THE METHODOLOGY OF ESTIMATING THE RESPONSE OF PHILIPPINE RICE FARMERS TO PRICE*

By
MAHAR MANGAHAS

1. Introduction

Recent popular literature has given much attention to the issue of establishing a price support for the benefit of the Philippine rice sector. The important question is whether the response of rice output as a whole to the guaranteed price will be quantitatively significant. This is part of a larger question raised frequently in recent economic literature—whether the price response of the agricultural sector in under-developed countries is positive, zero, or even negative. It is useful to know to what extent measures of price policy help the agricultural sector fulfill its role in the nation's economic development. This role of the agricultural sector is roughly, (a) to provide the increasing food and fiber requirements of the non-agricultural sector, and (b) to provide an expanding market for the products of the non-agricultural sector. Intimately connected with this dual role is the concept of the marketed surplus, or total agricultural output less the agricultural produce consumed by the agricultural sector. The marketed surplus must expand both to meet the non-agricultural sector's raw material needs and to provide the farm sector with increasing income with which to buy the products of industry.

This paper discusses the methodology of estimating the price response of the output and marketed surplus of an important food crop (rice). The next section is a survey of the literature on the price response of the output and marketed surplus of an individual crop. Then a theoretical discussion of the rice

*Paper presented at a meeting of the Philippine Statistical Association on June 24, 1965.

economy follows to show the relevance of the response functions to the system of relations that governs the rice industry. This discussion also gives a basis for appraising the estimation methods presented later.

2. Survey of the literature

The price-response question has four parts: (1) Does aggregate agricultural output respond positively to changes in internal terms of trade that favor agriculture? (2) Does aggregate marketed surplus respond positively to similar changes? (3) Does the output of an individual crop respond positively to increases in its farm price relative to farm prices of other crops? (4) Does the marketed surplus of an individual crop respond positively to similar changes? Research to date has been mostly directed towards answering the third and fourth questions. This is the type of research reported here. The first two questions have thus far been answered more on the bases of speculation than on data derived from research.

Price response of the output of individual crops.

At least two studies had been published on the price response of individual agricultural crops in under-developed countries before 1960. In 1957, Ralph Clark[1] showed that from 1911/12-1954/55, both jute output and area in Bengal, India, and Pakistan were positively related to the logarithm of the lagged price of jute and negatively related to the logarithm of the lagged price of rice (the competing crop). (In an unpublished study in 1958, L.C. Venkataraman found a

---

[1] Ralph Clark, "The Economic Determinants of Jute Production," *FAO Monthly Bulletin of Agricultural Economics and Statistics*, 6:9 (September 1957), 1-10.

short-run elasticity of acreage[2] for jute of +0.46 for India in the period 1911-1938.)[3] In 1959, P. T. Bauer and B. S. Yamey[4] reported that cocoa producers in Nigeria reacted positively when the government marketing board offered growers a price for Grade I cocoa much higher than lower grade prices. Whereas Grade I cocoa constituted 47% of the marketing board's purchases in 1947/48, it constituted 98% of the purchases in 1953/54.

In 1960 the price response question stimulated debate at the annual meeting of the American Farm Economic Association, during which papers were read on the "Impact and Implications of Foreign Surplus Disposal on Underdeveloped Economies." At this meeting T. W. Schultz[5] expressed the opinion that total food ouptut in under-developed countries responds positively to increases in farm prices of food:

> "If in the process [of distribution of PL 480 food by the United States in an underdeveloped country] farm prices decline relatively, this is looked upon as of no economic consequence because of the widely held belief that the price response of cultivators is zero. Lower farm prices by this view will not induce cultivators to produce more..

---

2 The elasticity of hectarage with respect to price is a lower limit to the elasticity of output with respect to price provided that yield is not negatively related to price.

3 L.C. Venkataraman, *A Statistical Study of Indian Jute Production and Marketing with Special Reference to Foreign Demand*, Ph.D. dissertation, University of Chicago, 1958 (unpub.). This study is not available; but Mr. Venkataraman's estimate is cited in both Krishna's *Economic Journal* article and Hussain's *Pakistan Development Review* article. See infra.

4 P. T. Bauer and B. S. Yamey, "A Case Study of Response to Price in an Underdeveloped Economy," *Economic Journal*, 69:276 (December 1959), 800-805.

5 T. W. Schultz, "Value of U.S. Farm Surpluses to Underdeveloped Countries," *Journal of Farm Economics*, 42:5 (December 1960), 1019-1030. The quotation following is from page 1029.

"I take a dim view of this climate of opinion."

R. O. Olson,[6] a discussant, opposed Schultz's view thus:

> "I am not sure it is a misconception to believe that the price response of Indian cultivators is very low; on the contrary, there is convincing evidence that there is a negative supply response by way of income effect. For the vast majority of farmers, the marketable surplus is very small. The response to a price rise may well be to retain more for consumption."

Olson's "supply response" is, more precisely, **marketed-surplus** response; this differs from Schultz's "production response" and, in the absence of empirical information, the direction of one type of response has no conclusive implications for the direction of the other type of response.

The price-response of the output of certain other individual crops was shortly after demonstrated to be positive in India, Pakistan, and Indonesia. The next study to appear was of Raj Krishna[7] for the undivided Punjab in 1961. Krishna estimated acreage response functions for 11 crops, mostly for the period 1914-1945, and found significant short-run (one-year) elasticities in seven cases, ranging from +0.08 for irrigated wheat to +0.72 for American cotton. For rice, he found a short-run elasticity of +0.31 and a long-run elasticity

---

6 R. O. Olson, "Discussion: Impact and Implications of Foreign Surplus Disposal in Underdeveloped Economies," *Journal of Farm Economics*, 42:5 (December 1960), 1042-1045. The quotation is from page 1043.

7 Raj Krishna, "Farm Supply Response in India-Pakistan: A Case Study of the Punjab Region," *Economic Journal*, 73:291 (September 1963), 477-487. Based on his Ph.D. dissertation, *Farm Supply Response in the Punjab: A Case Study of Cotton*, University of Chicago, 1961 (unpub.).

of +0.59. The following year, Walter P. Falcon[8] found price elasticities of acreage of +0.4 for cotton and +0.2 for irrigated wheat, for the Punjab area of West Pakistan, during 1933/34-1958/59. As Krishna, he did not find a significant elasticity for unirrigated wheat. In 1963, Ghulam Mohammad[9] found the price elasticity of cotton acreage in West Pakistan during 1935/36-1962/63 to be +0.5. In 1964, Syed Mushtaq Hussain[10] found that in East Pakistan during 1948-1963 the price elasticity of jute acreage was +0.4, and the price elasticity of summer-winter rice was +0.05. Then, in 1965, Mubyarto[11] estimated the price elasticity of rice acreage in Indonesia during 1951-1962 at +0.30. The major independent variable used in these studies was the lagged (one-year) ratio of the price of the crop in question to the price (or an index of the prices) of the competing crop(s). An important finding was that price response was greater for crops grown primarily for sale than for crops grown primarily for home consumption (cash crops and food crops, respectively); it was also greater for irrigated crops than for unirrigated crops.

Added to these three time-series studies is a cross-section study in Pakistan. (Cross-section studies are unusual because observations of responses to different prices are ordinarily available only for different points in time.) Mahmood Hasan

---

8 Walter P. Falcon, "Factor Response to Price in a Subsistence Economy: the Case of West Pakistan," *American Economic Review*, 54:3 (May 1964), 580-591. Based on his Ph.D. dissertation. *Farmer Response to Price in an Underdeveloped Area. A Case Study of West Pakistan*, Harvard University, 1962 (unpub.).

9 Ghulam Mohammad, "Some Physical and Economic Determinants of Cotton Production in West Pakistan," *Pakistan Development Review*, 3:4 (Winter 1963), 491-526.

10 Syed Mushtaq Hussain, "A Note on Farmer Response to Price in East Pakistan," *Pakistan Development Review*, 4:1 (Spring 1964), 93-106.

11 Mubyarto, *The Elasticity of the Marketable Surplus of Rice in Indonesia: A Study in Java-Madura*, Ph.D. dissertation, Iowa State University, 1965 (unpub.).

Khan[12] reported in 1964 that, in a sample survey in which farmers were asked how much more or less land they would use if the wheat (or rice) price rose or fell, West Pakistan wheat farmers indicated that they would respond positively if the wheat price rose (but not if it fell) and that East Pakistan rice farmers indicated they would not respond to any significant extent.

Thus it has already been shown that in a number of countries the output or acreage of individual crops responds positively to price incentives. The extent of the responses found has varied and has been greater for cash crops than for food crops. These studies, however, have no necessary implications for the direction of the response of total agricultural output, total agricultural marketed surplus, or the marketed surplus of individual crops.

Price Response of the Marketed Surplus of Individual Crops

The next question concerns the price response of the marketed surplus. The leading hypothesis is that of P. N. Mathur and Hannan Ezekiel[13] in 1961: due to the low level of monetization in the agricultural sector of subsistence economies, farmers have a fixed cash requirement; thus they need to market less out of a given output at higher current prices. The fixed cash requirement covers necessities not produced on farms, and, according to Mathur-Ezekiel, is a first lien upon the agricultural output.[14] A further argument in favor of the

---

[12] Mahmood Hassan Khan, "Real Effects of Foreign Surplus Disposal in Underdeveloped Economies: Comment," *Quarterly Journal of Economics*, 78:2 (May 1964), 348-349.

[13] P. N. Mathur and Hannan Ezekiel, "Marketable Surplus of Food and Price Fluctuations in Developing Economy," *Kyklos*, 14: Fasc. 3 (1961), 398-407.

[14] This makes the residual the amount retained, not the amount sold. Hence Mathur-Ezekiel favor the term "marketed *proportion*" over "marketed surplus."

negative marketed surplus response hypothesis is the alleged strong tendency of farmers to increase home consumption (rather than marketed surplus) when their incomes rise following a rise in farm prices. This is the "income effect" to which Olson referred.

The opposing hypothesis was later presented by Vinod Dubey.[15] He contented that the marginal propensity to consume food out of income is not too high in subsistence economies because of the growing importance of inter-sector and intra-sector demonstration effects. These demonstration effects tend to raise the level of monetization in these economies. In addition, farms have a high marginal propensity to save in order to purchase land and precious metals. Finally, much agricultural land in under-developed countries is in large holdings that operate on cash basis. Dubey presented the following estimates in support of his hypothesis: income elasticities of expenditure on food in Madras, India of only +0.49 (1939) and +0.47 (1945); income elasticities of expenditure on cereals in India of only +0.25 (urban areas) and +0.50 (rural areas), in 1957.

A great barrier exists, both here and abroad, against the direct empirical testing of either the Mathur-Ezekiel or the Dubey hypothesis: this is the unavailability of marketed surplus data in time-series in the under-developed countries. Krishna has suggested an indirect method[16] whereby the price elasticity of the marketed surplus of a crop is expressed in terms of the price elasticities of output and of home consumption. Taking plausible value ranges for the latter parameters (for

---

[15] Vinod Dubey, "The Marketed Agricultural Surplus and Economic Growth in Underdeveloped Countries," *Economic Journal*, 73:292 (December 1963), 689-702.

[16] Raj Krishna, "A Note on the Elasticity of the Marketable Surplus of a Subsistence Crop," *Indian Journal of Agricultural Ecnoomics*, 17:3 (July-September 1962), 71-84.

wheat in India) he concluded that the plausible value-range for the price elastcity of the marketed surplus was entirely positive. Using an elaboration of Krishna's method, Mubyarto has concluded that in Indonesia the price elasticity of the marketed surplus of cerals is positive except in relatively poor areas where it is negative.[17]

It may not be premature to distinguish at this point between the response of the marketed surplus of a crop to **current** price and its response to **expected** price. Many economists have shown a positive relation to hold between current output of a crop and its expected relative price.[18] Cross-section studies by Krishna[19] and A. S. Kahlon and H. N. Dwivedi[20] for India and Azizur Rahman Khan and A.H.M. Nuruddin Chowdhury[21] for West Pakistan have shown that a strong positive relation would also exist between marketed surplus and output. By this, a positive relation would also exist between marketed surplus and expected price. Farmers would plan to both produce more and market more of a given crop, **cet. par.**, if its expected relative price rose. It nevertheless remains possible that **out of a given harvest** farmers would market less than they previously intended if the current price were greater than the expected price; this is because it is current price rather than expected price that **immediately** determines the marketed

---

17 Mubyarto, *op, cit.*, 129-130. I doubt the necessity of Mubyarto's elaboration, however. A clarification of Krishna's method is presented in Section 4.

18 That is, researchers have implicitly assumed that lagged relative price equals expected relative price.

19 Raj Krishna, "The Marketable Surplus Function for a Subsistence Crop," *The Economic Weekly*, February 1965, 309-320.

20 A. S. Kahlon and H. N. Dwivedi. "Inter-relationship Between Production and Marketable Surplus" *Asian Economic Review*, 5:4 (August 1963), 471-487.

21 Azizur Rahman Khan and A.H.M. Nuruddin Chowdhury, "Marketable Surplus Function: A Study of the Behavior of West Pakistan Farmers,"*Pakistan Development Review*, 2:3 (Autumn 1962), 354-376.

surplus. The explanation for such behavior would be the presence of a strong income elasticity of home consumption (as per Olson) and/or a low demand of farmers for cash (as per Mathur-Ezekiel). (There have been no empirical studies of the response of the marketed surplus in this respect.) Thus the response of the marketed surplus to "price" may be thought "rational" in one context and "perverse" in another.

3. The basic relations of the rice economy

This analysis assumes that the palay industry in the locale under study is purely competitive, i.e., that palay is a homogeneous product, and that there are many sellers and buyers of this product, none of whom singly handles so much of it that he has any significant influence upon the farm price of palay.[22] It also assumes that palay buying and selling only takes place in a few months after harvest, and that no stocks of palay enter the market aside from those resulting from current production. This allows the supply function to be constructed for palay to be relatively uncomplicated. In this simplified setting, there will have been, at various past years, various palay prices, and corresponding to each of these prices, some part of the total output of palay will have been marketed. In a competitive industry, these variables are determined by whatever characteristics the market supply of and the market demand for palay happen to have at the moment. (These characteristics constantly change, for if they did not, one could not explain changes in the price of palay and in the amount marketed.)

---

[22] There are scores of varieties being planted in the Philippines; there are similarities enough among them to make feasible classifying them as either Fancy, Special, Ordinary or Inferior.The more important assumption is that there are no buyers and sellers of palay big enough to affect prices. Suspicions have always abounded that there are middlemen powerful enough to "manipulate" prices, but there is no evidence to this effect. On the other hand, it can be shown that the marketing margin in most regions does not vary as farm prices vary.

To repeat, the marketed surplus of palay during a particular season is defined to be the total palay output less the amount the producers consume at home. Under such a definition, "home consumption" covers **all amounts not put on the market** and includes investment in inventory, gifts, etc. Symbolically,

(1) $M_t = Q_t - C_t$,

where M is actual marketed surplus, Q is actual palay output, and C is actual palay consumption by palay producers.[23]

Give the rice production function (representing the state of rice technology) and given the climatic conditions, Q_t depends on the amount of inputs rice producers employ during season t — hectarage planted, amount of labor applied, etc. Presumably, rice producers decide on how much output to produce with maximization of expected net profit as one of their major objectives. The amounts of inputs that they wish to employ would then depend, in most part, on the expected prices of these inputs and on the price at which they expect to sell palay, as well as the cost conditions governing crops that can alternatively be planted on rice land, and the expected prices of these alternative crops. It is uncertain whether the amounts of inputs actually employed are equal to the amounts rice farmers desire to employ. Differences may occur, for instance, due to a shortage of some inputs when they are needed. Hence the basic output response function for palay is:

---

[23] Stress is laid on the adjective *actual* in recognition of the possibility that the *observed* outcome of various variables might significantly differ from their *intended* outcome. In addition, we distinguish between the expected level of a variable, e.g., Pt*, the price of palay expected to be current at time t, and the *actual* value of the variable, e.g., Pt, the observed price of palay at time t. The * — superscript given any variable is used to indicate that the variable is either an expected level or a desired level.

(2) $Q^*_t = f_1 (P^*_t, F^*_t, A^*_t, T^*_t)$,

where Q_t is the amount of palay it is desired to produce during production period t, P^*_t is the palay price farmers expect after harvest of season t, F^*_t is an index of factor prices expected to obtain during growing period t, A^*_t is an index of the expected prices of crops that can alternatively be planted during season t, and T^*_t is a measure of the expected standing of rice technology relative to technology regarding alternative crops.[24] The variables P^*_t, F^*_t, A^*_t and T^*_t are all exogenous (hence Q^*_t is also exogenous) to the model given here.[25]

Per capita consumption of palay by producers, C_t, on the other hand, can be made a function of the current price of palay, the current prices of those foods that substitute for rice, and the per capita real income of the population dependent on rice in the region. Real income of this population falls under two categories: income from palay production, and income from other sources. Income from palay is $P_tM_t + P_tC_t = P_tQ_t$, i.e., money income from sale of palay and the value of home consumed palay. Per capita income is

$$\frac{Y_t}{N_t} = \frac{P_tQ_t + Z_t}{N_t}$$

where Z represents income from sources other than palay production, N is the population dependent on rice in the region

---

24 T can be represented by the ratio of an index of palay yield to an index of the yields of alternative crops, if it can be assumed that improvements in these yields were the result of the use of better varieties and cultural operations, rather than the increased use of such inputs as fertilizer and chemicals.

25 The behavioral relation (2) is not directly observable. For empirical purposes, one needs to assume certain fixed relationships holding between *expected* or *planned* variables and directly observable variables. See Section 4.

and Y is total income of N. The home consumption function can be written in per capita terms,

$$\frac{C_t}{N_t} = f_2 \left(P_t, S_t, \frac{Y_t}{N_t}\right)$$

or in original aggregate terms,

(3)

$$C_t = N_t \cdot f_2 \left(P_t, S_t, \frac{Y_t}{N_t}\right)$$

where S is an index of the prices of substitute foods. For rice farmers a change in P_t affects C_t insofar as it represents a change in relative food prices (the price effect) and also insofar as it represnts a change in the real income of rice producers (the income effect).

Thus, not considering climatic conditions, marketed surplus M_t is a function of all independent variables found in (2) and (3), provided that the relationship assumed for empirical purposes between planned output Q^*_t and actual output Q_t does not contain any new variables.[26]

The non-palay-producers in the region would express on their part a per capita demand for milled rice, dependent on the current price of milled rice, the current prices of substitute foods, and on their per capita real income. We can represent this demand by

$$\frac{R_t}{N'_t} = f_n \left(P'_t, S_t, \frac{Y'_t}{N'_t}\right)$$

where R is the total number of sacks of milled rice demanded (at rice price P'), N' is the regional population not dependent on rice for income, and Y' is the total income of N'. In the case where the marketing margin is treated as a constant, as when there is no independent demand for marketing services,

---

[26] A statistical function set up for M_t would presumably have a random residual term; this term would reflect the influence of such non-economic factors as weather.

the price of milled rice will be a linear function of the price of palay. Let r be the volume conversion ratio, i.e., $rM_t = R_t$, and m be the marketing cost per unit of M.[27] The sales value of milled rice is defined to be the sales value of the palay sold plus palay marketing cost, i.e.,

$$(P_t + m)\ M_t = P'_t R_t$$

It follows that

$$(P_t + m) M_t = P'_t\ r\ M_t$$

$$\frac{P_t + m}{r} = P'_t$$

The demand function for milled rice is then transformed into a demand function for palay:

$$\frac{r\ M'_t}{N'_t} = f_3\left(\frac{P_t + m}{r}\ ,\ S_t,\ \frac{Y'_t}{N'_t}\right)$$

or

(4)

$$M'_t = \frac{N'_t}{r} \cdot f_4\left(P_t,\ S_t,\ \frac{Y'_t}{N'_t}\right)$$

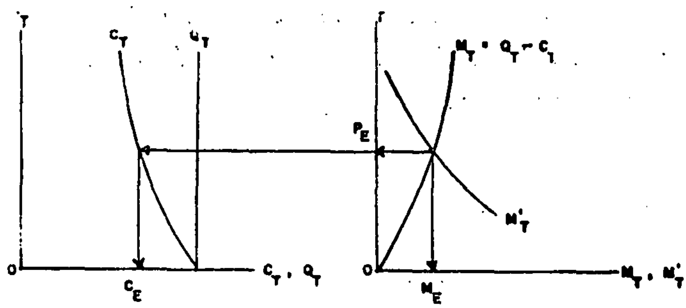
where M'_t is the quantity of palay demanded by the non-palay producers.

If t measures off years, (1), (3) and (4) give us a short-run market supply function and a short-run market demand function. Attaching equilibrium condition $M_t = M'_t$, we have the framework for a model that simultaneously determines P_t, M_t and C_t, given values for the exogenous variables

[27] Use of the volume conversion ratio implies that both M_t R_t are measured in cavans or sacks. The palay weighs 44 kg., the milled rice cavan, 56 kg.. The official weight conversion ratio: 1 kg of palay = .65 kg. of milled rice; the official volume conversion ratio (which derives from the weight conversion ratio): 1 cavan of palay = .51 cavan of milled rice.

Q_t, S_t, Z_t, N_t, Y'_t and N'_t.[28] Figure 1 shows a market supply function for palay derived from a home consumption function and an output function. The current market price of palay and the amount marketed are determined in the palay market; the current market price in turn determines the current level of home consumption.

Q_t is drawn at a constant level for all values of P_t, due to the important assumption that the palay price variable influencing Q^*_t is not the current price of palay, P_t, but the **expected price of palay, P^*_t.** Actual output is produced by inputs committed to palay production before the post-harvest price is known.



ACTUAL PALAY OUTPUT AND HOME CONSUMPTION

PALAY MARKET

FIG. 1

The negative slope of C_t implies that the (negative) price effect of a price change on farmers as consumers outweighs both the (positive) income effect and any fixed cash-requirement effect combined. This is the stand that Krishna and

---

28 In an impirical model, one would have to consider X_t palay shipped out of the region, I_t palay shipped into the region, and B_t, of palay supplied in the region is then defined to be $M_t + I_t + B_t - X_t$, assuming all of I_t and B_t are for sale.

(to a lesser extent) Mubyarto have taken, **contra** the views of Olson and Mathur-Ezekiel. C_t is drawn negatively sloped here, in deference to the empirical work (by an indirect method) of Krishna and Mubyarto, and following the convention of demand curves. It is also drawn to show that at zero palay price no amount of the palay output will be offered for sale, although farmers might reasonably refuse to sell any palay at some low but positive price. The M_t function follows from the C_t– and Q_t– functions by definition, and its slope and intercept depend on the same factors that determine the slope and intercept of C_t. (The signs and values of these parameters are still open to debate and to research, and those used in Figure 1 are for illustrative purposes only.) M'_t is the familiar negatively sloping market demand curve. P_e is the equilibrium current price of palay.

4. Estimation methods

4.1 The output response function

Intended palay output has been assumed to be a function of the expected prices of palay, of inputs and of alternative crops, in addition to the technology variable. The available data do not directly describe the amounts of output rice producers planned in the past, nor the corresponding expectations they had regarding crop and input prices. These problems are handled by a hypothesis regarding the length of time it takes farmers to fully adjust their use of inputs, and thus their intended output, to the levels made desirable by expected revenue and cost conditions. This enables the expression of directly unobservable variables such as Q^*_t, P^*_t, F^*_t and A^*_t in terms of past observable events.

The distributed lag method: a positive approach

The positive[29] approach would be to set up one regression equation that would measure the influence of each of these variables on planned output. The simplest pair of hypotheses would state that farmers can immediately adjust output to the desired level and that this period's expected price is simply the projection of last period's actual price (i.e., that $Q^*_t = Q_t$, and $P_{t-1} = P^*_t$, $A_{t-1} = A^*_t$, $F_{t-1} = F^*_t$, $T_{t-1} = T^*_t$). From these,

(5) $$Q_t = a + bP_{t-1} + cA_{t-1} + dF_{t-1} + eT_{t-1} + u_t$$

where u_t is a residual term.

---

[29] A normative approach would relate the response of the rice industry's output to the production function of an individual rice farm, thus establishing a link between farm-level and industry-level research. Since some production functions for Philippine rice farms have already been estimated, it is useful to determine the implications of the estimated parameters of these functions for the parameters of the output response function of the industry of a region. (See Emilio U. Quintana, *Resource Productivity Estimates for Five Types of Philippine Farms*, Ph.D. thesis, Purdue University, 1960. Quintana in 1957 surveyed 62 rice farms, 21 of them in Nueva Ecija, 20 in Laguna, and 21 in Pangasinan. Basilio N. de los Reyes, *Resource Productivity and Adjustment Possibilities on Lowland Rice Farms in Selected Areas of the Philippines*, Ph.D. thesis, North Carolina State College, 1962. De los Reyes used data for 1958-59 from 53 farms in San Isidro, Nueva Ecija, 59 in Bay, Calauan, Laguna, and 60 in Cabuyao, Laguna. He divided farms in each area into two groups, on the basis of cultural practice, and then compared the estimated production functions of the two groups. Both Quintana and de los Reyes used Cobb-Douglas functions.)

Production functions derived from cross-section data are long-run functions, since the observations used represent farms at different scales of operation. If a farm-level Cobb-Douglas production function, in particular, is combined with profit maximizing conditions, the elasticity of a farm's output with respect to product price is found to be $\frac{\Sigma b_i}{1-\Sigma b_i}$, where the b's are the production function's parameters. The elasticity of the industry's output with respect to product price is also $\frac{\Sigma b_i}{1-\Sigma b_i}$, if the farms

The relationship between desired output and actual output may be handled instead, however, by a so-called "adjustment" model. It may be relevant to assume that farmers are not necessarily able to equalize desired output with actual output,[30] i.e., it may be relevant to write

$$(6) \quad Q_t - Q_{t-1} = \gamma\,(Q_t^* - Q_{t-1}) \, . \qquad 0 < \gamma \leq 1 \, .$$

---

29 (con't.)
in the industry have identical production functions and face identical output and input prices. We must restrict b_i to values less than one, since only in this range are the price-output elasticities positive. The conditions of constant or increasing returns to scale are not consistent with the assumption of pure competition, since a farm with the advantage of either condition would try to dominate the industry. If factor supplies were perfectly price elastic, such a farm would expand output indefinitely. If one or more factors (say land) is fixed in total, this farm will expand output to the limit set by the constraining factor.

In Quintana's second-trial production function, $\Sigma b_i = .926$. The product price-output elasticity implied by this is $\frac{.926}{1 - .926} = 12.6$. In some cases, de los Reyes' second-trial production functions have sums of exponents larger than one. In the cases where they are less than one, the implied price-output elasticities are 32.2, 17.9 and 11.5. (These are all long-run elasticities, thus should be larger than short-run elasticities.) However, the errors of estimate of the exponents are larger relative to the exponent-estimates, so much so that if one standard error is deducted from each exponent-estimate (thus lowering the Σb_i estimate), the implied supply elasticities become 1.13, .84 and 1.50, respectively. The sensitivity of the derived supply elasticities to the estimate of Σb_i indicates the need for precise estimates of the parameters of a production function.

30 Previous researchers have often measured the response to price variables of hectarage rather than the response of output itself. They felt actual output was a less close indicator of planned output for a season than hectarage planted because they presumed unforseen crop growing conditions caused significantly large disparities between actual and intended output. See Marc Nerlove. *The Dynamics of Supply;*

γ, called the coefficient of adjustment, will be positive (provided farmers have any influence at all in adjusting output) and is expected to be a fraction. $\gamma = 1$ implies that full adjustment is possible within the space of one period: this is the case consistent with regression equation

(5). Equation (6) can be written

$$(7) \qquad Q_t = \gamma Q_t^* + (1-\gamma) Q_{t-1}$$

which, expanded, becomes

$$(8) \qquad Q_t = \gamma Q_t^* + (1-\gamma)\gamma Q_{t-1}^* + (1-\gamma)^2 \gamma Q_{t-2}^* = (1-\gamma)^3 \gamma Q_{t-3}^* + \ldots$$

Actual output in period t is thus the weighted average of desired output in period t and outputs desired in all previous periods. The weights are given by the coefficients γ, $(1-\gamma)\gamma$, etc., the sum of all of which equals one. The weights progressively decrease for outputs desired during less recent periods.

If the independent expectational variables can be dealt with by assumption (if we assume $P_{t-1} = P_t^*$, $F_{t-1} = F_t^*$, $A_{t-1} = A_t^*$, $T_{t-1} = T_t^*$), the parameters of the adjustment model, and

---

30 (con't.) *Estimation of Farmers' Response to Price* (Baltimore: Johns Hopkins, 1958), 66-67. The difference between actual and planned output is thus due to both unexpected weather, etc., and to inability of farmers to employ precisely the levels of inputs that they desire. The first factor is more or less random, and one might account for it by introducing a random term into (6); this complicates estimation, however. The second factor is accounted for by the coefficient in (6).

By definition, $Q_t^* = h_t^* y_t^*$, where h^* is planned hectarage and y^* is planned yield. The price elasticity of hectarage estimates the lowest possible price elasticity of output under the assumption that the price elasticity of yield is non-negative.

the coefficient of adjustment, y can be estimated in the following manner.[31] The object will be to estimate the parameters of

(9) $$Q_t^* = a + bP_{t-1} + cF_{t-1} + dA_{t-1} + eT_{t-1} + u_t$$

From (7) and (9) we get

(10) $$Q_t = a\gamma + b\gamma P_{t-1} + c\gamma F_{t-1} + d\gamma A_{t-1} + e\gamma T_{t-1} + (1-\gamma)Q_{t-1} + \gamma u_t$$

One may then estimate by this least-squares method the parameters of an equation of the form.

(11) $$Q_t = \pi_o + \pi_1 P_{t-1} + \pi_2 F_{t-1} + \pi_3 A_{t-1} + \pi_4 T_{t-1} + \pi_5 Q_{t-1} + V_t$$

and use relations.

$$\pi = a\gamma,\ \pi_1 = b\gamma,\ \pi_2 = c\gamma,\ \pi_3 = d\gamma,\ \pi_4 = e\gamma,\ \pi_5 = (1-\gamma).$$

to obtain a, b, c, d, e, and γ. Notice that there is one more independent variable in regression equation (11) than in adjustment model (9). This indicates the addition to computation cost due to unwillingness to restrict the value of γ to one.

---

31 The estimation method follows that discussed in Nerlove, *ibid.* The same method was used by Krishna in the research presented in his 1963 *Economic Journal* paper.

The distributed lag approach to the measurement of an expected price is so termed because it stems from the hypothesis that this period's expected price is a weighted average of all past prices, the weights decreasing systematically for prices going further back in time. A method for arriving at these weights will follow from the assumption that farmers change their expectation of a price in proportion to the error in predicting the previous price level, i.e., (in the case of palay price),

$$(12) \quad P_t^* - P_{t-1}^* = \beta(P_{t-1} - P_{t-1}^*) \qquad 0 < \beta \leq 1$$

β, the coefficient of expectation, is expected to be a fraction. $\beta = 0$ would be the implausible case where actual prices never cause farmers to change their expectation of price. $\beta = 1$ implies farmers reject an old expectation of price (P_{t-1}^*) completely and take actual price of the moment (P_{t-1}) to be their expectation of next period's price (P_t^*). Thus the simplc hypothesis regarding expected prices used to set up regression equation (13) states that coefficients of expectation concerning crop and factor prices are all equal to one.

An expectational model is one in which the independent variables are expressed in expected levels. Estimation of the coefficient(s) of expectation and of the model's other parameters is relatively simple in two cases: (a) when there is only one independent variable, the expectational variable; (b) when all independent variables are expectational variables, and it is assumed that the coefficients of expectation relevant to these variables are one and the same. To neglect all possible independent variables but one, however, is to do so at the cost of remaining ignorant of what influence the neglected variables might have on the dependent variable. To assume that only one coefficient of expectation applies to all expectational variables is to some extent unrealistic. The estimation procedure becomes much more complicated in other cases of expectational models.[32]

4 2. The market supply and demand functions

A model based on the framework in Section 3 would be expressed as a set of simultaneous equations, generating as solutions the observations of the endogenous variables, current price and the amounts marketed and consumed at home, as the values of the exogenous variables vary through time. The theoretically best way of estimating the parameters of this model would be the simultaneous equations method. Briefly, this method consists of (a) solving the set of simultaneous equations for the endogeneous variables in terms of the parameters and the exogenous variables in terms of the parameters and the exogenous variables, thus arriving at a set of equations called the reduced form of the system; (b) estimating the parameters of the reduced-form equations by separate regressions; and (c) solving for the parameters of the original equations from the estimated parameters of the reduced form.[33]

Data requirements are time-series for each of the endogenous and exogenous variables. The great obstacle to the use of this approach is the lack of time-series data for either marketed surplus or home consumption. These are necessary

---

[32] Methods of estimation used for complicated expectational models are discussed in Marc Nerlove, *Distributed Lags and Demand Analysis for Agricultural and Other Commodities*, U.S. Dept. of Agri. Handbook No. 141, June 1958.

[33] For the assumptions and problems involved, see Wm. C. Hood and Tjalling C. Koopmans, *Studies in Econometric Method*, Cowles Commission Monograph No. 14 (1953), esp. M.A. Girshick and Trygve Haavelmo, "Statistical Analysis of the Demand for Food: Examples of Simultaneous Estimation of Structural Relations," 92-111, and Jean Bronfenbrenner, Sources and Size of Least-Square Bias in a A Two-Equation Model," 221-235.

to provide an output response function capable of forecasting Q_t with a simultaneous structure with which to combine and forecast M_t and P_t.

4.3 Estimation of the price elasticity of the marketed surplus by an indirect method

Knowledge of the output response function may provide insight on the price response of the marketed surplus of palay. The price elasticity of the marketed surplus of a subsistence crop (a crop used for home consumption to a large extent) may be estimated by the indirect method Krishna[34] has pointed out. From the basic definition

(1) $M_t = Q_t - C_t$

one may take derivatives with respect to price and get

$$\frac{dM_t}{dP}\frac{P}{M_t} = \frac{dQ_t}{dP}\frac{P}{Q_t}\frac{Q_t}{M_t} + \frac{dC_t}{C_t}\frac{P}{C_t}\left(1-\frac{Q_t}{M_t}\right)$$

(13)

$$E_{M_tP} = E_{Q_tP} \cdot \frac{Q_t}{M_t} + E_{C_tP_t}\left(1-\frac{Q_t}{M_t}\right)$$

where $E_{M_t}P$ is the price elasticity of the marketed surplus, $E_{Q_t}P$ the price elasticity of palay output, and $E_{C_t}P$ the price elasticity of home consumption. The nature of the price variable in (13) is ambiguous, as it was in Krishna's note. One must go further and distinquish between

(13a) $E_{M_tP_t} = E_{Q_tP_t} \cdot \frac{Q_t}{M_t} + E_{C_tP_t}\left(1-\frac{Q_t}{M_t}\right)$

and

(13b) $E_{M_tP_t^*} = E_{Q_tP_t^*} \cdot \frac{Q_t}{M_t} + E_{C_tP_t^*}\left(1-\frac{Q_t}{M_t}\right)$

---

34 Raj Krishna, "A Note on the Elasticity of the Marketable Surplus of a Subsistence Crop," *Indian Journal of Agricultural Economics*, 17:3 (July-September 1962), 79-84.

Let us start with (13a), $E_{M_tP_t}$, the elasticity of the marketed surplus with respect to current price, gives us information on the shape of the M_t curve in Figure 1. This shape, it was theorized, derives directly from the shape of the C_t function, i. e., it derives directly from $E_{C_tP_t}$. Since current price is determined only after harvest, $E_{Q_tP_t}$. Since current shown by the vertical line Q_t in Figure 1. Thus (13a) might as well be written

---

[35] The taking of a derivative of Q_t with respect to P_t does not insure that the derivative exists (is non-zero). Mubyarto (*op cit., page* 81) elaborated on Krishna's method by taking derivatives with respect to farm income, Y, as well. Thus he arrived at

$$E_{M_tY_t} = E_{Q_tY_t} \cdot \frac{Q_t}{M_t} + E_{C_tY_t} (1 - \frac{Q_t}{M_t});$$

he used this relation to get

$$E_M = E_{M_tP_t} + E_{M_tY_t}$$

There is a reason to expect $E_{C_tY_t}$ (income elasticity of consumption) to exist but there seems to be no *a priori* justification for the existence of $E_{Q_tY_t}$. The interpretation of his E_M is puzzling.

[36] To state that $E_{C_tP_t} = 0$ is also to state that $E_{M_tP_t} = 0$. This statement has been implied by the National Economic Council in its estimates of the national rice requirement: the NEC divides the estimated national population into sex and age groups, and on the basis of a 1958 survey of the Philippine Statistical Survey of Households (unpublished data) assumes that 76.8% of the people in each sex-age group are rice eaters and that males of 10 years or more consume 128.8 kg. of milled rice annually, females of 10 years or more 117.9 kg., and children below 10 years 63.7 kg. See *Report on the Rice and Corn Outlook for the Crop Year Ending June* 30, 1964 *Based on December* 1, 1963 *Production Forecast for Rice and October* 1, 1963 *Production Forecast for Corn,* submitted to the NEC by Inter-Agency Committee on Rice and Corn Production and Consumption, January 6, 1964.

(13a) $E_{M_tP_t} = E_{C_tP_t} \left(1 - \frac{Q_t}{M_t}\right)$[36]

Equation (13b), on the other hand, states that the response of the marketed surplus to expected price depends on the responses of both output and home consumption to expected price. Previous research has shown that output response in subsistence crops is small but positive. This suggests, in terms of Figure 1, that the vertical Q_t — line shifts to the right as P_t^* increases. As long as $E_{C_tP_t}^*$ is negative (as long as the price effect outweighs the income effect and any fixed-cash requirement effect), $E_{M_tP_t}^*$ will be positive, and the M_t function will follow the Q_t function in shifting to the right as P_t^* rises. This behavior is supported by cross-section studies, in other countries, relating M_t to Q_t.

Figure 2 illustrates the distinction between $E_{M_tP_t}^*$ and $E_{M_tP_t}$. A rise in P_t^* shifts Q_t from Q_1 to Q_2 in both (a) and (b). The M_t function then responds, shifting from M_1 to M_2; this shift is measured by $E_{M_tP_t}^*$, the parameter that Krishna estimates, and is positive in both (a) and (b). $E_{M_tP_t}$, on the other hand, is illustrated by the slopes of the M_t functions, and is positive in (a) but negative in (b). Case (b), which Mathur-Ezekiel think is prevalent, shows that the amount marketed may fall even though P* has risen if P rises sufficiently. In spite of the shift from M_1 to M_2 P_t may increase (due to a shift in demand, not illustrated) from P_1 to P_2 and the amount marketed may fall from A. to B. Thus policy measures that increase both expected and current price will raise the amount marketed if both $E_{M_tP_t}^*$ and $E_{M_tP_t}$ are positive[37] and de-

[37] More precisely, if one parameter is positive and the other is non-negative.

crease it if both are negative. The result is uncertain should parameter be positive and the other negative.

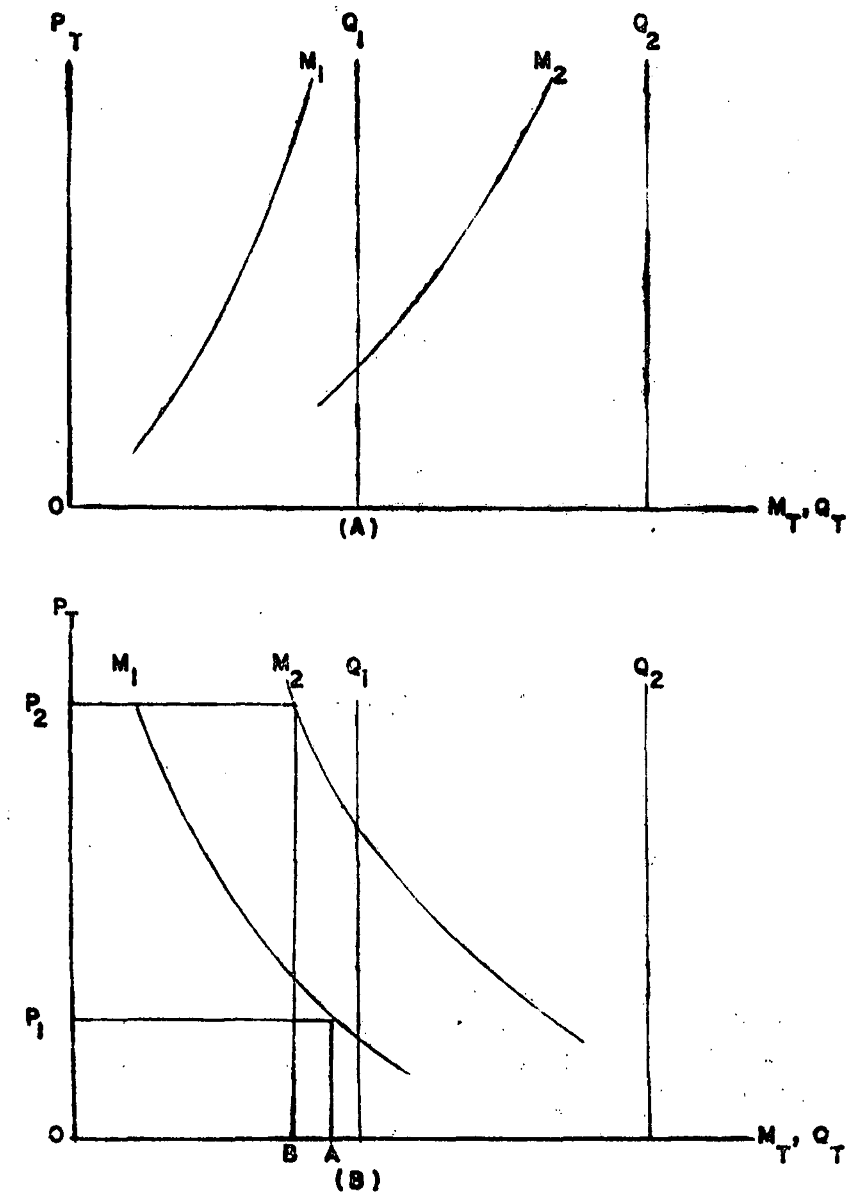


FIG. 2

5. Summary

The response of an under-developed country's agricultural sector to price is a factor relevant to its economic growth. There is more than one aspect to price response; one needs to distinguish between the responses of aggregate agricultural output, aggregate marketed surplus, the output of an individual crop, and the marketed surplus of an individual crop. Although all of these aspects are important, the availability of data has led researchers in other countries to concentrate studies on the price response of the output of an individual crop. This response has been found to be almost always positive and lower for food crops than for cash crops. Another important point is the distinction between the response to current price and the response to expected price. It is quite possible that these responses are opposite in direction. In brief, the question of whether a backward-bending supply curve exists in under-developed countries is answered first by specification of what is meant by **supply** and what is the **price** to which this supply responds. The backward-bending supply curve may exist in some contexts, and may not in others.

This paper dealt with methods of measuring the price response of the output and the marketed surplus of an individual subsistence crop, rice, in the Philippines. A theoretical discussion of the rice economy in a given region was presented to serve as a foundation for empirical analysis. The simultaneous equations method was shown to be capable of estimating the parameters that simultaneously determine the amount of palay marketed and the market price. This method has been thus far untried in the Philippines, the main restriction being that it requires time-series data for all the variables of the economic model. There does not seem to be a good method of obtaining a structure with which to predict the palay market price without it.

An estimate of the relation of palay output to input and output prices and to technology is required for use within the palay market structure. The distributed lags method of measuring this relation, a positive approach, has also not been tried here before. The available data makes this method feasible for simple distributed lag models. There is strong **a priori** basis for using the adjustment model in particular when studying the agriculture of under-developed countries. It is in these countries that many types of constraints may cause lags to exist in the acceptance of new factors with which to raise output. Schultz[38] has pointed out that private concerns supplying seed, fertilzer, pesticide, or amchinery may find costs of entering the market high relative to the size of the market, that poor farmers are less able to cope with uncertainty, that tenure arrangements may not favor the adoption of new factors, and that poorly-educated farmers tend not to search for new methods or factors. Falcon[39] has called attention to the poor condition of transportation, storage, credit facilities, and of general technical knowledge in these countries.

An indirect method may be used to obtain the elasticities of the marketed surplus with respect to expected price and to current price, requiring knowledge of the corresponding price elasticities of both output and home consumption. The main purpose of a current study at The International Rice Research Institute is to estimate the elasticity of rice output with respect to expected price; the effect of price on home consumption is a problem suitable for another study. At this time, values for the price elasticities of home consumption must be assumed in order to get a notion of the elasticities of the marketed surplus.

---

[38] T. W. Schultz, *Transforming Traditional Agriculture*, Yale, 1964, 164-169.

[39] Walter P. Falcon, *op. cit.*, 950.