

A Model for the Rice and Wheat Economy in Malaysia: An Empirical Assessment of Alternative Specifications

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ABSTRAK

Satu model bagi ekonomi beras dan gandum Malaysia ditentu dan disesuaikan untuk data daripada 1960-87. Beberapa ujian diagnostik digunakan dalam analisis ini untuk menentukan spesifikasi model tersebut. Penyelidikan ini menggabungkan interaksi di antara beras dan gandum.. Anggaran keanjalan harga penawaran untuk jangkamasa pendek adalah 0.03 sementara keanjalan harga penawaran untuk jangkamasa panjang ditentukan pada 0.11. Keanjalan metrik harga dan pendapatan yang diperolehi daripada analisis permintaan menunjukkan bahawa keanjalan harga sendiri adalah kurang daripada unitan. Hasil kajian ini menyokong hipotesis bahawa beras adalah barangan bawahan sementara gandum adalah normal. Paras import bergantung kepada penawaran tempatan, tingkat pendapatan dan harga-harga tempatan bagi beras dan gandum.

ABSTRACT

A model of the Malaysian rice and wheat economy is specified and fitted to data from 1960-87. Several diagnostic tests were employed in the analysis to determine the specification of the model. The present work incorporates the interaction between rice and wheat. The estimate for the short-run supply price elasticity is 0.03 while the long-run price elasticity is estimated at 0.11. The matrix of price and income elasticities obtained from the demand analysis indicates that the own-price elasticities are less than unity. The present work supports the hypothesis that rice is an inferior good while wheat is normal. The level of imports depends on domestic supply, income level and domestic prices of rice and wheat.

INTRODUCTION

The openness of the economy has allowed Malaysia greater flexibility in adjusting to the changing world economic environment. The availability of ample foreign exchange receipts has made it possible for Malaysia to import rice (a food commodity) with minimum restrictions, except in the past two years with the collapse of commodity prices. The economy depends on the world market for its supply of many food items such as rice, wheat, fruits, mutton and beef. Malaysia is 100 per cent self-sufficient in pork, poultry, eggs and fish. The country produces 5 per cent of its needs for milk, 50 per cent for beef and 20 per cent for mutton. In

1985, food imports accounted for 28 per cent of the nation's total imports.

In Malaysia, the imports of rice are restricted through tariffs/quotas, and domestic rice prices are maintained above world prices. To ensure adequate supply to the consumers, the Malaysian government has been directly involved in rice imports since 1967. Government-to-government imports are based on contracts by the Malaysian government and foreign governments with terms and agreements varying among contracts. Malaysia imports rice from 15 countries with about 90 per cent of all imports coming from Thailand, China, and Burma. (Tan 1987; Ahmad Zubaidi Baharumshah 1990).¹

¹For more detailed discussion on government policy and rice production in Malaysia, see Tan (1987) and Ahmad Zubaidi Baharumshah (1990).

The objective of this paper is to formulate and estimate an econometric model for the supply and demand for rice in Malaysia. The complete model includes the demand for wheat as well as an import equation for rice. The wheat equation is added to the model to account for the interaction between rice and wheat on the demand side. In addition, the present work, unlike previous studies, employs several specification tests to diagnose the appropriate specifications.

Review of Previous Research

Past research on the supply and demand analysis has been conducted for the Malaysian rice sector using both time series and cross sectional data. Aromdee (1969) using a Nerlovian model estimated the short run supply elasticity of 0.22 for Malaysia. Squire and Barnum (1980) found it to be 0.61 but this was for the Muda area which is the most productive rice-growing area in Malaysia. Haughton (1983) found the supply elasticity for a single crop area to be 0.25. Nik Fuad (1985), using more recent data and disaggregating domestic market for the demand and producing regions for the supply, found that the elasticities differ from one area to another but the general finding is that rice producers are unresponsive to price changes in all growing regions. Supply elasticity estimates are generally positive and small. Most studies found the elasticity estimates to be smaller (in absolute value) than 0.25.

On the demand side, these studies indicated that elasticities ranged from -0.2 to -0.5 and -0.31 to 0.47 for price and income respectively. Aromdee reported a price elasticity ranging from -0.35 to -0.46. Goldman (1975) also found that consumers are unresponsive to price change (-0.47). Nik Fuad found the elasticity to be -0.5. A survey conducted by the Ministry of Agriculture in 1980 reported income elasticity to be 0.47. Cheam (1984), using a time series data, however, estimated it at -0.12. Similarly, Nik Fuad, using a time series data, estimated demand elasticity with respect to income at -0.31. Thus, both price and income elasticities appear to be low.

Islam (1978), with annual data from 1953-72, had derived an import demand function which had foreign reserves, price, income and domestic production as independent variables for six Asian rice deficit countries. The hypothesis that governments interfere in rice imports in order to conserve foreign exchange was rejected for

countries like Malaysia and Sri Lanka. Islam reported that elasticity of imports with respect to foreign exchange reserves for Malaysia is close to zero (-0.01).² However, imports were found responsive to changes in foreign reserves for countries like India (2.48) and Pakistan (4.24). Islam also computed the elasticity of imports with respect to price and income for Malaysia and found them to be 0.32 and 0.34 respectively. This is small in absolute terms compared to other Asian importing countries like India, Pakistan, Korea and the Philippines

Obviously there is some variation in the estimates of price and income elasticity from these studies, perhaps due to different types of data and the treatment of price structure in the estimation procedure. However, these estimates will provide a benchmark for comparison with the model to be employed in the present work.

MODEL AND ESTIMATION

The Econometric Model

The model consists of four basic components which explain the behaviour of producers, consumers and the importing agency which controls prices with tariff/quota. The empirical model consists of four behavioural equations - a domestic supply equation, a domestic demand for rice, a domestic demand for wheat and an import equation. The model is completed by introducing a stock equation and market-clearing identity. The assumption here is that governments use stocks to clear the market. That is, in the short-run the governments holds stocks so as to smooth out seasonal or unanticipated fluctuations in supplies and to meet production shortfalls at ruling prices or policy choices. This assumption is consistent with an economy where the government cannot exactly forecast supply and demand levels and stocks are held for precautionary purposes.

The complete model described above consists of six endogenous variables, two lagged endogenous variables and eight exogenous variables. The empirical model is specified as follows

$$DSR_t = a_{10} + a_{11} PD_{t-1} + a_{12} DSR_{t-1} + a_{13} TEC_t + a_{14} ALP_t + e_{1t} \quad (1)$$

$$DDR_t = b_{10} + b_{11} PC_t + b_{12} DPS_t + b_{13} YM_t + e_{2t} \quad (2)$$

$$DDW_t = b_{20} + b_{21} PC_t + b_{22} DPS_t + b_{23} YM_t + e_{3t} \quad (3)$$

$$MR_t = b_{30} + b_{31} PD_{t-1} + b_{23} DSR_{t-1} + b_{33} DPS_t + b_{35} PW_t + b_{36} YM_t + e_{4t} \quad (4)$$

²This was expected since the economy did not experience any foreign reserve shortages during the observation period.

$$STO_t - STO_{t-1} = MR_t - DDR_t + DSR_t \quad (5)$$

$$MW_t = DDW_t \quad (6)$$

Where

Endogenous variables:

DSR_t = Malaysian production of rice (MT) in period t.

DDR_t = Domestic demand for rice (MT) in period t.

DDW_t = Domestic demand for wheat (MT) in period t.

MR_t = Malaysian net import of rice from ROW (M\$/MT) in period t.

STO_t = Malaysian stocks of rice (MT) in period t.

MW_t = Malaysian imports of wheat from the ROW (M\$/MT) in period t.

Lagged Endogenous variables:

DSR_{t-1} = Malaysian rice production in period t-1.

STO_{t-1} = Malaysian stocks of rice (MT) in period t-1.

Exogenous variables:

PD_t = Guaranteed minimum price for producer (M\$/MT) in period t.

PD_{t-1} = Guaranteed minimum price for producer in period t-1.

ALP_t = Price of natural rubber (M\$/MT) in the period t.

TEC_t = Time trend (technological change) for the period t.

DPS_t = Domestic retail price of wheat (M\$/MT) in period t.

YM_t = Malaysian per-capita income (M\$) in period t.

PW_t = World price of rice (M\$/MT) in period t.

PC_t = Domestic retail price of rice (M\$/MT) in period t.

The supply equation in (1) is the Nerlovian type of model where the quantity of rice produced is regarded as a function of the lagged quantity (DSR_{t-1}), lagged price of rice (PD_{t-1}), price of a competitive crop (ALP_t) and technology (TEC_t). The guaranteed minimum price is assumed to be exogenous in the supply equation. This assumption is consistent with the government's policy of setting the guaranteed minimum price.³ Thus the supply equation has one endogenous

variable and four predetermined variables. Quantities are adjusted in each period by a fraction of the discrepancy between last period's observed value and the desired value. This partial adjustment hypothesis is consistent with an economy where there are rigidities which prevent complete adjustment in each period. In Malaysia, paddy farmers are guaranteed a minimum price (PD_t) and this price is maintained above world price. The variable ALP_t , the price of rubber in Equation 1, is added as a supply shifter to represent the expected opportunity cost of resources. Alternatively, the variable can be interpreted as the influence of the Malaysian rubber policy on rice production. Based on the dynamic supply theory discussed above, it is hypothesised that both DSR_{t-1} and PD_{t-1} will be positively related to DSR_t . The variable ALP_t is expected to have a negative sign, reflecting negative influence of rubber policy on paddy production.

Finally, technological improvements may cause the supply function to shift. The technological shift may be the result of adoption of new varieties, improved cultivation practices, higher fertilizer consumption and improved water management. To account for these technological improvements, a simple time trend variable: T=1 for 1960 to T=28 for 1987 is used.

Equations 2 and 3 are the consumption equations for rice (DDR_t) and wheat (DDW_t) respectively. Both rice and wheat consumption are specified as functions of their own prices, the price of the other goods (substitute) and per capita income (YM_t). The consumer prices are assumed to be exogenous, again set by the government in the demand system, so that each equation has one endogenous variable and three exogenous variables. It is hypothesised that own-price will be negatively related to demand. The price of the substitute is expected to have a positive sign. The coefficient on income can either be positive (i.e. normal good) or negative (i.e. inferior good).⁴

Import demand, Equation 4, is conceptually like any other demand model except that in this study it includes the variables in the supply equation and the government policy variables. The Malaysian government can meet the domestic demand for rice by either increased domestic

³In Malaysia, paddy farmers are guaranteed a minimum price and this price is maintained above world price.

⁴These staple grains are controlled items and during each marketing year, the authorities determine and announce both the retail and wholesale prices of rice and wheat.

production or imports. When the government decided to reduce dependency on foreign markets, it had to increase domestic production and this could be achieved by increasing the support level (PD_t). Alternatively the government can reduce the price of wheat in the domestic market (DPS_t). Thus the signs expected on PD and DPS are negative and positive, respectively, in Equation 4. This implies that government purchasing agents are willing to substitute wheat for rice.

The sign of the parameter associated with the income variable is expected to be positive since imports of rice are expected to rise with income increases. Malaysia's imports of rice are expected to rise as the world price falls.⁵ The sign on the coefficient PW, world price of rice, is expected to be negative. The price and quantity demanded are expected to be inversely related *ceteris paribus*. Finally, two identities, Equations 5 and 6, are added to close the domestic market.

Data and Estimation Method

The data on the rice statistics used in fitting the model are obtained from *Paddy Statistics* published annually by the Department of Agriculture, Malaysia, *Rice Statistics* 1984 and various FAO sources. The time period selected for this study is from 1960 to 1987.

If the classical assumptions are satisfied, the parameters for the supply and demand equations can be estimated by OLS method. The estimators provided by this technique will be unbiased and efficient. A simultaneous estimator is not required here because there is only one endogenous variable in each of these equations. However, the structure of the error term in the supply equation is unlikely to satisfy the conditions required for OLS estimation.

The two demand equations can be estimated by OLS if the disturbance is independently and normally distributed and there is no contemporaneous correlation between disturbances of the two commodities. The OLS method yields unbiased, consistent and efficient estimators. But to impose cross-price restrictions in both equations, the Zellner's Seemingly Unrelated Regression (SUR) technique is employed in this study.

The precise specification of import demand

specification, as pointed out by Thursby and Thursby (1984) is largely an empirical issue. The issues involved are the appropriate variables, functional form and the possibility of simultaneity bias in single equation estimation. Leamer and Stern (1970) and Tegene (1989) argued that in the case of a small country, it is reasonable to assume an infinitely elastic supply (or, at least, a relatively large supply elasticity). Thus, given this assumption, Equation 4 can be estimated by OLS.

RESULTS AND DISCUSSIONS

Supply Equation

The supply equation was nested in the more general partial adjustment-adaptive expectation (PAAE) model. To diagnose the appropriate specification, the procedure outlined by Doran (1988) using likelihood based principles was used in the analysis. The general results rejected adaptive expectation (AE) model in favour of partial adjustment (PA) to examine the supply response. The preferred model for the supply equation that appears in Table 1 meets two other diagnostic tests: linear specification and autocorrelation.⁶

In this model both the dummy variable and the lagged dependent variable are statistically significant at one per cent level. The trend variable which reflected the technological advancement and the

TABLE 1
The supply function

$DSR_t = 1.7125 + 0.7411 DSR_{t-1} + 0.0293 PD_{t-1} + 0.0095 TEC_t$	
(0.6210)*	(0.0957)** (0.0397) (0.0043)*
-0.1744 DUM	Rho = -0.906
(0.0517)**	(0.4726)
	R ² =0.94 h=0.5358

Note: Figures in parenthesis denote standard errors. Using the Wald and LM tests we conclude that the partial adjustment model is the preferred specification. For detailed discussion on the diagnostic checks for the appropriate specification, see Doran (1988). The model was corrected for first-order autocorrelation using Cochrane-Orcutt technique and Rho is the value of first-order autocorrelation. The coefficient of adjustment was estimated at 0.2589. Single asterisk indicates significant at 5% level; double asterisk indicates significant at 1% level.

⁵This hypothesis is consistent with the recent experience when imports share of the domestic demand rose from 11% in 1980 to 24% in 1985 as world price fell from US\$ 433.9 to US\$ 215.9.

⁶Several tests are available for testing functional form. In this study we used the Box-Cox (1964), RESET and Bera-McAleer tests (1989).

expansion of are cultivated in 60s and 70s had the expected positive sign and was statistically significant at the five per cent level. The estimated coefficient of the trend variable is small, suggesting poor growth in yields for rice in Malaysia. Only minor technological changes took place during the period under consideration.⁷

The dummy variable was added to the supply equation to account for the differential intercept in the 80s. The downward shift implies that for a given support price, producers supplied less as of 1980 than before. This is equivalent to a shift in supply curve of farm products to the left. A plausible cause for the left shift in the supply is that when prices are supported above world prices and 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 (or put submarginal land into cultivation) and consequently produce at higher cost.⁸

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. The estimates for the short run price elasticity of supply is fairly low, 0.03, and is insignificant at the five per cent level. The long run price elasticity is estimated at 0.11. The low own-price elasticity estimate is in general agreement with those reported by King (1987) and Haugton (1983).⁹

We conclude that Malaysian rice producers are generally unresponsive both in the short and long run to price change. The results suggest that 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 cannot be used for other crops. In the granary areas which produce

more than 60% of the domestic supply, paddy is a mono-crop. In the single cropped areas water supply is the major constraint. This low supply response implies that continuing price incentive at the expense of consumers may not be a meaningful way to increase domestic production.

The Demand Equations

The consumption side of the model was specified with per capita consumption of rice and wheat as functions of retail prices for rice and wheat and income. The preliminary results of the demand equations suggest that the demand equations are not robust under different specifications and estimation techniques. The model was first diagnosed for appropriate functional form using the RESET test and the Bera-McAleer test (1989). We conclude that the log-linear model is the "Correct" specification for both the rice and wheat equations.¹⁰

A further inspection of the demand equation residuals revealed the presence of first order autocorrelation. The model was diagnosed for autocorrelation using the test suggested by Guilkey (1974) and the computed LR statistics reject no autocorrelation in favour of diagonal ARS.¹¹ The problem of autocorrelation in the system of demand equations called for an alternative method of estimation to eliminate the inconsistencies and improve the sample efficiencies of the estimators. In most empirical work the parameters of the coefficients of autocorrelation (autoregressive parameters) are unknown and must be replaced by a consistent estimator.

Several methods are available to estimate the parameter and in this study the method suggested by Kmenta and Gilbert (1970) was employed. Following Kmenta and Gilbert, the autoregressive parameters were used to transform original observations and to retain the first observations in both the demand equations.

Both the homogeneity and symmetry conditions were tested and imposed in the model. The estimated coefficient for the two equations system

⁷The growth in paddy yields averaged about 1.2% between 1969 to 1977, declined to less than 1% in the 80s. In fact in the past few years growth has been negative as paddy production was plagued by pests and diseases.

⁸See Floyd (1965) for detailed discussions on the effect of farm supports on land and labour in agriculture.

⁹The variable ALP was dropped in the final estimation because it was giving wrong signs and was statistically insignificant.

¹⁰The model was also diagnosed for the appropriate specification using the LR test suggested by Savin and White (1978). The specification results of the joint test of functional form and autocorrelation do not reject the log-linear specification.

¹¹The test produced an LR value of 10.713 compared to the 5% critical value of 5.99.

is reported in Table 2 along with some of the single-equation statistics.¹² The wheat equation appears to fit the data better under the diagonal AR specification. Although the R² were fairly low, the estimated coefficients were statistically significant and of expected signs. The results in Table 2 indicate that 7 out of a total of 8 estimates have t-ratios greater than 2. The restricted elasticities were obtained after 8 iterations on the transformed data.

All the own-price, cross-price and income parameters in the restricted SUR model had the expected signs. The coefficients of these variables except for income in the wheat equation were found to be statistically significant. Demands for rice and wheat are inelastic with respect to their own-price and income.

TABLE 2
Per capita demand for rice

$\text{DDR}_t = 0.1855 - 0.3090 \text{PC}_{t-1} + 0.5486 \text{DSP}_t - 0.2396 \text{YM}_t$ <p>(0.0797)* (0.1132)* (0.1120)** (0.0852)**</p> <p>R² = 0.5885 D.W. = 1.4503 Rho = 0.2220 (0.1843)</p>
$\text{DDW}_t = -4.3606 + 0.2136 \text{Pct} - 0.3198 \text{DSPt} + 0.1062 \text{YM}_t$ <p>(0.7699)** (0.4884)** (0.0956) (0.0956)</p> <p>R² = 0.7014 D.W. = 1.5319 Rho = 0.2674 (0.1821)</p>

Note: Figures in parentheses denote standard errors. All variables were expressed in log linear form and deflated by CPI (1980 = 100). The system was estimated by SUR method with restrictions on cross-price and the homogeneity imposed. The model was corrected for autocorrelation using the method suggested by Kmenta and Gilbert (1970). The Rho is the estimated first-order autocorrelation coefficient. Single asterik indicates significant at 5% level; double asterik significant at 1% level.

The estimated Hicksian own-price elasticities are all negative. Generally, the elasticity estimates seem reasonable apart from income elasticity of wheat being insignificant. The own-price elasticities from the model were -0.309 and -0.320 for rice and wheat respectively.

Comparing the estimated parameters of the untransformed model (results not shown here) with the specification in Table 2 revealed that the magnitude of the coefficients is fairly robust under the alternative specifications. However, the standard errors in the model with auto-regressive transformation are for the most part larger. A plausible explanation for this phenomenon was provided by Maeshiro (1976). Given the trended explanatory variables, the Cochrane-Orcutt transformation reduces the sample variation in the transformed independent variables, compared with the untransformed variable. Thus the reduction in the dispersion of the explanatory variable increases the variance of the estimators.¹³

The present work, unlike the previous efforts on food grain demand for Malaysia, explicitly tested for homogeneity and symmetry properties of the empirical model. In addition, both equations were tested for functional form and subjected to a number of residual diagnostic tests before they were selected in the final analysis. The estimated price elasticity for rice is about -0.309 which is smaller than that of King's and Nik Fuad's but the cross-price elasticity (0.549) in the rice equation is higher than that of King's.

The income coefficients obtained were negative for rice (-0.240) and positive for wheat (0.106). The income elasticity for rice obtained from the preferred model compares favourably with the results obtained by Nik Fuad but not with those of King whose estimate was almost three times larger. Although the magnitude of the income coefficient varies across studies, the results seem to support the hypothesis that rice is an inferior good in Malaysia. Wheat is a normal good and the higher income elasticity of wheat reported in this study is not surprising. Although no previous study on Malaysia has included wheat for comparison, the result is consistent with the declining pattern in rice consumption and upward trend in wheat consumption in Malaysia in the 1980s. Thus as income increases, the demand for rice decreases while the demand for wheat increases.

The matrix of price and income elasticities obtained in this study indicates several points with important policy implications. First, the presence

¹²The parameters of the rice equation changed little when the restrictions were imposed. However, the wheat equation's coefficient changed considerably. For example, the estimated income elasticity was twice as large in the unrestricted SUR model compared to the restricted model.

¹³The model was also estimated using the approach suggested by Judge *et al.* (1985). The transformation of the first observation for a given equation in this case depends on the first observation in all other equations. The results obtained cannot be justified from the economic point of view. For detailed discussion on the results and the source of the estimation procedure, See Ahmad Zubaidi (1990) pp. 120-123).

of significant price effects for these two important food commodities indicates that price policy is an important agricultural policy instrument. It is also important to recognise that substitution between these two grains exists. The finding is important in designing future grain policy especially when a country like Malaysia depends on the world market for all of her wheat. Second, wheat has acquired an important position in the Malaysian diet. This is indicated by the two-fold increase in total quantity consumed and by its higher income elasticity. Third, demand for rice is expected to decline as income increases.¹⁴

Finally, the studies by King and Nik Fuad used single equation methods without any restrictions on the parameters. The parameters in the present work are obtained using the SUR model with restrictions imposed, producing a different matrix of price and income elasticities. Thus, the elasticities estimates are not robust to model specification. The choice of the specification will affect the estimates of the welfare surplus. For example, researchers have recognised the central role of the choice of functional form plays on the estimates of consumer surplus and producer surplus. The potential errors which may arise from the incorrect functional form may be reduced by employing model specification test(s).¹⁵

The Rice Import Equation

The formulation of the import equation assumed that imported and domestic rice are substitutes. Thus the import demand function can be viewed as an excess demand schedule. The model had serious autocorrelation problems and because the autocorrelation parameters for the second and fourth order were large, the model was corrected for autocorrelation. The model was re-estimated to correct for autocorrelation and the results are presented in Table 3.

The model explained 65 per cent of the variation in rice imports. The import equation was tested for stationarity and the roots of the fourth degree polynomial are $0.5113 \pm 0.9197i$ and $0.5286 \pm 0.8753i$. Thus, the AR(4) process is stationary given that the values (a^2+b^2) are greater than unity. All the coefficients in the import equation, except

TABLE 3

Import of rice

$MR_t = 5.3400 - 1.8684 PC_{t-1} - 2.3789 DSR_{t-1} + 1.1381 DSP_t$
(4.7365) (0.8008)* (1.381)** (0.8231)*
$+0.5299 PW_t + 2.2077 YM_t$
(0.2123)* (0.4335)** $R^2 = 0.6559$ D.W. = 2.508
$Rho_1 = 0.0875$ $Rho_2 = -0.9257$ $Rho_3 = 0.1376$ $Rho_4 = -0.8637$
(0.1218) (0.1360)** (0.0299) (0.1348)**

Note: Figures in parentheses denote standard errors. All variables were expressed in log-linear and deflated by CPI (1980=100). Rho (i), where $i=1, \dots, 4$ were the i th-order autocorrelation coefficients. The model was corrected for autocorrelation using the GLS estimators. Single asterisk indicates significant at 5% level; double asterisk indicates significant at 1% level.

for world price, have the expected signs and are found to be statistically significant. We expect the price elasticity to be small and negative to reflect the domestic pricing policy as an effective means of insulating the domestic market from the changing world price.

Despite the simplicity of the model, the results of the import equation provide some useful insights into the rice trade flows in Malaysia. The coefficient on the domestic price was found to be negative and statistically significant at the five per cent level. The estimated price elasticity is high, indicating that domestic price has significant influence on the imports of rice. The results suggest that imports decrease with increases in domestic price. An increase in the protection to producers, implying higher domestic prices, would increase domestic production and induce the authorities to import less.¹⁶ The results also suggest that the Malaysia government sets the level of imports according to the supply in the previous period. The higher the domestic supply, the lower is the level of imports, *ceteris paribus*. Imports provide a substitute for domestic production. The large production elasticity (-2.4) is expected given the current high level of self-sufficiency in Malaysia.

The coefficient of domestic income (real GNP) suggests that as income increases, greater reliance is placed on imports. The positive relationship is consistent with that predicted by trade theory. The high income elasticity of demand suggests that

¹⁴In the 1980s per capita demand for wheat grew at an average annual rate of 4 per cent. Per capita rice consumption declined from 108 kilogram in 1980 to 95 kilograms in 1988.

¹⁵For an exposition of the choice of functional form and welfare measurement see for example Ziemer *et al.* (1980) and Kling (1989).

¹⁶Alternatively, one could also argue that higher producer prices would also translate into higher consumer prices thus reducing domestic consumption and induce the authorities to import less.

imported rice may be considered a luxury item. This does not contradict the earlier conclusion that the domestic rice is an inferior good in Malaysia. Alternatively, the sign on the income coefficient suggests that as income grows, the Malaysian government depends on foreign supply to satisfy the domestic demand.

The coefficient on wheat price is positive and significant, suggesting that as the price of wheat increases, more rice is imported. Alternatively, as the price of wheat falls relative to the price of rice, more wheat is imported, thus reflecting the pattern that existed in Malaysia in the 1980s. The results imply that government purchasing agents are willing to substitute wheat for rice.

CONCLUSION.

The PAAE model was used to investigate the rice supply response in Malaysia. The model was diagnosed for appropriate specification and the results of the diagnostic tests suggest that the PA model is the preferred specification to examine the supply response. The preferred model for the supply equation met two other diagnostic tests: log-linear specification and autocorrelation. Unlike the supply equation, the demand equations are not robust to changes in specification as revealed by the estimated elasticity coefficients. Demand restrictions on these equations were tested and imposed in the model. In addition, the model was tested for functional form and was corrected for autocorrelation using the approach suggested by Kmenta and Gilbert (1970).

Despite the simplicity of the model and data problems, an examination of the econometric model leads to several conclusions with possible important policy implications for the rice economy in Malaysia. The estimate for the short-run price elasticity of supply is 0.03 while the log-run price elasticity is estimated at 0.11. We conclude that Malaysian rice producers are generally unresponsive both in the short and long run to price change. The guaranteed minimum price, which is the single most important rice policy instrument, is ineffective in boosting domestic production. Thus, the guaranteed minimum price may have been justified on income distributional grounds or for political reasons.

The matrix of price and income elasticities obtained from the demand analysis indicates several points with important policy implications.

First, the presence of significant price effects for rice and wheat indicates that price policy is an important agricultural policy instrument. It is also important to recognise that substitution between rice and wheat exists. This is important especially when a country like Malaysia depends on the world market to provide all wheat consumed domestically. Second, wheat has acquired an important position in the Malaysian diet. This is indicated by the increase in per capita consumption and by its higher income elasticity.

Third, the income elasticities obtained from the present study are negative and positive for rice and wheat, respectively. These results support the hypothesis that rice is an inferior good in Malaysia while wheat is normal. The hypothesis that domestic rice is an inferior good in Malaysia is consistent with the earlier findings. Thus as income increases, the demand for rice decreases and self-sufficiency in rice may more easily be achieved.¹⁷

Demand for wheat and other substitute commodities is expected to increase as income increases. Unfortunately, Malaysia produces no wheat and only a small percentage of all other grain requirements. This would result in an increased dependency on the international market for the domestic food grain demand. In addition, consumers in Malaysia are likely to increase their consumption of meat and dairy products as incomes grow. It may be unreasonable for a middle income country like Malaysia to adopt the narrow concept of food security that includes only rice or certain cereals. Instead, a broader concept of food security that includes a whole range of food items may need to be considered. This suggestion is consistent with the National Agricultural Policy objective to broaden the concept of food security by diverting some land to more profitable crops.

Import restrictions have protected producers from the cheaper world price and consumers have paid the cost of the protection by paying a price above the import price. Imports were heavily influenced by governmental regulatory instruments. The results of the regression analysis suggest that the Malaysian government sets the level of imports according to the supply in the previous period, income level and domestic prices of rice and wheat. Imports provide substitutes for domestic production. As income grows, the authority depends on foreign supply to satisfy the domestic demand. The coefficient on wheat price is positive, implying the

¹⁷A referee points out that wheat is normal and imported rice is superior. Thus, the imports of grains are expected to rise in future because of improved income in Malaysia.

willingness on the part of the importer to substitute wheat for rice.

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