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## AGRICULTURAL PRODUCTIVITY GROWTH IN INDONESIA

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Growth rates of productivity have often been measured by using average value added by specified inputs (e.g., see David and Barker; and Ban). Also, a production function often has also been used to estimate input weights necessary in aggregation (e.g., see Griliches; and Hertford). This average productivity approach is quite demanding in terms of data. The concept of value added in a restricted profit function, proposed by Bruno, provides an alternative for measuring and analyzing productivity growth. Lesser data requirements make this approach particularly appropriate in developing countries.

### Value Added in a Restricted Profit Function

Every concave function has a dual which is a profit function convex in input prices, and vice versa. The existence of a one-to-one correspondence between a concave production function and convex profit function has been shown by McFadden. One can, therefore, consider only the profit function for production analyses.

By profit maximization, and assuming that prices are fixed and production is carried out in the economically rational area, Lau and Yotopoulos came up with the indirect unit-output-price (UOP) profit function:

$$(1) \quad \pi^* = y^*(R, Z) - R'X^*(R, Z),$$

where  $y$  = output,

$X$  = an  $m$ -vector of variable inputs,

$Z$  = an  $n$ -vector of fixed inputs, and

$R$  = a vector of normalized prices of the variable inputs.

This is an envelope function that represents the maximized value of profit for each set of values of  $R$  and  $Z$  (Silberberg).

Bruno developed the concept of value added as a restricted profit function and showed how it could be used to measure productivity growth. Nominal value added (NVA) is defined as gross returns minus total costs of intermediate inputs. The NVA functions vary as output or input prices do. One modification is value added based on a single output price deflation (SVA), denoted as  $G$ . Corresponding to (1), one can write the SVA function as:

$$(2) \quad G = Y^*(R, Z) - R'X^*(R, Z),$$

where  $Y$  = a composite of gross output,

$X$  = an  $m$  by 1 vector of intermediate inputs,

$R$  = an  $m$  by 1 vector of normalized prices of the elements of  $X$ , and

$Z$  = an  $n$  by 1 vector of primary inputs.

The dual property holds simultaneously on this function:

$$(3) \quad G_Z = Y_Z = W^* \text{ and } G_R = -X^*.$$

Here  $W^*$  (the derivative of  $G$  with respect to primary inputs) gives the shadow prices of inputs, and  $-X^*$  (the derivative with respect to the normalized prices of intermediate inputs) gives the negative of the optimal input bundle.

In order to derive a measure of productivity, assume that the underlying gross output function takes the form  $Y = Y(X, Z, T)$ , where  $T$  is a scalar for technical progress shift factors. The corresponding SVA function is  $G = (R, Z, T)$ . It can be shown (Bruno) that  $G_T = Y_T$ , implying that an estimate of technical progress can be represented by either the first derivative of SVA or gross output with respect to the scalar  $T$ . But the observed estimate from this SVA function ignores variation in the normalized prices of intermediate inputs.

Consider another modification of NVA--the double-price deflated value added (DVA), which is defined as  $F = Y^* - X^*e$ , where  $e$  denotes a vector of 1's. Prices in the base period are normalized to be equal to 1, and the real value added is measured in the base year output and input prices. Using (2) and (3) the function can be expressed as:

$$(4) \quad F = G + G'_R (e - R).$$

The total differential of  $F$  divided by  $F$  gives:

$$(5) \quad dF/F = (F_Z/F)'dZ + (F_R/F)'dR + (F_T/F)'dT,$$

which is the rate of change in DVA.

The total productivity change (Bruno) in terms of the original function  $Y$ , corrected for output scale, is given by:

$$(6) \quad 0 = (Y/F)(Y_T/Y)dT = (Y_T/F)dT,$$

while the observed rate of change using observations on changes in DVA ( $dF/F$ ), factor input change ( $dZ$ ), and competitive income shares per unit of input ( $G_Z/G$ ) is given by:

$$(7) \quad \tilde{0} = dF/F - (G_Z/G)'dZ.$$

The relationship between  $0$  and  $\tilde{0}$  can be derived by totally differentiating  $F$  with respect to  $T$ , multiplying the result by  $(1/F)dT$ , and applying (5) and (6). The result will show that there are three alternative conditions for  $\tilde{0}$  to be an unbiased estimate of  $0$ . First, a divisia index is used to obtain DVA so that  $R = e$  and hence  $F_R = 0$ . In the case of functional separability, Sims has shown that a double deflation procedure will yield a simple divisia index for value added. The second is that each intermediate input left out is used in fixed proportion, so that  $Y_{XX} \rightarrow 0$  which also gives  $F_R \rightarrow 0$ . The third is constant relative prices implying  $R = e$  and  $F_R = 0$ .

### Functional Model and Description of the Analyses

Equations (2) and (4) express  $G$  and  $F$  as functions of  $R$  and  $Z$ . Translog functions were fitted to the data to approximate these functions. In specific regions in input space, the monotonically increasing output and the convex isoquant conditions are satisfied by this functional form (Berndt and Christensen). The method of estimating productivity growth rates as defined by equation (7) is outlined in footnotes to table 1.

Estimation of productivity growth was also undertaken by periods to relate the growth rate to the changes in basic development strategies. Fitting the translog model to these subperiods was not possible with ordinary regression techniques because of an undersized sample problem. To overcome this problem, the maximum-entropy (ME) procedure was applied. The ME-moment matrix is always positive definite (Theil).

The effect of changes in normalized prices of intermediate inputs on DVA was estimated by taking the partial derivative of F with respect to R and applying the estimated parameters of the fitted translog model. Similar procedures were used in estimating the response of DVA to the changes in primary inputs. These effects were measured using the elasticity concept.

The response of changes in relative prices can be observed through the changes in intermediate inputs being applied in production. This will be observed using derived demand for the inputs described by (3).

### Basic Development Strategies

Based on the development strategies adopted, the postwar economy of Indonesia can be broken down into three major periods: postwar reconstruction, the guided economy, and the new order. Each of these strategy periods has some very typical characteristics which reflected public sentiments, the economic situation, and the political climate.

**Table 1. Growth Rates of Value Added, Factor Shares, and Total Productivity of Indonesian Agriculture**

Period	Annual growth rate		
	Gross value	Factor	Total
	added <sup>1</sup>	share <sup>2</sup>	productivity <sup>3</sup>
	Percent		
1950-1958 (Postwar reconstruction)	3.93	3.48	0.45
1959-1966 (Guided Economy)	1.64	3.62	-1.99
1967-1978 (New Order)	3.79	2.22	1.57
1950-1978	2.82	2.22	0.60

<sup>1</sup> Denoted as  $dF/F$  and estimated by regressing the logarithm of DVA on time.

<sup>2</sup> Defined as  $(G_Z/G)'dZ$  of equation (7).  $G_Z/G$  is a vector and each of its elements is a function of  $R$ ,  $Z_1$ ,  $Z_2$ , and  $Z_3$ --normalized price of intermediate inputs, acreage of agricultural land, number of labour force, and value of fixed capital. The functions were derived from the translog model. All values were evaluated at their geometric means. Elements of vector  $dZ$  were estimated by regressing the logarithm of  $Z_i$ 's on time. Agricultural land was composed of arable land and permanent cropland (in million hectares). Labour force was in million workers engaged in agricultural activities in the respective years. Fixed capital consisted of irrigation facilities, tractors, equipment, fishing boats, and livestock capital (in billions of 1960 rupiahs). The aggregate price of intermediate inputs was the weighted sum of the price indexes of fertilizers, farm chemicals, seeds, and feed (1960 = 100). The aggregate price of agricultural output was based on the food crop price index and price indexes of rubber, copra, coffee, tea, buffalo meat, and dried fish (1960 = 100).

<sup>3</sup> Defined as  $dF/F - (G_Z/G)'dZ$  as per equation (7).

The first phase began in 1950 and continued up to 1958. This period was characterized by substantial reliance on private enterprise tolerance of foreign investment and management, foreign exchange controls, and price regulation during the later part of the period.

The guided economy which was announced in late 1958 and extended until the first quarter of 1966, was characterized by an emphasis on national control and ownership, a heavy government influence on the market, an emphasis on equality, and very rigid controls on foreign exchange.

The new order period which began during the second quarter of 1966 has been characterized by an emphasis on economic rehabilitation and growth, a reliance on private enterprise, some role for foreign investment, and a high degree of freedom in the foreign exchange sector.

### **Productivity Growth**

An estimate for the entire 1950-1978 period showed a 2.82 percent average annual growth rate of agricultural value added (table 1). Total income share of primary inputs—land, labour, and fixed capital—grew at an annual rate of 2.22 percent. Therefore, the total productivity of the agricultural sector grew at 0.60 percent a year.

Increases in the amount of fixed capital in agriculture, expansion of land area, and allocation of more labour in the postwar reconstruction period gave a high average growth rate of value added (3.93 percent). Total productivity was rising, but the rate was relatively low (0.45 percent)—perhaps due in part to low managerial skills of farmers, low quality of labourers, lack of adaptable technology, and limited technical inputs.

Centralized control, domestic political rivalries, and unproductive spending were some of the factors which led the economy to a sluggish growth, high inflation, and a decline in productivity (-1.99 percent) in the years of the guided economy.

During the new order period, the value added increased at an average rate of close to that of the postwar reconstruction years. However, the growth rate of the factor share of primary inputs was lower, so the productivity growth rate was higher—1.57 percent annually. Public expenditures for extension and research to support agricultural growth have increased substantially since the first REPELITA (Five Year Development Plan, 1969-1974).

### **Elasticities of Output and Derived Demand for Intermediate Inputs**

The elasticity of value added with respect to the normalized price of intermediate inputs in Indonesian agriculture during the period under study was estimated using the translog model to be -0.03 (table 2). This implies that as the price of the input bundle relative to the price of output declines by 1 percent, the real value added could be expected to increase by around 0.03 percent.

This inelastic response of value added to price changes may be due in part to the fact that fertilizers, farm chemicals, and seeds are not inputs into fisheries and forestry—important components of value added. Also, input prices used in the analysis may not correctly represent the prices paid by the farmers due to subsidies and other forms of market intervention.

Addition of 1 percent of land area was estimated to bring about an increase of 0.40 percent in real value added. A 1 percent increase in labour force was estimated to give the highest impact on agricultural value added. Finally, the elasticity of value added with respect to fixed capital was estimated to be 0.18.

Producer response to any change in input and output prices is reflected in the changes in inputs demanded. The demand function is obtained using equation (3). Response was measured by the elasticity of derived demand.

A reduction of 1 percent in the relative price of intermediate inputs was estimated to raise the amount of input demanded as much as 4.9 percent (table 3). A 1 percent increase in land could bring about a 0.13 percent increase in current inputs demanded. Estimated elasticities of demand for intermediate inputs with respect to labour and fixed capital were 0.14 and 0.20 percent, respectively.

### Some Policy Implications

As part of a broader economic system, agricultural growth naturally depends on the economic strategy adopted. Inappropriate monetary and fiscal policies which created high inflation rates during the guided economy era, combined with policies which neglect price parity, were destructive to agricultural growth and productivity. Emphasis on irrigation combined with a diversification strategy was helpful in the postwar reconstruction period. And research on better varieties, reasonable prices of fertilizers, cash credit, and guaranteed price floors enabled the new order administration to increase productivity.

Productivity growth in Indonesian agriculture has been relatively modest and the levels of production per hectare as well as per worker have been generally low. The opportunity to raise agricultural productivity remains a viable option. Such increases are needed to meet the rapidly increasing domestic demand for food commodities and to prevent declining agricultural export earnings.

**Table 2. Price and Input Elasticities of Value Added  
in Indonesian Agriculture, 1950-1978**

Source	:	Elasticity <sup>1</sup>
	:	
Price of intermediate inputs	:	-0.03
Agricultural land	:	0.40
Labour force	:	2.04
Fixed capital	:	0.18
	:	

<sup>1</sup>Based on the results from the transcendental logarithmic model for real value added (DVA).

**Table 3. Elasticity of Derived Demand for Current Input with Respect  
to Its Relative Price, and to the Amount of Basic Factors in  
Indonesian Agriculture, 1967-1978**

Source	:	Elasticity of derived demand <sup>1</sup>
	:	
Price of intermediate inputs	:	-4.93
Agricultural land	:	0.13
Labour force	:	0.14
Fixed capital	:	0.20
	:	

<sup>1</sup>Estimates were based on the regression coefficients of the translog model for single-price deflated value added.

A very elastic demand indicates that reduction in normalized prices of intermediate inputs would substantially increase the demand for inputs which, in turn, will raise the level of value added and, hence, productivity. The response could be accelerated by land reclamation and development, and by allocating more fixed capital to the agricultural sector.

Fixed capital in the form of tractors and working animals facilitates an expansion of agricultural production onto new land. Some such capital would also substitute for some of the agricultural labour force, which could raise the unemployment rate. Mechanization should, therefore, be undertaken with careful calculations--particularly in regions where the man/land ratio is high. Whenever nonagricultural sectors are expanding and able to absorb a substantial number of workers, farm mechanization could be encouraged. The type of power equipment should be appropriate for a labour abundant system so that the labour discharging effect in agriculture can occur at a socially acceptable rate.

### Note

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