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Specification Issues and the Estimation of Supply Equation for Rice in Malaysia

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ABSTRAK

Model penawaran disarangkan dalam model umum pelarasan separa-jangkaan mudahsuai. Hasil ujian-ujian diagnostik mencadangkan model pelarasan separa merupakan specifikasi yang bersesuaian untuk persamaan beras di Malaysia. Persamaan penawaran yang terpilih ini juga menyamai dengan dua ujian diagnostik yang berlainan: specifikasi loglinear dan autokorelasi. Hasil kajian mendapati keanjalan harga penawaran jangka pendek adalah rendah, 0.03 dan keanjalan jangka panjang ditentukan pada 0.11. Keanjalan harga yang rendah ini secara umum menepati dengan keputusan yang telah dilapurkan terdahulu.

ABSTRACT

The supply model was nested in the general partial adjustment-adaptive expectation model. The results of the diagnostic tests suggest that the partial adjustment model is the preferred specification for the rice equation in Malaysia. The preferred model match with two other diagnostic tests: loglinear specification and autocorrelation. The estimates for the short-run price elasticity of supply are fairly low, 0.03 and the long-run elaticity is estimated at 0.11. The low price elasticities are generally in agreement with those reported earlier.

INTRODUCTION

Over the last ten years, economists have shown great interest in model validation. Many models that appear to have been estimated satisfactorily in terms of "sign" and "significance" have performed poorly. Judge et al. (1988) assert "that the possibilities for model misspecification are numerous and false statistical models are most likely the rule rather than the exception" (p.854). Pagan (1984) explained earlier that the problem was partly due to little effort on the part of model builders to validate their models. Today, the idea that a model must be tested before it can be used for studying economic behaviour or policy analysis has been widely accepted.

A model can be misspecified in a number of ways and two major sources are invalid assumptions about the disturbance term and incorrect functional form. In theory all the assumptions made about the disturbance term in the classical regression model are in fact testable. The properties of the error term of zero mean, serial independence, homoscedascity and normality, are testable and now available in most statistical packages. Further, the assumptions regarding the linearity of the model is also testable.

Agricultural economists have devoted considerable attention to the estimation of supply elasticities of agricultural products because of their importance in policy analysis. However, there is considerable disagreement among economists relating to this fundamental market parameter. Given that policies derived from misspecified model are unlikely to produce desired results, it is appropriate to subject policy models to some form of specification tests. Such action(s) will add either to the credibility of the model or information gained from the tests may be used to produce a more accurate model for policy analysis. In this paper, an attempt is made to estimate the supply equation for rice in Malaysia. Special emphasis is given to the specification of the disturbance term, the specification for the adaptive expectations (AE) and partial adjustment (PA) models and the functional forms of the supply equation.

THE THEORETICAL MODEL

The partial adjustment (PA) and adaptive expectations (AE) models which give rise to a simple dynamic model have been used widely in empirical research to examine the supply response, input demand and inventory investments. Examples of the application of the models used to examine the supply response are Nerlove (1958), Anderson (1974) and Jumah (1986).

The supply model of the partial adjustment type can be represented by the following output adjustment model:

$$Q_t^* = \alpha_0 + \alpha_1 X_t + \alpha_2 Z_t, \qquad \alpha_1 > 0, \alpha_2 < 0 \text{ or } > 0. \qquad (1)$$

Equation (1) assumes that the long-run equilibrium supply (Q_t^*) is a linear function of the output price (X_t) and some exogenous factors (Z_t) affecting supply at time t.

$$Q_t - Q_{t-1} = (1 - \theta)(Q_t^* - Q_{t-1}) + w_t, \qquad 0 < \theta \leq 1. \quad (2)$$

Equation (2) indicates the way in which supply adjust towards the long-run equilibrium supply (Q_t^*). The coefficient of adjustment ($1 - \theta$) represents the proportion of the adjustment towards equilibrium, which occurs in one period. The time necessary to adjust fixed factors of production is one reason for the existence of this parameter. The error term is denoted by w_t in equation (2) and is i.i.d. $N(0, \sigma^2)$. The equation can be solved for Q_t and substituted into (1). Thus, remove the unobservable variable Q_t and obtain the reduced form of the model:

$$Q_t = \beta_0 + \beta_1 X_t + \beta_2 Q_{t-1} + \beta_3 Z_t + w_t \quad (3)$$

where $\beta_0 = \alpha_0(1 - \theta)$, $\beta_1 = \alpha_1(1 - \theta)$, $\beta_2 = \theta$, $\beta_3 = \alpha_2(1 - \theta)$.

The PA model given above can be nested in the partial-adjustment adaptive-expectations (PAAE) model. This can simply be done by replacing X_t in (3) by X_t^* and adding an auxiliary equation explaining the formation of expectations:

$$X_t^* - X_{t-1}^* = (1 - \delta)(X_{t-1} - X_{t-1}^*) \quad (4)$$

The above equation implies that the expected price is adjusted in each period by a proportion of the difference between the pervious period's actual price (X_{t-1}) and its previous expected price (X_{t-1}^*). The coefficient of expectation ($1 - \delta$) is associated with price uncertainty. Equation (4) also implies that $X_t^* = (1 - \delta) \sum_{i=0}^{\infty} \delta^i X_{t-i-1}$. Using (2) and (4) to eliminate the unobservable variables yield the general PAAE model:

$$Q_t = \beta_0 + \beta_1 \left\{ \sum_{i=0}^{\infty} \delta^i X_{t-i-1} \right\} + \beta_2 Q_{t-1} + \beta_3 Z_t + w_t, \ t \geq 2 \quad (5)$$

where $\beta_0 = \alpha_0(1 - \theta)$, $\beta_1 = \alpha_1(1 - \theta)(1 - \delta)$, $\beta_2 = \theta$, and $\beta_3 = \alpha_2(1 - \theta)$.

In the past, model validation was based on R^2 and the standard error of the coefficient of the lagged dependent variable and the Durbin's h-test.[1] Recently, Doran (1988) derived diagnostic specification tests for PA and AE using likelihood based principles.[2] The diagnostic tests for PA and AE models were constructed by testing $\delta = 0$ for PA model and $\theta = 0$ for AE model on the general PAAE model given by (5). The model given by (5) cannot be estimated directly because it involves unknown parameters and pre-sample observations. For estimation purposes, Dhrymes (1971) specified the model by expressing Q_t in terms of Q_{t-1} and all past values of X and is given by:

$$Q_t = \beta_0 + \beta_0\overline{X}(\delta) + \theta Q_{t-1} + \beta_3 Z_t + a_0\beta_1\delta^{t-1} + w_t \quad (6)$$

where $\overline{X}_t(\delta) = \sum_{i=0}^{t-2} \delta^i X_{t-i-1}$, $t \geq 2$, and $a_0 = \sum_{i=0}^{\infty} \delta^i X_{-i}$.

In most empirical research the last term in Equation 6 which involves higher orders in δ is not estimated since (δ^{t-1}) tends to zero as (t) approaches infinity. Consequently, it makes no difference asymptotically if the term is dropped or not. If δ is known, $\overline{X}_t(\delta)$ could be constructed and the parameters of the model could be estimated by regressing Q_t on $(1, \overline{X}_t(\delta), Q_{t-1}, Z_t)$. The estimation procedure suggested by Doran is to apply OLS to Equation 6 for values of (δ) in the range $0 \leq \delta < 1$ which minimizes the residual sum of squares (RSS). The procedure will yield an estimator which is equivalent to the maximum likelihood (ML) estimates. The estimates obtained from such procedure, therefore, are consistent.

Alternatively, the PAAE model can be expressed in terms of lagged values of dependent variable (Q_t). The estimating model then becomes:

$$Q_t = b_0 + b_1 X_{t-1} + b_2 Q_{t-1} + b_3 Q_{t-2} + b_4(Z_t - \delta Z_{t-1}) + (\mu_t) \quad (7)$$

where $b_0 = \alpha_0(1 - \theta)(1 - \delta)$, $b_1 = \alpha_1(1 - \theta)(1 - \delta)$, $b_2 = (\theta + \delta)$, $b_3 = -\theta\delta$ and $\mu_t = w_t - w_{t-1}$. Two important features emerge from the above model: the disturbance is a first-order moving-average process with parameter δ and the parameters b_2 and b_3 involve nonlinear restrictions. Applying OLS to (7) will yield inconsistent estimates of the parameters and the appropriate technique is ML estimation.

In many applied works [e.g., Jones (1962) and Anderson (1974)] the error disturbance, μ_t in (7), is replaced by $w_t \sim N(0, \sigma^2)$ so that the PAAE model can be simply estimated by OLS.[3] However, it will be impossible to obtain separate estimates of θ and δ and the assumption may be unrealistic (See Doran and Griffiths 1978).

DATA

The supply equation is specified with the quantity supplied as function of output of the previous year, price, and technical progress. Data used in calibration of the supply equations was gathered from a number of sources. The primary source of price and quantity data was the Rice Statistics (1988). The price variable is deflated with the consumer price index (1980 = 100), obtained from various publication by Bank Negara Malaysia. The prices are measured in Malaysia ringgit (M$) per metric tons. Data is annual from 1960 through 1987 (twenty-eight observations) and are in natural logarithms except for TIME.

ESTIMATION, SPECIFICATION ISSUES AND RESULTS

For this research, the PAAE model employed for investigating the dynamic supply response used OLS as well as MLE given the two alternative sets of assumptions about the disturbance term in Equation (7). The results of the OLS and the MLE are given in Table 1. In the MLE method the variable X_{t-1}, the lagged price (relative price) was replaced by the quantity $\overline{X}(\delta)$ as defined in equation 6.

Comparing the OLS with the ML estimates in Table I revealed little difference in the estimated parameters between the two estimators. The value of δ that minimized the RSS is 0.03, which is close to zero. This probably accounts for the close agreement of OLS and MLE. Thus, both the short run and long run elasticities were not sensitive to whether the ML method was used or not for the data set used in the analysis.

TABLE 1. The Supply Function for Rice

Quantity of Rice Produced Variable	OLS[a]	MLE[b]
Constant	1.7747	1.7913
	(0.8610)*	(0.7243)*
Lagged Dependent Variable (Q_{t-1})	0.7548	0.7292
	(0.2143)**	(0.1119)**
Lagged Dependent Variable (Q_{t-2})	−0.0229	—
	(0.1966)	
Relative Price (X_{t-1})	0.0241	0.0264[c]
	(0.0519)	(0.0456)
DUMMY (80)	−0.1629	−0.1745
	(0.0639)*	(0.0603)**
Technology	0.0094	0.0098
	(0.0054)	(0.0052)
Log likehood	37.059	38.960
R^2	0.9241	0.9362
h statistic	—	−0.5408
SEE	0.0663	0.0663
Coefficient of Adjustment	0.2452	0.2708
Elasticity with respect to price of rice:		
Short-run	0.024	0.026
Long-run	0.098	0.097

Note: Estimates are based on 28 yearly observation relating to the period 1960-1967. Figures in the parenthesis denote standard errors. All variables were deflated by the CPI (1980 = 100) and expressed in log linear form. The dependent variable in the model is quantity of rice produced in thousand metric tons. Price in the equation is the ratio of relative prices of rice to natural rubber. The dummy varaible (DUM = 1 if year $\geq$ 1980 and 0 otherwise) is added to account for the differential intercept in the 1980's and Z is the trend variable, where T = 1 for 1960 and T = 28 for 1987.

** Significant at 1% level using a two-tail test.

* Significant at 5% level using a two-tail test.

[a] The PAAE model repesented by equation (7) is estimated by OLS.

[b] The ML estimates were obtained by a search procedure. Apply OLS to equation (6) for different values of δ and choosing the estimates with the minimum RSS. The value for δ in this case was 0.03.

[c] The variable X_{t-1} is replaced by the quantity $\overline{X}(\delta) = \sum_{i=1}^{t-2} \delta^i X_{t-i-1}$, $t \geq 2$ for the ML method.

The coefficient of Q_{t-2} in the PAAE model estimated by OLS is small (−0.0229) and not statistically different from zero. The significance of the coefficient of the lagged dependent variable (Q_{t-2}) has often been used to justify that $\theta = 0$ (or $\delta = 0$) and hence the adaptive expectations model (or partial adjustment model) by itself is the correct specification. The "OLS" test, Doran (1988), can be misleading especially for time series data with strong autocorrelation among the regressors (X).[4]

The experimental results of a Monte-Carlo study by Doran showed that the "OLS" test performed well in cases when autocorrelation in regressors was moderate (i.e., $p \leq 0.5$) for both the AE and PA models. However, the situation is unlikely to hold with most time-series economic data.

Doran, however, recommended the Wald (W) test for testing the AE model. The test is relativly simple and has considerable power. Similarly, for the PA model with strong autocorrelation in the regressors ($\underline{X}$), both the OLS test and h-test perform poorly. The Monte-Carlo study recommended the Lagrange Multiplier (LM) test for this case since it is powerful even for a sample size of 20. The specification tests for the AE and PA models using the likelihood principles are summarized below.[5]

TESTING FOR ADAPTIVE EXPECTATIONS MODEL

The model can simply be validated by testing the hypothesis $\theta = 0$ in the general model specified in equation (5). The restricted model in this case reduces to $Q_t = \beta_0 + \beta_1 X_t(\delta) + \beta_2 Z_t + v_t$. The Wald test for AE could be performed by the following simple procedure:

i) Run the unrestricted model and obtained the residual sum of square ($R\hat{S}S$),
ii) Regress Q_{t-1} on (j, $\overline{X}(\hat{\delta})$, $\overline{X}(\hat{\delta})$ and Z) to obtain the residual summ of squares, $R\hat{S}S^*$. The variable $\overline{X}(\hat{\delta})$ is as defined above, j being a vector of ones and $\overline{X}'(\hat{\delta}) = X_{t-2} + \sum_{i=2}^{t-2} i\delta^{i-1} X_{t-i-1}$
iii) Finally, the test staistic is given by:

$$T^{1/2}\,\hat{\theta}\,[R\hat{S}S^*/R\hat{S}S]^{1/2} \sim N(0, 1^2)$$

where T is the sample size and $\hat{\theta}$ is the regression coefficient of Q_{t-1}.

TESTING THE PARTICAL ADJUSTMENT MODEL

This model is much easier to validate than the AE test since the restricted ML estimate is equivalent to the OLS model. The restricted model in this case is given by $Q_t = \beta_0 + \beta_1 Y_{t-1} + \beta_2 Z_t + v_t$, given that $\delta = 0$ in (5). The model could be validated by using the LM test which only requires the OLS estimation procedure. The test is performed by the following steps:

i) Run OLS on the PA model to obtain residuals, $\tilde{RSS}$ and $\tilde{v}$, where $\tilde{v}$ is the estimated residuals of the PA model,
ii) Run OLS of X_{-2} on (j, X_{-1}, Q_{-1}, Z) to obtain the residual sum of squares RSS_1^*,
iii) Run OLS of X_{-2} on $\tilde{v}$ to get ñ, where ñ is the regression coefficient of v,
iv) Finally, the test statistics is given by:

$$T^{1/2}\, ñ\, [RSS_1^*|/RSS]^{1/2} \sim N(0, 1^2)$$

The models were estimated and various statistics computed for the above diagnostic tests and the results are summarized in Table 2 below. The conclusion from the diagnostic tests is that the partial adjustment model is the preferred specification. This makes the estimation of the supply of rice easier since we can use OLS of Q_t on (j, X_t, Y_{t-1}, Z), and assuming that $E(e_t e_s) = 0$ for all $t \neq s$, to get a consistent and asymptotically efficient estimates of the parameters of the model.

TABLE 2. Results of the Diagnostic Tests for AE and PA Model

Test	Computed Statistics	Critical Value	Conclusion
Wald (AE)	9.205	1.645	Reject AE
Lagrange Multiplier (PA)	1.139	1.645	Do not Reject PA

Note: The critical values are for five percent.

OTHER SPECIFICATION ISSUES

Economic theory provides information regarding the set of variables that should be included in an economic relationship, but it seldom suggest the appropriate functional form. Since misspecifying the functional form will, in general, lead to inconsistent parameter estimates, it is important that the model be subjected to some form of diagnostic check for alternative functional forms.[6] The Box and Cox (1964) procedure has been employed for testing functional form. The likelihood ratio statistic can be used as a model selection criterion if the choice is strictly between linear and log-linear specifications. The supply model was tested for linear versus log-linear specification. The result of this specification test clearly rejects the hypothesis that the supply equation is linear in favor of the log-linear specification.[7]

The results of the double-log form of the PA model estimated by OLS method along with other single equation statistics are reported in Table 3. The data fit the model fairly well as indicated by the high value of the R^2. All the parameters of the supply equation have the correct algebraic signs. Both the dummy variable and the lagged dependent variable were found to be statistically significant at five per cent level. However, the ratio of price received by the farmers (GMP) to the price of natural rubber was found to be statistically insignificant at the five percent level.

The low estimated h-statistic (-0.5358) suggested no serial correlation, however, the statistic is valid only for large samples.[8] To overcome the problem associated with this test, the null hypothesis of no autocorrelation was ignored and the model was corrected for first order autocorrelation (AR1) using the Iterative Cochrane-Orcutt (C–O) esimation procedure.[9]

Results after correcting for first order autocorrelation are presented in Table 4. The estimated first order serial correlation (R40) was small and statistically insignificant. It is also interesting to note here that the estimated parameters for the corrected model do not differ significantly from the previous specification. These findings seemed to suggest that autocorrelation among the residuals in the supply equation is not serious and could be ignored.

In this model both the dummy variable and the lagged dependent variable are statistically significant at the one percent level. The trend variable ($T = 1$ for 1960 and $T = 28$ for 1987) which reflects the technological advancement and the expansion of cultivated area had

TABLE 3. The Supply Function for Rice (OLS)

Variable	Quantity of Domestic Rice Produced	
Constant	1.7942	
	(0.7253)*	
Lagged Dependent Variable	0.7287	
	(0.1117)**	
Relative Price (GMP/PNR)	0.0268	
	(0.0468)	
DUM (80)	−0.1748	
	(0.0603)**	
Technology	0.0098	
	(0.0050)	
R^2	0.9362	
Log likehood	38.959	
h statistic	− 0.5358	
SEE	0.0633	
Coefficient of adjustment	0.2713	
Elasticity with respect		
Price of rice:	Short-run	Long-run
	0.0268	0.0988

Note: Estimates are based on 28 yearly observations for the period 1960-1987 using OLS method. Figures in parenthesis denote the standard errors. All variable were deflated by the CPI (1980 = 100). All variables were expressed in log linear form.

* Significant at 5% level using a two-tail test.

** Significant at 1% level using a two-tail test.

the expected positive sign and was statistically significant at the five percent level. The estimated coefficient of the trend variable is small, suggesting the poor growth in output for rice in Malaysia. Only minor technological change took place during the period under consideration.[10]

The dummy variable (DUM = 1 if Year $\geq$ 1980 and 0 otherwise) was added to the supply equation to account for the differential intercept in the 80's. The downward shift implies that given a support price (guaranteed minimum price), producers supplied less after 1980 than before. This is equivalent to a shift in supply curve of farm products to the left. A plausible cause for the leftward shift in the supply is that when prices are supported above world prices and

TABLE 4. The Supply Function for Rice (C–O)

Variable	Quantity of Domestic Rice Produced	
Constant	1.7125	
	(0.6210)*	
Lagged Dependent Variable	0.7411	
	(0.0957)**	
Relative Price (GMP/PNR)	0.0293	
	(0.0397)	
DUM (80)	−0.1744	
	(0.0517)**	
Technology	0.0095	
	(0.0043)	
R^2	0.9367	
h statistic	−0.5358	
SEE	0.0569	
RHO	−0.0906	
	(0.4726)	
Coefficient of adjustment	0.2589	
Elasticity with respect		
Price of rice:	Short-run	Long-run
	0.0293	0.1132

Note: Figures in the parenthesis denote standard errors. All variables were expressed in log linear form and deflated by the CPI (1980 = 100). The model was corrected for first-order autocorrelation using Cochrane-Orcutt (C-O) technique and RHO is the value of first-order autocorrelation.

* Significant at 5 level using a two-tail test.

** Significant at 1 level using a two-tail test

output is not controlled, gross income will rise and the demand for all factors increase accordingly and thus shift the supply function to the left. Alternatively, given that land for rice cultivation is a major constraint for the rice producers in Malaysia, farmers respond to the higher price supports by non-optimal combination of non-land inputs (putting submarginal land into production) and consequently producing at higher cost.[11]

The findings imply that the adjustment of domestic supply of rice takes place within a year and this is supported by the small difference between the short-and long-run supply elasticities. Since the model is specified in double-log form, the behavioral coefficients are themselves elasticities. The estimates for the short-run price elasticity of supply are fairly low, 0.03 (Table 4) and is insignificant at the five percent level. The long-run price elasticity is estimated at 0.11.[12] The low own-price elasticity estimate is in general agreement with those reported by King (1987) and Haugton (1983). King (1987) and Haugton (1983) reported elasticities of 0.12 and 0.25, respectively. Nik Fuad's (1985) estimates for various regions in Malaysia were within the 0.32 – 1.26 range, which yields a weighted average of 0.57.

CONCLUSION

In the present paper an attempt is made to estimate the supply response for rice in Malaysia. The PAAE model is used to investigate the supply response. The model was diagnosed for appropriate specification and the results of diagnostic tests suggest that the PA model is the preferred specification to examine the rice supply response in Malaysia. The preferred specification for the supply equation matched with two other diagnostic tests: Log-linear specifications and autocorrelation. Two clear conclusions emerged from the supply equation. First both the short-run and long-run prime elasticities are low. Second, the estimated coefficient of the trend variable is small.

Although the estimates of the supply parameters vary from one study to another depending on the time period, model specification and method of estimation, we can conclude that Malaysian rice producers are generally unrespensive both in the short and long run to price change. A high guaranteed minimum price will have little impact on domestic production. An important factor preventing farmers' response to price change is the lack of available land for paddy cultivation. Most land areas devoted to paddy cultivation cannot be used for other crops. In the granary areas which produce more than 60% of the domestic supply, paddy is a mono-crop. However, in the single cropped areas, water supply is the major constraint.

NOTE

[1]For example, the most comman method of diagnostically validating PA is to run PA specification and examine the residuals for autocorrelation using the Durbin's h-statistic. However, Doran (1986) has shown that the use of h-test ignores the non-linear restriction in the parameters in 5 and therefore results in a loss of power.

[2]Griffith and Doran (1978) demonstrated the importance of the specification of the disturbance in the model. They showed that the inconsistency in the estimates for the short-run elasticity could be serious if the model is wrongly specified.

[3]See Doran and Griffiths (1978) for the discussion on how the stochastic element for the PAAE model may be introduced.

[4]The PAAE model can be expressed in the form of equation 7. The OLS test refers to estimating the equation by OLS and examining for the significance of b_3, where $b_3 = -\theta\delta$. If $b_3 = 0$ then the model is either PA or AE.

[5]The appropriate model can be verified by using the three likelihood principles-likelihood (LR), Wald (W) and Lagrange Multiplier (LM). These tests generally differ in computational complexities but are asymptotically equivalent under the null as well as the local alternatives. Based on mathematical tractibility and computational convenience, Doran recommended the W test for validating AE, and LM for the PA model.

[6]See Godfrey et al. (1988) for a discussion on the various tests for the functional form and the power of these tests.

[7]The Ramsey's specification test (RESET) was also performed on the model and the results of this test also suggest that the log-linear model is the appropriate specification.

[8]The h-statistic is an symptotic test. Monte Carlo studies indicate that the power of this test can be low and that the nominal size of the test in finite samples is often quite different from its asymptotic size.

[9]There is a problem using the C-O method here because of the presence of lagged dependent variable in the equation. The consistent estimates of the parameters can be obtained by the method of instrument variables (IV) or by ML principle. The simplest approach of course is the IV method but the results of this regression were found to be unsatisfactorily based on the expected signs and are not reported here.

[10]In fact in the past few years growth has been negative as paddy production was plagued by pests and diseases.

[11]See Floyd (1965) for detail discussions on the effect of farm supports on land and labor in agriculture.

[12]The very low long-run supply elasticity reported in this study may also be due to the fact that there is little variation in total rice produced domestically over the sample period.

[13]Nik Fuad used estimated both the acreage and yield equations for five regions in Malaysia. The elasticity of planted acreage with respect to price ranged from 2.48 to 0.23 while the elasticity of rice yield with respect to price ranged from 0.13 to 0.68.

REFERENCES

Anderson R. 1974. Distributed lags and Barley acreage respond analysis. *Australian Journal of Agricultural Economics* 18: 119-32.

Box, G.E.P. & D.R. Cox. 1964. An analysis of transformations. *Journal of the Royal Statistical Society Series* Vol. 26, B: 211-42.

Dhrymes, P.J. 1971. *Distributed Lags: Problems of Estimations and Formulation.* San Francisco: Holden-Day.

Doran, H.E. & Griffiths, W.E. 1978. Inconsistency of the O.L.S. estimator of the partial adjustment-adaptive expectations model. *Journal of Econometrics* 7: 133-46.

Doran E.D. 1988. Specification Tests for the Partial Adjustment and Adaptive Expectations Models. American *Journal of Agricultural Economics* 70: 713-23.

Durbin J. 1970. Testing for serial correlation in least-square when some of regressors are lagged dependent variables. *Econometrica* 38: 410-21.

Floyd J.E. 1965. The effects of farm price supports on the returns to land and labour in agriculture. *Journal of Political Economy* 73: 148-58.

Haughton, J. 1983. Rural development in Peninsular Malaysia: The case of cingle crop padi cultivators. Ph.d Dissertation, Harvard University.

Jumah, A. 1986. The demand for cocoa in the E.C. countries-forecasting and policy implications. Quart. *J. Int. Agr.* 25: 360-73.

Judge, G.G., R.C. Hill, W.E. Griiffiths, H. Lutkepohl & T.C. Lee. 1985. *Introduction to the Theory and Practice of Econometrics.* Wiley: New York.

King R.E. 1987. Malaysian agriculture pricing policies: A dynamic model. Ph.d Dissertation, The George Washington University.

Nerlove, M. 1958. *The Dynamics of Supply: Estimation of Farmers Response to Price.* Baltimore: John Hopkins Press.

Nik Fuad Kamil. 1985. Modelling the Operation of the Malaysia Rice Sectors. *Malaysian Journal of Agriculture Economics* 2(2): 89-110.

Pagan, A.R. 1984. Model Evaluation by variable addition. In *Econometrics and Quantitative Economics*, ed. D.F. Hendry and K.F. Wallis, pp. 103-33. Oxford: Basil Blackwell.

Waud, R.J. 1979. Mis-specification in the 'Partial Adjustment' and 'Adaptive Expectations' models. *International Economic Review* 9: 204-217.

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