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26 October 2009

Online at <https://mpra.ub.uni-muenchen.de/19568/>  
MPRA Paper No. 19568, posted 25 Dec 2009 10:43 UTC

## Supply and Demand Model for the Malaysian Cocoa Market<sup>1</sup>

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### Abstract

This paper investigates a system of supply, demand, and price equations for Malaysian cocoa using annual data over the period 1975-2008. Theoretically, in supply and demand models, the price variable is treated as endogenous. However, Hausman specification test result indicates that there is no simultaneity problem in the model. Thus, we estimate the system of equations utilizing the Seemingly Unrelated Regression (SUR) estimation technique which might be considered a more efficient estimator for supply and demand model of the Malaysian cocoa. The results suggest that the Malaysian cocoa production is mainly affected by the previous year production, price of cocoa beans at lag two as well as the harvested area. In the export demand equation, the real effective exchange rates is statistically significant determinant while the index of industrial production of advanced economies and the world price of cocoa are found to be insignificant. The results also suggest that both Malaysian industrial production index and domestic price of cocoa beans are key determinants of domestic demand for cocoa beans in Malaysia. Finally, the domestic price of cocoa beans is highly sensitive to its domestic consumption, lagged domestic price, and its world price.

*Key words: Supply and Demand, Malaysian Cocoa, SUR technique.*

### I INTRODUCTION

The development of the cocoa planting and downstream industries in Malaysia follows various national policies, *inter alia*, National Agricultural Policy (NAP) and Industrial Master Plan (IMP). To achieve the national economic development towards maximizing income through optimum utilization of resources, these national policies focus on crop diversification and value added agro-based industrialization (Azhar, 2007).

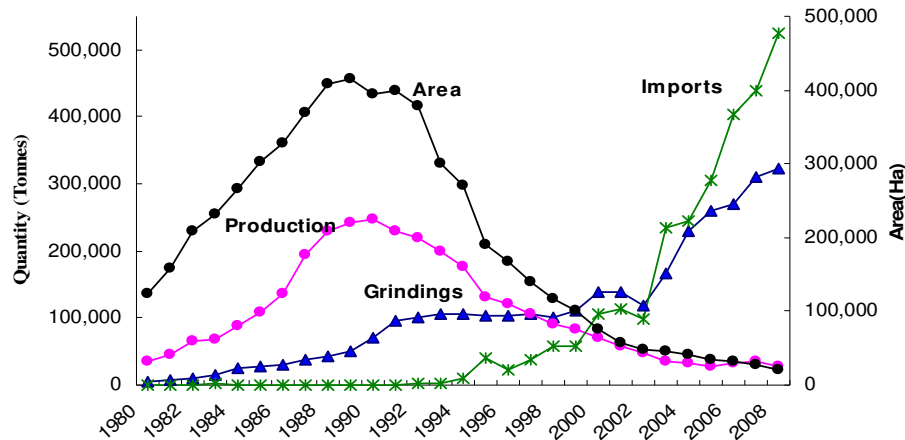
The Malaysian cocoa sector has undergone dramatic changes during the last few decades. As relatively low production costs and efficient marketing structure made cocoa production a profitable venture, Malaysia maintained an upward trend in the area and, consequently, the production of cocoa to reach their peaks of over 414 thousand hectares and 247 thousand tonnes in 1989 and 1990, respectively. However, since then declining

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<sup>1</sup> Paper presented at the Workshop on Agricultural Sector Modeling in Malaysia: Quantitative Models For Policy Analysis, organized by Institute of Agricultural and Food Policy Studies (IKDPM), Universiti Putra Malaysia, The Puteri Pacific, Johor Bahru, 26-28 October 2009

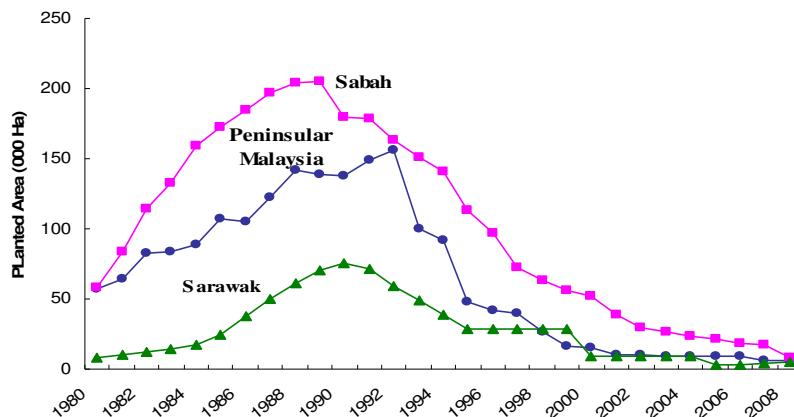
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world prices, higher labour costs, loss of production due to pests and diseases (which is the main reason of economic decay in most producing countries) along with a switch in the relative competitiveness of other crops (particularly oil palm) have transposed the previous trend, when production grew at a rapid rate. In 2008 only about 20 thousand hectares were under cocoa with a total production of about 28 thousand tonnes (Figure 1). Most of the planting areas are situated in Sabah, while most of the grindings and manufacturing are based in the Peninsula.



Source: Malaysian Cocoa Board (2009)

**Figure 1: Cocoa Area (ha) and Cocoa Production, Imports and Grindings (tonnes) in Malaysia, 1980-2008**



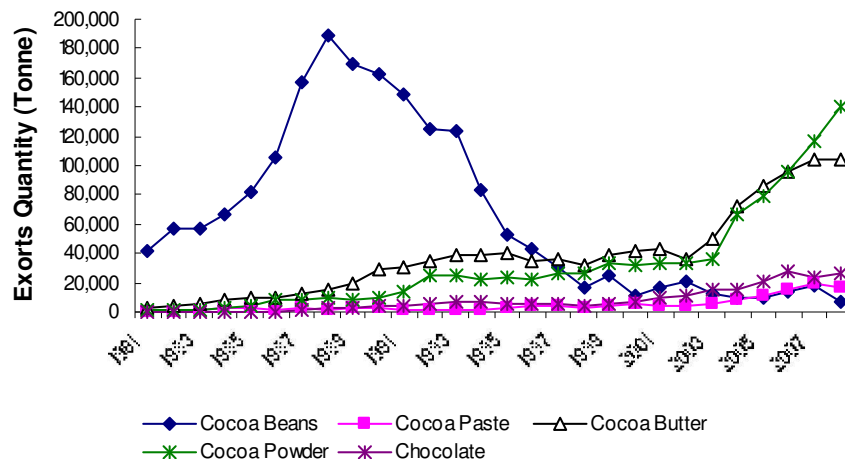
Source: Malaysian Cocoa Board (2009).

**Figure 2: Distribution of Cocoa Planted Area in Malaysia (ha), 1980-2008**

The Malaysian cocoa grindings and downstream industry has however, expanded dramatically. Currently, Malaysia, with a total grindings of 324 thousand tonnes in 2008 is occupying the fifth position among the largest cocoa grinders in the world and the

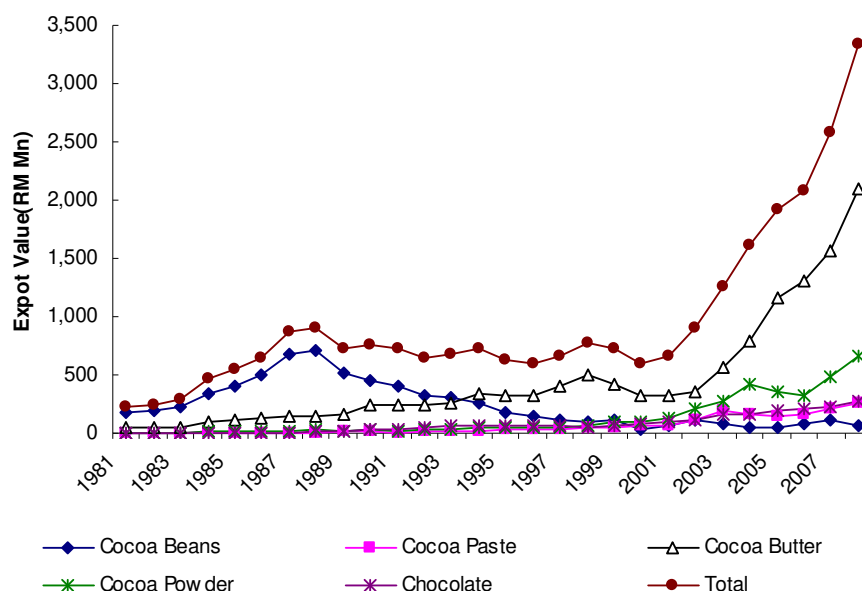
largest in the South East Asia. To fill the gap between the local production of cocoa beans and the rising demand by the grinding industry, Malaysia increased its imports of this commodity.

In 2008, Malaysia exported 8 thousand tonnes of cocoa beans, 18 thousand tonnes cocoa paste, 104 thousand tonnes of cocoa butter, 141 thousand tonnes of cocoa powder and 27 thousand tonnes of chocolate (Figure3). Cocoa butter was the highest contributor to the total export earnings of cocoa beans and its products in 2008 as it accounted for 63 per cent of them (Figure 4). This is attributable to the premium price received for it as a result of the special characteristic of the high melting point of the Malaysian cocoa butter, which is advantageous for chocolate products in warm countries. Malaysian cocoa industry plays an important role in the global market of cocoa products. In 2007 it accounted for 15% of the world exports of each of cocoa butter and cocoa powder and cake compared to 8% and 6% shares respectively in 1990. Its share in the global exports of cocoa paste increased from 1% in 1990 to 5% in 2007. However, it decreased its share in the global exports of cocoa beans from 9% in 1990 to 1% in 2007 to benefit from the value added resulting from manufacturing its downstream products (refer to Appendix). Currently, 70 per cent of the dried cocoa beans produced locally are consumed by local grinders and manufactures. Currently, there are 11 local grindings and more than 40 chocolate and cocoa products manufacturers.



Source: Malaysian Cocoa Board (2009)

**Figure 3: Export Quantities of Cocoa Bean and Cocoa Products of Malaysia, 1981-2008**



Source: Malaysian Cocoa Board (2009).

**Figure 4: Export Values of Cocoa Bean and Cocoa Products of Malaysia, 1981-2008**

Owing to the growing importance of cocoa to the Malaysian economy and the global cocoa industry, this study attempts to estimate the supply and demand model of the Malaysian cocoa to investigate the relationships between the different market variables. It makes three noteworthy contributions to the existing literature on the Malaysian cocoa industry. First, the econometric methodology employed in this study uses Seemingly Unrelated Regression (SUR) estimation technique, which has not been applied in any of the previous perennial crop studies. Secondly, it employs different model specification. Thirdly, this study uses a relatively more recent data than those used in previous studies on the Malaysian cocoa.

The remainder of the paper is organized as follows: Section II briefly reviews the literature on previous economic studies on cocoa and the methodologies used for examining its market models, Section III outlines the empirical methodology and Section IV reports and discusses the results while a summary and some conclusions are presented in Section V.

## II LITERATURE REVIEW

The basic structure of models proposed in the analysis of agricultural commodity markets are formed from the components of the market model approach developed by Labys (1973) which suggests that for a particular commodity, four equations supply, demand,

price and stock (commonly used as an identity to reveal the market clearing condition) are used simultaneously. To elucidate more complex structures of the market behavior, these basic market models can be tailored and reformulated. Incorporation of more variables enables the market model to be extended. In this section, relevant previous econometric studies of perennial crops including cocoa are highlighted with special reference to cocoa in order to understand the market model especially in the system where the market model works.

The relatively simple generalized theoretical model of Labys (1973) has widely been applied to most of the agricultural commodities. In Malaysia, it has been applied to analyze and model the palm oil (e.g. Shamsudin et al., 1988; Shamsudin and Arshad, 1993; Shamsudin et al., 1994; Lubis, 1994 and Talib and Darawi, 2002, Ernawati, 2004, Amna Awad, 2005), rubber (e.g. Yusoff, 1978 and 1988a) and cocoa market (Rosdi, 1991, Remali Yusoff et al., 1998 and Kox, 2000). The following paragraphs will briefly review some of the recent studies on the Malaysian cocoa industry.

A study by Rosdi (1991) investigated the main factors that determine the cocoa prices. Econometric cocoa models for the world and Malaysian markets were developed. The models were estimated using annual time series data. Each model consists of supply, demand and price equations, with stock as the identity. His results show that domestic cocoa prices are determined by prices prevailing in the world market. Domestic stock change is not significant. The world market itself, stock and consumption are the main factors that influence the behaviour of cocoa prices. World consumption and export demand are significantly influenced by the production index of the industrial nations and price of cocoa. On the supply side, cocoa production is determined by cocoa price lagged by the gestation period. This implies that investment decision on cocoa three to five years earlier is an important factor that determines cocoa supply.

Shamudin *et al.* (1993) constructed a model of the Malaysian cocoa market following the approach by Labys (1973). The model consists of production, demand and price equations in addition to stock as an identity. They conducted their study utilizing data over the period 1965-1987. The findings of their study indicate that the Malaysian cocoa price is dependent on the world cocoa price. The study revealed that the industrial index of the industrialized nations is the key determinant for the demand of cocoa and consequently, its price. Moreover, the price elasticity of supply with respect to cocoa has been found to be low (consistent with *a priori* expectations) and is inline with the previous studies of perennial tree crops.

Yusoff *et al.*, (1998) conducted a study to determine the factors affecting the supply and demand for the Malaysian cocoa beans using annual data over the period 1973-1992. His supply sub-model followed the work of Alias *et al.*, (1987) that diversified the supply into matured area and production equations. They also differentiated demand into domestic demand, specified as derived demand, and export demand. The results of their study suggest that cocoa hectareage is affected by the local prices of dried cocoa beans, the price of copra, the cost of labour, and interest rates. Production is found to be dependant on hectareage of matured cocoa, quantity of labour used, amount of fertilizer applied and the level of technology used. In addition, their results show that domestic demand for cocoa is dependant on local prices of dried coco beans and palm oil as well as price of local cocoa- based beverage (MILO) and the local demand of the previous year. It is also revealed that among the factors affecting the foreign demand for Malaysian cocoa are: the exchange rate of the Malaysian ringgit against the US dollar, level of world cocoa grinding and one year lagged foreign demand.

A study by Mohammad Haji Alias *et al.*, (2001) has investigated the impact of government rural development expenditure, a proxy for government policy, particularly, public investment on the supply response of tree major perennial export crops. Time series annual data for the period 1975-1997 have been used. The Engle-Granger two step procedures for co-integration analysis have been applied. The response of cocoa producers to government expenditure is elastic in the long run, while yield has remained fairly stable.

### III METHODOLOGY

#### 1. Model Specification

The basic market model which was proposed by Labys (1973) has been used to develop the framework in this study. The construction of the market model can be summarized into supply ( $Q_t$ ), demand ( $C_t$ ) and price ( $P_t$ ) models in addition to supply equal to demand ( $Q_t = C_t$ ) as market equilibrium condition, is as follows

$$Q_t = q(Q_{t-1}, P_{t-i}, Z_t, U_t) \quad (1)$$

$$C_t = d(D_{t-1}, P_t, P_t^s, A_t, T_t) \quad (2)$$

$$P_t = p(P_{t-1}, I_t) \quad (3)$$

$$Q_t - C_t \quad (4)$$

where;

$Q_t$  = commodity supply

$C_t$  = commodity demand

$P_t$  = commodity price

$P_{t-i}$  = prices with lag distribution

$I_t$  = inventory or stock

$Z_t$  = policy variables influencing supply

$P_t^s$  = prices of substitute commodities

$A_t$  = economic activity level or income

$T_t$  = technical factors

$i = 1, 2, 3, \dots$

According to Labys (1973) and Pollak (1984), it is assumed that in the system of equations, prices adjust to clear the market. The supply of the commodity depends on the lagged supply, lagged price and policy variables. Demand is dependent on lagged demand, own price, prices of one or more substitute commodities, level of economic activity and technical factors. Lagged price and changes in inventory can also be used to explain the price. Since the supply process normally uses the general class of distributed lag functions so the lagged price variables are included. The market model is closed using an identity which equates quantity supplied minus quantity demanded.

### ***i. Cocoa Beans Production***

The model specification used in estimating the supply response for Malaysian palm oil production is based on the model developed by Shamsudin et al., (1993). The supply equation is specified as a function of the lagged production, price of cocoa, price of cocoa at lag two, price of competitive crop (palm oil) lagged two years, and the harvested area<sup>3</sup>. So the supply equation is specified as follows

$$PRC_t = f (PRC_{t-1}, CP_{t-2}, POP_{t-2}, HA_t, U_{1t}) \quad (5)$$

where

$PRC_t$  = Malaysian production of cocoa at time t.

$PRC_{t-1}$  = Malaysian production of cocoa lagged one year .

$CP_{t-2}$  = Price of cocoa beans lagged two years.

$POP_{t-2}$  = Price of palm oil lagged two years.

$HA_t$  = Cocoa beans harvested area at time t.

$U_{1t}$  = Disturbance term.



## ***ii. Cocoa Beans Demand***

According to Yusoff et al., (1998) the demand for cocoa beans is a derived demand as it used as input for producing final cocoa products such as cocoa butter, cocoa powder and chocolates etc. When price determining factors change over time, firms in general do not respond immediately, but they rather, delay their responses to changes affecting the demand. Thus, they spread their responses over some period of time. The nature of such response would vary from commodity to another, the differentiating factor being the durability or perishability of the commodity of interest (Labys, 1973). Due to lagged or incomplete information and adjustment cost, the relaxation of the equilibrium hypothesis in the general function has usually been achieved by specifying a dynamic model within the framework of a general distributed model. The demand for cocoa beans does not often adjust immediately to the changes due to various institutional and technological rigidities. Therefore, lagged price variables were included, then, some of them were dropped from the demand equations during the general to specific exercise.

### ***a. Domestic Demand***

Domestic demand is assumed to depend on the domestic price of cocoa and domestic economy activity as follow:

$$DD_t = f(IPIM_t, CP_t, U_{2t}) \quad (6)$$

where

$DD_t$  = Domestic consumption at time  $t$

$IPIM_t$  = Malaysian industrial production index at time  $t$

$CP_t$  = Price of cocoa beans at time  $t$ .

$U_{2t}$  = disturbance term

### ***b. Export Demand***

Following Yusoff *et al.*, (1998) the specification of export demand of cocoa beans is similar to that of the domestic demand with slight differences in the variables *i.e.* instead of local price we used world price of cocoa beans and instead of the Malaysian Industrial Production we used that of the advanced economies. Incorporating a separate exchange rate variable in the foreign demand models was found to be very important (Schuh, 1974; Chambers and Just (1979). Thus, export demand is modelled as a function of index of industrial production of advanced countries (as advanced countries are major consumers of this commodity), real effective exchange rate, and world price of cocoa as follows:

$$DEX_t = f(IPIA_t, REER_t, WCP_t, U_{3t}) \quad (7)$$

where

$DEX_t$  = Export demand for cocoa beans.

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<sup>3</sup> It is worth mentioning that in supply equation, although the coefficient on government expenditure on agricultural sector was found to be positive in the preliminary running of the model, it is removed from the equation during the general to specific process because it was, statistically, insignificant and it affected the overall performance of the system.

$IPIA_t$ , = Industrial Production Index of advanced countries at time t.

$REER_t$ , = Real effective exchange rate at time t.

$WCP_t$  = world Price of cocoa beans at time t.

$U_{3t}$  = disturbance term

### iii. Price

Stockholding of coca is assumed in the market place for the international trading. The price of cocoa is determined by the supply and demand. The price in the market is a result of partial adjustment process. The price equation can be specified as price of domestic cocoa is regarded as a function of stock of cocoa, domestic consumption, lagged price of cocoa, and world price of cocoa.

$$PC_t = f(DD_t, WCP_t, SC_t, U_{3t}) \quad (8)$$

where

$CP_t$  = Price of cocoa beans at time t.

$CP_{t-1}$  = Price of cocoa beans at previous year.

$DD_t$  = Domestic consumption at time t

$WCP_t$  = World price of cocoa beans at time t

$SC_t$  = Stock of cocoa in period t,

$U_{3t}$  = disturbance term

## 2. Functional Form

For the appropriate specification the theory does not provide any specific suggestion on the best functional form and the most pertinent measures of variables involved in the analysis. An appropriate model was defined as one which generate unbiased (or at least consistent) and efficient elasticity estimates (Thursby and Thursby, 1984). In the current study the linear form has been rejected against the log-linear form. In log-linear form the equivalent specifications are<sup>4</sup>:

$$prc_t = \alpha_0 + \alpha_1 prc_{t-1} + \alpha_2 cp_{t-2} - \alpha_3 pop_{t-2} + \alpha_4 ha_t + \varepsilon_{1t}. \quad (9)$$

$$dex_t = \beta_0 + \beta_1 ipia_t + \beta_2 reer_t - \beta_3 wcp_t + \varepsilon_{2t}. \quad (10)$$

$$dd_t = \gamma_0 - \gamma_1 cp_t + \gamma_2 ipim_t + \varepsilon_{3t} \quad (11)$$

$$pc_t = \phi_0 + sc_{t-1} + \phi dd_{t-1} - \phi_3 wcp_t + \varepsilon_{4t} \quad (12)$$

<sup>4</sup>

The lower case denotes the natural log of the variables.

**Expected signs**

Following the above discussion the a priori expected signs of the regression coefficients are as follows:

$$\alpha_1 > 0, \alpha_2 > 0, \alpha_3 < 0, \alpha_4 > 0; \beta_1 > 0, \beta_2 > 0, \beta_3 > 0; \gamma_1 < 0, \gamma_2 > 0; \phi_1 < 0, \phi_2 > 0, \phi_3 < 0$$

Table 1 provides definitions and description of the variables whereas table 2 provides the descriptive statistics for them.

Before computing the descriptive statistics, all variables are converted into the natural logarithmic form. The mean values for all variables are positive. As kurtosis coefficients and Jarque-Bera test statistics indicate all variables are normally distributed. Production, index of industrial production, and domestic consumption have exhibited the negative skewness. This indicates that large negative changes are more common than large positive changes.

**Table 1: Definitions of the Variables Used in the Study**

Variables	Definitions
<b>Endogenous Variables</b>	
$prc_t$	Malaysian production of cocoa at time t in tonnes
$dex_t$	Malaysian cocoa export quantity at time t in tonnes
$dd_t$	Domestic consumption at time t in tonnes
$pct$	Price of cocoa beans at time t USD /tonne
<b>Exogenous Variables</b>	
$hat$	Harvested area in period t in Hectares
$aciip_t$	Industrial Production Index of advanced countries at time t (2005=100).
$reer_t$	Real effective exchange rates at time t RM/USD
$wcp_t$	World cocoa beans price at time t
$ipim$	Malaysian industrial production index at time t (2005=100)
$sc_t$	Stock of cocoa at time t

**Table 2: Descriptive Statistics**

Variable	Mean	Median	Max	Min	St.dev	Skew.	Kurt.	Jar.-Bera
$prc_t$	11.125	11.151	12.417	9.4727	0.8958	-0.1302	1.8635	1.9257 [0.382]
$pc_t$	7.3433	7.3012	8.1255	6.6307	0.3610	0.2986	2.6799	0.6504 [0.722]
$dec_t$	10.486	10.411	12.151	8.8268	1.0256	0.1540	1.7069	2.5032 [0.286]
$aciip_t$	4.3804	4.4024	4.6656	3.9757	0.1999	-0.2464	1.8599	2.1856 [0.335]
$reer_t$	4.8293	4.8144	5.1898	4.5525	0.1971	0.1536	1.8438	2.0273 [0.363]
$pop_t$	5.9838	6.0214	6.7603	5.3583	0.3169	0.1862	2.8917	0.2130 [0.899]
$sc_t$	10.126	10.028	12.813	7.8698	1.4206	0.2101	1.9807	1.7218 [0.423]
$dc_t$	10.684	11.487	12.687	7.3777	1.5781	-0.7436	2.3143	3.7993 [0.149]
$wpc_t$	7.4472	7.4067	8.2404	6.8067	0.3474	0.4177	2.6700	1.1432 [0.564]

Note: Figures in parentheses denote p-values

### Data Sources

Data on the world cocoa price, the price indices of Malaysia and advanced countries as well as the real effective exchange rate are obtained from the International Financial Statistics of the International Monetary Fund. FAOSTAT online database provided the data on quantities of palm oil imports by country. The data on cocoa production, area and grinding (as proxy for domestic demand) are available at the Malaysian Cocoa Board website.

### Estimation Method

In supply and demand model, the price variable  $pc_t$  is usually treated as endogenous where  $cov(pc_t, \varepsilon_{1t}) \neq 0$ , or  $cov(pc_t, \varepsilon_{3t}) \neq 0$ . Since price variable is augmented in both supply and demand equations, we bear risk of simultaneity. To test whether the simultaneity exists or not in the model, we conduct Hausman specification test. Test results indicate that there is no simultaneity problem in the model.

In addition, if the classical assumptions of least squares are satisfied, the parameters of system of equations can be estimated using Ordinary Least Squares (OLS). However, OLS does not take into account contemporaneous correlation among residuals of different equations in the

system. Thus, this study, utilizes the Zellner's Seemingly Unrelated Regression (SUR) technique. Moreover, as reported in Table 2, Jarque-Bera test statistics indicate that the structure of disturbance term in all equations is likely to satisfy normality condition.

Autocorrelation in the residuals may arise from many sources. In time series data it is common that the residuals at one point in time are correlated with the residuals of the adjacent observations. The effect of autocorrelation on OLS is the loss of precision in the parameter estimates. Moreover, existence if autocorrelation in the model will lead to biasness of estimates. Thus, the autocorrelation in the model should be detected and corrected. In this paper, we relied on Ljung-Box Q statistics to test for autocorrelation. This test statistics detects the problem of correlated errors in the individual equations in the system. Preliminary results indicate that the export and domestic demand equations really suffered from autocorrelation. Then generalized least squares method is utilized to correct for autocorrelation. In this method, the linear transformation of variables is carried out so that the model with transformed variables will satisfy the classical assumption of OLS  $\text{var}(\varepsilon) = I\sigma^2$ .

The generalized least squares allows arbitrary positive definite variance-covariance matrix of disturbances to be  $\text{var}(\varepsilon) = V\sigma^2$ . If  $V$  is positive definite matrix, one may find a nonsingular matrix  $T$  such that  $TT' = V$ . Thus, one can compute the inverse of  $T$  which is usually denoted as  $T^{-1}$ . Premultiplying the model by  $T^{-1}$ , the following can be obtained.

$$Y^* = X^* \beta + \varepsilon^*$$

Obviously,  $Y^* = T^{-1}Y$ ,  $X^* = T^{-1}X$ , and  $\varepsilon^* = T^{-1}\varepsilon$ . Using this transformation, variance-covariance of  $\varepsilon^*$  equals  $\text{var}(\varepsilon^*) = T^{-1}V(T^{-1})'\sigma^2 = I\sigma^2$

The OLS can be applied for the transformed variables as

$$\begin{aligned} \hat{\beta}_G &= (X^{*'}X^*)^{-1} X^{*'}Y^* = \left( X'(T^{-1})'T^{-1}X \right)^{-1} X'(T^{-1})'T^{-1}Y = \left( X'(TT')^{-1}X \right)^{-1} X'(TT')^{-1}Y = \\ &= \left( X'(V)^{-1}X \right)^{-1} X'(V)^{-1}Y \end{aligned}$$

Since our model employs the particular form of GLS we carry out following transformation to correct for autocorrelation in demand equations.

$$\begin{pmatrix} Y_1^* \\ Y_2^* \\ \vdots \\ Y_t^* \end{pmatrix} = \begin{pmatrix} \sqrt{1-\rho^2}Y_1 \\ Y_2 - \rho Y_1 \\ \vdots \\ Y_t - \rho Y_{t-1} \end{pmatrix} = \begin{pmatrix} \sqrt{1-\rho^2} \\ 1-\rho \\ \vdots \\ 1-\rho \end{pmatrix} \beta_0 + \begin{pmatrix} \sqrt{1-\rho^2}X_1 \\ X_2 - \rho X_1 \\ \vdots \\ X_t - \rho X_{t-1} \end{pmatrix} \beta_1 + \dots + \varepsilon^*$$

As mentioned earlier, the variance  $\text{var}(\varepsilon^*) = I\sigma^2$ .

In our system, we used above transformations in foreign and domestic demand equations. As reported in Table 3 the results of Q statistics show that there is a significant decrease of correlated error problem in foreign demand equation while autocorrelation is removed from the domestic demand equation. Once all transformations are made, then SUR is employed for the system to obtain the parameter estimates.

#### IV RESULTS

The econometric analysis of the data produced the results displayed in Table 3 below along with the diagnostic tests statistics. The supply equation appears to fit the data better according to the diagnostics and estimated parameters and it shows a high explanatory power. Furthermore, all the coefficients carry the correct signs and they are all statistically significant at 1% level except the price of palm oil at lag 2. The price of palm oil is found to be negative which indicates a negative relationship between palm oil price and cocoa production. This is a plausible result since an increase in the price of palm oil leads to an increase in its profitability which becomes the “pull factor” that attracts resources such as land, labour and capital into the sector in the 1980s and 1990s. In the case of cocoa industry both “push” and “pull” factors were at work. The “push” factor includes, higher cost of inputs, low level of technology and large scale incidence of cocoa pod diseases. These two factors explained for the rapid decline in the cocoa planted area and production starting 1989.

The area planted with cocoa turned out to be an important determinant in supply equation due to the direct association of cocoa production and harvested land. The price of cocoa beans is another factor affecting its supply lagged two years, which indicates that the farmers take decision about production two years ahead. The previous year production also emerged as a determinant factor for the current one. Mohammad Haji Alias (2001) in his paper has included government expenditure as one of the factors as supply determinants of palm oil, rubber and cocoa and found it to be significant. In the preliminary estimation of the cocoa supply response, this study found that the said variable showed positive

coefficient (as expected) but not statistically significant and hence was dropped from the equation. The plausible explanation to this is that the benefits development expenditure may have not reached the major production areas which are located in remote areas in Sabah and Sarawak where infrastructures and institutional supports are less developed and the majority of the producers are smallholders.

The diagnostic tests are presented in Table 3.  $Q(10)$  is the Ljung-Box- $Q$  statistics for autocorrelation at lag 10 for the residuals of supply, demand, and price equations respectively. JB is Jarque-Bera test statistics is computed to test for normality. Autoregressive Conditional Heteroskedasticity (ARCH) test statistics at lag 10 based on F-test to test for heteroskedasticity.

**Table 3:** Parameter Estimates for System of Equations Employing SUR technique and Residual Diagnostics

Supply Equation		Export Demand		Domestic Demand		Price Equation	
Variable	Coefficient	Variable	Coefficient	Variable	Coefficient	Variable	Coefficient
$c_1$	-2.1834*** (-3.2128)	$c_2$	0.1757 (0.0181)	$c_3$	1.6063*** (3.9417)	$c_4$	-1.3874*** (-3.8193)
$prc_{t-1}$	0.7386*** (7.2503)	$aciip_t$	0.8921 (0.7418)	$pc_t$	-0.5593*** (-2.7001)	$sc_t$	0.0129 (1.3643)
$pc_{t-2}$	0.3900*** (7.7344)	$reer_t$	1.8664* (1.7370)	$miip_t$	1.7104*** (5.8148)	$dc_t$	0.0188* (1.6825)
$pop_{t-2}$	-0.0731 (-1.1347)	$wpc_t$	-0.3735* (-1.1469)			$pc_{t-1}$	0.1665*** (3.9290)
$ha_t$	0.2444** (2.4995)					$wpc_t$	0.9626*** (19.645)
<b>Diagnostic Tests</b>							
Q(10)	7.4548 [0.682]		22.145 [0.014]		6.3652 [0.784]		7.8042 [0.648]
JB	1.5595 [0.458]		1.6364 [0.441]		1.4238 [0.491]		0.8015 [0.669]
ARCH(10)	0.5022 [0.856]		1.4710 [0.253]		0.4729 [0.877]		1.5496 [0.233]
R-squared	0.9861		0.7633		0.6592		0.9763

Notes ; Figures in parentheses are t statistics, figures in square brackets are  $p$  values; Asterisks \*, \*\*, \*\*\* denote 10%, 5% and 1% significance levels respectively.

We attempted to estimate the demand equation using different specifications and estimation techniques. The preliminary results indicate that demand equation is not robust. A further analysis of stochastic term revealed that the demand model suffers from autocorrelation problem. The demand specification was diagnosed for autocorrelation using the Ljung-Box  $Q$  test procedure. In addition, heteroscedasticity test is conducted using the ARCH test. The result of this test shows that disturbances are not heteroscedastic. Moreover, as Jarque-Bera test

statistics indicates that the estimated errors are distributed normally. In the export demand, the world economic activity parameter carries the expected positive sign and the magnitude is 0.8921 but it is insignificant. World income elasticity for cocoa demand from the model does not compare favourably with the results obtained by Shamsudin *et al.*, (1993) who found 1.7640 but it is still in the elastic range. The export demand for cocoa is also significantly related to real effective exchange rates. The estimated parameter is high (1.8664). Another important determinant of the export demand is the world price of cocoa which is found to be negative, statistically significant but not in the elastic range. This indicates that export demand for Malaysian cocoa is not so sensitive to world price of cocoa. This is due to the fact that Malaysia is not a significant exporter of cocoa beans in the world market.

As regards the domestic demand, it is modelled incorporating the price of cocoa and Malaysia's index of industrial production. The results indicate that domestic consumption is highly sensitive to both of them. Both determinants carry the *a priori* expected signs and are statistically significant. After the transformation of the variables the autocorrelation in the residuals is removed totally. Furthermore, ARCH test statistic shows that residuals are not heteroscedastic.

Previous studies on the demand for the agricultural primary commodities have shown that the price elasticities, both in the short and long run were generally low and inelastic. Similar results of the studies were obtained for cocoa by Bateman (1965), Behrman (1968), Melo (1973), Hwa (1981) Claessens (1984) Shamsudin *et al.*, (1993) and Yusoff (2001). These findings were consistent with most of the other studies on other primary commodities which were presented earlier such as on palm oil (Yusoff, 1988b and Shamsudin *et al.*, 1988), and on rubber (Yusoff, 1978 and Mohammad Haji Alias, 1988). Furthermore, the role of the economic activity level was found to be highly significant relative to the commodity demand in all the studies presented above.

In the price equation, all estimated parameters are statistically significant and carry the expected signs except the parameter for the stock of cocoa. Although the coefficient of the domestic consumption variable has the expected positive sign, it is statistically insignificant. The results also indicate that the domestic price of cocoa is determined by the lagged local price and the world price of cocoa. The coefficients on lagged price and world price of cocoa are found to be positive and statistically highly significant. A one percent increase in average world price of cocoa would increase the domestic price by about 0.9626 percent. However, the elasticity with respect to the one year lagged local price is very low which indicates that it is more elastic to the world price than to its previous year's level.



## V CONCLUSIONS

The main objective of this paper is to examine the market variables of the Malaysian cocoa. The SUR technique is employed to investigate the domestic supply, foreign demand, and domestic price responses to the main determinants. All the models are consistent with theory as all the variables carried the correct signs. The models are diagnosed for the appropriate specification. The results of the diagnostics test indicate that the model described in methodology section is the proper specification to examine the supply and demand response. Moreover, the models are satisfactory in terms of their explanatory powers ranging from quite high to very high. The findings indicate that the cocoa production is determined by its own and palm oil price lagged two years, planted area and the previous year production. The Malaysian cocoa beans exports are influenced by cocoa world price and the real effective exchange rate of the Malaysian ringgit. The domestic demand appears to be dependent on its own price and the economic activity of Malaysia. The previous year domestic price as well as the world price of cocoa emerged to be key factors influencing its current price. The price is also affected to less extent by the demand whereas stock level is found to be an insignificant factor. The estimated model appears to explain the cocoa market in terms of its major structural elements, supply, demand and price. However, the study does not address the development of the cocoa grinding industry which is experiencing a rapid growth in the last decade. Hence, to have a complete picture of the cocoa industry, further research is required to analyse the grinding industry in detail and its relation to the other cocoa sub-sectors as well the relevant manufacturing sectors.

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## Appendix

## Exports of Cocoa Beans and Cocoa Products by Major Exporters

Product	Country	1991		2000		2007	
		Quantity	%	Quantity	%	Quantity	%
Cocoa Beans	Brazil	118,127	6%	1,900	0%	718	0%
	Cameroon	104,448	6%	77,381	3%	161,961	6%
	Côte d'Ivoire	675,525	36%	1,113,476	44%	803,886	29%
	Ghana	248,970	13%	360,250	14%	506,358	18%
	Indonesia	104,472	6%	333,619	13%	379,829	14%
	Malaysia	162,618	9%	11,408	1%	17,821	1%
	Nigeria	147,915	8%	139,000	6%	174,900	6%
<b>World</b>	<b>1,896,400</b>	<b>100%</b>	<b>2,503,449</b>	<b>100%</b>	<b>2,746,970</b>	<b>100%</b>	
Cocoa Butter	Brazil	47,652	13%	30,399	6%	32,744	5%
	Cameroon	4,802	1%	3,283	1%	2,243	0%
	Côte d'Ivoire	34,828	9%	33,550	7%	57,685	8%
	Ghana	7,450	2%	16,733	3%	15,920	2%
	Indonesia	8,440	2%	32,072	6%	51,149	7%
	Malaysia	29,097	8%	41,490	8%	103,307	15%
	Nigeria	3,072	1%	22	0%	10,370	1%
<b>World</b>	<b>368,295</b>	<b>100%</b>	<b>495,815</b>	<b>100%</b>	<b>700,073</b>	<b>100%</b>	
Cocoa Paste	Brazil	33,077	21%	9,474	3%	12,258	3%
	Cameroon	6,966	4%	17,244	6%	13,134	3%
	Côte d'Ivoire	15,497	10%	91,060	32%	121,066	29%
	Ghana	6,350	4%	7,538	3%	26,044	6%
	Indonesia	38	0%	2,614	1%	2,055	0%
	Malaysia	2,296	1%	5,099	2%	19,479	5%
	Nigeria	135	0%	661	0%	880	0%
<b>World</b>	<b>158,882</b>	<b>100%</b>	<b>280,900</b>	<b>100%</b>	<b>418,903</b>	<b>100%</b>	
Cocoa Powder & Cake	Brazil	53,441	15%	21,171	4%	36,803	5%
	Cameroon	2,250	1%	3,189	1%	2,287	0%
	Côte d'Ivoire	32,683	10%	12,638	2%	38,659	5%
	Ghana	6,956	2%	19,600	3%	18,977	2%
	Indonesia	812	1%	25,137	4%	52,350	7%
	Malaysia	17,465	6%	45,852	8%	112,968	15%
	Nigeria	2,398	0%	5,138	1%	5,730	1%
<b>World</b>	<b>325,129</b>	<b>100%</b>	<b>590,627</b>	<b>100%</b>	<b>778,898</b>	<b>100%</b>	

Source: FAOSTAT online database (2009)