8-1992

Reliability and Robustness in Yield and Input Elasticities for Wetland Rice in Java

Thulasiram Kesavan
Iowa State University

Frederick C. Roche
Iowa State University

Bambang Adinugroho
Iowa State University

Recommended Citation

Kesavan, Thulasiram; Roche, Frederick C.; and Adinugroho, Bambang, "Reliability and Robustness in Yield and Input Elasticities for Wetland Rice in Java" (1992). *CARD Working Papers*. 141.
http://lib.dr.iastate.edu/card_workingpapers/141

Reliability and Robustness in Yield and Input Elasticities for Wetland Rice in Java

Abstract

This study attempts to address the issues of "reliability" and "robustness" in the supply parameters using pooled time series data for wetland rice in Java. In particular, the sensitivity of the yield and input demand elasticities are evaluated due to differences in specification of farmers' expectations variables, alternative data sources, (dis)aggregation of inputs, and functional forms. The analysis indicates that the yield and fertilizer input elasticities are fairly robust across different specifications. However, the estimates of labor demand elasticities are quite sensitive to data and model specifications.

Disciplines

Agricultural and Resource Economics | Agricultural Economics | Economics

Reliability and Robustness in Yield and Input Elasticities for Wetland Rice in Java

T.Kesavan, Fred Roche,
Bambang Adinugroho, and
Alirahman

Working Paper 92-WP 96
August 1992

Center for Agricultural and Rural Development
Iowa State University
Ames, Iowa 50011

T. Kesavan is adjunct assistant professor, CARD; Fred Roche is adjunct professor and project director; Bambang Adinugroho is project assistant; and Alirahman is head of the Bureau of Agriculture and Irrigation; all are with the Food Crop Monitoring Study, BAPPENAS/ADB/CARD.

This paper was written as part of the Study on Monitoring the Impact of Policy Changes on Food Crop Production, Employment, Income, and Poverty Alleviation in Indonesia funded by Asian Development Bank,

Abstract

This study attempts to address the issues of "reliability" and "robustness" in the supply parameters using pooled time series data for wetland rice in Java. In particular, the sensitivity of the yield and input demand elasticities are evaluated due to differences in specification of farmers' expectations variables, alternative data sources, (dis)aggregation of inputs, and functional forms. The analysis indicates that the yield and fertilizer input elasticities are fairly robust across different specifications. However, the estimates of labor demand elasticities are quite sensitive to data and model specifications.

1. Introduction

Much research has been undertaken in recent years on the estimation of aggregate supply response for food crops in Indonesia. The aggregate supply relationships in terms of factor-factor, factor-output, and output-factor are crucial in any policy analysis. These relationships, measured in terms of output and input price elasticities, are used widely to guide many policy formulations ranging from evaluating the fertilizer subsidy issue to allocation of government expenditures towards appropriate investment in research and irrigation development and to analyzing the impact of alternative pricing strategies and trade liberalization on food supply, rural employment, and farmers' income.

A number of studies, concentrating mainly on the fertilizer subsidy issue, have contributed to the knowledge of these supply parameters for food crops in Indonesia (see Timmer 1985; Rosegrant et al., 1987; Tabor et al., 1988; and CARD/MOA, 1989). Often the supply parameters derived by different studies are quite varied, leading to conflicting results in policy simulations. A detailed discussion of this problem can be found in Ellis (1988). The observed discrepancies in the available estimates have been attributed to a number of factors including misspecification, measurement errors, differences in data sources, and differences in aggregation of factors and commodities.

The differences in the important policy parameters have raised doubts about the application of stylized economic models to "limited and noisy data." In this respect, it is particularly important to recognize that economic models (and theory) are fairly simple representations of complex behavior. Given this premise, as well as the nature of the data available for most empirical analyses, then the relevant question to ask about a model is not whether it is "realistic," but whether it is a sufficiently good approximation for the desired policy purposes. In this respect, it is not best to treat economic models as exact representations of true behavior. Instead, a more pragmatic approach is to regard the estimated models as "approximations." Such a recognition also suggests that the parameter estimates must be assessed through specification testing, diagnostic checking, model comparison, and an adequate formulation of the expectational variables. Ultimately, these tests provide confidence among the policy parameters, and can be addressed only by using data at hand and the data available from alternative sources.

This study attempts to address the issues of "reliability" and "robustness" in the supply parameters using pooled time series over cross-section data for wetland rice in Java. The purpose of this paper is to analyze and synthesize the sensitivity of the estimates due to differences in specification of farmers' expectations variables, alternative data sources, (dis)aggregation of inputs, and functional forms. The results should be viewed as indicators of the confidence surrounding these important policy parameters, rather than settling on one set of elasticities that are in some sense superior to others.

The analysis is limited to wetland rice cultivation in Java as a case study. The choice of the crop and region are obvious in the Indonesian context, because rice is the dominant crop and Java contributes nearly 65 percent of national production. Further, since the data and information on Java are considered to be more reliable, the results compiled in this study can serve as a numerical benchmark for predicting the probable effects (or ill effects) for other crops and regions. Since the amount of permutation and combination are almost endless in an exercise like this, it is necessary to keep the analysis confined to a few limited cases, dictated partly by the authors' knowledge about data and partly by the project's objective.

The paper is organized as follows. In section 2, the data and methods are described in detail. The important issues related to data and choice of profit supply systems in relation to the subsequent empirical analysis are discussed. An outline of econometric considerations along with the adapted empirical approach are also provided. The estimation results of the various analyses are discussed in section 3. Finally, in section 4, some important implications of the study are provided.

2. Methods and Data

The technical relationship between factors of production used by farmers to produce an output can be defined using either a primal or dual approach. The primal approach consists of direct estimation of a production function. Alternatively, the aggregate technology and the production behavior can be represented equivalently (and indirectly) through duality theory. Recent studies of supply response for food crops in Indonesia have adapted the dual approach because of its flexibility in choosing a functional form directly to represent profit maximization, avoidance of simultaneity problems that are inherent in the primal approach, and the relative ease of imposing (or maintaining) the properties implied by economic theory (see Fuss et al. 1978).

In general, the estimation of supply parameters for the Indonesian food crop sector has followed a two-step process, where the area allocation is decided first within a multicommodity framework, and then, the profit maximization principle is invoked for individual crop productivity. This paper adapts this process implicitly and focuses on the estimation of yield and input demand system elasticities for wetland rice in Java. A translog profit system is used as the basis for evaluating the sensitivity of estimates due to alternative specification of variables. The dependency of the estimated parameters due to functional form specification is also analyzed using an alternative form, namely the Generalized Leontief. The various issues related to data and alternative specifications of variables are discussed below, in addition to the profit systems used.

2.1. Data and Related Issues

The variables required for the analysis included profit, expected price of output, current observed prices and quantities of variable inputs, technology, and weather. The data were collected from the cost structure survey published by the annually Central Bureau of Statistics (BPS). The variables related to yield, fertilizer, and labor uses and the value of output and input were collected for the three important provinces in Java: Java Barat, Java Tengah, and Java Timur. The period of analysis was 1978 to 1989 with lagged values derived from the corresponding previous periods. The variable inputs considered were labor and fertilizer, so the profit was calculated as gross value of production minus the variable costs of labor and fertilizer. A complete list of data used in the analysis is available upon request from the primary author.

Technology and fixed factors were represented by an index based on the total cost of rent for agricultural implements, rent for animals, irrigation fees, maintenance, transportation, contracted work, and others reported in the BPS Cost Structure publications. The index of the total cost of these activities was computed using 1976 as the base. Variables such as time trend, percentage of area irrigated, and percentage of area under an intensification program were also explored as proxies for technology. The estimates based on the time trend variable produced results similar to the results based on the fixed factor variable. The qualitative nature of the sensitivity of the results also did not change appreciably when other irrigation variables were used in combination with time trend.[1] Climatic conditions, particularly rainfall, are also important in determining rice production, however, for simplicity it was not considered in this analysis.[2]

---

[1] Several alternative definitions of irrigation variable were examined. In general, the percentage of irrigated area to total area harvested showed a declining trend, irrespective of the data source. The attempted analysis considered only the technical and semitechnical irrigation from BPS data, and public works (PU) and nonpublic works (NPU) sources from BIMAS data.

[2] A recent study by Mitchell (1990) showed that area was more affected by rainfall than yield. Our preliminary analysis also indicated that rainfall may be more important in predicting seasonal variation in output rather than annual data.

2.1.1. Price Expectations

The implicit producer (farm) price was derived by dividing the value of production per hectare by yield per hectare.[3] Since farmers do not have complete knowledge of the price of output at the time of harvest or sale period, the decisions are made under uncertainty conditional on expected prices. These expected prices are not typically observable and need to be incorporated prior to estimation of the profit function. Commonly, adaptive expectations such as lagged price or weighted average of past prices are assumed in the supply response analysis (e.g., Rosegrant and Kasryno, 1991 Shumway, 1983). While there is overwhelming evidence favoring the adaptive expectation hypothesis in agricultural markets (Askari and Cummings, 1977), there have been few attempts in Indonesia to test this hypothesis against alternative expectations. A similar effort was made in a recent study by CARD/MOA (1989).

Mitchell (1990) has shown that price expectations are important in forecasting supply and procurement of rice. Following the theory of rational expectations, appropriate expected prices can also be approximated by a model based on past and current information. In this regard, the use of current price is not correct, as it does not account for the unanticipated changes from errors in the creation of farmers' expectations. The sensitivity of the supply parameters due to alternative specifications of producer price expectations were analyzed based on two types of expectations given by,

$$P^{e}_{t} = 0.666\ PY_{t-1} + 0.334\ PY_{t-2}\ , \qquad (1)$$

---

[3] The use of unit values as prices may be questioned on the basis of differences in gabah quality. Econometrically, this leads to measurement error bias, which is ignored here, although it is not clear that substantial gains estimate can be obtained through correction for such bias. A cursory examination of the implied unit values with the producer price for IR36 reported by BPS indicated that both series moved together and exhibited similar patterns, despite the differences in actual values.

$$\ln(P^{e}{}_{t}) = a_1 \ln PY_{t-1} + A_2 \ln PY_{t-2} + a_3\, t + a_4\, (t^2), \tag{2}$$

where p^e is the expected producer (farm) price, py is the observed price per unit at time t; and t is the time trend. Equation (1) indicates a weighted average of the past two years prices, hence referred to as adaptive expectation model. The weights were based on the earlier work by Rosegrant and Kasryno (1991). On the other hand, equation (2) represents a model for predicting expected price, referred to as *model consistent* expectations.[4]

2.1.2. Wage Data

Since the translog profit system is based on input (and output) shares, information on wage rates is sufficient for estimation. For the generalized Leontief profit system, both the actual labor use and the wage rate data are required. Since the value of hired labor is available from the BPS cost structure data, the implied labor use can be estimated by dividing the value of labor by the average rate (or vice versa). In this study, the rural wage rate series collected by BPS were used. Regional wage rate was represented by the average of wages paid for three operations in rice cultivation, namely hoeing, weeding, and planting.

The labor use data were available for rice. However, for other crops, such information is lacking, so researchers have to rely on rice wage rate series for analysis. Therefore, to understand the sensitivity of parameters under alternative labor use assumptions, an experiment was conducted using the data on actual labor use per hectare. For this purpose, the data on labor use for the three

---

[4] The rational expectations hypothesis suggests that expectations are consistent with a structural model. Since equation (3) is based on a model that is not structural in nature, we adapt the terminology of model-consistent-expectation. Several other variations in (2) were also attempted. The choice reflected in equation (2) is based on statistical criteria such as R^2 and other similar model selection criteria, as well as the plausibility of the supply parameters. It should be noted that estimates of the supply system are conditional on this specification.

farm operations were computed regionally based on rice production data specially processed for BIMAS by BPS. This alternate source and method is referred to as *BIMAS labor use data* in our analysis, while the former source, based on the wage rate series, is referred to as *BPS wage data*. This experiment was also stimulated by the team's observation of great differences in labor use and labor demand elasticities reported in Indonesian food crop studies. The various issues related to labor data and their implication for policy analysis will be discussed in a forthcoming paper.

2.1.3. Fertilizer Data

Until recently, a panterritorial pricing policy existed for both urea and TSP products. Consequently, most supply response analyses have faithfully concentrated on the response of fertilizer as a whole, aggregating urea, TSP/DAP, and others. Since the reduction of the budget subsidy for urea and TSP in 1989, and because TSP accounted for almost 46 percent of the overall subsidy cost, there is a need to understand the differential impact on the urea and TSP inputs from changes in pricing strategies.

Currently, the knowledge about the demand parameters at the disaggregated product level of urea and TSP is somewhat lacking. BPS has reported urea, TSP, and DAP separately only from 1979. Hence, given degrees of freedom constraints, a disaggregated analysis has only become possible now. The available data from BPS allowed us to disaggregate the fertilizer use only into urea and TSP/DAP components. Hence, for comparing the individual component estimates with the aggregate fertilizer demand parameters, a supply system with urea and TSP/DAP specified separately was estimated. These results should provide an understanding of the possible bias involved in using aggregate fertilizer input estimates to assess the differential impact on urea and TSP products. The nationally announced fertilizer price was used until 1986 in all analyses, due to the prevalence of the panterritorial pricing policy.

2.2. Functional Forms and Profit Systems

Empirical applications of supply response for food crops using the duality approach have, in general, relied on flexible functional forms. Among the various specifications, translog (TL), Generalized Leontief (GL) and normalized quadratic (NQ) have been successfully applied for food crops in Indonesia. For instance, Altemeier, Tabor, and Davis (1988) applied a translog profit function to pooled cross-section farm survey data in order to estimate supply parameters for Java and Off-Java. Recently, the TL profit function was also extended to estimate fertilizer response to prices on a regional basis using time series data (see CARD/MOA, 1989). Kesavan et al. (1989) applied a normalized quadratic profit function using cross section data for South Sulawesi. All these studies followed the customary approach of estimating the profit function together with the input demand system. Alternatively, Rosegrant and Kasryno (1991) estimated the system of yield and input demand derived from GL, but using a pooled cross-section/time series analysis.

It is worthwhile to mention that the TL, GL, and NQ profit functions belong to the class of second-order flexible functional form based on Taylor series. Economic theory does not provide guidelines for choosing a functional form. At the same time the properties of the functional forms are varied and have a number of implied restrictions. For a discussion about the properties of TL, GL, and NQ profit functions and their practical implications, see Lopez (1984) or Dixon, Garcia, and Anderson (1987). Since the choice of functional form is arbitrary, flexible functional forms are preferred purely on statistical grounds. The problem in practice is that most of these functional forms are only consistent with the aggregation conditions under very restrictive conditions. Alternatively, one can apply a system-wide approach as an approximation to any "true" unknown production behavior. Such an assumption is implied in this study. To understand the nature of approximations due to differences in the specification of functional forms, an experiment was conducted to compare the estimates from the translog profit system with that of Generalized Leontief profit system. Models of TL and GL systems are given below.

The estimated (normalized) translog profit system can be specified as,

$$\begin{aligned}
\ln(\pi/P^{e}) = {} & C_0 + C_{02}\ln(W_1/P^{e}) + C_{03}\ln(W_2/P^{e}) \\
& + 0.5\, C_{22}(\ln(W_1/P^{e})^2 + 0.5\, C_{33}(\ln(W_2/P^{e}))^2 \\
& + C_{23}\ln(W_1/P^{e})\ln(W_2/P^{e}) + T_0\ln(Z) + T1\,(\ln(Z))^2 \\
& + T2\ln(W_1/P^{e})\ln(Z) + T3\ln(W_2/P^{e})\ln(Z) \\
& + D11\ DUMR1\ln(W_1/P^{e}) + D12\ DUMR2\ln(W_2/P^{e}) \\
& + D21\ DUMR1\ln(W_2/P^{e}) + D22\ DUMR2\ln(W_2/P^{e}) + E_1\ ,
\end{aligned}$$

$$\begin{aligned}
-S_2 = {} & C_{02} + C_{22}\ln(W_1/P^{e}) + C_{23}\ln(W_2/P^{e}) + D11\ DUMR1 \\
& + D12\ DUMR2 + E_2\ ,
\end{aligned}$$

$$\begin{aligned}
-S_3 = {} & C_{03} + C_{23}\ln(W_1/P^{e}) + C_{33}\ln(W_2/P^{e}) + D21\ DUMR1 \\
& + D22\ DUMR2 + E_3\ ,
\end{aligned} \tag{4}$$

where, π indicates profit; S refers to share of input to profit; P^{e} is the expected crop price; w_1 is the wage rate; w_2 is the fertilizer price; Z indicates the fixed factor or technology variable, DUMR1 is a dummy variable equal to one for West Java (coded as i), 0 otherwise; DUMR2 is a dummy variable equal to one for Central Java (coded as 2), 0 otherwise.

The formula for computing elasticities in a translog profit system are given by,

$$E_{ij} = (C_{ij}/S_i) - \delta + S_j\ ,$$

$$\begin{aligned}
E_{iT} = {} & (T_i/S_i) + T_0 + 2T_1\ln(z) \\
& + T_2\ln(W_1/P^{e}) + T_3\ln(W_2/P^{e})\ ,
\end{aligned} \tag{5}$$

where, E_{ij} indicates elasticity of i^{th} netput with respect to j^{th} price; δ is Kronecker delta equal to 1 for $i=j$, 0 otherwise; S is the netput share to profit, and E_{iT} refers to elasticity with respect to fixed input variable for i^{th} netput.

The Generalized Leontief (GL) profit system is given by,

$$\begin{aligned}\pi = {} & B_0 + B_1 P^e + B_2 W_1 + B_3 W_2 + B_{21} (P^e)^{1/2} (W_1)^{1/2} \\ & + B_{23} W_1^{1/2} W_2^{1/2} + B_{31} (P^e)^{1/2} (W_2)^{1/2} \\ & + T_1 Z P^e + T_2 Z W_1 + T_3 Z W_2 + E_1 ,\end{aligned}$$

$$-q_2 = B_2 + B_{21} (P^e/W_1)^{1/2} + B_{23} (W_2/W_1)^{1/2} + T_3 Z + E_2 ,$$

$$-q_3 = B_3 + B_{31} (P^e/W_2)^{1/2} + B_{23} (W_1/W_2)^{1/2} + T_3 Z + E_3 , \tag{6}$$

where π is the profit per ha; q_2 is the labor use per ha; q_3 is the quantity of fertilizer per ha; p^e is the expected output price and E's are the disturbance terms. Note that the yield equation is dropped to maintain the adding-up restriction. The cross-price elasticities are given by,

$$E_{ij} = (B_{ij}/2 \, q_i) \, (X_j/X_i)^{1/2} , \tag{7}$$

and the own-price elasticities are derived through the homogeneity condition as,

$$E_{ii} = - \sum_{i \neq i} E_{ij} , \tag{8}$$

where E_{ij} refers to the elasticity of i^{th} input or yield with respect to j^{th} input or output price; q refers to quantity; X indicates crop (for $i,j=1$) and input (for $i,j = 2,3$) prices.

2.2.1 Econometric Considerations

Following Sidhu and Baanante (1981), the profit functions (both TL and GL) were estimated together with the respective input demand system. This is also consistent with the notion of extending profit systems as approximate systems.[5]

To account for the pooled nature of the data "fixed" effects procedure was followed. Accordingly, the regional variations were measured by dummy variables in the translog profit system—two dummy variables were introduced corresponding to three regions. Since the translog specifications implied logarithmic transformation of variables, the dummy variable technique was considered to be adequate for the pooled estimation. For GL, the fixed effects were introduced through mean scale transformation of the variables; that is, the variables were transformed by taking deviations from their respective (regional) means.

A maximum likelihood procedure was applied with symmetry conditions imposed in each model. Since a normalized translog specification was followed, the homogeneity condition was automatically satisfied. The adding up restriction was maintained by deleting the yield equation in the profit system.

The validity of the model can be tested through testing randomness in the estimated residuals. This could be performed either through Durbin-Watson or Q statistics. The Q statistics (commonly known as Box-Pierce Q statistics) are distributed as a chi-square and indicate the presence or absence of first-order autocorrelation among the residuals. The failure to reject Q statistics is generally considered as a test for model specification. The Q statistics for 12 lags in correlation structure were also reported for each model, for individuals with more quantitative outlooks, but are rarely discussed

---

[5] For econometric reasons, we need to add a disturbance term to each equation in the system, which is usually justified by the errors created in the farmers' optimal decision making. Since our treatment of the system follows approximation, the error term is automatic, but has a different interpretation. Basically the error term in approximate systems includes errors due to all the implied assumptions in the model, which are commonly referred to as *approximation error*.

in the text. Similarly, the log-likelihood values were also reported for various models that could be used for formal (informal) comparisons of nested (nonnested) models, but were not pursued here.

Instead, since the estimated yield and input demand elasticities are of primary importance from a policy perspective, the evaluation of alternative specifications was made based on these parameters. This was accomplished by computing elasticities at each data point (year) and estimating bias over the sample period on the basis of a *true* model. For this purpose, the mean absolute bias was calculated as,

$$BIAS = \sum_{t=1}^{n} |E^{a}_{ijt}| - |E^{R}_{ijt}|$$

where $| E^{a}_{ijt} |$ indicates absolute value of the estimated elasticity based on an alternative model and $| E^{R}_{ijt} |$ refers to the absolute value of the estimated elasticity based on an *alternate* model. In subsequent analyses, where needed, the mean absolute bias of the estimated elasticities was reported, using the *model consistent* translog profit system as the basis for comparison. Unless specified, the average of the elasticities for the whole sample was reported in the tables.

3. Estimation Results and Discussion

The results are discussed in the same order as the analysis (referred to as *experiments*.)

3.1. Alternative Price Expectations

The elasticity estimates for different price expectations based on the translog profit system are presented in Table 1. As described earlier, two models were estimated corresponding to "adaptive" and "model consistent" price expectations. A number of other alternatives such as one year lagged price and current price formulations (perfect foresight) were also attempted. Both the adaptive and model-consistent models performed well and produced elasticity estimates that are reasonable in sign and magnitude. The own-price elasticities for input demand were negative, while the output-price elasticity for yield was positive. The cross-price elasticity between labor and fertilizer (and vice versa) was negative, indicating complementarity between the two inputs. A comparison of the estimates between the alternative price expectation models revealed the following:

1. The own-price elasticity of fertilizer varied slightly based on the specification of price expectations, ranging from -0.37 to -0.52, respectively, under model consistent and adaptive expectations assumptions. However, the wage elasticity of labor demand changed only marginally across the two price expectation models. Interestingly, the yield elasticities did not change much due to differences in price expectations. This suggests that price expectations are probably more important in fertilizer applications than in hired labor use, and that better informed (knowledgeable) producers may be less responsive to changes in the expected crop price.

2. The parameter estimates of the fixed factor/technology variables are rarely discussed in supply response studies and deserve some mention here. It is apparent from the results reported in Table 1 that these elasticities are fairly stable across different price expectations. The fixed input (and technology) elasticity was the highest for fertilizer (0.28), followed by yield (0.2), and then labor use (0.15). For recent years, it was observed that these elasticities have become smaller, indicating that the response of yield and input may have slowed down. This has implications for public investment in research and irrigation facilities and needs further investigation.

3. Comparing the results with other studies (see Appendix A for a summary of results from other studies), it could be observed that there is a certain level of consistency among the important policy parameters that are used in evaluating the fertilizer subsidy issue. The yield response to fertilizer price was fairly low and the own-price elasticity for fertilizer demand was between -0.4 and -0.38. For 1988 and 1989, when the fertilizer subsidy program was not in effect, the model-consistent expectation specification produced an estimate of -0.41 and 0.52, respectively, for own-price and cross-price elasticity for fertilizer demand (Appendix A). These results corroborate that the expected price increase from removing the fertilizer subsidy program will lead to a substantial budget gain without much reduction in rice productivity.

3.2. Alternative Labor Data

Table 2 reports the results due to alternative method of deriving wage rate information for labor demand. When compared with the results in Table 1, the important differences among the estimates due to the sources of labor data under alternative price expectations are succinctly brought out. Notably, the demand for labor became less elastic with respect to wage rate based on the BIMAS labor data. Considering that the labor use data derived from the BIMAS source were less volatile (see figure 1) this result is not surprising. Figure 1 shows that the derived labor use data from BIMAS source, in general, exhibited a much smoother pattern than the implied labor use data derived based on the BPS wage series. This indicates that if one is interested in deriving an elastic labor demand, all that is required is a smoother wage rate series which will essentially translate all the gyrations (or volatility) in the value of labor series to the labor use data. Alternatively, by using a smoother (or for that matter a constant) pattern on labor use, the implied wage rate would absorb the volatility in the value series leading to relatively inelastic labor demand.

Because of the cross equation restriction involved in a theoretically consistent model such as the one used here, the alternative specification for labor also affected the estimates for fertilizer and yield. However, the bias in elasticities in approximating different elasticities was rather small for fertilizer compared to that of labor demand. This indicates that the fertilizer demand estimates are robust even under alternative labor data definitions.

3.3. Disaggregated Fertilizer Data

The estimated elasticities for the TL profit function system with fertilizer input disaggregated into urea and TSP/DSP uses under alternative price expectations are provided in Table 3. To the best of our knowledge, this is the first time such disaggregated estimates for urea and TSP products have been derived using these data. However, it should be noted that these estimates are preliminary, and should be used mainly to study the implication of using aggregate fertilizer variables to analyzing the differential impact of prices on urea and TSP. Considering that the price variations are available in the last few years the actual measurement of individual fertilizer elasticities should be viewed with caution.

The elasticity estimates for yield and labor are quite comparable to the estimates reported in Table 2. When comparing the aggregate fertilizer elasticities (Table 1) with of the disaggregated results (Table 3), the aggregate fertilizer demand elasticity depicts more closely the demand for urea.

More important, the own-price elasticity for TSP was found to be more elastic than that of urea (in absolute terms), indicating that the TSP products are more price responsive than urea. Since TSP accounted for a major share of the fertilizer subsidy budget, this result would mean even greater savings for the government. The lower response to yield due to TSP price supports the contention that farmers are indeed on or near the flat surface of the production function. Such a finding is also consistent with agronomic findings that TSP may be used too often in Javanese agriculture (see Manwan and Fagi, 1989). Investigations using micro level data may provide further insights on this matter.

Another result which merits further study is the substitution behavior observed between TSP and urea. If this is accurate, an increase in TSP price would lead to urea substitution, in which case the gains from the economic subsidy for urea may be estimated incorrectly.

3.4. Alternative Functional Forms: GL vs. TL

In order to understand the sensitivity of the estimates due to alternate functional forms the data were also applied to the generalized Leontief profit system. The results under alternative price expectations are provided in Table 4. Care should be taken in interpreting the differences in elasticity estimates due to functional forms as they were not derived under a controlled experiment condition (such as in a Monte Carlo set up). However, some understanding about the sensitivity of estimates under Generalized Leontief (alternative) specification can be brought out. The results in Table 4 and Table 1 indicated that the GL estimates were, in general, lower than the TL estimates (in absolute terms). For instance, the wage elasticity of labor demand was only -0.48 under GL system, whereas it was almost -1 under TL profit system. While it may be difficult to sort out the differences due to methods and functional forms, one logical explanation is that the mean scale transformation adapted in the estimation procedure for GL probably has the same effect as "smoothing" of the wage series, as described earlier. It was argued that such smoothing of labor series, would lead to relatively inelastic labor demand. On the same token, the discrepancy between fertilizer demand elasticities seem to be smaller as the fertilizer data exhibits a gradual trend. The own price elasticity for fertilizer was -0.3 and -0.38, respectively, based on GL and TL profit systems. Nevertheless, one cannot fail to notice the level of consistency in the fertilizer estimates derived either from GL or TL profit systems. Both models consistently indicate that the fertilizer demand is rather inelastic and the yield response with respect to fertilizer are very small. Hence, policy makers can certainly have a fair degree confidence among the fertilizer demand parameters.

4. Implications of the Study

This paper attempted to address the issue of sensitivity of important policy parameters in supply response due to alternative methods, specification of variables, and functional forms. The major conclusions and implications of these experiments are summarized here.

1. The signs of the yield and input demand elasticities were consistent, indicating that the data can be used effectively to estimate supply parameters dictated by economic models. While correct signs and "plausible" parameter magnitudes are sufficient to corroborate a model's consistency with economic theory, such consistency per se may not be sufficient to convince policymakers to use these estimates for decision making. Yet overall, it does seem that the data, such as they are, are providing a reassuringly limited band of estimates for important policy parameters on fertilizer use and rice yields. The labor demand estimates are more suspect and are subject to specification bias, plus variation on methods and data sources. This is rather troublesome, as the response of labor demand is important to analyzing the impact of pricing strategies to sustain rural employment within the food crops and agricultural sectors. Juxtaposed to the prevalence of poverty among agricultural labor households and the lack of understanding of the rural labor market, there must be a conscious and concentrated effort to improve the data quality and consistency. Some of these issues are already discussed in Roche and Adinugroho (1992).

2. The question of "Are we trying to make too much out of bad and noisy data?", although philosophical, as demonstrated here, can be answered objectively. Clearly, model building is both art and science. Some differences in the estimates are not avoidable; however, they do not imply that stylized economic models are inappropriate for policy modeling. On the contrary, by systematic and scientific investigations, it was found that a good degree of confidence can be placed in the important policy parameters related to the fertilizer subsidy issue. To add more, the ratio of output-price to own-price ranging from 1.31 and 1.39, respectively, under TL and GL specifications. This indicates that the net impact of fertilizer use would depend upon the relative price effect between fertilizer and crop price. Such an

outlook then provides testimony to the usefulness of the economic models in policy simulations because of their internal consistency.

3. The analysis with the new data and information pointed out that the yield response to output price elasticity may have become smaller over time. For instance, Tabor et al. (1988) reported an output price elasticity of 0.24 for yield (see Appendix A), but a more recent study by Rosegrant and Kasryno (1991) reported that the crop price elasticity for yield was 0.2. Based on our analysis, the price elasticity for yield was observed to be 0.13, suggesting that farmers' potential to increase yield due to economic factors is indeed limited. Furthermore, the low fixed factor/technology elasticity observed in recent years indicates that past yield increases that were observed the past, could not be achieved in the future given the current technology. Therefore, nonprice factors such as irrigation investments and area expansion may very well dictate future progress in maintaining trend self sufficiency in rice production.

4. In summary, the empirical investigations conducted in this study indicate that fairly consistent and reliable results can be obtained on important supply parameters for rice by careful analysis of data, with some caveats for labor demand parameters. Since practice leads to perfection, the estimation and modeling activities should be viewed as a continuous process rather than a one-time effort. At the same time, feedback among the agencies involved in policy analysis and the agencies responsible for data collection and processing is essential to improving data quality and consistency. As new and revised information is made available, it can be applied to derive new sets of policy information. Given the dynamic nature of the economic issues, this type of constant and continuous process also helps to monitor structural changes in the economy and facilitate interaction with data collection agencies to further improve data quality and the collection process.

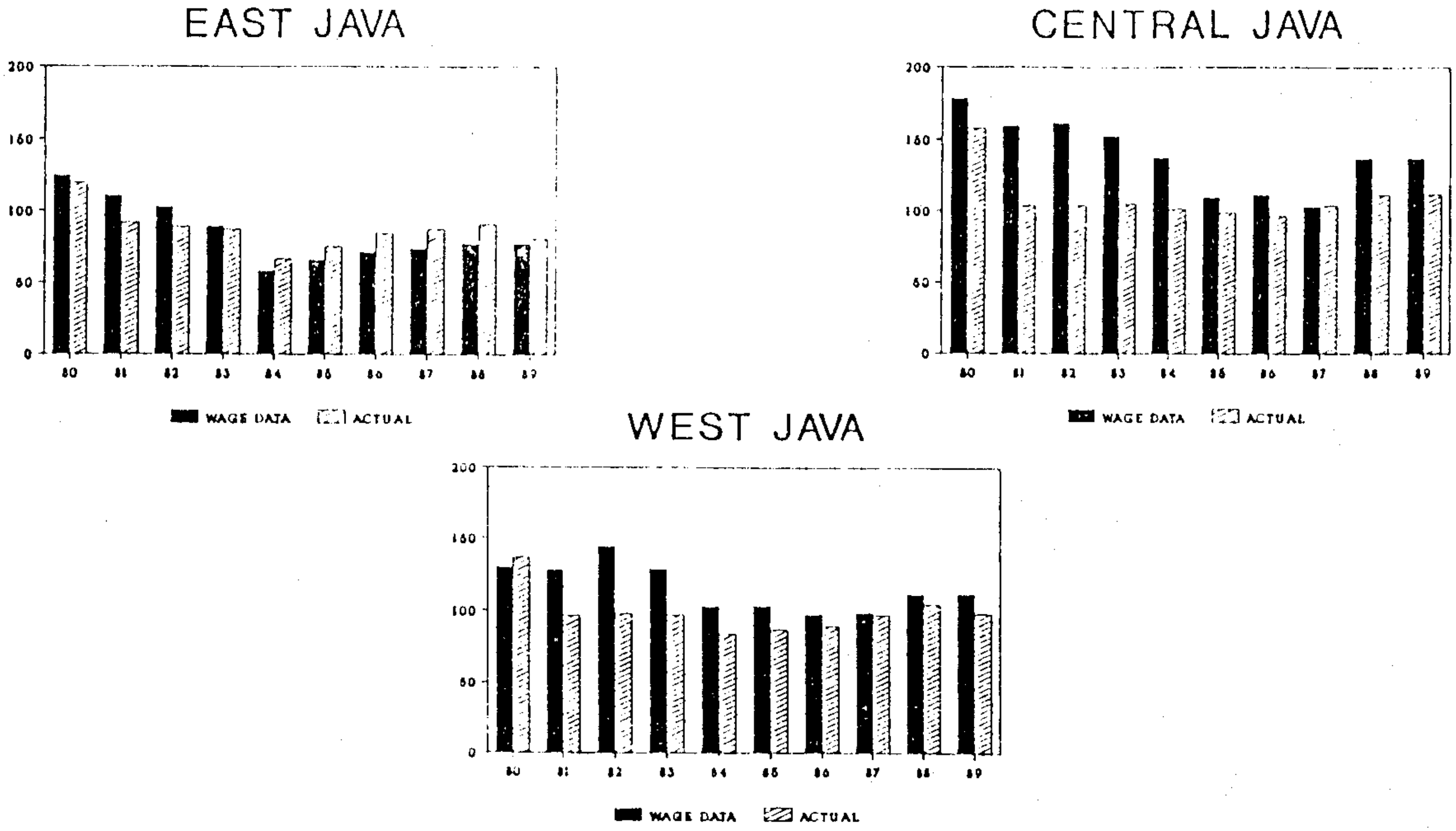

Figure 1. Hired labor use in Java for sawah rice from alternative sources

Note: Attached bars show actual labor use from BPS cost surveys. Dark shaded bars show labor days estimated with independent wage data from BPS.

Table 1. Estimated elasticities for wetland rice in Java based on translog profit system under alternative price expectations

Parameter	Adaptive (1)	Model Consistent (2)	Bias (1)vs(2)
Yield w.r.t.			
Output price	0.143	0.137	0.007
Wage	-0.108	-0.111	-0.003
Fertilizer price	-0.035	-0.026	0.009
Fixed input	0.247	0.207	0.027
Labor demand w.r.t.			
Output price	1.081	1.110	-0.029
Wage	-1.020	-1.050	-0.030
Fertilizer price	-0.061	-0.060	-0.001
Fixed input	0.164	0.133	-0.010
Fertilizer demand w.r.t.			
Output price	0.668	0.486	0.183
Wage	-0.117	-0.115	0.002
Fertilizer price	-0.552	-0.371	0.181
Fixed input	0.294	0.275	0.018
Q Statistics			
Profit equation	20.110	11.130	
Labor equation	13.680	13.510	
Fertilizer equation	26.030	13.170	
Log-likelihood	263.610	274.880	

Table 2. Estimated elasticities for wetland rice in Java based on translog profit system using BIMAS labor use data under alternative price expectations

Parameter	Adaptive (3)	Model Consistent (4)	Bias (4)vs(2)
Yield w.r.t.			
Output price	0.250	0.254	0.117
Wage	-0.161	-0.162	0.051
Fertilizer price-0.088	-0.092	0.066	
Fixed input	0.235	0.186	-0.025
Labor demand w.r.t.			
Output price	0.713	0.707	-0.403
Wage	-0.702	-0.700	-0.351
Fertilizer price	-0.011	-0.007	-0.047
Fixed input	0.089	0.059	-0.047
Fertilizer demand w.r.t.			
Output price	0.653	0.580	0.094
Wage	-0.025	-0.019	-0.088
Fertilizer price	-0.628	-0.562	0.191
Fixed input	0.264	0.235	-0.039
Q Statistics			
Profit equation	29.900	13.490	
Labor equation	12.790	11.670	
Fertilizer equation	32.160	16.530	
Log-likelihood	266.050	276.290	

Table 3. Estimated elasticities for wetland rice in Java using disaggregated fertilizer data based on translog profit system under alternative price expectations

Parameter	Adaptive[a] (5)	Model Consistent[a] (6)
Yield w.r.t.		
Output price	0.204	0.211
Wage	-0.115	-0.111
Urea price	-0.058	-0.064
TSP price	-0.031	-0.036
Labor demand w.r.t.		
Output price	1.082	1.130
Wage	-1.016	-1.060
Urea price	-0.070	-0.063
TSP price	-0.006	-0.003
Fertilizer demand w.r.t.		
Output price	0.589	0.430
Wage	-0.187	-0.171
Urea price	-0.520	-0.432
TSP price	0.118	0.171
TSP/DSP demand w.r.t.		
Output price	0.888	0.625
Wage	-0.027	-0.017
Urea price	0.190	0.276
TSP price	-1.050	-0.883
Q Statistics		
Profit equation	17.530	11.770
Labor equation	13.760	14.110
Urea equation	16.510	8.870
TSP equation	22.060	12.320
Log-likelihood	438.260	449.050

[a] The reported elasticities are based on the average values for 1988 and 1989.

Table 4. Estimated elasticities for wetland rice in Java using Generalized Leontief profit function under alternate price expectations

Parameter	Ad-hoc Adaptive	Model Consistent
Yield w.r.t.		
Output price	0.085	0.088
Wage	-0.062	-0.068
Fertilizer	-0.023	-0.020
Labor demand w.r.t.		
Output price	0.568	0.713
Wage	-0.510	-0.660
Fertilizer	-0.058	-0.053
Fertilizer demand w.r.t.		
Output price	0.407	0.398
Wage	-0.109	-0.101
Fertilizer	-0.298	-0.297
Q Statistics		
Profit equation	30.780	45.670*
Labor equation	25.400	23.470
Fertilizer equation	10.580	11.980
Log likelihood	781.890	781.880

* Significant at 0.05 probability level.

Appendix A

Summary of estimated elasticities for wetland rice in Java for selected studies

	Yield w.r.t.		Fertilizer w.r.t.	
Study	Crop price	Fertilizer price	Crop price	Fertilizer price
1. Tabor et al. (1988)	0.24	-0.03	0.47	-0.45
2. Rosegrant et al. (1987)	0.13	-0.20	-0.71	-0.71
3. CARD/MOA (1989)	0.30	-0.03	0.55	-0.32
4. Rosegrant and Kasryno (1991)	0.20	-0.12	0.57	-0.39
5. This study[a]	0.13	-0.03	0.52	-0.41

[a] The reported elasticities are average values for 1988 and 1989.

References

Altemeier, K,'S. Tabor, and Davis. "Supply Parameters for Indonesian Agricultural Policy Analysis." *Ekonomi dan Keuangan di Indonesia* 36 (1988): 111-130.

Askari, H. and J.T. Cummings. "Estimating Agricultural Supply Response with the Nevlove Model: A Survey." *International Economic Review* 18 (1977): 257-292.

CARD/MOA "Fertilizer Response Special Study: Final Report." Technical Report No.7, Dec. 1989.

Diewert, W.E., and T.J. Wales. "Flexible Functional Forms and Global Curvature Conditions." *Econometrica* 55 (1987): 43-68.

Dixon, Bruce L., Philip Garcia, and Margot Anderson. "Usefulness of Pretests For Estimating Undulying Technologies Using Dual Profit Functions." *Int. Econ. Rev.* 28 (1987): 623-33.

Hedley, D.D. and S.R. Tabor. "Fertilizer in Indonesian Agriculture: The Subsidy Issue." *Agricultural Economica* (1989): 49-68.

Kesavan, T., Pantjar, Simatupang, and Nizwai Syafáat. "Farmers' Responsiveness to Price and Returns to Size: An Application to Wetland Rice Production in South Sulawesi." CARD/MOA Study, Technical Paper No.55, 1989.

Lopez, R.E. "Estimating Substitution and Expansion Effects Using a Profit Function." *Amer. J. Agr. Econ.* 66 (1984): 358-67.

Manwan, I. and A. Fagi. "N, P, K, and S Fertilization for Food Crops: Present Status and Future Challenges." Paper presented at the workshop on Sulfur Fertilizer Policy, Ministry of Agriculture, Jakarta, July 18-20, 1989.

Mitchell, M. "Forecasting Rice Areas Harvested on Java." IPU Technical Paper No.12, BULOG/ODNRI Development Project, Jakarta 1990.

Roche, F. and B. Adinugroho. "Monitoring Indonesian Food Crop Income, Wage Rates, and Labor Adsorption: Uses and Limitations of the Central Bureau of Statistics Farm Cost Structure Survey." Staff Report, Center for Agricultural and Rural Development, Iowa State University, 1992 (forthcoming.)

Rosegrant, M., F. Kasyrno, L.A. Gonzales, C. Rasahan, and Y. Saefudin. "Price and Investment Policies for the Indonesian Food Crop Sector." International Food Policy Research Institute and Center for Agro-Economic Research, Ministry of Agriculture, August 1987.

Rosegrant, M. and F. Kasryno. "Food Crop Supply Response in Indonesia." International Food Policy Research Institute, Washington, D.C., February 1991.