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Supply Response and Price Setting under Indonesia's Rice Intensification Program

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In 1968, the Indonesian government introduced the Rice Intensification Program aimed at stimulating new technologies in rice (paddy) production. The Rice Intensification Program includes a price support or floor price policy for rice. The objectives of this study are to examine responsiveness of Indonesian rice farmers to changes in output price and to utilize estimated elasticities to evaluate pricing policy by the Indonesian government.

The economic model incorporating the rice price support program is derived from cost minimization via the dual theorem. Both the supply of output and the demand for inputs can be derived simultaneously. This model also allows disaggregation of paddy production to major islands/provinces enabling examination of differential effects.

Our results indicate that the Indonesian government is setting the floor price too low from the point-of-view of the farmer. Also, the Indonesian government should consider setting differentiated paddy floor prices on the basis of paddy cultivation type and location.

I. Introduction

For Indonesia, rice is the deminant food crop. During the time period 1981-1985, grain production averaged 40.9 million tons annualy with rice accounting for 87% of the total (Central Bureau of Statistics, Indonesia).

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In 1985, rice consumption per capita was estimated as 139.73 kg/year which represented an increase of 18.35% from 1969 (118.07 kg/year).

Paddy[1] or rice cultivation in Indonesia is divided into two categories: wetland paddy (wes monsoon) and dryland paddy (east monsoon). Wetland paddy production occurs during the period January 1 to August 31, while dryland rice crops are primarily produced from September 1 to December 31. Wetland rice crops contribute more than 90% of the total annual rice production.

Increases in paddy yields have averaged 3.61% per year for the period 1969-1985. This increase in rice yields can largely be attributed to government programs. In 1968, the Indonesian government introduced the Rice Intensification Program. By 1983, more than 70% of the total cultivated area for paddy was under the Rice Intensification Program.[2] This program has two major components: a price support policy for rice and a credit package consisting of provisions for cash, fertilizers, high yielding variety (HYV) seeds, and pesticides, as well as providing production information and assistance to farmers by the government's extension service. While the credit package has been successful in stimulating adoption of new technologies and thus increasing paddy yields over time (Birowo, Sugiyanto and Kartono, 1979), there has not been research on the effects of the rice price support program. Government policies have generally kept domestic rice prices well below world prices in an attempt to insulate domestic prices from instabilities in the world market (Timmer, 1986). The rice price support program also serves as a subsidy for consumers.

The objectives of this study are towfold. First, an analytical framework is developed to measure the responsiveness of Indonesian rice farmers to changes in output and input prices. Second, estimated price elasticities will be used to evaluate the rice pricing policies of the Indonesian government.

Subsequent sections of this paper include a background of the rice price support programs in Indonesia, the proposed moedling methodology and review of relevant literature and data and estimation results. The last section summarizes our results and discusses implications for the Indonesian government and the rice producing sector.

[1] The terms paddy and rice are used interchangeably in this study. The official conversion used for dry stalk paddy to milled rice is 0.52, gabah (unhusked rice) is 0.68.

[2] The participation rate in the Rice Intensification Program has steadily increased from 26% in 1969 to 42% in 1975 and 72% in 1983 (*Statistical Pocketbook of Indonesia*, Jakarta).

II. Indonesia's Rice Intensification Program and Floor Price System

Food prices in Indonesia are determined in a market framework through a combination of basic market forces and government intervention. Rice prices have nearly always been heavily influenced by direct policy intervention. Pricing policies for production inputs directly affect the profitability of crop production, and hence the supplies available in the market. The Indonesian government has used input subsidies designed to assist farmers in purchasing the package of inputs available as part of the Rice Intensification Program (BIMAS program).

Administratively, the prices for rice (and other agricultural commodities such as corn and cassava) are set by the government via BULOG (Badan Urusan Logistik National or National Logistic Board). Floor and ceiling prices for rice are maintained through buffer stock management. When prices decline, observed usually at the harvest season, BULOG enters the market to make necessary purchases to maintain the floor price. During lean months, when the price of rice is high, BULOG releases its stock to keep the price below the ceiling price. In Indonesia, it is illegal for farmers or merchants to sell rice for less than the floor price. However, BULOG is obligated to purchase rice from farmers as long as the market price is below the floor price. This implies that the quantity of rice BULOG eventually purchases domestically in a given year is primarily determined by the floor price and not necessarily by the level of stocks that BULOG chooses to maintain.

There is only one floor price set each year for all varieties of rice, irrespective of locality. This price is based on one quality standard, however, distinguished by moisture content and degree of purity. It is usually announced late in the preceding year in order to give farmers the opportunity to make production decisions, based on a firm expected floor price at harvest time.

The level of the floor price is recalculated every year in conformity with the current economic situation. The price calculation of the floor price is based upon average input costs including the fertilizer price. It is further adjusted by comparing wages in the industrial sector with the agricultural sector. The reason for tying the floor price to the fertilizer price is to increase fertilizer application rates and the use of HYVs which will in turn increase yield.

III. Review of Previous Studies and Proposed Modeling Methodology

Most supply and demand studies on rice in Indonesia have emphasized demand aspects. Little consideration has been given to the analysis of the government's price policy and its impact on supply response and factor demands. Only two studies on supply response for rice in Indonesia have been done by no study exists which models the rice market with price supports. These two studies on rice supply were done by Mubyarto and Fletcher (1975) and more recently in 1986, by the international Food Policy and Research Institute (IFPRI) with cooperation from the Center for Agro Economic Research (CAER), Ministry of Agriculture, Indonesia. Both studies estimated price elasticities of supply for rice. The latter study compared supply elasticities for Indonesia, Java and Outer Java. The research by Mubyarto and Fletcher estimated supply elasticities for Java only but under wetland and dryland paddy cultivation.

Rather than estimating production relationships directly (primal approach) to derive output supply and input demand parameters, this study proposes use of the dual approach. Duality between the production and cost functions means that the existence of one function implies the existence of the other — for well behaved functions (Diewert, 1974). Also, the cost function contains all the information necessary to reconstruct the structure of the corresponding production function (McFadden, 1972).

Estimating an indirect cost function to derive input demand and output supply parameters has several advantages than the corresponding direct production function. First, the primal approach of estimating production parameters may be a very arduous procedure (Silberberg, 1978). Production functions are often unobservable because input data may not be available. A cost function, on the other hand, is a function of output and input prices, all of which are potentially observable. Second, the dual approach is useful because it avoids the pitfalls in generating an *a priori* functional form (Beattie and Taylor, 1985). Third, in production function estimation, high multicollinearity may exist among input variables. Collinearity among input prices is not as severe in the cost function approach (Binswanger, 1974).

In this study, the translog cost function was used because of its features: (i) it can be viewed as a local, second order approximation to an arbitrary cost function, (ii) all estimation equations of the translog cost function are linear in logarithms, and (iii) the translog function satisfies a subset of the regularity conditions concerning the validity of the dual approach by imposing linear constraints on the parameters of the function. The latter reason facilitates the estimation of the parameters via the restricted least squares technique and allows statistical tests of the regularity conditions by testing linear restrictions on model parameters. The translog cost function can be written as:

$$(1)\qquad \ln C = \ln A + \sum_{i=1}^{n} b_i \ln W_i + e\ln Q + \frac{f}{2}(\ln Q)^2 + \frac{1}{2}\left(\sum_{i=1}^{n}\sum_{j=1}^{n} d_{ij}\ln W_i \ln W_j\right) + \sum_{i=1}^{n} h_{iq}\ln W_i \ln Q + \text{remainder}$$

$$i = 1, 2, ,,,, n$$
$$j = 1, 2, \ldots, n$$

where A = constant,
C = total cost,
W = input price
Q = unit of output,
remainder = such as dummy variables, and

A, B_i, e, d_{ij} and h_{iq} = parameters to be estimated.

Homogeneity of degree one in input prices requires: $\sum_{i=1}^{n} b_i = 1$, $\sum_{i=1}^{n} d_{ij} = 0$ and $\sum_{i=1}^{n} h_{iq} = 0$ and the symmetry condition states that $d_{ij} = d_{ji}$ (Beattie and Taylor, 1985 and Ray, 1982).

The derivative of the translog cost function (equation 1) with respect to lnQ yields:

$$(2)\qquad \frac{\partial \ln C}{\partial \ln Q} = e + f\ln Q + \sum_{i=1}^{n} h_{iq}\ln W_i.$$

Since $\frac{\partial \ln C}{\partial \ln Q} = \frac{\partial C}{\partial Q}\,\frac{Q}{C} = MC.\,\frac{1}{AC}$ where MC = marginal cost and AC = average cost and assuming a competitive market structure with P = MC, we can modify equation (2) to:

$$(3)\qquad P\frac{Q}{C} = e + f\ln Q + \sum_{i=1}^{n} h_{iq}\ln W_i.$$

It follow that:

$$(4)\qquad P = \left(e + f\ln Q + \sum_{i=1}^{n} h_{iq}\ln W_i\right)\frac{C}{Q}.$$

Taking the inverse of the price flexibility of supply the elasticity of output supply can be approximated as:[3]

$$(5) \qquad \eta = \left[\frac{-C(e + f\ln Q + \sum_{i=1}^{n} h_{iq} \ln w_i) + fC}{PQ} \right]^{-1}$$

Finally, the economic model incorporating the floor price of paddy can be constructed. The following assumptions are required. First, government intervention is treated as a given. Second, the Indonesian rice market is competitive in structure with many buyers and sellers and rice is a relatively homogeneous product. Third, farmers are rational and respond positively to product price changes and allocate resources in a profit maximizing fashion.

Using equation (4) and assuming that Q and W are exogenous, the price of paddy at the farm gate (P) can be calculated. This estimated paddy price can be thought of as the "desired" price by farmers since it is derived from cost minimization. The estimated paddy price can then be compared to the floor price set by BULOG. This comparison can provide information about whether or not the government is setting the paddy price too high or too low for production incentives to rice producers.

IV. Data and Estimation Results

The data used in this study were obtained from agricultural survey publications for the period 1970-1983 published by the Central Bureau of Statistics (CBS) Indonesia (Biro Pusat Statistik). Both dependent and independent variables were calculated on a per hectare and a per year basis.[4]

The explanatory variables are the yield of paddy (in kg) and nominal prices of inputs (in domestic currency — rupiah). These input prices include prices for seeds, pesticides/insecticides, fertilizers, hired animals (bullocks), total wage labor, and other production inputs. Another explanatory variable is the type of paddy cultivation (wetland or dryland paddy) which is treated as a dummy variable in the model. The dependent variables of the factor cost share equations are the shares of seeds, pesticides/insecticides, fertilizers, bullocks, labor and other production inputs.

Input prices are nominal prices and are computed from the value and quantity of the input used in the production process. The price of paddy

3 See Tomek and Robinson pages 49-50.

4 Land was assumed to be fixed and excluded from the model.

is also a nominal and implicit price and calculated similarly to input prices. The output price is the price of paddy at the farm gate (dry stalk paddy — padi kering lumbung).

The cost share equations are estimated as a system of equations by Zellner's efficient procedure (SUR or Seemingly Unrelated Regression). Since the factor cost shares sum to unity, the stochastic error term must sum to zero at each observation. This constraint implies that the covariance structure is not of full rank and the system cannot be solved. To overcome this problem, one of the cost share equations is dropped before the system is solved (Zellner, 1962; Binswanger, 1974; Johnston, 1984). The factor share equation eliminated from the system was the "other" expenses cost share equation. Estimates of the parameters of this equation are calculated from the restrictions imposed on the parameters of the system of factor share equations.

The estimated price elasticities of supply for paddy are shown in Table 1 for major islands/provinces of Indonesia.[5] For both wetland and dryland paddy production, irrespective of location, the estimated price elasticities

Table 1

PRICE ELASTICITY OF SUPPLY FOR PADDY[1]

	Wetland	Dryland
Indonesia	0.32	0.26
Java	0.40	0.54
Outer Java	0.21	0.19
West Java	0.45	0.53
Central Java	0.33	0.85
East Java	0.46	0.61
Yogyakarta	0.67	0.16
North Sumatra	0.14	0.36
Lampung	0.21	0.64
West Sumatra	0.25	0.25
Bali	0.34	0.23

1 Evaluated at mean values of appropriate variables.

5 In the estimated model, an intercept shifter is used to account for the type of paddy cultivation (wet vs. dryland paddy).

of supply are less than one. The estimated price elasticities of supply for Java are also larger than for the Outer Java islands. This is expected since farmers in Java have lower opportunity costs associated with growing paddy, higher levels of technological development and a greater degree of market orientation than farmers in Outer Java areas. Studies by IFPRI/CAER (1986) and Mubyarto and Fletcher (1966) generally found similar price elasticities of supply.

Parameter estimates were then used to calculate the floor price of paddy given the model described earlier. The price of paddy from this calculation is the "desired" price by farmers since in deriving the total revenue function (i.e., multiplying both sides of equation (4) by Q), the assumption of a competitive market is used. The estimated floor prices are presented in Table 2 for selected years. The calculated floor price for dryland paddy was generally higher than for wetland paddy. Also, the estimated floor price for Java was lower than for Outer Java areas. The most striking result is that for most cases, the calculated paddy floor price was larger than the floor price set by the government.

V. Summary and Implications

Conceptually, the model incorporating the price support program has some advantages. First, model construction is straightforward — cost minimization via the dual theorem is consistent with the nature of Indonesia's rice eoriomy, where the government sets prices and production targets in her Five Year Development Plans. Second, disaggregation to major islands/provinces is advantageous in examning differential effects.

Our results show that the Indonesian government is setting the floor price too low from the point-of-view of the farmer. This result probably is anticipated, however, this finding and the positive price elasticities of supply estimates indicate that the floor price is an effective mechanism by which the government can stimulate paddy production in achieving self-sufficiency in rice. Also, the Indonesian government should consider setting differentiated paddy floor prices on the basis of paddy cultivation type and location. This methodology and these findings can be further utilized by BULOG to evaluate the role of predetermined floor price and its role in achieving national and regional policy objectives.

Table 2

CALCULATED PADDY FLOOR PRICE FOR SELECTED YEARS
(Rupiah per kg)

	Indonesia		Java		Outer Java		Floor Price as determined by the government	
	I[1]	II	I	II	I	II	paddy	gabah[2]
1970	20.71	16.87	21.95	12.46	19.38	19.62	13.20	18.40
1975	41.50	46.73	39.59	44.45	46.46	50.38	42.00	58.50
1980	84.44	101.35	77.03	84.37	100.57	115.95	n.a.	105.00
1981	127.82	162.47	115.85	121.60	148.42	186.47	n.a.	102.00
1982	141.47	156.60	128.06	133.85	161.06	178.11	n.a.	135.00
1983	155.67	173.21	138.99	160.20	190.09	183.53	n.a.	145.00

1 I = wetland paddy and II = dryland paddy
2 Gabah is unhusked paddy and the floor price is at the village cooperative level
3 n.a. = Not available
Source: Floor prices for paddy and gabah determined by BULOG.

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