maximum Q begins falling at a decreasing rate. Thus, the results of Equation (1) can be plotted as shown in Figure 1a.[3]

An income elasticity, E_Y, the percentage change in consumption due to a one percent change in income, is derived from Equation (1) as follows:

(7) $E_Y = \partial Q/\partial Y * Y/Q = b/Y - c$.

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[3] If coefficients b and c are negative in Equation 1a, then the curve would be a mirror image reflecting at the maximum point of the curve in Figure 1a.

The plotted curve of Equation (7) is shown in Figure 1b.

Income elasticity, corresponding to the model, decreases constantly intersecting the income axis at b/Y=c and turning negative at a higher income value. The equation, therefore, shows that the commodity becomes an inferior good as income levels rise above a certain point.[4]

Where point b/Y=c is located depends on the magnitude of coefficients b and c and the level of Y. These coefficients reflect the consumption pattern for the commodity in each country. In this analysis, fourteen Asian countries were studied. Their consumption practices vary to a certain degree from one country to another. It is necessary, therefore, to adjust the slope and/or intercept coefficients to each country after pooling the data among the countries.

Adding the cross-sectional factors and own- and cross-price variables, Equation (1b) is modified as follows:

$$(8) \quad \ln Q_{it} = a_i - b_i Y_{it}^{-1} - c_i \ln Y_{it} + d_{si} \ln P_{sit} + e_{it}, \quad (b>0,\ c>0)$$

i = 1, 2, ... m (countries)
s = 1, 2, ... n (own and substitute commodities)
t = 1, 2, ... T (years)

where a, b, c, Y^{-1} and lnY are the same as those for Equation (1b), and P_s are own/substitute commodity price variables and d_s the estimated coefficients for $\ln P_s$. The subscript, i, indicates adjusted coefficients for each country. This adjusted coefficients can be obtained by using intercept and slope dummies for all independent variables in the form of a generalized covariance model.

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[4] If -c turns out positive with -b<0 in Equation (1b), the sign of Equation (7) does not turn to be negative. But it still meets with the assumption that the income elasticity is becoming negative. In this case, Q increases at a decelerating rate as income increases. The calculated income elasticity geometrically decreases as income level increases, although the elasticity stays positive. See Equation 7.

Multicollinearity often causes a problem in econometric analysis. Multicollinearity diagnostics, initiated by Belsley, Kuh, and Welsch (1980), indicates that variables Y^{-1} and lnY are seriously collinear. In order to solve this problem, the ridge regression method (Montogomery and Peck, 1982) was employed.

In the ridge regression analysis, the fourteen countries were divided into three groups based on change in per capita rice consumption levels during the studied period, which is basically 1961 through 1985 (Table 1). Group I includes those whose per capita rice consumption decreased more than 10%; Japan, Malaysia, Nepal, Singapore, Thailand, and Taiwan. Group II includes those whose rice consumption changed within ± 10%; Bangladesh, India, S. Korea, and Sri Lanka. Finally, Group III includes those with rice consumption increasing by more than 10%; Burma, the P. R. C., Indonesia, and the Philippines. Thus, three ridge regression models were employed with specific k-values for each Group.

Given that income in each country is basically increasing over time, it is generally expected that countries in Group I should show negative income elasticities because of a decrease in per capita rice consumption of more than 10% during the period, while countries in Group II positive or negative (or close to zero) inelastic elasticities because of only ±10% change in per capita consumption and those in Group III positive income elasticities due to a more than 10% increase in consumption.

Wheat is the major substitute for rice in Asia. Therefore, the price ratio of rice to wheat was used as a proxy for own and substitute price variables. Using the world prices, which are rice prices at Bangkok and wheat prices at the U.S. Gulf, the price coefficients were also adjusted for each country by employing dummy variables.

DATA

Data for rice consumption are from USDA (1986), and gross domestic products (GDP), populations, and exchange rates are from IMF (1986). In this analysis, GDP in per capita base was used as a proxy for income because GDP represents the nation's welfare level, which basically indicates income level, and IMF provides it most consistently for all the nations[5] studied. World prices, i.e., rice prices at Bangkok and wheat prices at the US Gulf, are also from IMF. The time period of the data was basically 1961 through 1985.

RESULTS

The results of the selected k-value, R^2, F-value, and number of observations in ridge regression are reported for each Group in Table 5. The selected k-value and R^2 are .000002 and .889, .05 and .939, and .1 and .855 for Groups I, II, and III, respectively. The high F-values indicate that the models for all Groups are significant at 1% level.

The estimated coefficients of income variables are reported in Table 6. Base countries are Taiwan in Group I, India in Group II, and Burma in Group III. Coefficients of income variables for these base countries were all significant except for the coefficient of log of income variable for Burma. Coefficients of slope dummies for inversed income variables (Y^{-1}) were significantly different from base countries in all countries except for Tahiland and S. Korea. Large coefficients of inversed income variables reflcted large number of income in their own currencies. Coefficients of slope dummies for log of income variables were not significantly different from base country for countries in Group I but

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[5] The P.R.C. is the only exception. IMF does not report GDP for this country; therefore, the national income reported by IMF was used. Data for Taiwan are from *Taiwan Statistical Data Book 1985,* published by Republic of China, 1985.

significantly different from base countries for Group II and III countries except for Indonesia. All of the studied countries, except for Bangladesh and Sri Lanka, showed expected signs for total[6] income variables; "-" for inversed income variable and "- " or "+" for log of income variables: This assures a decrease in income elasticity with an increase in income.

The corresponding income elasticities are reported in Table 7. As expected prior to analysis, countries in Group I generally showed large negative income elasticities as income increase over time. Situations are different to a certain extent depending upon country, however. Japan, the most economically advanced country in Asia with per capita income level in the mid-1980's at US$10,456 (Table 3), showed a clear change in income elasticities during the one quarter century period. Income elasticities were positive in the early 1960's then changed to negative in the middle of the 1960's, during which time economic growth in the country was dramatic. Income elasticity has decreased almost continuously since then and reached -.708 in 1984. The volatility of elasticities in 1972 through 1975 and a slow decrease in 1980 possibly reflect a new government rice consumption promotion program. Funding for the program varied over time affecting efficiency of the program (Coyle, 1981).

Malaysia, the fourth wealthiest country with per capita income at US$2,237, showed negative income elasticities since 1969. Coincidentally, the national economy took off drastically from that year. Income elasticity in Malaysia changed most among the studied nations, from .328 in 1961 to -.671 in 1984. Income elasticity in Nepal appeared to be unique. Although Nepal holds the lowest income level among the studied

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[6] This means total coefficient of base country and slope-dummy country. For example, total coefficient of inversed income variable (Y^{-1}) for Malaysia is -2496 (=-21815 + 19319).

countries at US$138 and her per capita income level not only fluctuated over time but also declined after 1976, the nation is one of the traditional rice exporters. The estimated income elasticity in the nation fluctuated due to volatility of the economy but remained at around -.3 during the whole period.

In Singapore, per capita income was at US$7,206, the second highest after Japan. Although rice is the staple food in Singapore, the nation is the only country that is not producing rice domestically. All domestic rice demands depend on imports. Per capita consumption was over 100kg in the early 1960's but decreased to around 70kg in the 1980's. Income elasticities in the country ranged from .211 in 1961 to -.599 in 1984.

Thailand, the world's largest rice exporter, has the fifth highest per capita income level (US$752) among the fourteen countries in Asia. The Thai per capita rice consumption level was relatively high at 159kg in 1985. However, the consumption level has decreased over time. The estimated income elasticity was .237 in 1961 decreasing to -.437 by 1985. Taiwan, also a rice exporter, has grown economically over time, and her per capita GDP at US$3,033, was the third highest after Japan and Singapore. Taiwanese income elasticities ranged from .015 in 1961 to -.594 in 1984.

Income elasticities in Group II countries were very inelastic. In Bangladesh, which declared independence in 1971, has a very low per capita income level at US$144. The estimated income elasticities were very inelastic throughout the period. They increased toward postive direction due to a negative coefficient for the inverse income variable. In India, income level at US$252, per capita rice consumption decreased by 2.6%, while per capita GDP increased by 31% between early 1960's and 1980's. The estimated income elasticities declined from .163 in 1961 to .125 in

1984.

The economy in S. Korea, where per capita GDP is the fourth at US$2,052, grew by remarkable 417% during the studied period. This dramatic increase is way above of what any other nation achieved. The estimated income ealsticities in S. Korea were very inelastic, although the magnitude decreased half from .095 in 1961 to .046 in 1984. These inelastic income elasticities are in between the previous estimates of .124 in the urban area and .329 in the rural area (Moon, 1975) and -.245 in the urban area and .263 in the rural area (KREI, 1984). Because urban people account for approximately three quarters of the national population, the income elasticity in the urban area should dominate the elasticity in the rural area. Thus, the national aggregate income elasticities would be slightly greater than .124 based on Moon's or somewhere close to -.2 based on the KREI. Given, however, that per capita national economy grew over 400% and rice consumption increased by only 5.2% during the period, it is hard to believe the nation's aggregate income elasticity would be greater than 0.1 in absolute value.

In Sri Lanka, with per capita GDP at US$371, the economy grew by 162% during the period. Although income elasticities increased slightly over time due to a positive coefficient for the inversed income variable, it remained very inelastic at around .03.

Income elasticities in Group III countries varied depending upon country, from being constantly very inelastic in Burma to substantially decreasing in the P. R. C. and Indonesia. Burma, where per capita GDP depressed in the mid-1960's and -1970's and grew by only 8% with a rice consumption increasing by 67% during a quarter century, showed very inelastic income elasticities at around .03 with almost no change over time. In the P. R. C., on the other hand, per capita GDP increased by

140% and rice consumption increased by 33%. Meanwhile, the estimated income elasticities sharply decreased from .418 in 1961 to .133 in 1984.

The estimated income elasticities in Indonesia, where income level is much higher at US$519 than the P. R. C.'s US$222, were almost the same as in the P. R. C.: They declined from .310 in 1968 to .108 in 1984. Indonesian per capita GDP increased by 152%, and rice consumption increased by 47%. In the Philippines, where income level was at US$603, per capita GDP increased by 52% while rice consumption increased by 12% over time. The estimated income elasticities decreased from .201 in 1961 to .110 by 1979. They turned slightly upward in the 1980's due to a decrease in income.

Coefficients for world price ratio of rice to wheat were also estimated (Table 6). Because the dependent variable and the price variables are both in log forms, the estimated coefficients are the estimated elasticities. Coefficients of price variables are generally not significant among Group I countries after magnitude of coefficients being taken into consideration. The coefficient for Singapore, however, indicates a significant and relatively elastic price elasticity at -.508. This may be reflecting the nation's sensitivity to world prices due to the fact that Singapore imports all rice consumed domestically. Among Group II countries, price coefficients are not significant for the base country, Burma, but significantly different from the base country for the slope-dummy countries. All countries in Group III showed the price variable coefficient to be significant and inelastic.

In most of Asian countries, governments control the domestic rice economies in order to insulate the domestic prices from the world prices. This is accomplished through floor/ceiling prices, rationing, and export/import quota, tax, or subsidies. Thus, world prices do not always precisely affect domestic rice consumption. The estimated insignificant and/or inelastic price elasticities may be reflecting this political rice situation in Asian countries.

CONCLUSIONS AND IMPLICATIONS

In this paper, we studied income elasticity for rice in fourteen Asian countries, where rice is historically the staple food. Using a time-series and cross-sectional analysis, twelve out of fourteen countries had expected signs for income variables and showed decreasing income elasticities over time. Rice was a normal good at the begining then gradually turned to be an inferior good during the one quarter century (1961-1985) in Japan, Malaysia, Singapore, Thailand, and Taiwan, while it was an all-time inferior good in Nepal. Although rice still was continuously a normal good in the P. R. C., India, Indonesia, and the Philippines, the estimated income elasticities decreased sharply in the P. R. C. and Indonesia and moderately in India and the Philippines. In S. Korea and Burma income elasticities decreased but were estimated to be very inelastic throughout the study period. Income elasticities in Bangladesh and Sri Lanka increased positively over time; however, the estimated elasticities were very inelastic throughout.

These results together with the fact that most Asians have traditionally the same type of diet, centering on rice, strongly suggest that rice in Asia is generally changing its position from a normal good to an inferior good and that consumption levels will decrease over time as income level increases. This leads us to conclude that Asia may decrease rice consumption and hold a potential for increased rice exports in the future. Currently, Asia consumes and produces approximately 90% of the world rice. A one percent decrease in consumption in this region would make available a few million tons of rice for exports. Taking into consideration that only eleven to twelve million tons of rice are currently traded in the world markets, Asia could place enormous pressure on world rice trade in the near future. On the other hand, demand for wheat, meat, and dairy products in Asia may increase to offset decrease in demand for rice.

Suggestions for Further Research

There are a few suggestions regarding this type of analysis. First, grouping seems to be essential. A ridge regression for all fourteen countries was attempted. This, however, caused complication in the model, and it was too hard to select one k-value from which the results would be reasonable for all countries. Grouping was based on change in per capita rice consumption during the studied period. It might be possible to group them based on welfare level, growth rate of economy, or internationalized cultural factors, if at all quantified, in each country.

Second, the functional form used in this analysis might be inappropriate for certain countries, such as Bangladesh and Sri Lanka, where the coefficients of inversed income variables (Y^{-1}) did not have expected negative sign. It is suggested to explore other functional forms that allow income coefficients to change signs between positive and negative over time. A form used by Barker *et al.* mentioned in a footnote above can be a candidate for this sort of analysis.

Third, it is very difficult to calculate standard errors for the estimated income elasticites from the results of this analysis. Because income elasticities are calculated as expressed by Equation (7), the variances of elasticities could be calculated as:

$$(9) \quad Var(E_Y) = Var(b/Y) + Var(c) + 2Cov(b/Y, c).$$

It may be possible to calculate Var(b/Y) using procedure explained by Miller, Capps, and Wells (1984); however, it is almost impossible to estimate Cov(b/Y, c). This is a problem in using the log-inverse-log functional form.

Last, it is of extreme interest to estimate a longrun effects. Nerlovian model (Nerlove, 1956) and a state adjustment model (Phlips, 1974) were attempted for unsatisfactory results in the whole program studies. In estimating longrun coefficients, however, the form needs to allow the sign of the longrun coefficient to change in the future. In this analysis, income elasticites in some countries still remained postive, although they were decreasing over time. It will be meaningfull to estimate longrun effects, particularly to estimate when rice shifts to an inferior good in these countries.

References

Barker, Randolph, Robert W. Herdt, with Beth Rose, *The Rice Economy of Aisa*, Resources for the Future, Inc., Washington D. C., 1985.

Belsley, D. A., E. Kuh, and R. E. Welsch, *Regression Diagnostics,*, John Wiley & Sons, New York, 1980.

Chen, H. Y., W. F. Hsu, and Y. K. Mao, "Rice Policies of Taiwan," *Food Research Institute Studies*, Vol. XIV, No. 4, 1975.

Coyle, William T., *Japan's Rice Policy*, Foreign Agricultural Economic Report Number 164, ESS, USDA, 1981.

Daly, Rex F., R. G. Hoffman, F. Nelson, and H. Weingarten, *Agriculture in the Vietnam Economy: A System for Economic Analysis*, ERS,USDA, June 1973.

Food and Agriculture Organization of the United Nations (FAO), *Income Elasticities of Demand for Agricultural Products,* Projections Research Working Paper No. 1, Committee on Commodity Problems, Forty-Seventh Session, Rome, 1972.

International Monetary Fund (IMF), *International Financial Statistics, 1986*, IMF, Washington, D.C.

Ito, Shoichi, Eric J. Wailes, and Warren R. Grant, "Asian Rice Elasticities," *Rice Outlook and Situation Report,* RS-45, ERS, USDA, March 1985.

Korea Rural Economics Institute *Seoul-shi Migok Utong Gaesun Bang Hyang (Studies for Improving Rice Marketing in Seoul Area --Focusing on the Wholesale Market)* Seoul, S. Korea, 1984.

Mann, Jitendar S., *Food Demand Pattern in Thailand*, IED Staff Report, ERS, USDA, 1982.

Mears, Leon A., *The New Rice Economy of Indonesia*, Gadjah Mada University Press, Indonesia, 1981.

Miller, Stephen E., Oral Capps, Jr., and Gary J. Wells, "Confidence Intervals for Elasticities and Flexibilities from Linear Equations," *American Journal of Agricultural Economics*, Vol. 66, No. 3, 1984.

Montogomery, Douglas C. and Elizabeth A. Peck *Introduction to Linear Regression Analysis*, John Wiley & Sons, New York, 1982.

Moon, Pal Yong, The Evolution of Rice Policy in Korea, *'Food Research Institute Studies*, Vol. XIV, No. 4*, Stanford* University, 1975.

Nerlove, Marc, "Estimates of the Elasticities of Supply of Selected Agricultural Commodities," *Journal of Farm Economics,* Vol. XXXVIII, No. 1, 1956.

Phlips, L., *Applied Consumption Analysis*, Amsterdam and Oxford, North-Holland, 1974.

Republic of China, *Taiwan Statistical Data Book 1985*, Council for Economic Planing and Development, Republic of China, 1985.

United States Department of Agriculture (USDA), *Foreign Agriculture Circular, Grains, World Grain Situation and Outlook, 7*, FG-8-86, FAS, USDA, August 1986.

Wong, Chung Ming, *A Model of the Rice Economy of Thailand*, Ph. D. Dissertation, Department of Economics, The University of Chicago, 1976.

Table 1. Annual per capita rice consumption in Asia, by group. (five year average, milled, kg)

	1961-65	1981-85	Change (%)
Group I			
Japan	124	88	-29.0
Malaysia	132	109	-17.4
Nepal[1]	126	105	-16.7
Singapore	103	74	-28.2
Thailand	191	164	-14.1
Taiwan	161	98	-39.1
Group II			
Bangladesh	154	156	1.3
India	77	75	-2.6
S. Korea	129	136	5.4
Sri Lanka	109	113	3.7
Group III			
Burma[1]	133	222	66.9
P.R.C.[1]	81	108	33.3
Indonesia	107	157	46.7
Philippines	91	102	12.1

[1] Including stocks.

Table 2. Growth of per capita GDP between 1961 and 1985.
(Domestic currencies[1], deflated by CPI, five year average)

	1961-65	1966-70	1971-75	1976-80	1981-85	Δ (%)[2]
Bangladesh	--	--	1875	2131	2226	19[a]
Burma	1131	931	1015	1019	1224	8
P.R.C.	179	231	290	344	429	140
India	1468	1450	1587	1806	1924	31
Indonesia	--	132000	178000	246000	333000	152[b]
Japan	894000	1391000	1839000	1964000	2140000	139
S. Korea	210000	315000	529000	930000	1085000	417
Malaysia	1655	1930	2345	3314	3895	135
Nepal	1621	1711	1672	1769	1614	0
Philippines	3372	3838	4344	5294	5132	52
Singapore	3169	4396	6895	8759	11972	278
Sri Lanka	2026	2277	2786	4172	5299	162
Thailand	6938	9012	10766	13504	15303	121
Taiwan	32044	46322	68441	93751	112548	251

[1] Domestic currencies are Taka in Bangladesh, Kyats in Burma, Yuan in the P.R.C., Rupees in India, Rupiah in Indonesia, Yen in Japan, Won in S. Korea, Ringgit in Malaysia, Rupees in Nepal, Pesos in the Philippines, Singapore Dollars in Singapore, Rupees in Sri Lanka, Baht in Thailand, and Taiwan Dollars in Taiwan.

[2] Change in percentage between 1961-65 and 1981-85 periods.
[a] Between 1971-75 and 1981-85 periods.
[b] Between 1966-70 and 1981-85 periods.

Table 3. Per capita GDP in 1985 converted to U.S. Dollar

	GDP in 1985 (US$)
Bangladesh	144
Burma	171[a]
P.R.C.[1]	222
India	252[a]
Indonesia	519[a]
Japan	10,456[a]
S. Korea	2,052[a]
Malaysia	2,237[a]
Nepal	138
Philippines	603
Singapore	7,206[a]
Sri Lanka	371
Thailand	752
Taiwan	3,033[a]

[1] Per capita national income.
[a] Data in 1984.

Table 4. Previouly found income elasticities for rice in Asian countries

	FAO (1971)	Others	IWG[1] (1985)
Bangladesh	--	--	--
Burma	.10	--	-.218
P.R.C.	.40	--	--
India	.40	--	-.079
Indonesia	.70	.319 (Mears, 1981)	.308
Japan	-.10	--	-.189
Kampuchea	.40	--	--
S. Korea[2]	--	.124 urban, .329 rural } (Moon, 1975) -.245 urban, .263 rural } (KREI, 1984)	.102
Laos	.40	--	--
Malaysia	.20	--	--
Nepal	--	--	--
Pakistan	.30	--	-.534
Philippines	.20	--	.243
Singapore	--	--	--
Sri Lanka	.40	--	--
Thailand	.20	.0559 (Wong, 1976) -.024 (Mann, 1982)	-.131
Taiwan	.30	-.44 (Chen, 1980)	-.081
S. Vietnam	--	.25 to .35 nation -.1 to -.15 rural (Daly et al., 1973)	--

[1] Ito, Wailes, and Grant (1985).
[2] KREI stands for Korea Rural Economics Institute (1984).

Table 5. Results of ridgeregression analyses.

	k-Value	R^2	F-Value	# of obs.	D.F.
Group I	.000002	.889	41.0	142	118
Group II	.05	.939	72.1	86	70
Group III	.1	.855	26.7	84	67

Table 6. Estimated coefficients of inversed income, log of income and price variables in each country.

	Inversed Income		Log of Income		Price	
	Base country	Slope dummies	Base country	Slope dummies	Base country	Slope dummies
Group I						
Taiwan	-21815		-.769		.079	
	(7334)		(.141)		(.113)	
Japan		-1055022		-.425		-.151
		(487589)		(.363)		(.157)
Malaysia		19319		-.497		-.271
		(7244)		(.469)		(.161)
Nepal		20775		-.205		.029
		(7001)		(.211)		(.150)
Singapore		18633		-.072		-.587
		(7337)		(.294)		(.171)
Thailand		14563		-.119		-.218
		(8066)		(.497)		(.156)
Group II						
India	-187		.028		-.050	
	(50.9)		(.002)		(.041)	
Bangladesh		343		.023		.039
		(72.9)		(.002)		(.003)
S. Korea		-9896		.009		.024
		(8469)		(.001)		(.003)
Sri Lanka		217		.009		.013
		(79.4)		(.001)		(.002)
Group III						
Burma	-32.0		.002		-.134	
	(9.91)		(.003)		(.059)	
P. R. C.		-42.6		-.018		-.025
		(7.9)		(.004)		(.003)
Indonesia		-37540		-.001		-.008
		(8612)		(.001)		(.003)
Philippines		-649		-.016		-.029
		(146)		(.002)		(.003)

Table 7. Change in income elasticities in Asian countries.

Year	Group I						Group II				Group III			
	Japan	Malaysia	Nepal	Singapore	Thailand	Taiwan	Bangladesh	India	South Korea	Sri Lanka	Burma	P.R.C.	Indonesia	Philippines
1961	0.165	0.328	.	0.211	0.237	0.015	.	0.163	0.095	0.022	0.030	0.418	.	0.201
1962	0.125	0.290	.	0.172	0.221	-0.014	.	0.161	0.090	0.023	0.030	0.462	.	0.194
1963	0.049	0.283	.	0.121	0.176	-0.063	.	0.150	0.083	0.023	0.028	0.438	.	0.180
1964	-0.091	0.206	-0.331	0.182	0.127	-0.142	.	0.149	0.080	0.023	0.031	0.380	.	0.186
1965	-0.141	0.110	-0.335	0.128	0.042	-0.192	.	0.157	0.081	0.023	0.033	0.327	.	0.179
1966	-0.234	0.073	-0.369	0.054	-0.058	-0.224	.	0.156	0.077	0.023	0.043	0.292	.	0.176
1967	-0.332	0.113	-0.328	0.002	-0.053	-0.273	.	0.155	0.074	0.023	0.041	0.321	.	0.172
1968	-0.420	0.090	-0.377	-0.091	-0.075	-0.295	.	0.157	0.070	0.025	0.035	0.348	0.310	0.163
1969	-0.492	-0.060	-0.404	-0.188	-0.107	-0.322	.	0.150	0.066	0.025	0.033	0.311	0.284	0.155
1970	-0.546	-0.064	-0.352	-0.267	-0.123	-0.356	.	0.148	0.064	0.026	0.032	0.266	0.266	0.151
1971	-0.561	-0.086	-0.368	-0.333	-0.142	-0.394	.	0.145	0.062	0.025	0.033	0.253	0.259	0.151
1972	-0.608	-0.124	-0.397	-0.400	-0.182	-0.440	.	0.142	0.060	0.026	0.033	0.251	0.227	0.154
1973	-0.649	-0.281	-0.300	-0.387	-0.251	-0.490	-0.040	0.140	0.056	0.026	0.034	0.236	0.207	0.139
1974	-0.618	-0.290	-0.289	-0.381	-0.238	-0.456	-0.042	0.151	0.054	0.028	0.033	0.237	0.188	0.138
1975	-0.603	-0.200	-0.392	-0.392	-0.250	-0.455	-0.016	0.153	0.053	0.028	0.036	0.226	0.195	0.131
1976	-0.611	-0.367	-0.426	-0.432	-0.284	-0.496	-0.021	0.137	0.051	0.029	0.038	0.211	0.188	0.122
1977	-0.622	-0.429	-0.355	-0.448	-0.316	-0.515	-0.032	0.136	0.049	0.030	0.036	0.226	0.174	0.117
1978	-0.649	-0.497	-0.379	-0.468	-0.360	-0.540	-0.018	0.131	0.047	0.031	0.033	0.201	0.161	0.112
1979	-0.673	-0.589	-0.415	-0.500	-0.386	-0.556	-0.017	0.130	0.047	0.031	0.032	0.185	0.142	0.110
1980	-0.671	-0.625	-0.351	-0.525	-0.396	-0.562	-0.017	0.126	0.047	0.031	0.030	0.183	0.122	0.110
1981	-0.678	-0.599	-0.339	-0.548	-0.395	-0.563	-0.018	0.125	0.047	0.031	0.028	0.177	0.118	0.110
1982	-0.685	-0.598	-0.334	-0.565	-0.396	-0.564	-0.019	0.127	0.047	0.032	0.028	0.169	0.119	0.112
1983	-0.692	-0.630	-0.298	-0.584	-0.411	-0.577	-0.021	0.124	0.046	0.032	0.028	0.156	0.110	0.112
1984	-0.708	-0.671	-0.346	-0.599	-0.431	-0.594	-0.016	0.125	0.046	0.032	0.028	0.133	0.108	0.121
1985	.	.	-0.332	.	-0.437	.	-0.015	.	.	0.032	.	.	.	0.140

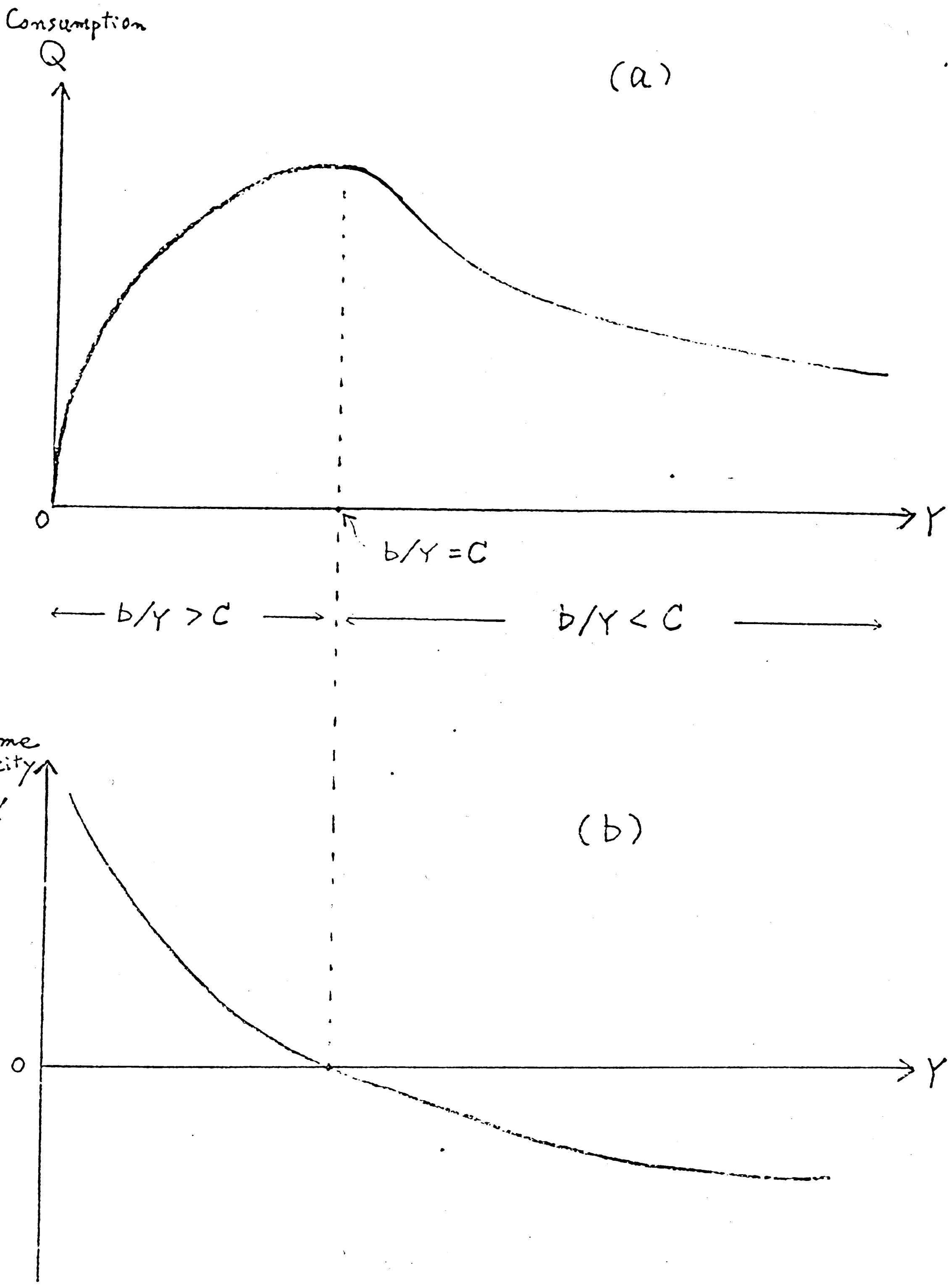

Figure 1. (a): Plot of Equation (1); $Q = EXP(a - bY^{-1})Y^{-c}$
Consumption level, Q, peaks at b/Y=c and decreases gradually after the point.

(b): Income elasticity corresponding to Equation (1). Income elasticity decreases descendingly from positive to negative intersecting the Y-axis at b/Y=c.