GOVERNMENT POLICIES AND SUPPLY RESPONSE IN THE PADDY SECTOR OF SRI LANKA

P.L. PUSAPALANA and E.A. DZHEROWSKI

School of Commerce
Charles Sturt University - Riverina
Goolgowi, NSW
Introduction

Governments in many developing countries provide assistance to foodgrain production sectors through a variety of policies and programmes such as price support, import restrictions, insurance, credit, irrigation and land development, research and extension, and crop insurance. When the primary objective of such policies is to increase domestic production of foodgrains, the nature and extent of producers' supply response to various policy instruments becomes an important issue for the purpose of designing appropriate food policies. As Hauser and Stonehouse (1978, p. 885) note, when the policies distort the traditional market price decision mechanism the producers become shielded from the full impact of price variations and learn to respond not only to market price variables but to government policy variables as well. Moreover, Nerlove (1979, p. 895) states that, in the presence of government intervention, supply response occurs in a complex and interrelated system of which government is one element. The paddy sector of Sri Lanka provides an interesting case study of producers' supply response in the presence of various policy instruments not only towards paddy production and marketing, but towards consumption of rice as well.2

The purpose of this paper is to examine the impact of four of the major policy pricing policy, irrigation programmes, indirect-financial, and concessional sales of rice on the annual supply response in the paddy sector of Sri Lanka during the period 1964 to 1987. The paper has the specific objective of attempting to answer the following questions: (i) How did producers operate within a complex policy environment? What is the nature of supply response to price? (ii) Given that producers, in the main, had a free choice of selling their paddy either to the government or in the open market, what is the price that producers respond to in making overall supply decisions? (iii) Given the commonness characteristic of paddy production, and because they also received rice under the public food distribution system, what is the nature of the impact of compensation sales of rice on supply response?

Producers' decisions with regard to paddy production consist of two separate decisions: the decisions on area planted (hectares) and the decisions on yield per hectare. Therefore, the impact of the policy variables on area and yield decisions are examined separately. Alternative functional forms (linear versus log-linear) for both area and yield response equations are compared using appropriate criteria suggested in recent econometric literature. Furthermore, both area and yield response equations are estimated with three alternative specifications of the price variable: the price support, the open market price and the weighted average of these two types of price. A non-
nested testing exercise is used to discriminate between these alternative specifications in order to identify the type of price to which producers respond in making area and yield decisions.

The rest of the paper is organised as follows: A brief review of literature with special emphasis on the previous studies of supply response in the paddy sector of Sri Lanka is undertaken next. This is followed by a specification of analytical methods used in this study. Results and discussion are then presented. Finally, conclusions of the analysis are summarised.

**Review of Literature**

**General Issues**

In this paper, the econometric approach to the estimation of partial (area) adjustment model of agricultural supply response developed by Nerlove (1958) has been extensively used to estimate short-run and long-run supply responses in agriculture in both developed and developing countries. Comprehensive reviews of the studies which used the Nerlove model, with or without various modifications, have been undertaken by Askari and Cummings (1973; 1977). Reviews of various aspects of agricultural supply response model can also be found in Nerlove (1979), Colman (1980), Beyers (1989) and Rao (1989).

The partial adjustment model is based on the assumption that producers continually adjust output towards a long-run equilibrium. The validity of this assumption has been questioned in the context of developing countries where market imperfections and government intervention are pervasive (Yates, 1976; Askari and Cummings, 1977; Nerlove, 1980). However, the use of the simple, static model which does not take into account the long-run adjustment process has the limitation of assuming an instantaneous adjustment of supply to changes in economic and other variables. In any economic environment, adjustment of agricultural production changes in economic and other variables takes time, therefore, the partial adjustment model is still useful in analysing the adjustment lags in agricultural supply response in developing countries.

Following Nerlove (1979), supply response of annual crops has often been analysed in terms of area planted (ar, area sown) as the proxy for price, assuming that producers have more control over area, while yield is determined by factors
such as weather and state of technology which are beyond producers' control. According to this view, once producers make their area decisions, they in effect complete their output decisions.

However, if producers also make active decisions with regard to yield per unit of land in response to market and policy variables, given the state of technology and weather, then the acceptance of the area response as the true supply (output) response leads to a downward bias in supply response estimation and consequently in elasticity estimates (Gemmill, 1978). To avoid this downward bias, a number of supply response studies have estimated both area and yield response equations and indirectly derived output price elasticities as the sum of area and yield elasticities with respect to price (see Askari and Cummings, 1976; Gemmill, 1978 and references cited therein). Recent applications of this indirect method of estimating price elasticity of output can be found in Krishna and Chhibber (1983), Samaratunga (1984), and Nainggolan and Suprapto (1987). The indirect method is justifiable if the area and yield response functions are separable in the sense that the two functions are behaviourally different (Gemmill, 1978).

Askari and Cummings (1976; 1977) cite some twenty studies of supply response in rice (paddy) sectors in various countries. More recent examples of studies of supply response of rice producers are Bogahawatte (1983), Samaratunga (1984), Sangwan (1985), Nainggolan and Suprapto (1987), Chellaran and Brorsen (1988), and Peterson (1988). The price elasticities of supply estimated by these studies show a wide variation, sometimes for the same region/country, and between regions/countries with the same natural and economic environment. This variation of the results is partly a reflection of different modifications made by individual researchers to the original Nerlov model. The majority of short-run price elasticity estimates are between zero and 0.5, while the majority of long-run price elasticities are less than one. In some cases, the estimated price elasticity values are negative.

The possible reasons for the observed low price responsiveness of agricultural producers (including rice producers) in developing countries are discussed in detail in Askari and Cummings (1976), Rao (1988) and Beynon (1989). The main reasons cited are the imperfect product and factor markets, price and yield risks, constraints with regard to land, labour and capital, land tenure problems, inadequate rural infrastructure, low level of farmer education, and technological backwardness.

The majority of studies of supply response of rice producers have been interested in analysing the impact of prices of output and inputs, weather, technological change and
irrigation on area and/ or yield. Only a few studies have examined the impact of various other government policies, except pricing policy and irrigation, on the supply response of rice producers. For example, Behrman (1968) investigated the impact of public health expenditure on rice supply response in Thailand. More recently, Bogahawatte (1983) studied the impact of credit and crop insurance on paddy supply response in Sri Lanka. Peterson (1988) analysed the effects of real government subsidies to agriculture on rice area response in Spain.

Previous Sri Lankan studies

Amerasinghe and Mahendraraajah (1974/75) estimated area and yield response equations for Maha (wet) and Yala (dry) seasons separately. Linear as well as log-linear functional forms were used in the estimation. In most cases, the results from the linear models were accepted. The authors concluded that there was a positive but statistically insignificant response of both area and yield of paddy to changes in the guaranteed price. In another study, Amerasinghe (1976) estimated paddy area response equations separately for wet and dry zones of Sri Lanka and again concluded that the impact of price on area was positive but insignificant.

Singh (1975) estimated an aggregate area response equation for the paddy sector of Sri Lanka using the log-linear functional form, and found that the guaranteed price was a positive and significant determinant of area. Hussain (1977) estimated a linear equation for paddy area with two specifications of the price variable: the guaranteed price and the average of guaranteed and open market prices. He concluded that the results did not significantly differ between the two specifications.

Bogahawatte (1983) estimated yield and area response equations for the wet and dry zones of Sri Lanka. For each zone, linear equations were estimated separately for Maha and Yala seasons, using Zellner's Seemingly Unrelated Regression procedure. Among the various equations estimated by Bogahawatte, those for Maha season in the dry zone can be regarded as representative of the aggregate area and yield responses since the major portion of paddy output in the country comes from the Maha crop in the dry zone. These results showed that the proportional areas under irrigation and hybrid varieties had positive and significant effects on yield. The impact of credit, crop insurance and the guaranteed price on yield was positive but insignificant. The guaranteed price, irrigation, credit and crop insurance were the positive and significant determinants of the area planted to paddy.
The Sri Lankan studies reviewed above used the partial adjustment model in analysing area response. By contrast, Samaratunga (1984) used a static, instantaneous adjustment model to analyse area and yield response in the paddy sector. The results from the estimated linear equations with a correction for first-order autocorrelation showed that the guaranteed price and the proportional area under irrigation had positive and significant effects, while fertiliser price had a negative and significant impact, on the area planted to paddy. Moreover, the effects of the guaranteed price and the fertiliser price on yield were negative and insignificant.

The analysis in this paper differs from the previous Sri Lankan studies mainly in two ways: first, by assessing the impact of concessional sales of rice in addition to other selected policy variables and, secondly, by using more systematic procedures in model selection and evaluation.

Method

The model

The model used in this study to estimate the aggregate paddy supply response in Sri Lanka in the period 1952 to 1987 consists of equations expressing area and yield, and an identity expressing paddy output. Following the Nerlovian partial adjustment model, the equation for area planted to paddy in any year \( t \) is built up by combining two equations.

In the first equation, the desired area at time \( t \) is determined by coefficients associated with price and other explanatory variables. In the second, a lag coefficient is introduced to allow for an adjustment process whereby producers are assumed to move from current area toward desired area. The two equations are:

\[
A^*_t = a_0 + a_1 P_e^t + a_2 Z_t + u_t \\
A_t - A_{t-1} = \gamma (A^*_t - A_{t-1})
\]

where, at year \( t \), \( A^* \) is the area desired to be planted, \( A \) is the actual area planted, \( P_e \) is the expected price, \( Z \) is the other exogenous factor(s) affecting area planted, \( \gamma \) is the coefficient of adjustment (where \( 0 < \gamma < 1 \)), and \( u \) is the random error term.

As shown in equation (2), the process of adjustment toward the desired area from the opening area is not complete within one period. Thus, area planted in any one year is a function of the desired area and the area in the previous
year. The change in area is equal to some fraction \( \gamma \) of the difference between the desired area for the current year and the actual area in the previous year. The reduced-form relationship which combines the above two equations excludes the unobservable variable of area desired to be planted.

Thus, the equation for area planted to paddy is:

\[
A_t = \beta_0 + \beta_1 P^e_t + \beta_2 I_t + \beta_3 CR_t + \beta_4 CS_{t-1} + \beta_5 A_{t-1} + u_t
\]

where, at year \( t \), \( A \) is the area planted to paddy (in thousand hectares), \( P^e \) is the expected price of paddy (in Rs per metric ton), \( I \) is the area under irrigation as a percentage of total paddy area, \( CR \) is the amount of institutional credit (in Rs million) and \( CS \) is the expected concessional sales of rice (in metric tons).

The hypotheses to be tested with regard to the area equation (equation 3) are: \( \beta_1 > 0; \beta_2 > 0; \beta_3 > 0; \beta_4 < 0 \); and \( 0 < \beta_5 < 1 \).

The yield equation is:

\[
Y_t = \beta_6 + \beta_7 P_t + \beta_8 I_t + \beta_9 CR_t + \beta_{10} CS_t + u_t
\]

where, at year \( t \), \( Y \) is yield of paddy (metric tons per hectare), \( P \) is the current price (Rs per metric ton) and other variables as defined for equation (3). Instantaneous adjustment of yield is assumed.

The hypotheses to be tested with regard to the yield equation (equation 4) are: \( \beta_7 > 0; \beta_8 > 0; \beta_9 > 0 \); and \( \beta_{10} < 0 \).

The identity giving quantity (\( Q_t \)) of paddy output is:

\[
Q_t = A_t \cdot Y_t
\]

Theoretically, the price elasticity of output (\( e_{QP} \)) should be equal to the sum of the price elasticities of area (\( e_{AP} \)) and yield (\( e_{YP} \)):

\[
e_{QP} = e_{AP} + e_{YP}
\]
Variables and data

Three alternative specifications of the output price variable are tested in both area and yield equations, since it is unknown, a priori, whether producers respond to the guaranteed price (PG) or the open market price (PO), or to an average of these two types of price (WAP). However, given that producers were free to sell their paddy either on the open market at PO or to the government at PG, it is postulated that producers consider both PO and PG in forming their price expectations, and hence WAP represents the most appropriate price variable in both the area and yield equations.

The guaranteed price was specified in current terms (PG\(_t\)) in both the area and yield equations because the guaranteed price was announced in advance for the current planting season and maintained until the next planting season. The expected open market price in the area equation is specified as the open market price of paddy in the previous year (PO\(_{t-1}\)). This simple specification of expectations with respect to the open market price is considered adequate because, in a majority of years during the study period, the open market price moved together with, and settled at a level above, the guaranteed price. In the yield equation the open market price variable is specified in current terms (PO\(_t\)). Following these specifications of PG and PO, the weighted average price is WAP\(_{t-1}\) in the area equation and WAP\(_t\) in the yield equation.

All prices were deflated by the Colombo Consumers' Non-Food Price Index (1952 = 100). This is based on the assumption that, in the aggregate, producers seek to increase the marketable surplus of paddy in order to increase the consumption of non-food items, while maintaining own consumption of rice.

Since paddy production is of semi-subsistence nature where producers are also significant consumers of rice, it is postulated that concessional rice received from the government acts as a disincentive to the expansion of paddy production. There are no separate estimates of concessional rice received by paddy producers and their families. Therefore, the total quantity of concessional sales of rice by the government was included in the equations.

The equations do not include separate variables representing government policies with regard to the use of fertiliser and modern varieties of paddy. It is assumed that irrigation and institutional credit variables represent these policies as well, since the availability of irrigation and credit encourages the use of fertiliser and modern varieties, while fertiliser and seeds of modern varieties were issued to producers by the government as part of institutional credit.
In the context of Sri Lanka's paddy sector, it is assumed that the risk component is negligible and hence can be ignored since input subsidies, institutional credit, crop insurance and guaranteed prices can be expected to have minimised the risk associated with production in the short-run. Moreover, while it is recognised that yield response in particular is subject to risks arising from variations of weather, it is assumed that the impact of variance of weather over the study period either remained constant or was moderated by the increasing availability of irrigation. However, the stochastic specification of the area and yield equations allows for the effects of random events such as variations in weather and socio-political disturbances.

Although the time period covered in the study is from 1952 to 1987, annual aggregate time-series data used in the estimation contained 35 observations due to the inclusion of the lagged area and lagged prices in the area equations. To ensure consistency, the same number of observations was maintained in the estimation of the yield equations.

Publications of relevant Sri Lankan authorities formed the sources of data. The data sources were: Central Bank of Ceylon (Sri Lanka); Commissioner of Agrarian Services; Department of Census and Statistics; Food Commissioner's Department; Paddy Marketing Board and Ministry of Agricultural Development and Research (1981).

It should be noted that the data used are likely to be subject to aggregation bias and measurement errors arising from the methods of collecting and reporting data (see Karunatilake, 1980) and those arising from the use of proxy variables. The results of the study should therefore be interpreted within these limitations.

**Procedures for model estimation, selection and evaluation**

Recall that the equations (3) and (4) were specified above in linear form. Before selecting the preferred models according to the econometric criteria described below, however, linear as well as log-linear models of area and yield, each with the three alternative specifications of the price variable, were estimated. A total of twelve models were estimated.

Area: (1) linear, PGₜ; (2) linear, POₜ₋₁; (3) linear, WAPₜ₋₁; (4) log-linear, PGₜ; (5) log-linear, POₜ₋₁; (6) log-linear, WAPₜ₋₁.

Yield: (7) linear, PGₜ; (8) linear, POₜ; (9) linear, WAPₜ; (10) log-linear, PGₜ; (11) log-linear, POₜ; (12) log-linear, WAPₜ.
The approach employed in this study in the selection and evaluation of the preferred models among these alternative specifications is not taken lightly. With an awareness of the current econometric methodological debate (for example, Hendry, 1987; Leamer, 1987; Beggs, 1986; Poirier, 1988; Phillips, 1988), a deliberate choice is made of the frequentist diagnostic testing approach to model selection and evaluation. The philosophy behind this approach is that some attempt should be made to choose the preferred model on the basis of a formal and strongly defensible procedure, and then the chosen model be subject to a battery of diagnostic tests to ensure that some degree of compliance with the methods' underlying assumptions is held. Thus, the approach used is based on the proposition that ad-hoc model selection techniques lead to inconsistent and unjustifiable model choices, while the incomplete checking of the preferred model's assumptions presumes great faith in specifications which often are based on loosely defined relationships.

It is explicitly recognised that the approach employed in this study is not without its drawbacks, its principal shortcoming being the pre-test problem. That is, the procedure is unable to precisely determine and hence control the true testing significance levels given that estimators are chosen upon the outcome of a battery of tests. To partially appease this drawback, in terms of model building, the principal regressors have been chosen 'a priori' and will not be included/excluded on the basis of t-tests, and further any identified inadequacies will not be mechanically remedied by modified estimation techniques. Moreover, the interpretation of the significance levels associated with the preferred model(s) concurs with that of Pagan (1988). That is, significant levels are interpreted as conditional ones, conditional upon the chosen model(s), and not unconditional levels based on all models estimated.

Initially, a choice is made of an appropriate functional form for regressions by contrasting linear and log-linear forms. The focus is on these two functional forms given their constancy of use in the overall econometric literature, their ease of estimation and interpretation, and the existence of well established diagnostic testing procedures. The RESET(2) specification test is employed to discriminate between the linear and log-linear functional forms. This test is recommended by Godfrey, McAleer and McKenzie (1988), after a Monte Carlo comparison of over ten alternative testing procedures, as having a high degree of robustness to non-normality and relatively good power.

Secondly, two non-tested tests are employed to discriminate between the three alternative specifications of the price variable. The two tests are the J and JA tests (see McAleer, 1987), each having its strengths and weaknesses. The J test
generally has good power but excessive size, while the JA test has acceptable size but relatively poor power.

Finally, a standard set of diagnostic tests is used to evaluate the reasonableness of the underlying assumptions of the estimation techniques. In particular, the following test statistics are presented: the Jarque-Bera normality test; Engle's autoregressive conditional heteroscedasticity (ARCH) test (Engle, 1982), the Breusch-Pagan heteroscedasticity test (HPG), Ramsey's RESET specification error tests, Lagrange Multiplier autocorrelation tests and CUSUMSQ stability intervals. For simple descriptions of and references for these tests and procedures, see Engle (1982).

Results and Discussion

Choice of functional form

The RESET(2) statistics for the comparison of the linear and log-linear forms for both area and yield equations, and the three alternative price variables, are presented in Table 1.

For the area equation, all test statistics are very small indicating strong acceptance of the null in all cases showing that there is no basis for discrimination. On the other hand, for the yield equation the linear form is rejected by the log-linear form at a 5 per cent level for PG_t and at a 10 per cent level for both PO_t and WAP_t. Thus, there is a clear preference for the log-linear form for the yield equation.

Given the failure of the RESET(2) test to discriminate between the functional forms for the area equation, the general performance of the alternative forms in terms of parameter significance and diagnostic tests are examined. Without discussing specific details, for all three price variables greater parameter significance was gained, while measures of goodness of fit was always higher, with the log-linear form. Diagnostic tests tend to point to more problems with the linear form. In particular, instability (about the years 1973-77) as detected by the CUSUMSQ intervals was always prevalent only for the linear form. Thus, there appear to be strong reasons to favour the log-linear form over the linear form for the area equation.

Choice of price variable

The results of J and JA tests for the log-linear form are presented in Table 2. In all cases, the statistics for both the tests are identical. For all pair-wise comparisons across the board the null is not rejected even at a 10 per cent level of significance. This implies that no price variable can significantly outperform any other and hence no
TABLE 1
Linear vs Log-linear RESET(2) Tests (a)

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Price: Guaranteed (PG_t)</th>
<th>Price: Open Market (PO_t)</th>
<th>Price: Weighted Average (WAP_t)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>H_0: Linear</td>
<td>H_1: Log-linear</td>
<td>0.0498</td>
</tr>
<tr>
<td></td>
<td>H_1: Linear</td>
<td>---</td>
<td>0.1292</td>
</tr>
</tbody>
</table>

(a) Test statistics distributed as F(1, 28) for the area equation and F(1, 28) for the yield equation. * Denotes significance at 5 per cent level. ** Denotes significance at 10 per cent level.
discrimination test is not on the basis of the non-nested tests. These results actually are due to the fact that in only one of the no-parameter equations the price variable was significant. Hence other criteria should be employed to choose among the alternative specifications of the price variable.

### Table 2

Price Variations: Non-Nested J and JA Tests for the Non-linear Form (a)

<table>
<thead>
<tr>
<th>Dependent Variable: Area</th>
<th>H₀: POₜ₋₁</th>
<th>H₁: PGₜ</th>
</tr>
</thead>
<tbody>
<tr>
<td>H₀: POₜ₋₁</td>
<td></td>
<td>1.2696</td>
</tr>
<tr>
<td>H₁: POₜ₋₁</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H₀: WAPₜ₋₁</td>
<td></td>
<td>1.2086</td>
</tr>
<tr>
<td>H₁: WAPₜ₋₁</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H₁: WAPₜ₋₁</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H₀: WAPₜ₋₁</td>
<td></td>
<td>-0.6643</td>
</tr>
<tr>
<td>H₁: WAPₜ₋₁</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dependent Variable: Yield</th>
<th>H₀: POₜ</th>
<th>H₁: PGₜ</th>
</tr>
</thead>
<tbody>
<tr>
<td>H₀: POₜ</td>
<td></td>
<td>-0.0935</td>
</tr>
<tr>
<td>H₁: POₜ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H₀: WAPₜ</td>
<td></td>
<td>0.2638</td>
</tr>
<tr>
<td>H₁: WAPₜ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H₁: WAPₜ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H₀: WAPₜ</td>
<td></td>
<td>1.5855</td>
</tr>
<tr>
<td>H₁: WAPₜ</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(a) All test statistics distributed as N(0,1).

For the yield equation, the choice of the appropriate price variable model is very hard. All three price variable models are similar in terms of diagnostic tests and parameter significance, except that the price variable is significant only in the weighted revenue price model. This model for the yield equation also has the highest R².
On the other hand, for the area equation, the price variable is insignificant in all three models. However, the weighted average price model (with WAP$_{t-1}$) is preferred for the area equation too, for the following reasons: acceptance of different price variables for area and yield equations appears inconsistent; diagnostics for the PG$_t$ model of the area equation yielded greater problems in terms of significant non-normality, and some autocorrelation; and the $R^2$ and $t$ ratios for the price variable of the WAP$_{t-1}$ model were greater than those for the PG$_t$-1 model.

Preferred parameter estimates

The parameter estimates of the preferred equations for area and yield are presented in Table 3, while the associated diagnostic test statistics are given in Table 4. The overall performance of the preferred equations appears acceptable in terms of the goodness of fit and the diagnostic tests. Only RESET(4) for the area equation and fourth-order autocorrelation for the yield equation are significant at 5 percent level.

For the area equation, the regression coefficients associated with price, credit and lagged area variables are significantly different from zero at 5 percent level and have expected positive signs. The coefficients relating to price and concessional sales variables are not significantly different from zero. While the price variable has the expected positive sign, the concessional sales variable does not have the expected negative sign.

For the yield equation, the regression coefficients relating to price and concessional variables are significantly different from zero at 5 percent level and have expected positive signs. The coefficient associated with the credit variable does not have the expected positive sign and is also not significantly different from zero. The coefficient relating to concessional sales of rice have the expected negative sign and is significantly different from zero.

Interpretation of results

The results indicate that the price variable has a significant impact on yield per hectare, but not on area planted to paddy. This result is the same as that obtained by Nainggolan and Suparto (1987) in their study of rice supply response in Java, Indonesia. In the Sri Lankan context, however, it is in contrast to the findings of Bogahawatte (1984) (for Maha season in the dry zone) and Samararatunga (1984) that paddy area, but not yield, is responsive to price.
TABLE 4
Estimated Linear Equations
with the Included Average Price Variable (a)

<table>
<thead>
<tr>
<th>Area</th>
<th>Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>WAAs</td>
<td>0.14* (3.49)</td>
</tr>
<tr>
<td>IRs</td>
<td>1.378* (10.86)</td>
</tr>
<tr>
<td>CHr</td>
<td>-0.009 (-0.47)</td>
</tr>
<tr>
<td>CRr</td>
<td>-0.1023* (-4.28)</td>
</tr>
<tr>
<td>Ar</td>
<td></td>
</tr>
<tr>
<td>Constant: -5.493* (-8.39)</td>
<td></td>
</tr>
<tr>
<td>R²:</td>
<td>0.97</td>
</tr>
</tbody>
</table>

(a) Figures in parentheses are t ratios. * Denotes significant at the 5 percent level.

In terms of the magnitude of the estimated coefficients and associated t-values, WAAs can be considered as the policy variable with the greatest impact on both area and yield. However, the impact of irrigation appears to be greater in yield than area. The area planted to paddy, but not yield, appears to be sensitive to changes in institutional credit. This may be partially attributable to the fact that the bulk of the land used for paddy is provided for land preparation and fertilizer application at the planting stage. Furthermore, any changes in area have a negative impact on yield, but appear to have no impact on area planted to paddy.

The positive and significant coefficient associated with the lagged dependent variable in the area equation lends support to the partial adjustment model hypothesis. The estimated coefficient indicates a 67 percent adjustment of area with the norm desired area within any one year, or the expected changes in the variables.
studied. That is, the experiment would take something like two years.

Table 4

<table>
<thead>
<tr>
<th>Test Statistic</th>
<th>Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normality (X^2)</td>
<td>X^2(4) = 1.709</td>
</tr>
<tr>
<td>BPG (Hetero.) (X^2)</td>
<td>X^2(4) = 4.699</td>
</tr>
<tr>
<td>ARCH (X^2)</td>
<td>X^2(1) = 0.38</td>
</tr>
<tr>
<td>RESET(2) (F, 1, 12)</td>
<td>F(1, 12) = 0.832</td>
</tr>
<tr>
<td>RESET(4) (F, 1, 16)</td>
<td>F(2, 28) = 0.772</td>
</tr>
<tr>
<td>RESET(4) (F, 1, 12)</td>
<td>F(3, 27) = 0.727</td>
</tr>
</tbody>
</table>

Autocorrelation:

<table>
<thead>
<tr>
<th>LM Test (Lag)</th>
<th>None at 5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.01</td>
</tr>
<tr>
<td>2</td>
<td>0.364</td>
</tr>
<tr>
<td>4</td>
<td>0.143</td>
</tr>
<tr>
<td>6</td>
<td>2.508*</td>
</tr>
<tr>
<td>8</td>
<td>0.826</td>
</tr>
<tr>
<td>10</td>
<td>0.74</td>
</tr>
<tr>
<td>12</td>
<td>1.076</td>
</tr>
<tr>
<td>14</td>
<td>0.491</td>
</tr>
<tr>
<td>16</td>
<td>0.54</td>
</tr>
<tr>
<td>18</td>
<td>1.081</td>
</tr>
</tbody>
</table>

CUSUMSQ

Instability: None at 5%

* Denotes significance at the per cent level.
(a) Autocorrelation coefficient distributed as N(0,1).

The results in general indicate that possibilities for changing land under paddy cultivation is rather limited. This may partly due to the rigidities of the paddy land use structure. For example, more than 60 per cent of paddy holdings in the country are below 1 hectare in size, while less than 6 per cent of the holdings are above 2 hectares in size (Department of Census and Statistics, 1984). On the other hand, producers have the scope and flexibility for changing paddy yield per unit of land by varying the levels of labour and other inputs such as fertiliser, improved seeds, pesticides, etc, in response to changes in price and other variables. Indeed, inspection of data for the study period suggests that yield has been increasing faster than the area planted to paddy. Production of paddy in Sri Lanka increased sharply from 603 thousand
metric tons in 1952 to 2,128 thousand metric tons in 1987. This represents an annual average increase of 7 per cent. The yield per hectare increased from 1.1 metric tons in 1952 to 2.72 metric tons in 1987, an annual average increase of 4 per cent. However, the area under paddy cultivation increased at an annual average rate of only 1.2 per cent, that is from 547 thousand hectares in 1952 to 782 thousand hectares in 1987.

A summary of the elasticity estimates derived from the preferred models are presented in Table 5. Any comparison of the price elasticities of supply estimated in this study with the estimates of previous Sri Lankan and other studies of paddy/rice supply response becomes difficult because of the differences in model specification, estimation and evaluation procedures. However, the price elasticity estimates in this study are within the range of those reported by Askari and Cummings (1977) in case of the majority of rice supply response studies in South and South East Asian countries.

### TABLE 5
Estimated Elasticities of Supply

<table>
<thead>
<tr>
<th>Variable</th>
<th>Area</th>
<th>Yield</th>
<th>Paddy Output</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Short-run</td>
<td>Long-run</td>
<td>Short-run</td>
</tr>
<tr>
<td>Price</td>
<td>----</td>
<td>0.14</td>
<td>0.14</td>
</tr>
<tr>
<td>Irrigation</td>
<td>0.64</td>
<td>0.92</td>
<td>1.38</td>
</tr>
<tr>
<td>Credit</td>
<td>0.05</td>
<td>0.07</td>
<td>----</td>
</tr>
<tr>
<td>Concessional Sales of Rice</td>
<td>----</td>
<td>----</td>
<td>-0.10</td>
</tr>
</tbody>
</table>

In the specific case of Sri Lanka, it is interesting that the aggregate paddy output elasticities with respect to price estimated in this study (short-run: 0.14; long-run: 0.21) are almost the same as those estimated by Bogahawatte (1983) and Samaratunga (1984). Among the various price elasticity estimates made by Bogahawatte, those for Maha season in the dry zone (short-run: 0.13; long-run: 0.19) can be considered as representative of price elasticities of aggregate paddy supply in Sri Lanka. Samaratunga's estimate...
of short-run price elasticity of aggregate supply of paddy in Sri Lanka is also high.

Conclusion

An analysis of the impact of four major policies—pricing policy, irrigation programmes, institutional credit and concessional sales of rice—on the aggregate paddy supply response in the paddy sector of Sri Lanka in the period 1952 to 1987 was undertaken in this paper. Supply response was analysed indirectly by estimating area and yield equations. The estimation procedure focused upon the choice of an appropriate functional form for regressions and the price variable that best represents the price to which producers respond in making their decisions with regard to area and yield. On the basis of the specification and diagnostic tests employed, estimated log-linear equations with the weighted average guaranteed and open market prices for both the area and yield are preferred. The following summary of the results is based on these preferred equations.

The weighted average price of paddy and concessional sales of rice have a positive but insignificant impact on the area planted to paddy. The impact of irrigation and credit on area is positive and significant. There is an apparent partial adjustment of area in response to changes in the policy variables studied. The weighted average price and irrigation have a positive and significant impact on yield. The impact of credit on yield is negative but insignificant. Concessional sales of rice have a negative and significant impact on yield.

The estimates of supply (output) elasticities can be used as evidence to provide some preliminary answers to the specific issues raised at the start of this paper. First, given the complex policy environment, producers do respond positively to changes in price. Secondly, producers appear to consider both the guaranteed price and the open market price together, not in isolation, in forming price expectations. However, the weight attached to the open market price in the weighted average price variable has become increasingly greater in recent years with the deregulation of the paddy/rice market. Finally, given the semi-subsistence character of producers, concessional sales of rice act as a disincentive to the expansion of paddy production, although this disincentive effect appears to be largely offset by the positive effects of the other policy variables.

The results imply that the continuation of policies and programmes to encourage the adoption of cultivation techniques which further improve the paddy yield per unit of land holds the key to success in Sri Lanka's quest for attaining 'self-sufficiency' in rice. The results also
suggest that the recent policy initiatives to return to a complete free market for paddy/rice and phasing-out of the food stamp scheme, together with the continuation of irrigation and institutional credit programmes, leaving aside broader issues of budgetary, welfare and nutritional implications, will have positive effects on aggregate paddy output.

Footnotes

1. 'Paddy' is the term for unmilled, rough rice. At some places in the paper 'paddy' and 'rice' are used interchangeably.


3. For detailed derivations, interpretations and estimation problems associated with the equations in the Nerlovian partial adjustment model, see Nerlove (1958; 1979) and Askari and Cummins (1977).

4. The weighted average price \( WAP_{t-1} \) specified in the area equation was calculated as follows:

\[
WAP_{t-1} = \frac{PG_t \cdot QG_t + PG_{t-1} \cdot QQ_{t-1}}{QG_t + QQ_{t-1}}
\]

where, at year \( t \), \( QG_t \) is the quantity supplied by producers to the government at the guaranteed price and \( QQ \) is the difference between the total paddy output and \( QQ \) (since separate estimates of open market paddy transactions are not available).

The weighted average price \( WAP_t \) specified in the yield equation was calculated as follows:

\[
WAP_t = \frac{PG_t \cdot QG_t + PG_{t} \cdot QQ_{t}}{QG_t + QQ_{t}}
\]

5. Some writers have conjectured that the public rice distribution schemes in Sri Lanka have been a disincentive to the expansion of paddy production (Bansil, 1971; Karunatilake, 1974; Sunit, 1975). Perumalpillai (1980) derived a labour supply equation from a profit function
estimated using time-series data, and inferred that labour supply to the paddy production sector, and hence the output of paddy, will decrease even if the guaranteed price is raised, given the price subsidy on rice.

6. Ordinary least squares (OLS) procedure is used in the estimation, given that area and yield equations are behaviourally different with different specifications of certain regressors. See Loomis (1978) for a discussion of the circumstances under which the use of OLS, as opposed to some joint estimation procedure, is appropriate.

7. The power of a test measures the probability of rejecting a false null hypothesis (i.e., type II error), while the size measures the probability of rejecting a true null hypothesis (type I error).

8. The area equation, given its partial adjustment structure, with the lagged dependent variable as a regressor. Generally, most of the tests described, given a lagged dependent variable, are still valid but only asymptotically. For example, the LM t statistics for autocorrelation and the problems associated with the Durbin-Watson test in the presence of lagged dependent variables (see Hamilton, 1989, pp. 395-6). For a discussion of the validity of non-nested tests given a lagged dependent variable, see Gregory and McAleer (1983).

9. The finding that the Hansen J and LM test statistics are similar is not uncommon. For example, Gregory and McAleer (1983) report practically identical statistics for Canadian money demand functions.
References


Central Bank of Ceylon (Sri Lanka). (various years), Annual Report, Colombo.


Commissioner of Agrarian Services. (various years), Administration Report, Department of Agrarian Services, Colombo.
Department of Census and Statistics. (various years), Statistical Abstracts of Ceylon (Sri Lanka), Colombo.


Food Commissioner's Department. (various years), Administration Report of the Food Commissioner, Colombo.


