1976

Price elasticity of marketable surplus of Thai rice

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by

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A Thesis Submitted to the

Graduate Faculty in Partial Fulfillment of

The Requirements for the Degree of

MASTER OF SCIENCE

Department: Economics

Major: Agricultural Economics

Signatures have been redacted for privacy

Iowa State University
Ames, Iowa

1976

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CHAPTER I. INTRODUCTION

Agriculture in developed countries is much different from developing countries. Most of the farmers in developed countries are commercial farmers, all food-crops output that are produced will go to the market which is called the agricultural supply, but the farmers in developing countries are the subsistence farmers who consume most of their product and sell the remainder on the market, which is called marketable surplus.

It is very useful to know the nature of supply response in agriculture because this knowledge includes improving (1) our understanding of the mechanism of supply response, (2) our ability to forecast supply changes and (3) our competence of prescribing solutions to problems related to agricultural supply (Nerlove and Bachman, 1960). Normally, the commercial farmers who want to maximize their income will make a decision on crop production based on price of product. The total area of land will be allocated between different crops in response to relative price movements. However, the subsistence farmers have a limited choice to shift the cultivated land from food grain to other crops. As Falcon states:

> For if the cultivator produces food grains for his own needs, he runs the risk of a poor crop. If he produces a cash crop and leaves part of his food needs uncovered, he stills runs the risk of a poor crop as far as the cash crop is concerned. He also runs a double risk on prices. The prices of cash crop may have fallen by the time he is ready to sell it, and the price of food grain may have risen by the time he is ready to buy it (Falcon, 1964, pp. 582-583).

Falcon also concluded that "as a result of these and other factors, uncertainty minimization and food grain self-sufficiency have been the historic keys to survival, and are the major factors in farm planning" (Falcon, 1964, p. 582).

Because price is the most effective channel that gives the incentive to the farmers, the reliable empirical knowledge about the supply response to the price movement is needed in order to set the effective price policy. Marc Nerlove and Kenneth L. Bachman indicated the importance of this kind of knowledge in that "supply or production response analysis is particularly needed currently because of the severe problems agriculture continues to face in adjusting supplies to market demands and the confusion existing with respect to the causes of these difficulties" (Nerlove and Bachman, 1960, p. 532). For commercial farmers the elasticity of production with respect to price is a good estimate of supply response to price. For subsistence farmers the elasticity of marketable surplus with respect to price is not easy to obtain because the subsistence farmers may have positive elasticity of production with respect to price but the amount of marketable surplus may or may not be increased which depends on the elasticity of home consumption with respect to price.

Falcon divided the reasons that cause the difficulties in estimating the price response of subsistence farmers into three general sources. The first reason comes from the difficulties in defining price and quantity variables, and also the analysts and policy makers have not distinguished clearly between the elasticity of "aggregate output" and the elasticity of "single commodity"; between "acreage" and "yield" response; between elasticity of "cash" and "home-consumed" crops; between "production" and "marketing" elasticities; and between the length of time to which the elasticities may refer. The second reason is a statistical problem which is often the result of limited and unreliable data. The last reason comes from the misunderstanding between the words "illiterate" and "irrational" when applied to the farmers. In order to obtain the price elasticity of marketable surplus, other parameters beyond the elasticity of supply response are required.

Nerlove (1956) showed that the responsiveness of supply to price can be estimated from the elasticity of acreage with respect to price because the individual farmer can shift the planted area from one crop to other crops that give him more profit. Nerlove uses the acreage planted as the function of expected price

$$X_t = a_o + a_1 P_t^* + U_t \qquad (1.1)$$

where X_t is the acreage planted, P_t^* is the expected price, and U_t is the residual. The problem is that the variable P_t^*, the expected price cannot be observed, as Nerlove states "In theory we can always find out what today's expected prices are by asking farmers; but we cannot find out what expected prices were in the 1920s by asking the farmers of 1955" (Nerlove, 1956, p. 499). But each year the farmers will revise the price they expect based on the error they made from the last year's actual price and last year's expected price

$$P_t^* - P_{t-1}^* = \beta \left[P_{t-1} - P_{t-1}^* \right] \qquad 0 < \beta \leq 1 \qquad (1.2)$$

Nerlove calls β the coefficient of expectation which lies between zero and one. From equation (1.1), P_t^* is a function of X_t, then the P_{t-1}^* can be presented by X_{t-1}. This means that the expected price this year (P_t^*) is a function of last year's actual price (P_{t-1}) and last year's acreage (X_{t-1}), obtaining

$$X_t = \pi_o + \pi_1 P_{t-1} + \pi_2 X_{t-1} + V_t$$

where V_t is a random residual different from U_t. π_o is equal to $a_o\beta$, π_1 equals $a_1\beta$, and π_2 equals $1-\beta$.

From this procedure the estimation of elasticity of acreage with respect to expected price can be obtained.

Background of Agricultural Situation in Thailand

Location, climate, soil types, and resources

Thailand, a constitutional kingdom, extends from 6° to 20° north latitude and stretches from 97° to 106° east longitude with a total of 514,000 square kilometers. It lies in Southeast Asia to the north and west of the Gulf of Thailand and is bounded by Burma and Laos to the north, by Malaysia to the south, by Cambodia and Laos to the east, and by Burma to the west. The kingdom is divided into 72 provinces or changwads in the four regions; Central, Northern, Northeastern, and Southern part which lies entirely within the tropical monsoon. The weather is warm and humid. The monsoon season starts in May and continues through September and October. The average annual rainfall is different in each part of the country. The four years average annual rainfall from 1971 to 1974 was 1,436 millimeters in 135 days of rain in Bangkok in the Central part; 1,251 millimeters in 121 days in Chiang Mai in the Northern region; 1,135 millimeters in 116 days at Nakon Ratchasima in the Northeastern region; and 2,178 millimeters in 153 days in Songkhla in the Southern part of Thailand.

There are three kinds of weather in Thailand--the rainy season, the cold season, and the hot season. The average temperature from 1971 to 1974 was about 28° C and ranged between 11.5° C to 38.3° C at Bangkok; at Chiang Mai, the average temperature was 25.4° C with a range of 3.7° C to 38.6° C; at Nakon Ratchasima, the average was 27.2° C with a range of 4° C to 41.3° C; and Songkhla had an average temperature of 27.8° C with a range of 20.1° C to 36.2° C (Division of Agricultural Economics, 1976).

Due to the different kinds of soil structure in Thailand, particular kinds of agriculture dominate each part of the country. As described by Lester R. Brown:

> Thailand central plain consists of fine sandy and silt loams superimposed upon a variety of heavy and relatively impervious clays. River banks usually consist of light sandy soils on which fruit and vegetables are grown. The Korat Plateau, in the Northeast consists largely of low fertility, sandy soils covered with a sparse natural grass vegetation, it supports most of Thailand's small but rapidly expanding commercial livestock industry. The river valleys in the Northern region, containing dark clay soils overlaid with alluvial deposit, are intensively cultivated with much double cropping of rice with rice or in combination with other crops such as soybeans or peanuts. Deep red soils on the southeastern coastal plain produce rubber, sugarcane, and fruit. On the infertile sandy loam and clay loam soils of the extreme southern peninsula, rubber is grown extensively (Brown, 1963, p. 1).

Thailand had 98 million rai[1] of cultivated land in 1974 with only 2 million rai or 2 percent of cultivated land irrigated. Of this irrigated area, 67 percent was in the Central region, 13 percent in the Northeastern region, 12 percent in the Northern region, and only 8 percent was in the Southern region (Division of Agricultural Economics, 1976).

Importance of rice in the economy

The economy of Thailand is heavily dependent upon agriculture. Pradit Charsombuti and Melvin M. Wagner estimated the Thai population from 1947 to 1976. With a projected 3.2 percent population growth rate, the population would increase from 35.9 million in 1970 to 45 million by 1976. Of this population, 70 percent is employed in the agricultural sector. Capital and land are used relatively less than labor as compared to developed countries (Charsombuti and Wagner, 1969). It is estimated that "the majority of farmers have holdings around 44 rai or 7.1 hectares, a few are rich farmers with larger holdings, and a very few are poor farmers with considerably smaller holdings and the farmers have an average of 6.7 members per family" (Food and Agriculture Organization, 1972, p. 5).

In 1972, the agricultural sector generated 30 percent of the gross domestic product at market prices and supplied about 70 percent of total merchandise exports (Department of Economic Research, 1974). Of this

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[1]One acre equals 2.5 rai.

agricultural production paddy is the most important crop. It is the backbone of the Thailand economy and the main source of staple food grain for the Thai people. Rice occupies the largest area of cultivated land. Fifty-one percent of cultivated land was under paddy with the remaining 49 percent of cultivated land planted to corn, cassava, sugarcane, and other crops. Rice as a single crop creates wealth in the kingdom of more than 28 billion baht[2] which is 64 percent of crop production (Division of Agricultural Economics, 1976).

Rice is the leading earner of foreign exchange and yields a stable revenue for the government. Due to the value of rice export, the government can get a lot of revenue from rice premium or export tax. Rice premium policy was established by the Thai government in 1955. It is actually an export tax and it is a charge per metric ton of rice authorized when an export license is issued and varied through time and with the grade of rice exported but not the price of rice. On an average between 1964 to 1972 the revenue from the rice premium and rice duties was 1,023 million baht which was 7 percent of total tax revenue (Department of Economic Research, 1974). This means that every 100 baht of the government revenue, 7 baht comes from the rice premium and rice duties.

Projection of rice demand and supply

In terms of food for Thai people, rice is the symbol of survival. In the Thai language "Khaaw" is the word for rice, and "Kab Khaaw" is

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[2] 20 baht equals $1.00.

the term for meal which means "eat with rice," so rice and meal have the same meaning in Thai's sense. It is the most important single dietary item that represents breakfast, lunch, and dinner. From the food consumption survey of the D.A.E.[3] in 1971, the average per capita consumption of rice was 144.51 kilograms per year which is 62 percent of the total quantity of food intake by weight. According to the survey, 53 percent of total food expenditures was for rice, and 22 percent of total income was allocated to rice expenditure (Supradit, 1975).

Thailand was a monocultural country in rice in the past, for example, 88 percent of cultivated land was under paddy in 1953. Without certainty in price and market, rice production is the rational way for the subsistence farmer. Growing rice provides the farmers and their family not only with a secure food supply but also with purchasing power from the surplus output. The result from the foreign demand and the availability of new land to open up, the agricultural pattern has changed to multicultural agriculture, and the share of paddy was reduced to 68 percent of total cultivated land in 1970 (Department of Agricultural Economics, 1976). The cash crops such as corn, cassava, and beans which are more profitable than rice are grown on these new lands, so the share of these cash crops has risen relative to rice. Even though the share of rice production in the agricultural sector has decreased, the quantity of rice production is still on the same level because the rice land has few alternatives for changing to other kinds of crops.

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[3]D.A.E. is the Division of Agricultural Economics, Ministry of Agriculture and Cooperatives, Bangkok, Thailand.

Using a native low level of technology Thailand still produces more than enough rice for domestic demand and permits surplus for sizable exports. The rice surplus brings many benefits to the kingdom. With the rice surplus, people are far away from the experience of food shortage. With the rice surplus, the government not only can save money from rice imports but also earn foreign exchange from rice exports.

Since rice is the principal food grain of Thai people and the people in many other countries, the demand for rice is increasing due to the increase in population and per capita income. The domestic demand for rice in Thailand increases rapidly. It increased from an estimated 9 million metric tons in 1967 to 12 million metric tons in 1971, and is projected to be 15 million metric tons by 1976, based on the increase in per capita income and population growth rate (Sriplung and Manowalailao, 1971). In terms of world rice situation, the rice consumption requirements increase about 2.5 percent annually from the population growth alone, and the rise in per capita income in developing countries could result in additional demand for rice. Since the domestic and export demand for rice have increased over time, the rice stock in Thailand declined from 1,521 thousand metric tons in 1971 to 797 thousand metric tons in 1974 (United States Department of Agriculture, 1974). This indicates the long run problem. The fluctuation and slight increase in production from 14.3 million metric tons in 1971 to 13.9 million metric tons in 1974, and 15 million metric tons in 1975 but with a significant increase in demand, the country might change from a rice-export country to a rice-import country in the future if the government does not do anything to change this situation.

Why the Price Elasticity of Marketable Surplus of Rice is Important for Thailand

Trying to increase the rate of rice supply to catch up the increment of domestic demand and export demand for rice, the government must have a policy to work with. What kind of policy should the government use to solve the problem? The government could use an input support policy or a price policy or other policies. It is possible to increase production by using input support policy because the rice production in Thailand still uses a low level of technology which is unqualified seed, small amounts of fertilizer, and dependence mainly on rainfall. The average fertilizer that the farmer used is 4.04 kgs/rai when the farmer could not afford to use more fertilizer because of the high price of fertilizer relative to the price of product. In 1974, the price index of fertilizer that was used for paddy is 241.94 from the numeraire in 1967, but the price index of rice is only 174.53 in the same year (Division of Agricultural Economics, 1975). If the government provides the irrigation system so the farmer can grow the intensive crop, and provides the good variety of seed, fertilizer, insecticide and herbicide in a special price to the farmer, the policy will bring the increment of rice supply. For price policy, the objectives of agricultural price policy that Krishna points out:

> A reasonable degree of stability of prices and of agricultural markets. . . was historically the first objective of price support policies. . . . An important objective of price policy continues to be. . . the

> avoidance of sharp price fluctuations but its primary feature is to contribute to the long term assurances to producers as regards the support of their income (Krishna, 1967, p. 489).

In developing countries, price policy has been used negatively to support the industrial sector by lowering the wage rate but increasing the real money income by providing the cheap price of staple food. Thailand used the negative price policy a long time ago in the term of "rice premium." The government collects a rice premium or a per ton charge to the exporter varying with the grades of rice to finance the urban consumer and the government. The government claims that "the rice premium merely captured the monopoly profits of Chinese middlemen and transferred them to the domestic consumer and the government," but T. H. Silcock, professor at Cornell University, rejects that claim. He believes that the burden of rice premium does not fall on the middleman but the farmer. He says, "the entire system rests on the back of the traditional Thai farmer" (Balwin, 1974, p. 12).

Without precise information about the effect of rice premium to the farmer, and because the government does not want to lose a large portion of revenue, the rice premium policy still goes on. A positive price policy is a policy that gives incentives to the farmer to produce more by paying him a fair price for his product. The price support was initiated in Thailand in 1974 to set the minimum price that the middlemen must pay to the farmer for paddy. This price is determined from the cost of rice production compared to the relative prices of the other consumer goods. This policy helps the farmer to get a higher price for his product. Krishna indicated the functions of positive price policy that becomes a part of growth policy in the following:

> (1) To accelerate the growth of agricultural output as a whole; (2) To accelerate or decelerate the growth of the output of individual crops or, in the context of planning, to steer the crop-mix according to targets; and (3) To secure adequate increases in the marketed supply of food crops in countries where a large part of output is retained by the peasants for home consumption (Krishna, 1967, p. 503).

The third function is very important because this function may help the government solve the problem of rice in Thailand. When the price of rice increases, it is positively sure that the farmer will try to increase his rice production, but will he allocate his production to the market more to increase his income, or sell to the market less and consume more rice because of increasing income? In order to formulate an effective price policy, the government needs to know the elasticity of marketable surplus of rice. This study estimates the elasticity of marketable surplus of rice to find the response of the subsistence farmer with respect to the change in price. This parameter could be very useful for the government in formulating policies to insure an adequate supply of rice.

Although Jere R. Behrman studied the price elasticity of marketable surplus of a subsistence crop in Thailand, in 1966, and obtained a positive elasticity. But he was not able to estimate all parameters of his model because of the limitation of data. Time series data of onfarm consumption by farm families were not available to him to compute the price and income elasticity of demand for rice, so he estimated the elasticity of marketable surplus with a zero value of price and income elasticity. In this study, many important sets of data were provided from D.A.E. to compute the price and income elasticity of demand for rice to estimate the elasticity of marketable surplus. Thus, the price elasticity of marketable surplus of Thai rice is reestimated using Behrman's complete model.

CHAPTER II. REVIEW OF LITERATURE

Krishna's Study

Recently many economists have studied the subsistence farmer's behavior toward changes in price of food grain. Many articles show the theoretical and empirical work of estimating the elasticity of marketed surplus in developing countries. They use different methodology and use data from different sources, but estimates of this elasticity are almost nonexistent. As Behrman said, "The absence of such estimates is explained, in large part, because the lack of time-series data for marketed quantities precludes direct estimation" (Behrman, 1966, p. 876).

One of the first attempts to estimate the elasticity of marketable surplus of a subsistence crop was by Raj Krishna (1962). In 1962 he established a model to investigate the farmer's reaction to changes in price of food grain in the sense that the farmer is a producer as well as the consumer of the subsistence commodity. The farmer would sell his product to the market when he has a surplus after his own consumption needs. Krishna studied the marketable surplus response of wheat in India. He uses the model

$$M = Q - C$$

where M is the quantity of wheat marketed, Q is the quantity of wheat produced, and C is the quantity of wheat consumed. Differentiating with respect to P and multiplying both sides by the ratio P/M he obtained

$$\frac{dM}{dP} = \frac{dQ}{dP} - \frac{dC}{dP}$$

$$\frac{dM}{dP} \cdot \frac{P}{M} = \frac{Q}{M}\left[\frac{dQ}{dP} \cdot \frac{P}{Q}\right] - \frac{C}{M}\left[\frac{dC}{dP} \cdot \frac{P}{C}\right]$$

$$e = rb - \frac{C}{M} d$$

but $\frac{C}{M} = \frac{Q-M}{M} = r - 1$, so

$$e = rb - (r-1)d \qquad (2.1)$$

where

P is the relative price of wheat;

e is the elasticity of marketable surplus with respect to price;

$r = Q/M$, the reciprocal of sales ratio;

b is the elasticity of output with respect to price; and

d is the elasticity of home consumption with respect to price.

The inverse of the sales ratio r is strictly positive with a lower bound of 1 which implies that r and $r - 1$ are nonnegative. Therefore, the sign of e will be determined by the values and signs of b and d, the price elasticity of output and price elasticity of home consumption, respectively. Krishna defines four possible cases:

(1) If b is positive and d is negative, e will be positive;

(2) If b is negative and d is positive, e will be negative;

(3) If b and d are both negative, e will be positive as long as $r|b| < (r - 1)|d|$; and

(4) If b and d are both positive, e will be positive as long as $rb > (r - 1)d$.

Economic theory suggests and empirical studies have tended to confirm that output elasticity or supply response is positive. The sign of d cannot be determined a priori.

Krishna derives the value of d from the consumption function

$$\frac{dC}{C} = g\left[\frac{dP}{P}\right] + h\left[\frac{dy}{y}\right] \tag{2.2}$$

He specifies g as the elasticity of the substitution effect, and h as the elasticity of income effect. The income effect due to increases in price will increase income for the pure producer and decrease income for the pure consumer. The total change in income would be

$$\frac{dy}{y} = \frac{dP}{P}\left[\frac{PQ}{y} - \frac{PC}{y}\right]$$

$$= \frac{dP}{P} \cdot \frac{PM}{y}$$

$$= \frac{PQ}{y} \cdot \frac{M}{Q} \cdot \frac{dP}{P}$$

$$\frac{dy}{y} = mk\,\frac{dP}{P} \tag{2.3}$$

where $m = M/Q$, the sales ratio and $k = \frac{PQ}{y}$, the ratio of income of wheat to total income. Substituting the income effect (2.3) into the consumption function (2.2), the equation will be

$$\frac{dC}{C} = g\left[\frac{dP}{P}\right] + mkh\left[\frac{dP}{P}\right]$$

$$\frac{dC}{C} \cdot \frac{P}{dP} = g + mkh$$

$$d = g + mkh \tag{2.4}$$

Substituting (2.4) into (2.1), the final model for elasticity of marketable surplus is

$$e = rb - (r - 1)(g + mkh).$$

Krishna uses the value of b from his Ph.D. dissertation (Krishna, 1964). He estimates the elasticity of the acreage of wheat with respect to the relative price for the Punjab region. This value ranges between .1 to .2. For the value of g and h, he uses estimates from prior demand studies. Krishna combines those results in terms of the range of parameters. The value of g ranges from -.2 to -.4, and the h ranges from .5 to .8. The value of k he obtains from the family budget studies of wheat farmers in Punjab, the ratio of wheat revenue to the total income varies from 10 to 70 percent. Krishna combines these parameters with the alternative values of m to obtain the estimates of e given in Table 1.

Table 1. Calculation of plausible limits of e[a]

Plausible ranges of parameters		Value relevant For min. e	Value relevant For max. e
b = .1 to .2		.1	.2
g = -.2 to -.4		-.2	-.4
h = .5 to .8		.8	.5
k = .1 to .7		.7	.1
m	0.1	0.5	0.9
r (= 1/m)	10	2	1.1
	m = .1	m = .5	m = .5
Min. e	2.30	.12	.08
Max. e	5.56	.78	.26

[a] SOURCE: Krishna, 1962, p. 83.

He gets the important outcome of the calculations that e is never negative and ranges between .08 to 5.56. The elasticity of marketable surplus varies inversely with sale ratio. This means a subsistence farmer who consumes a high proportion of his output will respond to price more than a commercial farmer who consumes a small proportion of output.

Mubyarto Studies

The next significant study of marketable surplus was by Mubyarto 1965) about rice in Indonesia. He followed Krishna's idea for the theoretical work

$$M = Q - C \tag{2.5}$$

then, differentiated (2.5) with respect to income and price, combining these two effects together as the total changes with respect to price because the farmer is a producer as well as a consumer. Differentiating (2.5) with respect to income and multiplying the result by Y/M, he obtains

$$\frac{dM}{dY} \cdot \frac{Y}{M} = \frac{dQ}{dY} \cdot \frac{Y}{Q} \cdot \frac{Q}{M} - \frac{dC}{dY} \cdot \frac{Y}{C} \cdot \frac{C}{M}$$

$$e_{MY} = \frac{Q}{M} \cdot e_{QY} - \left(\frac{Q}{M} - 1\right) \cdot e_{CY} \tag{2.6}$$

Differentiating (2.5) with respect to price and multiplying the result by P/M he obtains

$$\frac{dM}{dP} \cdot \frac{P}{M} = \frac{dQ}{dP} \cdot \frac{P}{Q} \cdot \frac{Q}{M} - \frac{dC}{dP} \cdot \frac{P}{C} \cdot \frac{C}{M}$$

$$e_{MP} = \frac{Q}{M} \quad e_{QP} - \left(\frac{Q}{M} - 1\right) \, e_{CP} \tag{2.7}$$

Adding equations (2.6) and (2.7) together results in (2.8):

$$e_{MY} + e_{MP} = \frac{Q}{M} \cdot e_{QY} - \left(\frac{Q}{M} - 1\right) \cdot e_{CY} + \frac{Q}{M} \cdot e_{QP} - \left(\frac{Q}{M} - 1\right) \cdot e_{CP}$$

$$e_M = \frac{Q}{M}\left[e_{QY} + e_{QP}\right] - \left(\frac{Q}{M} - 1\right)\left[e_{CY} + e_{CP}\right] \qquad (2.8)$$

where

Q is the quantity of rice produced;

C is the quantity of rice consumed;

M is the quantity of rice marketed;

$\frac{Q}{M}$ is the output marketing ratio;

P is the relative price of rice;

Y is the total income of the farmer;

e_{MY} is the elasticity of marketable surplus with respect to income;

e_{MP} is the elasticity of marketable surplus with respect to price;

$e_M = e_{MY} + e_{MP}$, the total elasticity of marketable surplus;

e_{QY} is the elasticity of output with respect to income;

e_{QP} is the elasticity of output with respect to price;

$e_Q = e_{QY} + e_{QP}$, the total elasticity of output;

e_{CY} is the income elasticity of demand for rice;

e_{CP} is the price elasticity of demand for rice; and

$e_C = e_{CY} + e_{CP}$, the total elasticity of home consumption.

After deriving the price effect of the consumption function, the same way as Krishna, Mubyarto gets the result

$$e_{CP} = e'_{CP} + e'_{CY} \cdot V \qquad (2.9)$$

which is the Slutsky equation where e'_{CP} is the substitution effect, e'_{CY} is the real income effect, and V is the ratio of rice revenue to total income. This is the important part that makes his model different from Krishna's because Mubyarto does not substitute the function of price effect, equation (2.9), into the marketable surplus function, equation (2.8). Mubyarto argues that e'_{CP} and e'_{CY} are not the price and income elasticity as is implicitly suggested by Krishna, and the Slutsky equation cannot be quantified empirically without knowing the utility function, so he uses equation (2.8)

$$e_M = \frac{Q}{M} (e_{QY} + e_{QP}) - \left(\frac{Q}{M} - 1 \right) (e_{CY} + e_{CP}) \qquad (2.10)$$

as his theoretical model for estimating the elasticity of marketable surplus. He obtains the aggregate data about rice production from the Central Bureau of Statistics in Djakarta which provides monthly reports on production, harvesting, and yield of rice for Java and Madura in 1951-1962. He chooses some observations from the Consumer Finance Study in the year 1958-1959 that provides information such as rice production, consumption, marketing of farm family, index of consumers unit, the output marketing ratio, and the relative importance about rice revenue. From the National Sample Survey in 1963-1964, for the farm families in Java, he obtained the total expenditure and used this data as the approximation of total income under the assumption of zero saving. From these sets of data, he uses the cross section of output and the income elasticity of rice. He obtains the positive results for both price and income elasticity of output, but he thinks that "the data to derive both estimates contain serious limitations and inaccuracies. . ., therefore, any attempt to integrate the two separate estimates should be considered only as a preliminary estimate. . ." (Mubyarto, 1965, p. 110).

Because of a lack of time-series data, he estimates the price elasticity of demand by using Engel elasticity from Frisch's (1959) approach

$$e_{CP} = -e_{CY}(w - \frac{1 - we_{CY}}{\check{m}})$$

where e_{CP} is the price elasticity of demand, e_{CY} is the income elasticity, w is the budget proportion of rice, and m is the money flexibility, which is defined as

$$\check{m} = \frac{\partial m}{\partial y} \cdot \frac{y}{m} \quad \text{(all prices } P_1, \ldots, P_n \text{ constant)}$$

where m is marginal utility of money and y is income. The $\check{m}$ is supposed to be computed independently, but the data were not available, so he "borrows" the value of $\check{m}$ from Frisch's estimation. He substitutes the value of parameters into his model and obtains the results in Table 2.

Mubyarto divides his results into two parts, the minimum e, and the maximum e. In the minimum case, the elasticity of marketable surplus for the farmer in Java and Madura is inversely associated with Q/M. Varying the inverse sales ratio, he estimates the elasticity of marketable surplus ranges from 0.34 to -1.12. From this result, Krishna's conclusion that "the elasticity of marketable surplus is never negative" is questionable. Mubyarto gives the conclusion for this result that "backward sloping market supply behavior can indeed be found in a poor subsistence

Table 2. Plausible values of the elasticity of the marketable surplus[a]

Plausible range of parameters	Value relevant Min. e_m		Max. e_m
e_{QY} = .3 to .5	.3		.5
e_{QP} = .1 to .3	.1		.3
e_{CY} = .6 to .8	.8		.6
e_{CP} = -.2 to -.4	-.2		-.4
Q/M	1.3 or	2.1 or	8.6
M/Q	.77	.48	.12
Min. e_m	.34	.18	-1.12
Max. e_m	.98	1.46	5.36

[a]SOURCE: Mubyarto, 1965, p. 125.

economy" (Mubyarto, 1965, p. 127). In the maximum case, Mubyarto gets the same answer as Krishna's, the elasticity of marketable surplus is directly related to Q/M, and ranges between .98 to 5.36. It means the less commercialized a farmer is, the higher the elasticity of marketable surplus will be. He explains this case in the sense that "the farmer who is less commercialized and who has limited outside cash income, has a high elasticity of marketable surplus of the crop he produces, because of the stronger need for cash income" (Mubyarto, 1965, p. 130).

Behrman Studies

In 1966 Jere R. Behrman made a significant contribution to the literature (Behrman, 1966). Noting that Krishna's model had been used by several researchers to estimate marketable surplus elasticity, Behrman presented a model which he felt was preferable. His points of concern regarding Krishna's model are:

(1) The income elasticity of demand for onfarm consumption in Krishna's model is a function of the income derived from the sales of the subsistence crop only. The quantity demanded for onfarm consumption more logically should be a function of the total net income (income from the subsistence crop, income from other farm production, and off-farm income).

(2) Krishna has used approximations without acknowledging them. These approximations are made by dropping or implicitly setting to zero some of the first partial derivatives without giving any justification for doing so.

(3) Krishna does not indicate the number of periods necessary for complete adjustment of production in response to a change in price. The supply or output elasticity he calculates may be correct only after many periods. Policy makers may be more interested in the short run adjustment rather than the complete adjustment.

(4) Krishna uses price of the subsistence crop as an absolute price instead of a relative price, although he defines it as a relative price.

For these reasons, Behrman improved Krishna's model in the way that "price and income are deflated by appropriate indices to remove general price level effects," and "the exact functional form of the dependence of these elasticities upon the elapsed time depends upon which functional forms are assumed for the relationships between the actual and the expected normal relative prices, between the desired and the intended quantities produced, and between the actual and expected normal incomes" (Behrman, 1966, p. 878).

Before proceeding with the formulation of Behrman's model, these variables are defined:

P_1 is the absolute price of the subsistence crop;

P_2 is the aggregate price of other production alternatives;

P_3 is the aggregate price of all commodities other than subsistence crops the farmer consumes;

Q_1 is the quantity produced of the subsistence crop, which is a function of the relative prices P_1/P_2;

Q_2 is the quantity of other farm production, which is a function of the relative prices P_1/P_2;

C_1 is the quantity of onfarm consumption of Q_1, which is a function of P_1/P_2 and I;

$M_1 = Q_1 - C_1$, the marketed surplus of the subsistence crop;

I is the total net income of the producer of Q_1, $I = P_1Q_1 + P_2Q_2$;

$r = \frac{Q_1}{M_1}$, the reciprocal of sales ratio (M_1/Q_1) for Q_1,

$k = \frac{P_1Q_1}{I}$, the ratio of total value of production of Q_1 to total income,

$e = \frac{\partial M_1}{\partial P_1} \cdot \frac{P_1}{M_1}$, the elasticity of marketable surplus with respect to P_1, as a function of time which is allowed for adjustment,

$b_1 = \frac{\partial Q_1}{\partial (P_1/P_2)} \cdot \frac{P_1/P_2}{Q_1}$, price elasticity of Q_1 with respect to P_1/P_2,

$b_2 = \frac{\partial Q_2}{\partial (P_1/P_2)} \cdot \frac{P_1/P_2}{Q_2}$, price elasticity of Q_2 with respect to P_1/P_2,

$g = \frac{\partial C_1}{\partial (P_1/P_3)} \cdot \frac{P_1/P_3}{C_1}$, the elasticity of C_1 with respect to P_1/P_3, and

$h = \frac{\partial C_1}{\partial I} \cdot \frac{I}{C_1}$, the elasticity of C_1 with respect to I.

Using subscript 1 to denote the subsistemce crop, 2 to denote other production activities available to the farmer, and 3 to denote the competing consumption goods; Behrman was able to introduce explicitly that output Q_1 is a function of the relative prices (P_1/P_2) of commodity 1 and 2. Likewise, the onfarm consumption of the subsistence crops is a function of the relative price of the subsistence commodity and other consumption goods (P_1/P_3). Behrman began his model from

$M_1 = Q_1 - C_1$ (marketable surplus of commodity 1, subsistence crop)

Taking the first partial derivative of M_1 with respect to its own price P_1 and using the chain rule of differentiation

$$\frac{\partial M_1}{\partial P_1} = \frac{\partial Q_1}{\partial (P_1/P_2)} \cdot \frac{\partial (P_1/P_2)}{\partial P_1} - \frac{\partial C_1}{\partial (P_1/P_3)} \cdot \frac{\partial (P_1/P_3)}{\partial P_1} - \frac{\partial C_1}{\partial I} \cdot \frac{\partial I}{\partial P_1} \quad (2.11)$$

But $I = P_1Q_1 + P_2Q_2$, so

$$\frac{\partial I}{\partial P_1} = Q_1 + P_1 \frac{\partial Q_1}{\partial (P_1/P_2)} \cdot \frac{\partial (P_1/P_2)}{\partial P_1} + P_2 \frac{\partial Q_2}{\partial (P_1/P_2)} \cdot \frac{\partial (P_1/P_2)}{\partial P_1} + Q_2 \frac{\partial P_2}{\partial P_1}$$

Setting $\frac{\partial P_2}{\partial P_1}$ equal to zero and simplifying terms

$$= Q_1 + P_1 \frac{\partial Q_1}{\partial (P_1/P_2)} \cdot \frac{1}{P_2} + P_2 \frac{\partial Q_2}{\partial (P_1/P_2)} \cdot \frac{1}{P_2}$$

$$= Q_1 + \frac{P_1}{P_2} \frac{\partial Q_1}{\partial (P_1/P_2)} + \frac{\partial Q_2}{\partial (P_1/P_2)} \tag{2.12}$$

Substituting equation (2.12) into equation (2.11)

$$\frac{\partial M_1}{\partial P_1} \cong \frac{\partial Q_1}{\partial (P_1/P_2)} \cdot \frac{\partial (P_1/P_2)}{\partial P_1} - \frac{\partial C_1}{\partial (P_1/P_3)} \cdot \frac{\partial (P_1/P_3)}{\partial P_1} - \frac{\partial C_1}{\partial I} \left[Q_1 + \frac{P_1}{P_2} \cdot \frac{\partial Q_1}{\partial (P_1/P_2)} + \frac{\partial Q_2}{\partial (P_1/P_2)} \right]$$

$$\frac{\partial M_1}{\partial P_1} = \frac{\partial Q_1}{\partial (P_1/P_2)} \cdot \frac{1}{P_2} - \frac{\partial C_1}{\partial (P_1/P_3)} \cdot \frac{1}{P_3} - \frac{\partial C_1}{\partial I} \left[Q_1 + \frac{P_1}{P_2} \frac{\partial Q_1}{\partial (P_1/P_2)} + \frac{\partial Q_2}{(P_1/P_2)} \right] \tag{2.13}$$

Multiplying (2.13) by P_1/M,

$$\frac{\partial M_1}{\partial P_1} \cdot \frac{P_1}{M_1} = \left[\frac{P_1}{M_1} \cdot \frac{1}{P_2} \cdot \frac{\partial Q_1}{\partial (P_1/P_2)} \right] - \left[\frac{P_1}{M_1} \cdot \frac{1}{P_3} \frac{\partial C_1}{\partial (P_1/P_2)} \right] - \left[\frac{P_1}{M_1} \cdot \frac{\partial C_1}{\partial I} \cdot Q_1 \right] - \left[\frac{P_1}{M_1} \cdot \frac{\partial C_1}{\partial I} \cdot \frac{P_1}{P_2} \cdot \frac{\partial Q_1}{\partial (P_1/P_2)} \right] - \left[\frac{P_1}{M_1} \cdot \frac{\partial C_1}{\partial I} \cdot \frac{\partial Q_2}{\partial (P_1/P_2)} \right] \tag{2.14}$$

Because this model is very complicated, the equation is separated into five terms to complete the mathematical procedure.

The first term of equation (2.14)

$$\left[\frac{P_1}{M_1} \cdot \frac{1}{P_2} \cdot \frac{\partial Q_1}{\partial (P_1/P_2)} \right] = \frac{P_1}{M_1} \cdot \frac{1}{P_2} \cdot \frac{Q_1}{Q_1} \cdot \frac{\partial Q_1}{\partial (P_1/P_2)}$$

$$= \frac{Q_1}{M_1} \left[\frac{P_1/P_2}{Q_1} \cdot \frac{\partial Q_1}{\partial (P_1/P_2)} \right]$$

$$= r\, b_1$$

The second term of equation (2.14)

$$\left[\frac{P_1}{M_1} \cdot \frac{1}{P_3} \cdot \frac{\partial C_1}{\partial (P_1/P_3)}\right] = \frac{P_1}{M_1} \quad \frac{1}{P_3} \cdot \frac{C_1}{C_1} \cdot \frac{\partial C_1}{\partial (P_1/P_3)}$$

$$= \frac{C_1}{M_1}\left[\frac{P_1/P_3}{C_1} \cdot \frac{\partial C_1}{\partial (P_1/P_3)}\right]$$

$$= \frac{C_1}{M_1} \cdot g$$

but $\frac{C_1}{M_1} = \frac{Q_1 - M_1}{M_1} = \frac{Q_1}{M} - 1 = r - 1$

thus the second term becomes $(r - 1)g$.

The third term of equation (2.14)

$$\left[\frac{P_1}{M_1} \cdot \frac{\partial C_1}{\partial I} \cdot Q_1\right] = \frac{P_1}{M_1} \cdot Q_1 \cdot \frac{I}{I} \cdot \frac{C_1}{C_1} \cdot \frac{\partial C_1}{\partial I}$$

$$= \frac{C_1}{M_1} \cdot \frac{P_1 Q_1}{I}\left[\frac{I}{C_1} \cdot \frac{\partial C_1}{\partial I}\right]$$

$$= (r - 1)kh$$

The fourth term of equation (2.14)

$$\left[\frac{P_1}{M_1} \cdot \frac{\partial C_1}{\partial I} \cdot \frac{P_1}{P_2} \cdot \frac{\partial Q_1}{\partial (P_1/P_2)}\right] = \frac{P_1}{M_1} \cdot \frac{Q_1}{Q_1} \cdot \frac{C_1}{C_1} \cdot \frac{\partial C_1}{\partial I} \cdot \frac{\partial Q_1}{\partial (P_1/P_2)} \cdot \frac{P_1}{P_2}$$

$$= \frac{P_1 Q_1}{I} \cdot \frac{C_1}{M_1} \cdot \left[\frac{\partial C_1}{\partial I} \cdot \frac{I}{C_1}\right]\left[\frac{\partial Q_1}{\partial (P_1/P_2)} \cdot \frac{P_1/P_2}{Q_1}\right]$$

$$= k(r-1)hb_1$$

$$= (r - 1)khb_1$$

Likewise, the fifth term

$$\left[\frac{P_1}{M_1} \cdot \frac{\partial C_1}{\partial I} \cdot \frac{\partial Q_2}{\partial (P_1/P_2)}\right] = \frac{P_1}{M_1} \cdot \frac{\partial C_1}{\partial I} \cdot \frac{\partial Q_2}{\partial (P_1/P_2)} \cdot \frac{P_2}{P_2} \cdot \frac{Q_2}{Q_2} \cdot \frac{C_1}{C_1} \cdot \frac{I}{I}$$

$$= \frac{C_1}{M_1}\left[\frac{\partial C_1}{\partial I} \cdot \frac{I}{C_1}\right]\left[\frac{\partial Q_2}{\partial (P_1/P_2)} \cdot \frac{P_1/P_2}{Q_2}\right] \frac{P_2 Q_2}{I}$$

$$= (r - 1)hb_2 \cdot \frac{P_2 Q_2}{I}$$

$$= (r - 1)hb_2\left(\frac{I - P_1 Q_1}{I}\right)$$

$$= (r - 1)hb_2(1 - k)$$

Replacing these five intermediate terms into equation (2.14)

$$e = rb_1 - (r - 1)g - (r - 1)kh - (r - 1)khb_1 - (r - 1)hb_2(1 - k)$$

$$= rb_1 - (r - 1)\left\{g + hk(1 + b_1)\right\} - (r - 1)hb_2(1 - k)$$

Using the same values of parameters as Krishna, Behrman substituted those parameters into his model and compiled the price elasticity of marketable surplus. The results are compared with Krishna's results in Table 3.

Behrman obtains a negative elasticity of marketable surplus as opposed to Krishna's positive value. Behrman compares the result from these two models and concludes that (1) the two models converge as the sales ratio (m) approaches one, (2) his model provides a wider range of value for the elasticity of M_1 than Krishna's, (3) using the same parameter values, the two models provide very different results, and (4) because of the different treatments of the price effect for onfarm consumption of the subsistence crop, differences in not only the magnitude but also the sign of price elasticity of marketable surplus can occur.

Table 3. Plausible ranges of the price elasticity of the marketed surplus for Punjabi wheat[a]

	m = .1	m = .5	m = .9
Behrman model	-2.56 to 6.03	-0.19 to 0.85	0.07 to 0.26
Krishna model	2.30 to 5.56	0.12 to 0.78	0.08 to 0.26
Difference between the two models	-0.57 to 5.32	-0.10 to 0.46	-0.01 to 0.02
Difference due to alternative treatment of the effect of price changes on income	0.45 to 5.53	0.03 to 0.39	0.00 to 0.02
Difference due to the inclusion of alternative income sources in Behrman model	-1.30 to -0.14	-0.14 to -0.01	-0.01 to 0.00

[a]SOURCE: Behrman, 1966, p. 883.

Because time series estimates of planned output are not available, and under the assumption that yields are not responsive to changes in the expected normal relative prices, Behrman uses the area planted in crops being the approximation of Thai supply response. The Nerlovian dynamic total supply model is used to obtain this estimation, but instead of using ordinary least squares method, Behrman uses a nonlinear, iterative technique to estimate, because the variables are not linearly independent and the variable constraints among the coefficients are not utilized in the least squares estimation procedures. Using the Nerlovian model, the structural model consists of a desired planted area relationship, a planted area adjustment relationship, and the expected yield relationship. These three structural relationships are manipulated to obtain the reduced form equation in which only observable variables appear. Behrman indicates the number of periods required for adjustment within 5 percent of complete adjustment. He uses aggregate data in terms of Changwad or province level in Thailand during the years from 1940 to 1963 to estimate the total supply response of rice. Because of a multicollineararity problem when both expected yield and population variables are included in the same equation, Behrman tries two cases. The first regression is estimated with expected yield excluded and the second with population excluded. The elasticities are calculated at the point of means after one year (short run), and after complete adjustment (long run). He obtained the results of the following table (Table 4).

Table 4. Short run and long run elasticities for the total supply response of Thai rice, 1940-1963[a]

	Elasticity of Planted Area with Respect to			
	$(P_1/P_2)t$	Y^e_t	σY_t	N_t
Case 1 (expected yield excluded)				
short run	0.18		-0.02	0.78
long run	0.19		-0.02	0.74
Case 2 (population excluded)				
short run	0.17	1.87	-0.02	
long run	0.43	1.17	-0.01	

[a] SOURCE: Behrman, 1966, p. 890.

In this table:

$(P_1/P_2)t$ is the actual price of Q_1 relative to the price of alternative income sources at the t-th production period;

$Y^e{}_t$ is the expected harvested production per unit planted area;

σY_t is the standard deviation of actual yields of Q_1 over the last three preceding production periods; and

N_t is the farm population in the geographical area of concern.

In estimating the price and income elasticity for home consumption, he used the aggregate level of data. Because the main group of Thai population is the agricultural household which produces rice, the time pattern of consumption is difficult to determine. Numerous forms of the demand function for domestic consumption were used, but none of them obtained significant levels of price and income response in per capita consumption, so the value of g and h are assumed to be zero. Behrman explained these cases as a result of limited data, otherwise the aggregate Thai consumption of rice may respond nonsignificantly to price and income changes. The aggregate Thai consumption may only shift the quality of rice to consume from cheap to expensive or vice versa, but not change the quantity of rice to consume. Due to the zero value of g and h, the model for estimating the elasticity of marketable surplus in the short run will be $e = rb_1$, and in the long run, the model will be identical for both Krishna's and Behrman's models. Behrman obtained the value of r, the reciprocal of sale ratio from "1953 Thailand Farm Survey" that provides such an estimate $r = 2.375$. From these parameters, Berhman estimated the price elasticity of the marketed surplus of Thai rice in the following table (Table 5).

Table 5. Time paths of adjustment of the price elasticity of the marketed surplus of Thai rice[a]

Total supply regression	Number of years for adjustment							
	1	2	3	4	5	10	15	20
Alternative 1	0.43	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Alternative 2	0.40	0.29	0.71	0.61	0.83	0.96	1.00	1.02

[a]SOURCE: Behrman, 1966, p. 892.

Behrman concluded from his results that:

(1) If second alternative is better than the first alternative, the partial adjustment for number of production period will be of greater interest than total adjustment.

(2) The elasticities of marketable surplus of Thai rice are positive because they present only the total production price response without counteracting from income effect in consumption.

(3) Due to the second reason, the price elasticity of marketable surplus of Thai rice is greater than the price elasticity of total supply.

Behrman suggested that, the supply of rice in the market will increase more than the increase in production, if the local price market of rice increases.

Other Studies

Due to the need for knowledge about price elasticity of marketable surplus, research on this subject has continued. Kalpana Bardhan

(1970) estimated the price elasticity of marketable surplus of food grains (cereals and pulses) in India. He presented the model

$$S = O_f - C_f - N,$$

where S, O_f, C_f, and N are sales, output, consumption, and net other disposal of food grains, respectively. Bardhan assumed a single demand function for food grains with only income and price affecting consumption and obtained

$$s = \frac{S}{O_f} = 1 - \frac{C_f(O,P_f)}{O_f} - n \qquad (2.15)$$

where n is net other disposal of food grains as a proportion of output. He denotes the cultivator total income is $O = P_fO_f + P_cO_c + P_mO_m$, P_fO_f and P_cO_c being the value of production of food grains and other crops, P_mO_m being the value of other sources of income.

For the empirical work, data from 27 villages of the Punjab and Uttar Pradesh regions was collected within the different years between 1954 and 1960. Using this cross-sectional village data, he used the regression model

$$s = \beta_0 + \beta_1(O_f) + \beta_2(P_f) + \beta_3(P_cO_c) + \beta_4(P_mO_m) + \beta_5(X_5) + \beta_6(n) \qquad (2.16)$$

where $s = \frac{S}{O_f}$ is the amount of food grains sold as percentage of production of food grains and X_5 is the index of concentration of cultivated acreage in a village.

The value of X_5 was computed by using size-distribution in terms of cumulative percentages, for example

Cumulative Size Class	Cumulative Percent of Farms	Cumulative Percent of Area
Up to 5 acres	35	10
Up to 15 acres	85	50
All farms	100	100

$$x_5 = \frac{35 - 10 + 85 - 50 + 100 + 100}{100} = .6$$ (Bardhan, 1970, p. 55).

He noted that "since price changes in one year cannot affect production before the next year or the next sowing season, there need not be any relationship between figures of price and outputs in a cross section of cases" (Bardhan, 1970, p. 53). Thus, rejecting the possibility of similarity between the dependent variable and the price of food grains, he used an ordinary least squares regression procedure.

Because Bardhan used s or the percentage of food grain output which was sold as the dependent variable, the elasticity calculated is not the marketable surplus response to price. Rather the estimated price coefficient multiplied by the ratio of the means provides an estimate of the elasticity of the proportion of output sold with respect to price. This elasticity was found to be negative and between 0.33 to 0.60. This implied that if food grain prices increase, less of the total output will be sold or marketed.

Walter Haessel (1975) did not accept Bardhan's contention that price and output of food grains are not simultaneously related. He said that "it is difficult to believe that both price and output can be exogenous." He gave the reason for this argument that "if each village is reasonably self-sufficient in food grains, the price must be endogenous to the system and will be affected by the quantity produced and marketed. Hence, ordinary least squares will not yield consistent estimates" (Haessel, 1975, p. 11). So Haessel reformulated the model and used two stages least squares to estimate the values of the parameters. Using the same data he obtained a positive price elasticity of marketable surplus which was in direct contradiction to Bardhan.

Zenaida Toquero, Bart Duff, Teresa Arden-Lacsina, and Yujiro Hayami (1975) estimated the elasticity of marketable surplus of rice for the Philippines. They presented the theoretical model as

$$\begin{aligned} M &= f(P, Q) \quad \text{(the marketable surplus function)} \\ C &= g(P, Q) \quad \text{(the consumption function)} \end{aligned} \qquad (2.17)$$

and the equilibrium identity

$$C = Q - f(P, Q)$$

where P is the price of rice and Q is the quantity of rice produced which is a function of P.

Differentiating (2.17) with respect to price P using the chain rule of differentiation and multiplying the result by P/M, they obtained

$$\frac{dM}{dP} = \frac{\partial f}{\partial P} \cdot \frac{dP}{dP} + \frac{\partial f}{\partial Q} \cdot \frac{dQ}{dP}$$

$$\frac{dM}{dP} \cdot \frac{P}{M} = \frac{\partial f}{\partial P} \cdot \frac{P}{M} + \frac{\partial f}{\partial Q} \cdot \frac{dQ}{dP} \cdot \frac{P}{M}$$

Simplifying terms, this equation becomes

$$\frac{dM}{dP} \cdot \frac{P}{M} = \frac{\partial f}{\partial P} \cdot \frac{P}{M} + \frac{\partial f}{\partial Q} \cdot \frac{Q}{M} \cdot \frac{dQ}{dP} \cdot \frac{P}{Q}$$

$$\alpha = \alpha_P + \alpha_Q \gamma \qquad (2.18)$$

where

α is the total price elasticity of marketable surplus;

α_P is partial price elasticity of marketable surplus;

α_Q is partial output elasticity of marketable surplus; and

γ is the price elasticity of output.

A previous study by Mangahas, Recto, and Ruttan (1966) estimated the short run (one period adjustment) price elasticity of output for rice as 0.30. To complete the estimation of total price elasticity of marketable surplus α, they needed estimates for the two remaining parameters of equation (2.18), namely α_P and α_Q the partial price and output elasticities of marketable surplus, respectively.

Data from 21 monocultural farms in rice were collected for three years from 1972 to 1974. The following regression equations were estimated

$$M_{ti} = a_o + a_1 P_{ti} + a_2 Q_{ti} + a_3 Q_{ti}^2 + a_4 N_{ti} + e_{ti} \qquad (2.19)$$

$$\left(\frac{M}{N}\right)_{ti} = b_o + b_1 P_{ti} + b_2 \left(\frac{Q}{N}\right)_{ti} + b_3 \left(\frac{Q}{N}\right)_{ti}^2 + e_{ti} \qquad (2.20)$$

where

Q is disposable output;

M is the quantity of rice marketed;

P is the price of paddy received by farmers deflated by an index of prices paid by farmers;

N is the number of farm household members per farms;

e is the error term; and

t and i identify the crop year and farm, respectively.

Both linear and quadratic term of output were used to allow for a possible nonlinear output response. Equation (2.20) is similar to equation (2.19) except the variables are on a per capita basis.

Although the authors reported estimates of short run price elasticities of marketable surplus varying from 0.41 to 0.67, neither of the two regression equations had significant price coefficients at even the 10 percent level.

CHAPTER III. APPROACH TO STUDYING THE PROBLEM IN THAILAND

Best Theoretical Study--Behrman

Comparing the theoretical models of all the studies for price elasticity of marketable surplus in Chapter II, the best theoretical model is presented by Jere R. Behrman (1966). His model is the most complete in that (1) farmers use the relative price of the subsistence crop to other cash crop alternatives and not just the absolute price in determining the supply response, (2) a more elaborate treatment of the income effect of onfarm consumption is developed, and (3) time needed for adjustment is explicitly incorporated in the supply response estimate.

As developed in Chapter II, an estimate of the elasticity of marketable surplus can be derived as

$$e = rb_1 - (r-1)\{g + hk(1+b_1)\} - (r-1)hb_2(1-k) \qquad (3.1)$$

To obtain the indirect estimate of e, values of the parameters on the right-hand side of equation (3.1) must be obtained.

Behrman did an exhaustive study on supply response for rice, kenaf, corn, and cassava in each changwad of Thailand which provided him with the values of b_1 and b_2. He obtained the value of r from the 1953 Thailand Economic Farm Survey. For the value of g and h, the price and income elasticity of demand for rice consumption by subsistence farmers, Behrman needed to estimate the demand function for rice by

Thai farm families. He was not able to develop a time-series of onfarm consumption of rice, so he used national aggregate consumption as a proxy. As two out of every three families in Thailand are farm families, he felt this data should not bias the results significantly.

Using many different formulations for this demand function he was not able to obtain statistically significant relative price and income coefficients in any, so g and h were assumed to be zero in the estimation of price elasticity of marketable surplus of Thai rice in his model. With the zero value for g and h, his model becomes

$$e = rb_1$$

In this case the price elasticity of marketable surplus depends only upon the value of r, the inverse sales ratio, and b_1, the price elasticity of output or supply response.

The major problem with Behrman's estimation of elasticity of marketable surplus of rice in Thailand was the lack of data necessary to estimate a demand function for rice by Thai farm families. To overcome this difficulty this study uses data collected from farm bookkeeping records to estimate the rice demand function of farm families.

The approach has been to collect data from a cross-sectional sample of farm families over a period of three years. The data used in this study is the (1) net family income (income from both farming operation and off-farm income), (2) family composition as to age and sex of all family members, and (3) total expenditures for rice. Rice expenditure data was available only in the form of total expenditures for cash purchases and the value of rice consumed on the farm which was produced by the farm family.

Let Q_p denote the quantity of rice which was purchased and Q_c be the quantity of rice which was produced by the farm family. Let P_p be the price of rice purchased and P_c the price at which rice could be sold. The rice expenditure data were available in the form

$$E_p = P_pQ_p \qquad \text{(cash expenditures for rice)}$$

and

$$E_c = P_cQ_c \qquad \text{(value of rice produced on the farm consumed)}$$

Total rice expenditures E is the sum of these two classes, or

$$E = E_p + E_c = P_pQ_p + P_cQ_c.$$

It would have been desirable to have the actual quantity consumed by each family instead of expenditures or value terms. If this was the case, the demand function estimation would be relatively straightforward. The demand function might be specified as

$$Q = b_o + b_1P + b_2Y$$

where

Q is the quantity of rice consumed $Q = Q_p + Q_c$;

P is the price of rice; and

Y is the family income.

Because the relevant quantity and price data were not available it was necessary to use price data from secondary sources to derive the quantity of rice consumed.

Three different assumptions as to the relevant price were used in this study resulting in three different sets of data of family consumption and price. The first model uses the average farm price of rice for the months of November to February. The reason for using this price is that most rice is harvested during this period. If rice is sold from the farm it is hypothesized that most rice sales would occur during this period. For this model the total expenditure for rice E were divided by average November to February farm price to get the implied quantity Q.

The second model uses the monthly average farm price for the full marketing year (April 1 to March 31). The logic for using this price is that stockholding of rice might be significant for some of the sample farms so that sales might be more evenly distributed throughout the year instead of just during the peak harvest period. Thus, total expenditures E for each family were divided by the monthly average farm prices for the relevant marketing year.

The third model is the result of more complicated assumptions regarding rice price, farm sales and consumption. This model again assumes that farm sales of rice are most likely to occur during the peak harvest season and thus uses November to February farm price. Dividing E_c by this price the implied quantity demanded of farm-produced rice Q_c is obtained.

The second assumption for this third model is that any cash expenditures for rice purchases is most likely to occur during the months of March to October. Therefore, the total expenditures for purchased rice E_p is divided by the monthly average retail price for the months of March to October to obtain Q_p, the quantity of purchased rice demanded.

Summing the two quantity variables Q_p and Q_c, the result is Q, the total quantity of rice demanded for the farm household. Dividing E, total expenditures for rice, by this implied quantity Q, a weight average price is obtained. This price is used as the relevant price variable in the third regression model.

One final data assumption is necessary before estimation can proceed. To transfer the data in a representative consumer form often the quantity and income variable are defined on a per capita basis. This could be done by dividing the quantity of rice consumed and income of each family by the number of household members.

Wold and Jureen (1953) and other similar studies have noted that estimating the demand for food on a per capita basis introduces a bias. The bias results from the fact that household expenditure patterns are significantly effected by the age and sex composition of households. A household with five adult members may have very different food requirements than a household with two adult members and three young children. To eliminate this bias the concept of consumer units was developed. The procedure to define consumer units is to conduct a food consumption survey to measure the physical quantities of food consumed, age and sex of all individuals surveyed. The value of one is given for an adult male.

If adult females average only 90 percent of the adult male's food consumption, then this group is assigned a consumer unit of 0.90. The consumer unit data used for this study is presented in Table 6.

The general functional form of demand equation is

$$Q_{it} = b_o + b_1P_t + b_2Y_{it} + b_3CU_{it} + b_4D_1 + b_5D_2 + b_6D_3 + e_{it}$$

where

Q is the implied quantity of rice consumed per consumer units;

P is the price of rice;

Y is net family income per consumer unit;

CU is the number of consumer units;

D_1, D_2 and D_3 are regional dummy variables; and

e_{it} is a random error term.

The price and income variables are hypothesized to be determinant of the quantity demanded from the standard results of utility theory. The price coefficient is expected to be negative and the income coefficient is expected to be positive. The use of CU, the number of consumer units, as an independent variable is less common. Some demand studies have shown an increased efficiency of food preparation as family size increases. That is, as the number of consumer units per family increases, the consumption per consumer units decreases. Thus, the number of consumer units is included in the regression and its coefficient is expected to be negative. The three regional dummy variables D_1, D_2, and D_3

Table 6. Consumer unit by age, sex, and region[a]

Region, Sex	Age Level								
	3 years and lower	4-6	7-9	10	11-12	13-14	15-16	17-19	19 years and over
Central									
Male	.22	.47	.54	.64	.69	.71	.83	.93	1.00
Female	.19	.32	.47	.49	.59	.63	.70	.71	.76
South									
Male	.25	.36	.48	.54	.67	.69	.89	.92	1.00
Female	.23	.35	.45	.47	.56	.49	.62	.63	.70
Northeast									
Male	.28	.42	.53	.61	.66	.79	.93	.94	1.00
Female	.22	.36	.47	.50	.59	.60	.68	.70	.72
North									
Male	.27	.30	.57	.66	.68	.78	.94	.99	1.00
Female	.23	.29	.53	.58	.63	.64	.50	.67	.69
Average									
Male	.25	.39	.53	.61	.68	.74	.90	.95	1.00
Female	.22	.33	.48	.51	.59	.62	.63	.68	.72

[a]SOURCE: Supradit, 1975, p. 6.

are included in the regression to allow for regional differences in tastes and preferences.

Demand Function for Rice by Farm Families

The data and models described above the regression equation were estimated. The estimated coefficients and t values are presented in Table 7. The price and income elasticities calculated at their mean values are also presented.

The price elasticity of demand is negative as expected and ranges from .399 to .517. These elasticities are similarities to the -.325 price elasticity of Sriplung and Manowalailao (1971) when they used national aggregate data. The income elasticity of demand is positive for all three regressions and ranges from .082 and .092. Other studies have had similar results. Prasit Supradit (1975) obtained an income elasticity of .106 and Kasem Sirisukhodom (1975) found the income elasticity to be in the range of .017 to .188.

The above regression models provide the 1 percent level of significance for the regression coefficients of each independent variable and also provide the 1 percent level of significance for overall regression models, but the value of R^2, the coefficient of determination is low in each model. The R^2 indicates that only approximately 10 percent of the variation of quantity demanded is explained by the regression equation.

Although it would be desirable to have regression with higher R^2's those results are not unusual for a study of a cross section of households.

Table 7. The regression results

Regression Model	Constant Term	P	Y	CU
Case 1				
(Farm price Nov.-Feb.)				
Coefficient	702.090	-266.596	0.012	-19.992
T-value	19.094**	-7.167**	3.332**	-4.333**
Elasticity		-0.517	0.082	
Case 2				
(Yearly farm price)				
Coefficient	663.691	-214.037	0.014	-21.117
T-value	13.794**	-3.604**	3.612**	-3.146**
Elasticity		-0.401	0.092	
Case 3				
(Weighted average)				
Coefficient	615.174	-190.984	0.013	-19.375
T-value	12.614**	-3.420**	3.558**	-4.230**
Elasticity		-0.399	0.090	

**Significant at the 1 percent level.

D_1	D_2	D_3	R^2	F
-66.232 -2.742**	-39.649 -1.671	103.972 3.310**	0.184	32.497
-84.117 -3.146**	-47.613 -1.887	125.806 3.832**	0.169	22.898
-70.081 -2.857**	-29.763 -1.259	146.783 4.494**	0.170	23.032

For example, a typical value of R^2 for various household behavior functions from the University of Michigan's Survey Research Center data (about 3,000 observations) is close to 0.20. This would indicate that 80 percent of the sample behavioral variation from household to household can be accounted for by factors other than the explanatory variable or variables (Kmenta, p. 234).

The problem lies with the fact that there exists extreme variation between households as to their expenditure patterns on specific items. This is because households have different preference functions. Individual household consumption of rice cannot be explained just by price, income, number of consumer units, etc. But is is possible to get an idea as to how families react to change in price, income, and number of consumer units. This is reflected by the very significant t-value obtained of the respective coefficients.

In testing the significance of the explanatory variables in the regression, the null hypothesis that the population value of the coefficient of determination is zero is tested by using the formula

$$F = \frac{R^2/k - 1}{(1 - R^2)/n - k}$$

In general, the value of R^2 is reported in evaluating the goodness of fit of a regression, but it could be misleading as it does not take into account sample size.

Suppose a sample of 7,000 observations was available and that $R^2 = 0.01$ for a regression with four explanatory variables. One would distinctly dismiss this regression as completely insignificant. In fact, the value for the F-test statistic under these conditions is 17.60 and the critical value for $F_{4, \infty}$ is 4.62 in a one tailed test at the 0.1 percent level of significance. Thus, the F-test shows that the population value of the coefficient of

> determination is significantly different from zero and that, although there is 99 percent unexplained variation, there is nevertheless a significant relationship between the dependent and explanatory variables.
>
> It is useful to contrast this result with $R^2 = 0.9$ for the same number of explanatory variables with a sample of 10 observations. In this case the value of the F-test statistic is 11.25. The critical value of F_{4}, tailed test at the 1 percent level of significance is 11.34. Thus, the null hypothesis of zero coefficient of determination would not be rejected at 1 percent significance, even though R^2 is as high as 0.9 (Currie, Miah, Moore, Rayner, and Stewart, 1972).

From the above example, both value of R^2 and F-test are necesary to look at in considering the goodness of fit of a regression.

From this study, as Table 7 shows, the value of F-test statistics is 32.797 for the first regression model, 22.894 for the second model, and 23.032 for the last model. The critical value for $F_{3,400}$ is 3.83 in one tailed test at 1 percent level of significance. It shows that the population coefficient of determination is significant in every regression.

CHAPTER IV. SUMMARY AND CONCLUSION

To estimate the price elasticity of marketable surplus of Thai rice by using Behrman's model, the value of g, the price elasticity of demand for rice consumption, and h, the income elasticity of demand for rice consumption are required to substitute into the model that Behrman developed.

As developed in Chapter II, an estimate of the elasticity of marketable surplus can be derived as

$$e = rb_1 - (r-1)\{(g + hk(1+b_1)\} - (r-1)hb_2(1-k)$$

To obtain the indirect estimate of e, values of the parameters on the right-hand side of the equation must be obtained.

These parameters are:

b_1 the price elasticity of supply of the subsistence crop;

b_2 the price elasticity of supply of other crop alternatives;

r the inverse sales ratio Q_1/M_1;

k the proportion of total net income derived from the subsistence crop;

g the price elasticity of demand for onfarm consumption of the subsistence crop by farm families; and

h the income elasticities of demand for onfarm consumption of the subsistence crop by farm families.

From the regression models in Chapter III, estimates for g and h are obtained. In 1974, the D.A.E. in Bangkok conducted the General Farm Survey. For the 1973-74 crop year this survey estimated total rice production, Q, to be 13.431 million metric tons and off-farm sales or marketings, M, to be 5.787 million metric tons.[1] Using these estimates r, the inverse sales ratio, Q/M is computed to be 2.407 which differs only slightly from the Behrman estimate.

The value of k, the ratio of the value of rice production to total net farm income, is obtained from the Agricultural Statistics of Thailand (Division of Agricultural Economics, 1976). For the 1974 crop year the farm value of rice production was 28.08 billion baht and the total crop and livestock farm income was 99.64 billion baht. This provides an estimate of .282 for k.

The last two parameters, the value of b_1 and b_2, were estimated by Jere R. Behrman (1966). The value of b_1, the price elasticity of rice production is in the range of .02 to .62, and the value of b_2, the price elasticity of competing crops which are corn and kenaf, is in the range of -.27 to -5.5. Behrman estimated the short-run and long-run price elasticities of desired production for the major cash crops of Thailand in each changwad, but this study uses the short-run price elasticity for the value of parameters because the price of agricultural products in Thailand is flexible all the time. It varies not only by year, but also by month, so the long-run price elasticity is not very useful. The cash

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[1]D.A.E. conducted the General Farm Survey and provided the unpublished data about rice production and rice marketing.

crops that Behrman estimated the price elasticity for were corn, cassava, and kenaf. In Thailand, cassava usually grows on sandy-loam soil, and this soil would not be used for rice cultivation. The upper and lower level of price elasticity of corn and kenaf are used for the elasticity of the competing crops to rice.

Having estimates for the values of all the parameters, the price elasticity of marketable surplus of Thai rice can be estimated in terms of minimum and maximum values. Krishna (1962) estimated the price elasticity of marketable surplus for the farmers who sold rice to the market at the different ratio of total output. He classified the farm families into three groups, the highly subsistent farmers who sold only 10 percent of the total production to the market (m = .1), farmers who sold 50 percent of total production to the market (m = .5), and the highly commercial farmers who sold 90 percent of total output to the market (m = .9). From these values of m, the values of r, the inverse sales ratio are 10, 2, and 1.1, respectively.

In this study the price elasticity of marketable surplus of Thai rice is computed at the different level of sales ratio, m, as Krishna has done. The results are presented in Table 8.

The results from this table imply that the price elasticity of marketable surplus of Thai rice is positive. This study supports the conclusion that subsistence farmers have a positive response to price in allocating the amount of rice between consumption and marketing. This result is similar to the results that were studied by Krishna (1962), Behrman (1966), and Toquero, Duff, Arden-Lacsina and Hayami (1975).

Table 8. The price elasticity of marketable surplus of Thai rice

Plausible Ranges of Parameters		Value Relevant Min. e	Max. e
b_1 = .02 to .62		.02	.62
b_2 = -.27 to -5.50		-.27	-5.50
g = -.399 to -.517		-.399	-.517
h = .082 to .092		.082	.092
k = .282			
r = 2.407			
e =		.598	2.671
	m = .1	m = .5	m = .9
Min. e	3.736	.411	.061
Max. e	13.742	2.078	.765

The price elasticity of marketable surplus is positive as long as the g is negative and the absolute value is higher than the h. The other outcome of this study shows that the value of e is inversely related to the value of m, the inverse sales ratio. This means that the farm families who consume the main portion of their product will allocate their product to market more when the price of rice increases. Krishna said that this case is "opposite of what is commonly supposed to be true in the current literature" (Krishna, 1962, p. 84), but it is possible. Mubyarto explained this case that "It is due to the fact that the negative 'consumption component'. . . is small (.2), while the positive 'outcome component' is high (.8). The multiplication of these components by their respective indices (Q/M - 1) and (Q/M) produces a progressively increasing e_m as Q/M increases" (Mubyarto, 1965, p. 127).

In the study of Thai rice, this case can be explained by looking at the model

$$e = rb_1 - (r - 1)\, g + hk(1 + b_1) - (r - 1)hb_2(1 - k)$$

The more commercial the farmers are, the less the value of r. The value of r will be equal to one for the fully commercial farmers who sold all the products produced to the market. The second and the last term will be zero because the value of r - 1 will be zero, so the price elasticity of marketable surplus will be $e = rb_1$ or $e = b_1$ (r = 1). For the farmers who are not fully commercial, the more subsistent they are, the higher the value of r. This will make the higher positive value of the first term in the model more than the commercial farmers, and the last term will be positive and add to the first term as long as the value of b_2 is negative. The second term will be positive or negative depending upon the value and the sign of g and h, which are determined by the utility preference. In this study the second term is positive, so the value of e is high for the subsistence farmers.

Policy Implications

The numerical results of this study provide important information for the government about the rice situation, the effect of price on the rice market, and the demand for domestic consumption of rice. From this study the following implications can be drawn:

1. The positive price elasticity of marketable surplus indicates that the Thai farmers' response to the price of rice is similar to that of the farmers in India, Indonesia, and the Philippines, but the Thai farmers are more responsive to price than the farmers in these other countries.
2. The high price of rice in this year is an adequate incentive to accelerate the rice production of next year. The farmers will supply more rice to the market because the farmers have a positive price elasticity of rice production which means that the farmers will produce more rice when the price of rice increases. The farmers also have a positive price elasticity of marketable surplus which means that the farmers will allocate an increased amount of rice to the market when price increases.
3. The estimate of price elasticity of demand for rice consumption for Thai farmers is negative. This means that the farm families will decrease the quantity demanded for rice when the price of rice increases. This price elasticity estimate is only for farm families, but the government could make a decision about demand for rice consumption or other agricultural products policy related to rice based on the information from farm families which comprise 70 percent of total population.
4. The estimate for income elasticity of demand for rice consumption for farmers is positive. When income increases, the farm famility will increase the quantity demanded for rice consumption. This information could help the government estimate the

demand for domestic rice consumption in the future based on national income and population trends. Although this estimate is specifically for farmers, since 70 percent of total population are farmers, this knowledge could provide an estimation for the whole country in domestic demand projection for rice.

The policy about rice in Thailand could not be suggested because the knowledge about price elasticity of marketable surplus is obtained, but this study provides the information that tells the government how much the farmers respond to price. The government can use this knowledge setting the effective policy and knowing the response from the farmers. The policies about rice that have been working in Thailand are listed below.

Policy in increasing the technology in rice production

Because rice is the most important crop in Thailand, the government tries to improve the quantity and quality of rice production by providing good variety of seeds, fertilizers, knowledge and information, and irrigation to the farmers. These programs will increase the quantity and quality of rice production in Thailand.

Rice premium policy

The government collects taxes from the rice exporter and pays it back to the farmers in the form of water-pump, fertilizers, other kinds of tools, and credit to the group of farmers.

Price regulation policy

The government sets the minimum price of rice that the farmers should receive. This policy will help the farmers get a reasonable price from their product and minimize the risk due to price fluctuations.

Rice buffer-stock policy

In the year that the farmers have a good production crop, the price of rice will decrease because the supply is higher than demand, the government will buy rice from the farmers at the regulation price and sell it back to the market in the years that production is bad. This policy could minimize the price fluctuation for the farmers as well as the consumers.

For the last two policies, price regulation policy and rice buffer-stock policy, the knowledge about price elasticity of marketable surplus could help the policy makers know about the price effect. They could estimate the total supply of rice in the market if they set a certain level price level for rice. Because the policy makers have a cue to estimate the results from price effect, they could make a decision to set an effective policy that would bring the prosperity to the country.

Conclusion

Thailand, the country of rice producers and rice exporters, faces the problem that the domestic demand and export demand are increasing all the time due to the increment of the world population. The cultivated area in Thailand cannot be increased. The rate of return to investment in rice is lower than the rate of return to investment in corn, cassava, kenaf, and sugarcane, which are the main cash crops. The production of cash crops has increased more rapidly during recent years. Even though rice production has not decreased, it has not increased at a satisfactory growth rate. The government has to find the means to increase rice production.

Because rice is the kind of crop where the producers are also the consumers, they have to allocate production for their own consumption first, then sell the surplus to the market. In order to increase the product in the market, it is very difficult for the government to choose the policy to work with if there is no information provided about the farmers' behavior. With the other kinds of production where all products go to the market price is a means to give farmers the incentive to provide more of the product to go to market. In the case of rice, the increment in price of rice may increase or decrease the amount of rice on the market because the farmers may consume more and market less, or consume less and market more when the price increases.

From this study it is known that the farmers will provide more rice to the market when the price increases. Positive price policy could be one of the policies that would make the marketable surplus of rice increase more rapidly. This study also provides information about price and income elasticity of demand for rice consumption. The government could project demand for rice in the country and, being aware of the problem, the potential to change the country from the rice exporter to the rice importer which might occur in the future. Besides the policy about rice, the policy makers could use the information from this study to set the policy for the other kinds of agricultural products related to rice.

CHAPTER V. RECOMMENDATION FOR FURTHER STUDY

This study uses a micro level or individual farm level data which provides the value of rice consumption in each farm family. To estimate the elasticity of demand for rice consumption, the quantity of rice consumption is needed instead of value of rice consumption. When the value of rice consumption is converted to be the quantity of rice consumption by price, the error cannot be avoided. If the improper price level of rice is used to convert the value of rice consumption, the over or underestimation of quantity of rice consumption will be obtained. Even the price and income elasticity of demand for rice consumption in this study are significant at the 1 percent level, it will be useful to reestimate again by using the direct set of data, quantity of rice consumption, and price of rice.

The weak points of estimating the price elasticity of marketable surplus in this study are using the national average of r, the inverse sales ratio, and k, the total value production of rice to the total net income. Thailand, the rice country, has a lot of rice producers who own cultivated land for rice production that varies from 6 rai to more than 100 rai. These farmers have different levels of capabilities of resources to produce rice. The farmers who have more resources can produce and sell more rice than the farmers who have less resources. Between these two groups of farmers, the value of r and k will differ completely and the value of price elasticity will differ also.

Instead of estimating the average price elasticity of marketable surplus for the whole nation, it will be interesting to estimate the price elasticity of marketable surplus for the farmers who own the different amounts of land. It can be done by selecting the observation samples from the farmers who own the land under 30 rai, 30 to 60 rai, 60 to 90 rai, and 90 rai and over. The value of parameters will be observed for each group of farmers and the price elasticity of marketable surplus should be estimated separately. The percentage of the number of farmers in each group to the total number of farmers can be estimated, then the total price elasticity of marketable surplus of Thai rice will be obtained. This procedure will provide the more detailed numerical information about how the farmers of varying farm sizes react to the change of price.

The above recommendation should be done in the case where the information about rice production, rice marketed, onfarm consumption of rice, and the farm price of rice are not provided. The theoretical model will be derived to use the parameters that can be estimated to compute the price elasticity of marketable surplus. It is called the indirect estimation for this procedure. Another method to estimate the price elasticity of marketable surplus is called the direct estimation. This can be done by regressing the amount of rice marketed on the price of rice and other relevant variables directly to give the regression coefficient, then the price elasticity of marketable surplus can be computed.

The direct estimation method should be used for Thai rice. The data about quantity of rice marketed, rice production, production of competing crops of rice, price of rice, income of the farmers, and other relevant variables should be collected. The regression model will provide the coefficients for estimating the price elasticity of marketable surplus and other interesting information. The result from direct estimation might show important outcomes that the indirect estimation did not show. The estimation for price elasticity of marketable surplus might be definite if the direct estimation can be done under the reliable data. At that time, there will be no doubt of how the farmers will react to the change of price.

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ACKNOWLEDGMENTS

I wish to thank many people who sacrificed a great deal of time and energy to help and encourage me in completing my thesis. I am indebted first to Dr. Somnuk Sriplung, Chief of D.A.E. in Bangkok, who selected me for the scholarship from AID for my master's degree at Iowa State University and encouraged me to this thesis by providing the sets of data from D.A.E. Without him, I would not have this great opportunity and this thesis would not exist.

The second person I have to thank is Dr. J.T. Scott, my major professor. He was so kind and understanding. I am very proud to be a student under his guidance. He tried very hard to make this thesis more complete and more valuable.

I also wish to thank Dr. Earl O. Heady and Dr. Richard D. Warren who were on my graduate committee, especially Dr. Heady who helped greatly in my completion of this thesis.

My greatest thanks go to Mr. Wayne D. Ellingson. He was a very helpful and dependable person, not only as my friend, but also as my teacher and my brother. He gave his valuable time to explain the problems and worked very hard to improve this thesis to make it more interesting.

I appreciate and am thankful also for the help of Dr. Leroy L. Blakeslee, Mr. Rodger D. Garner, Mr. Sakol Ooraikul, my husband, and all of my friends at the D.A.E. in Bangkok who helped me finish this thesis. If this thesis proves to be interesting or provides something valuable, the people named above are the people who made it so; but the errors in this thesis are due to my carelessness, my limited knowledge, and I apologize for them.

Anchalee Ooraikul