Pertanika 11(3), 441-449 (1988)

Malaysian Natural Rubber Market Model

MOHAMMED BIN YUSOF
Department of Economics,
Faculty of Economics and Management
Universiti Pertanian Malaysia
43400 Serdang, Selangor Darul Ehsan, Malaysia.

Key words: Natural rubber; model; simulations.

ABSTRAK

Tujuan kajian ini ialah untuk membentuk satu model persamaan serentak pasaran getah asli Malaysia. Keputusan regresi menunjukkan bahawa model yang dibentuk ini adalah memuaskan di segi tanda-tanda yang betul, R^2 yang tinggi, dan pembol*ehubah yang bermakna. Simulasi juga dicuba untuk melihat kebolehan model ini mengesan nilai sebenar. Pada umumnya, model ini berupaya mengesan pergerakan pembolehubah endogen terpilih. Model ini boleh digunakan untuk membuat ramalan kesan perubahan sesuatu pembolehubah eksogen, seperti cukai eksport, kadar pertukaran, atau kemelesetan ekonomi, ke atas pembolehubah endogen.*

ABSTRACT

This study is an attempt to formulate a simultaneous equations model of the Malaysian natural rubber market. The regression results suggest that the model is quite satisfactory in terms of correct signs, high R^2, and significance of variables concerned. A simulation exercise was done to ascertain the adequacy of the model in tracking the actual values. It was found that, in general, the model has the ability to trace, at least, the directions of the movements of certain selected endogenous variables. The model developed here could be used to forecast the effect of a change in an endogenous variable, such as export duty, exchange rates, or recession on endogenous variables.

INTRODUCTION

The importance of foreign trade to the Malaysian economy is fairly well accepted by policy makers and academics. Substantial portions of the Malaysian GNP is derived from the foreign sector. For example, in 1980 and 1985 the ratios of the value of exports to GNP were 54.5 percent and 49.5 respectively.

One of the major commodity exports of Malaysia is natural rubber. Although the share of natural rubber in the total exports has been declining in recent years, its contribution to Malaysia's foreign exchange earnings is still substantial. For example, the share of rubber export in the total exports in 1980 was 16.4 percent and by 1985 it declined to 7.9 percent. Due to recent world recession and competition with synthetic rubber, the world demand for natural rubber seems to be stagnant. Thus, steps should be taken to maintain its competitiveness in the world market, for example, by lowering the unit cost of production.

In order to analyse the effects of policy actions, a Malaysian natural rubber market model is formulated in this study. The model specifications presented here represent a significant departure from previous studies such as Yusoff (1978).

The model could be used to analyse the effects of, for example, world recession, exchange rate adjustment, and export tax on production acreage, prices, and export demand for natural rubber. Historical simulation exercise was carried out by using this model to ascertain its adequacy for forecasting. The results suggest that the model has the ability to trace the historical data reasonably well.

THE MODEL

In this section, we shall describe briefly a simple model of the Malaysian natural rubber market. The model consists of six behavioral equations and five identities. The behavioral equations are the equations for export demand, the world price of natural rubber, acreages for estate and smallholding sectors, and the yields of estate and smallholdings sectors; while the identities define the production of smallholding and estate sectors and the price of rubber in Malaysian ringgit, the price received by the producers, and the total production. In the discussion that follows the disturbance term in each of the behavioral equations will be suppressed for simplicity but without loss of generality.

Export Demand

Following Yusoff (1978), the export demand is specified as

$$\text{Log } XR_t = \alpha_0 + \alpha_1 \log (PR{*}e/PSR)_t + \alpha_2 \log t + \alpha_3 \log IPIW_t \quad (1)$$

where XR = foreign demand of Malaysian rubber in metric tons

PRW = world price of rubber in foreign currency per metric ton in Kuala Lumpur market

PSR = world price of synthetic rubber in foreign currency per metric ton in the U.S. market

e = effective exchange rate (foreign currency per ringgit)

t = year

IPIW = world industrial production index.

Equation (1) postulates that the foreign demand of natural rubber from Malaysia would be negatively related to the relative price of natural rubber to synthetic rubber and positively related to the world industrial production index. If the price of natural rubber is higher in relation to the synthetic rubber, the quantities demanded would fall and vice-versa; if the value of Malaysian currency depreciates, we would expect the demand for rubber to increase, other things unchanged. The exchange rate, e, was computed by finding the average exchange rate of ringgit in terms of Malaysian major trading partners' currencies, namely the U.S. \$, Singapore \$, U.K. pounds, Japanese yen, and German mark, weighted by their respective trade shares. For more detail, see Yusoff (1987). The variable IPIW represents the economic activities of the world. Since natural rubber is a raw material used by industries, it is expected that if industrial activities are higher, the demand for natural rubber would increase. The trend variable t is supposed to indicate the change in the tastes and preferences of the importing nations.

World Price

The world price of natural rubber, PRW is specified as

$$\log PRW_t = \beta_0 + \beta_1 \log PSR_t + \beta_2 \log IPIW_t + \beta_3 \log RSRW\ t{-}1 \quad (2)$$

where RSRW = ratio of stock of natural rubber between producing and consuming countries.

Since natural rubber and synthetic rubber are substitutes, these prices should be positively correlated; an increase in the price of synthetic rubber would encourage consumers to switch to natural rubber, thereby raising the price of natural rubber. And a fall in the industrial production index would reduce the demand for natural rubber and consequently, its price falls. The presence of the stock variable suggests that if the stock in the consuming countries are lower in relation to stock in producing countries, the price will rise as many consuming countries purchase rubber in the world market to replenish their stocks.

Acreage

Rubber growing in Malaysia is composed of two distinct sectors, namely the estates and the smallholdings. The acreage equations are specified as

$$\text{Log } AER_t = \theta_0 + \theta_1 \log (PR/CPI)_t\ \theta_2 \log t \quad (3)$$

$$\text{Log } (AER)_t - \log (AER)_{t-1} = \lambda_2\ [\log AER^*_t - \log AER_{t-1}] \quad (4)$$

$$0 < \lambda_2 < 1$$

where AER* = optimal harvested acreage of rubber in estate
PR = price of rubber in ringgit per metric ton
CPI = consumer price index in Malaysia
PR/CPI = deflated rubber price
AER = actual harvested acreage in estate

Since AER* is an unknown quantity, it is then approximated by an adjustment process (4). Substituting (3) in (4) for AER*, we obtain

$$\log AER_t = \lambda_2\ \theta_0 + \lambda_2\ \theta_1 \log (PR/CPI)_t + \lambda_2\ \theta_2 \log t + (1 - \lambda_2) \log AER_{t-1} \quad (5)$$

Equation (3) suggests that the harvested acreage is determined by the price of rubber deflated by the consumers price index. As the price of rubber increases in relation to the price of the producers for other crops in relation to price index, we would expect the harvested acreage to increase. The trend variable t is to capture the change in taste and the preferences of the producers for other crops in relation to natural rubber. Thus, if the returns from rubber is low in relation to other crops and economic activities, a profit maximizing grower should divert his resources to the more lucrative business opportunities.

In a similar manner, the harvested acreage for the smallholding sector, is specified as

$$\log ASH^*_t = \delta_0 + \delta_1 \log (PR/CPI)_t + {}_2\ \delta_2 \log t \quad (6)$$

$$\log (ASH)_t - \log (ASH)_{t-1} = \lambda_3 [\log (ASH)^*_t - \log (ASH)_t -1] \quad (7)$$

where ASH* = desired acreage of smallholding harvested
ASH = actual acreage of smallholding harvested

Substituting (6) in (7) for $\log ASH^*_t$, we obtain

$$\log ASH_t = \lambda_3\ \delta_0 + \lambda_3\ \delta_1 \log (PR/CPI)_t + \lambda_3\ \delta_2 \log t + (1 - \lambda_3) \log (ASH)_{t-1} \quad (8)$$

$$0 < \lambda_3 < 1$$

Equation (8) is the estimating equation for acreage. Since the actual harvested acreage for smallholders is unknown, it is replaced by the actual matured acreage for estimation purposes. This equation is used to forecast smallholdings production through equation (16). Simulation results suggest that equation (16) could corecast smallholdings production reasonably well. Therefore, we could proxy matured acreage for harvested acreage for our purpose here.

YIELD

The yield of any crop is expected to depend on the technological breakthrough in the industry. As new high yielding varieties are discovered, we would expect the yield to rise accordingly. The yield equation is a variant of Fisher and Temin (1978) model and is written as

$$\log (YRE)^*_t = \delta_0 + \delta_1 \log t \quad (9)$$

$$\log (YRE)_t - \log (YRE)_{t-1} = \lambda_4 [\log (YRE)^*_t - \log (YRE)_{t-1}] \quad (10)$$
$$0 < \lambda_4 < 1$$

where YRE* = optimal yield
YRE = actual yield

Equation (9) says that the optimal yield would depend on technological progress which is represented by time trend t. Substituting (9) into (10) for log (YRE*), we obtain

$$\log(YRE)_t = \lambda_4\ \delta_0 + \lambda_4\ \delta_1 \log t + (1 - \lambda_4) \log (YRE)_{t-1} \quad (11)$$

Similarly, the yield in the smallholders sector could be written as

$$\log (YRSH)^*_t = \phi_0 + \phi_1 \log t \quad (12)$$

$$\log (YRSH)_t - \log (YRSH)_{t-1} = \lambda_5 [\log YRSH^*_t - {}_Y RSH_{t-1}] \quad (13)$$
$$0 < \lambda_5 < 1$$

Substituting (12) into (13) for $\log (YRSH)^*_t$, and rearranging, we have

$$\log (YRSH)_t = \lambda_5 \phi_0 + \lambda_5 \phi_1 \log t + (1-\lambda_5) \log YRSH_{t-1} \quad (14)$$

The actual harvested acreage for smallholders is not available. Therefore YSRH was approximated by dividing its production with actual matured acreage. Since actual matured acreage is expected to be larger than harvested acreage, then YSRH calculated in this study tends to underestimate the actual YRSH.

The lagged yield as a regressor could be interpreted in the following manner. Write equation (10), for example, as

$$Y_t - Y_{t-1} = \lambda(Y_t^* - Y_{t-1}) \quad (10.1)$$

where Y = actual yield

Y^* = potential (desired) yield.

Rearranging (10.1), we obtain

$$Y_t = (1-\lambda)Y_{t-1} + Y_t^* \quad (10.2)$$

By process of lagging and substituting, (10.2) could be written as

$$Y_t = (1-\lambda)^{i+1} Y_{t-i-1} + \sum_{i=0}^{\infty} (1-\lambda)^i Y_{t-i}^* \quad (10.3)$$

As $i \to \infty$, equation (10.3) reduces to

$$Y_t = \sum_{i=0}^{\infty} (1-\lambda)^i Y_{t-i}^* \quad (10.4)$$

Lagging (10.4) by one period,

$$Y_{t-1} = {}_{i=0} (1-\lambda)^i Y_{t-i-1}^* \quad (10.5)$$

It is very clear from (10.5) that the lagged actual yield is positively related to the past potential yields. And of course these past potential yields were the result of research and development efforts in the past, which in turn, are positively related R & D expenditures. Thus, the past R & D expenditures are captured by the lagged actual yield, Y_{t-1}.

Production

In this model, quantity produced or simply production is identically equal to the yield multiplied by harvested acreage. Thus, for the estates, it is written as

$$QRE_t = YRES_t * ARE_t \quad (15)$$

and for the smallholdings, it is

$$QRSH_t = YRSH_t * ARSH_t \quad (16)$$

Where QRE = production from estate

QRSH = production from smallholdings.

This form of production identity is employed by Shonkwiler and Emerson (1982).

Identities

We shall close the model by defining three identities, namely the world price of natural rubber in ringgit, the price received by the exporters, and total rubber production in Malaysia as follows:

$$PR_t = (PRW / e)_t \quad (17)$$

$$PRR_t = PR_t - XTR_t \quad (18)$$

and

$$QR_t = DC_t + XR_t + \Delta IR_t \quad (19)$$

where

QR = total rubber production in Malaysia in metric tons

DC = domestic consumption of natural rubber in metric tons

ΔIR = change in rubber inventory in metric tons.

Equation (17) defines the domestic price of rubber as equal to the world price in foreign currency divided by the effective exchange rate in foreign currency per ringgit. Equation (18) on the other hand says that the price received by the exporters, PRR, is equal to rubber price in domestic currency less the export tax.

This simulatneous equations model has six behavioral equations and five identities. The behavioral equations are the export demand, world price, matured acreage disaggreaged into estates and smallholdings, and the yield equations for both estates and smallholdings. The identities define quantities produced in estates and smallholdings, world price, the price received by the exporters, and the total production. The endogenous variables are: export demand, world price, price received, world price in domestic currency, harvested estates acreage, matured smallholding acreage, yield of estates, yield of smallholdings, quantities produced by estates, and quantities produced by smallholdings. The exogeneous variables (including predetermined variables) are the price of synthetic rubber, time trend, consumer price index of Malaysia, world industrial production index, effective exchange rate, export tax, lagged ratio of world stock in producing countries compared to consuming countries, and the lagged endogeneous variables of production, acreages, and yields of both estates and smallholdings. Since a number of equations involved ratios and nonlinear in parameters, the model was estimated by nonlinear 2 SLS.

The data for this study (from 1960 to 1981) were extracted from the Quarterly Economic Bulletin of Bank Negara Malaysia, Rubber Statistics Handbook of the Department of Statistics of Malaysia, and International Financial Statistics of the International Monetary Fund.

TABLE 1
Nonlinear 2SLS estimates

Export Demand

$$\log (XR)_t = 729.10 - 0.0912 \log (PR^{*}e/PSR)_t - 96.1616 \log (t) + 1.6765 \log IPIW_t$$

(1.27) (3.94)** (7.07)**

$R^2 = 0.9652$, $DW = 1.62$

World Price

$$\log (PRW_t) = 1.9232 + 0.8064 \log PSR_t + 0.1238 \log IPIW_t + 0.2714 \log RSRW_{t-1}$$

(3.26)** (0.30) (0.1234)

$R^2 = 0.6811$, $DW = 1.97$

Acreage

$$\log AER_t = 127.50 + 0.0067 \log (PR/CPI) - 16.5320 \log t + 0.7098 \log (AER)_{t-1}$$

(0.77) (3.71)* (7.81)**

$R^2 = 0.9987$, $h = 0.81$

$$\log ASH_t = -34.3153 + 0.0065 \log (PR/CPI) + 4.8236 \log (t) + 0.7088 \log (ASH)$$

(0.46) (2.09) (12.30)**

$R^2 = 0.9919$, $h = 1.021$

Yields

$$\log (YRE)_t = -44.1963 + 5.8124 \log(t) + 0.8291 \log (YRE)_{t-1}$$

(0.52) (5.13)**

$R^2 = 0.9629$, $h^c = 2.021$

$$\log(YRSH)_t = -215.00 + 28.2832 \log(t) + 0.7008 \log (YRSH)_{t-1}$$

(1.65) (4.14)**

$R^2 = 0.9373$, $h^c = 1.81$

t – values are in the parentheses;
h^c – the equation was corrected for autocorrelation.

RESULTS

Generally speaking, the results of the regression analysis are satisfactory in terms of goodness of fit (R^2), significance of the explanatory variables, and correct signs (Table 1).

The foreign demand for Malaysian rubber would depend on the performance of the world economy represented by the world industrial production index. The elasticity of the demand with respect to industrial production index was estimated to be 1.6765, which is significant at one percent level and elastic. Thus, a one percent change in industrial production index would result in about 1.7 percent increase in the demand for Malaysian rubber. The coefficient of the time trend is significant at one percent level and negative suggesting that the foreign demand for rubber from Malaysia is declining overtime, perhaps in preference of its closest substitute, synthetic rubber or that more importers are opting to purchase rubber from other producing countries such as Indonesia, Thailand, and Sri Lanka. This trend is indeed very alarming. Malaysia therefore should take steps now to be more aggressive in its efforts to promote rubber in terms of quality, price, and services. As was found in other studies, for example Yusoff (1978), the price of natural rubber cannot explain the change in quantity demanded and its elasticity with respect to relative price is very inelastic, at 0.0912.

The results also suggest that the price of natural rubber could be significantly explained by the price of synthetic rubber; a ten percent increase in the price of synthetic rubber would increase the price of natural rubber by 8 percent. The ratio of stock of natural rubber in producing countries and consuming countries is also an important determinant of the natural rubber price, where it is significant at 5 percent level. It is estimated that a ten percent rise in the stock in the producing nation in relation to stock in consuming countries would result in a 2.7 percent increase in the price of natural rubber. Thus, assuming that the consuming countries would not release their stocks, one of the ways to increase the price of natural rubber is through accumulating its stock in the producing nations, if funds are available.

The price of natural rubber is found not to be an important determinant of harvested acreage in the estate sector. This is understandable since investment in rubber production involves a long gestation period. Thus, as long as the market price is above the average variable cost, rubber will be harvested. Therefore, it is found that the elasticity of acreage will with respect to price is very low, almost perfectly inelastic at 0.0067. The coefficient of the time trend is negative and significant at one percent level suggesting that the acreage is declining over time.

This is expected since many estates had diverted substantial acreage under rubber to grow oilpalm. The lagged acreage is also significant and the adjustment to the desired acreage is quite slow as indicated by the low coefficient of adjustment at 0.29, implying that about 30 percent of actual acreage is adjusted to the desired level per year. The results of the smallholding acreage equation follow closely to that of the estate, except that its acreage is on an upward trend since the smallholding sector has been expanding in recent years.

The yield equations for both the estate and smallholding produce similar results. The only important determinant of yield is the lagged yield itself which should capture the effect of technological progress. Both indicate that adjustment to the desired yields are slow at 17 percent and 29 percent for estate and smallholding respectively.

SIMULATION RESULTS

A dynamic simulation was carried out through the sample period to see how far the model could track the path of the actual data. We shall measure this tracking ability by using the mean percent error and root mean-square percent error (Table 2).

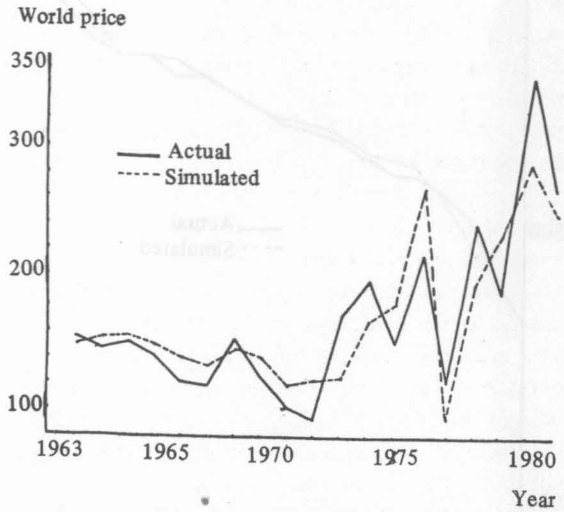
The mean percent error of the endogenous variables are relatively small (less than two percent) except for the production of the estates where the mean percent error is 9.40 percent. But the root mean-square percent error criterion indicates that the errors are more than five percent for prices, yield of smallholders, and production of both smallholders and estates, although they are still less than ten percent. The root mean percent error for the yield of estates, export, and acreages are all less than five percent.

In order to see more clearly the paths of selected endogenous variables, their simulated and actual values are graphed as shown in Appendices 1, 2, 3, 4, 5 and 6. By and large, the model could

TABLE 2
Historical simulation results

Endogenous variables	Mean percent error	Root mean square percent error
PRW	1.50	7.42
YRES	0.07	3.78
YSHR	0.29	7.42
PR	1.50	7.42
XR	0.11	4.66
AER	0.02	0.59
ASHR	0.02	0.85
QER	9.40	9.78
QSHR	0.28	7.06

trace the directions of the actual values quite well. The simulated values trace the actual world price of natural rubber satisfactorily; a number of critical turning points (1976, 1977, and 1980) were correctly predicted by the model. The acreage for estates has been declining steadily during the sample period and the simulated values trace the path quite closely. The smallholdings acreage, on the other hand is on an upward trend and its simulated values also follow the actual path satisfactorily. The model was not able to predict export as well as we would expect; it almost consistently underpredicts the export. This suggests that although an equation is satifactory in terms of correct signs, significance of the regressors, and high R^2, it does not necessarily imply that the equation could predict very well when all the equations are simulated. The simulated values of the production of estates also follow closely to that of the actual values; it correctly predicts two critical turning points in 1970 and 1973, although it misses a turning point in 1974. The quantity of production in the smallholdings is on an upward trend and the simulated values follow the movement of the actual values quite well.

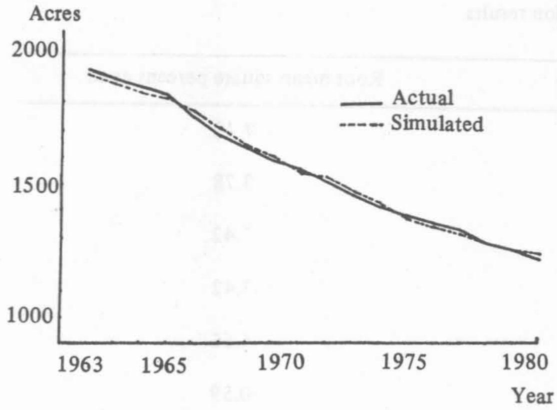


Appendix 1: World Price of Natural Rubber

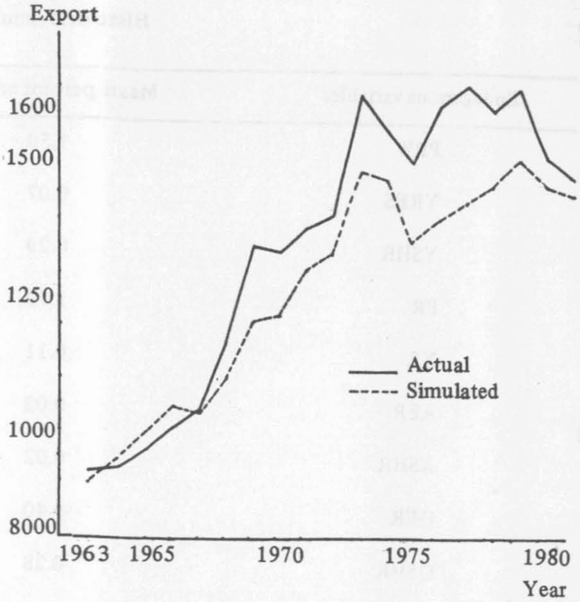
CONCLUSION

This study is an attempt to formulate a model of the Malaysian natural rubber market. Simultaneous equations model of production, acreage, yield, export, and price was developed and then estimated by using nonlinear two-stage least squares. The regression results suggest that the model is quite satisfactory in terms of correct signs, high R^2, and significance of variables concerned.

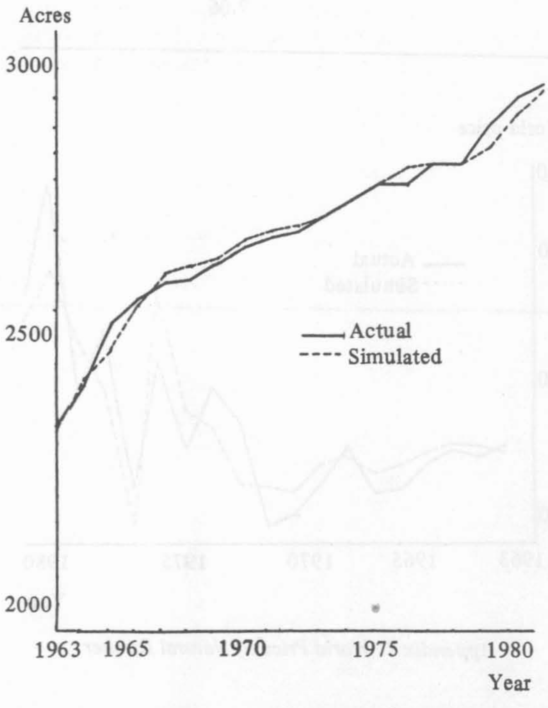
A simulation exercise was done to ascertain the adequacy of the model in tracking the actual values. It was found that, in general, the model



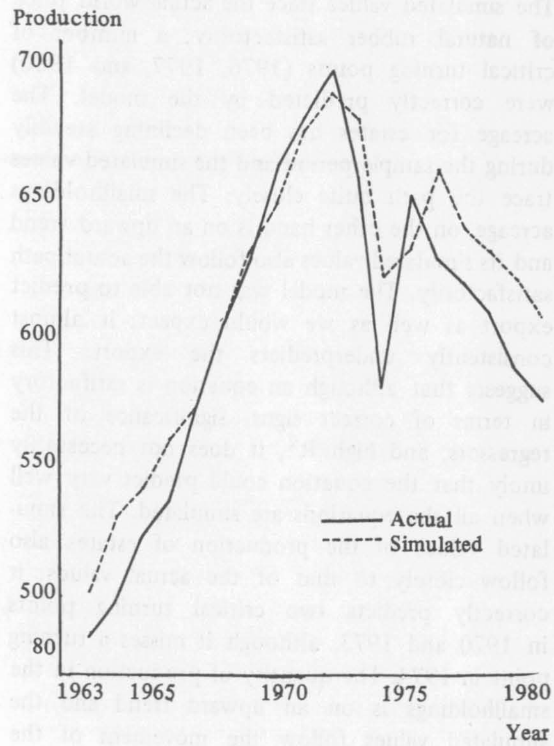
Appendix 2: Acreage (estates)



Appendix 4: Export

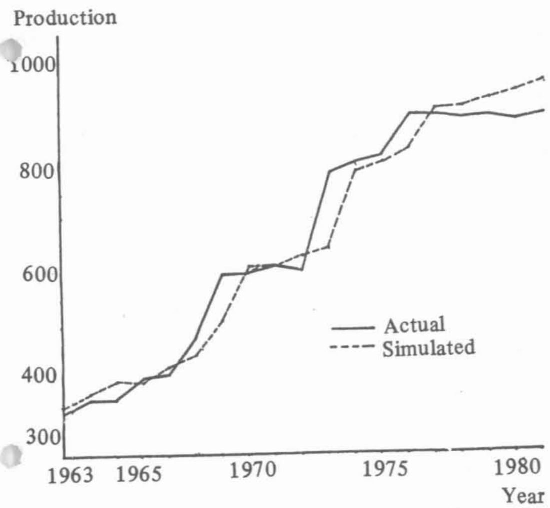


Appendix 3: Acreage (Smallholdings)



Appendix 5: Production (Estates)

has the ability to trace, at least, the directions of the movements of certain selected endogenous variables. The model developed here could be used to forecast the effect of a change in an exogenous variable, such as export duty, exchange rates, or



Appendix 6: Production (Smallholding)

recession on endogenous variables which is not done in this study.

REFERENCES

BANK NEGARA MALAYSIA. *Quarterly Economic Bulletin.* Various Issues.

DEPARTMENT OF STATISTICS, MALAYSIA. *Rubber Statistics Handbook.* Various Issues.

FAIR, R.C. (1980): Estimating the Uncertainty of Policy Effects in Nonlinear Models. *Econometrica.* **48(6):** 1381-1391.

FISHER, F.M. and P. TEMIN. (1970): Regional Specialization and the Supply of Wheat in the US., 1967-74. *American Journal of Agricultural Economics,* Vol. L11, No. 2, 121-134.

TAN, A.H. (1967): The Incidence of Export Tax on Small Producers. *Malayan Economic Review, 12(2):*

SHONKWILER, J.S. and R.D. EMERSON. (1982): Import and the Supply of Winter Tomatoes: An Application of Rational Expectations. *American Journal of Agricultural Economics,* **64(4):** 634-641.

INTERNATIONAL MONETARY FUND. *International Financial Statistics.* Various Issues.

YUSOFF, MOHAMMED B. (1978): An Econometric Model of the World Natural Rubber Industry. *Kajian Ekonomi Malaysia,* **25(2):**

YUSOFF, MOHAMMED . B. (1987): Exchange Rate Changes and the Terms of Trade. *PKDP Report,* No. 17/87, Centre for Agricultural Policy Studies, Fakulti Ekonomi & Pengurusan, Universiti Pertanian Malaysia.

(Received 4 August, 1987)