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How Do Biodiesel Blend Mandate (B5) Effect Malaysian Palm Oil Market Model?

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Abstract: Over the last ten years biofuels production has increased dramatically. The increment in production has been driven by governmental interventions. In the United States, strong financial incentives are guaranteed for biofuel manufacturers while in the European Union, biofuel consumption is mostly driven by blending mandates. In the case of Malaysia, the blend of palm oil based biodiesel into diesel in all government vehicles was implemented in February 2009 and it is expected to be implemented nationwide in the nearest time. This paper seeks to examine the effect of biodiesel blend mandate (B5) on the Malaysian palm oil market. A system of equations of eight structural equations and four identities is estimated by two-stage least squares method using annual data for the period 1976 - 2011. The results suggest that biodiesel blend mandate (B5) significantly affects domestic demand. Hence, our results support neutrality of palm oil commodity markets in Malaysia to direct effects of biodiesel blend mandate. Then, the elasticity of Malaysian palm oil domestic demand with respect to biodiesel blend mandate is obtained. Results suggest that biodiesel blend mandate has a positive effect on the Malaysian palm oil domestic demand. Thus, the implementation of blend mandate is important in explaining Malaysian palm oil domestic demand. This finding also could be important for marketing strategies such as differentiation of product from food base for fuel use. In terms of government policy, the blend mandate (B5) should be implemented by the Malaysian government if the objective is to boost domestic consumption.

Key words: Biodiesel blend mandate (B5) · Malaysian palm oil market · Simultaneous equations · Two stage least squares

INTRODUCTION

Over a few decades of development, the Malaysian palm oil industry has succeeded to be a powerful force in the global oils and fats economy. Investments in oil palm planting have been growing, because of its economic advantage, leading to expansion in output that surpassed the average global oils and fats growth. The National Economic Action Council (NEAC), in comparing the palm oil sector to the electrical and electronics (E&E) sector, has estimated that unless the E&E sector is dramatically upgraded, the palm oil sector could become a larger component than E&E in GDP contribution, rising in nominal terms to 12.2 percent of GDP by 2020. In terms of high income, the sector's share of real GDP can grow to 7.6 percent by 2020 if the value-added gains from efficiency and innovation can be realised. Palm oil exports could also grow by 7 percent per annum to RM84 billion by 2020 and probably more if new oil palm products and services can be successfully marketed. The sector employs 590,000 direct workers versus 316,956 in the E&E sector.

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As for sustainability, better R&D will help to improve productivity, better conservation of the environment and lower net carbon impact on operations has led to a sharp increase in biofuels production and related policy measures. The demand curve for biofuels was drawn through mandatory measures such as introducing legislation and subsidies. A number of countries have numerical targets for domestic consumption or production of biofuels. Brazil and United States (U.S.) succeeded in developing biofuel industries mainly because they have backed their industries with a variety of supportive policy measures especially for the use of ethanol. For instance, the U.S. is targeting 20 percent of ethanol to be blended with gasoline by 2030. The targets set by the European Union (EU) Biofuels Direction increased from two percent in 2005 to 5.75 percent by 2010 for biodiesel. By 2020, 10 percent of all conventional motor fuels in the EU will be replaced with biofuels. All these mandates were supported with massive subsidies and non-tariff protection by the U.S. and EU. The U.S. spends about USD 5.5-7.3 billion a year to support biofuel production, while EU subsidizes biofuel production to the tune of USD 4.6 billion [1].

The Association of South East Asian Nations (ASEAN) countries have also pushed the demand for biofuels through mandates and investment into the sector. The Indonesian government plans to replace 10 percent of its petroleum consumption with biofuel by 2020. Thailand, in an effort to support the domestic sugar and cassava producers and also to reduce the cost of oil imports has mandated two percent biodiesel to be blended with diesel since February 2008 and also an ambitious 10 percent ethanol mix in gasoline starting in 2007. For a similar reason, the same blend (two percent) of biodiesel has been used in Philippines to support coconut growers.

In Malaysia, biodiesel blending mandate was launched in 2011. The mandate, requires diesel to contain 5 percent of biodiesel (B5). The government, has allocated RM43.1 million (USD 14.3 million) to finance the development of in-line blending facilities at six petroleum depots in the region owned by Petronas, Shell, Esso, Chevron and Boustead Petroleum Marketing, through its Malaysian Palm Oil Board [2]. The implementation of the B5 blending policy is expected to go nationwide in the nearest time, giving oil companies plenty of time to install blending facilities.

Malaysia consumes 23,627.810 million tonnes of petroleum in 2012 [3]. The production of palm oil is 18,785,030 tonnes whereas the export figure stood at 17,575,486 in 2012 [4]. By adding 5 percent biodiesel to diesel at pumps will cut about 1,181.39 million tonnes of diesel. Malaysia is poised to benefit from prospective implementation of B5 given her position as second major producer of palm oil. What happens if 5 percent of biodiesel blended with diesel at pumps? This study, therefore seeks to contribute to our understanding of the effect of B5 on the Malaysian palm oil market model especially on supply, demand and price. Thus, this paper reports the findings of an empirical study using a structural simultaneous equations model on the effect of biodiesel blend mandate on the Malaysian palm oil market and to provide an updated tool for policy makers.

The remainder of the paper is organized as follows: In the Materials and methods section, briefly reviews the literature on previous studies on palm oil industry and the methodologies used for examining the market variables behavior. The following section is the results and discussion and some conclusions are presented in the last section

MATERIALS AND METHODS

Previous work of Malaysian palm oil market was done by [5-8]. There are also studies on factors affecting palm oil prices and forecasting palm oil prices using various techniques [9-11]. [5] incorporated export tax and exchange rate in his work. Later a study by [12] simulate the Malaysian palm oil market using the factors affecting palm oil in Malaysia. [11] expanded the earlier works on palm oil model by differentiating supply response of estate and smallholder sectors and diversify nature of export market. [13] have done a simulation of the impact of liberalization of crude palm oil imports from Indonesia. [8] carried out an economic analysis of the Malaysian palm oil market using annual data for the period 1970 and 1999 and identified the important factors that affect the market. [14] have analysed the supply response of the Malaysian palm oil market using [15] cointegration and error correction approach. There was a study on the impact of palm oil based biodiesel demand on palm oil price using time varying parameter by [16]. The most recent study by [17] analysed the link between biodiesel demand and Malaysian palm oil market by using econometric method using annual data for the period 1976-2008. This study included the role of stationarity and cointegration as a prerequisite test before proceeding to the simultaneous equation estimation procedure. Further, [18] have extended the study by examining the link between biodiesel demand, petroleum prices and palm oil market.

In terms of biofuel mandates impact studies, earlier studies examined and reviewed the impact of biofuel mandates on agricultural commodities. These studies were given by [19-22]. There are also other studies on the impact of mandate on other than agricultural commodities were done by [23] who study of the impact of ethanol subsidies and mandates on world food commodity prices, quantities and food consumers' surplus. [24] examined the effect of biofuel mandates under the RFS alone and biofuel mandates with volumetric tax credits. Meanwhile, [25] investigate the impact of biofuel mandates in the EU and the U.S. agricultural market and on the environment were assessed under three trade scenario assumptions using a global general equilibrium model.

To date, little research has specifically addressed biodiesel mandate effect in the Asian context especially in Malaysia. We will incorporate these factors into our analyses. Finally, we are unaware of any studies using more recent data in a simultaneous equation models to examine the blend mandate's effect on the agriculture market. This study utilised secondary data obtained from publications of the Department of Statistics of Malaysia, Malaysian Palm Oil Board (MPOB), Oil World and International Financial Statistics (IFS) of the International Monetary Fund (IMF) various editions. Annual data from 1976-2011 were used in this study.

Model Specification: The effect of B5 on Malaysian palm oil market is measured by a system of equations that consists of structural econometric model of eight behavioral equations and four identities. The behavioural equations describe the determination of Malaysian palm oil supply, domestic consumption, palm oil exports, palm oil import and palm oil domestic prices. From the world perspective; rest of the world excess supply, world excess demand and world palm oil price are included. This model is closed with an identity defining ending period stock level, Malaysian excess supply, world excess supply and world stock (Table 1).

Model Identification: Unit-Root Test: According to [26], [27] and [28], most of the time series variables are nonstationary and this situation is called as unit root. If the data contain unit root it is called nonsationary data and this will lead to spurious regression. Hence all the variables involved in the estimation have been tested for stationarity using Augmented Dickey Fuller (ADF) and Phillips Perron's test (PP).

Rank and Order Condition: The number of equations equal to the number of endogenous variables required for the completeness of the system. It is useful to check the order and rank conditions of a model. Based on the rules

Table 1: Model Listing

Supply	
[1]	$POQ_t = f_1 (CPOPNRP_t, CPOPNRP_{t-3}, GOVDE_{t-3}, IR_{t-3}, T, POQ_{t-1})$ Malaysian Crude Palm Oil Import
[2]	$CPOM_t = f_2 (POWP_t, PSB_t, GDP_t, STOCK_t, CPOM_{t-1})$ World Excess Demand (World Import)
[3]	$WEXCDD_t = f_3 (POWP_t, PSB_t, WGDP_t, WSTOCK_t, WEXCDD_{t-1})$ Domestic Consumption
[4]	$DCCPO_t = f_4 (CPOP_t, GDP_t, PSB_t, MPOP_t, BDDMAND_t, DCCPO_{t-1})$ Palm Oil Exports
[5]	$EXDD_t = f_5 (POWP_t, PSB_t, PRSOt, WGDP_t, ER_t, WPOPt, EXDD_{t-1})$ Rest of the World Excess Supply (Rest of the world Export)
[6]	$ROWEXCSS_t = f_6(POWP_t, ROWPOQ_t, ROWEXCSS_{t-1})$ CPO Domestic Prices
[7]	$CPOP_t = f_7 (STOCK_t, POWP_t, CPOP_{t-1})$ CPO World Prices
[8]	$POWP_t = f_8 (PSB_t, WGDP_t, WSTOCK_t, PCO_t, POWP_{t-1})$ Identities Malaysian Palm Oil Ending Stock
[9]	$STOCKPO_t = STOCKPO_{t-1} + POQ_t + CPOM_t - DCCPO_t - EXDD_t$ Malaysian Excess Supply
[10]	$MEXCSS_t = POQ_t - DCCPO_t$ World Excess Supply
[11]	$WEXCSS_t = MEXCSS + ROWEXCSS_t$ World Stock
[12]	$WSTOCK_t = STOCKPO_t + ROWSTOCK$

Note: Definition and classification of variables are given in Table 2.

Table 2: Definition and Classification of Variables

Definition of Variables			
1.	Endogenous Variables		
1.	POQ_t	=	Palm oil production (tonnes)
2.	$CPOM_t$	=	Palm oil import (tonnes)
3.	$WEXCDD_t$	=	World excess demand (tonnes)
4.	$DCCPO_t$	=	Domestic consumption of palm oil (tonnes)
5.	$EXDD_t$	=	Export demand of palm oil (tonnes)
6.	$ROWEXCSS_t$	=	Rest of the world excess supply (tonnes)
7.	$CPOP_t$	=	Real domestic price of CPO (RM/tonne)
8.	$POWP_t$	=	Real world price of CPO (USD/tonne)
9.	$STOCK_t$	=	Malaysian ending stock (tonnes)
10.	$MEXCSS_t$	=	Malaysian excess supply (tonnes)
11.	$WEXCSS_t$	=	World excess supply (tonnes)
12.	$WSTOCK_t$	=	World stock (tonnes)
2.	Exogenous Variables		
1.	$CPOPNRP_t$	=	Relative price of CPO and natural rubber
2.	$CPOPNRP_{t-3}$	=	Relative price of CPO and natural rubber lag three years
3.	$GOVDE_{t-3}$	=	Government agricultural and rural development expenditure lag 3 years (RM million)
4.	IR_{t-3}	=	Interest rate lag three years (%)
5.	T_t	=	Time trend
6.	PSB_t	=	World price of soybean oil (USD/tonne)
7.	GDP_t	=	Malaysia GDP (RM million)
8.	$WGDP_t$	=	World income (USD million)
9.	$WSTOCK_t$	=	World stock of palm oil (tonnes)
10.	$MPOP_t$	=	Malaysian population (million people)
11.	$PRSO_t$	=	Real price of rapeseed oil (USD/tonnel)
12.	$GDPBD_t$	=	Biodiesel importing countries GDP (USD billion)
13.	ER_t	=	Exchange rate (RM/USD)
14.	PCO_t	=	Price of crude oil (USD/barrel)
15.	$WPOP_t$	=	World population (million people)
16.	$ROWPOQ_t$	=	Rest of the world production (tonnes)
17.	BDDMANDt	=	Biodiesel blend mandate (B5) (tonnes)
18.	$ROWSTOCK_t$	=	Rest of the world stock of palm oil (tonnes)
3.	Predetermined Variables		
1.	POQ_{t-1}	=	Malaysian production of CPO lag one year (tonnes)
2.	$CPOM_{t-1}$	=	Palm oil import lag one year (tonnes)
3.	$WEXCDD_{t-1}$	=	World excess demand lag one year (tonnes)
4.	$DCCPO_{t-1}$	=	Domestic Consumption lag 1 year (tonnes)
5.	$EXDD_{t-1}$	=	Export demand of palm oil lag 1 year (tonnes)
6.	$ROWEXCSS_{t-1}$	=	Rest of the world excess supply lag 1 year (tonnes)
7.	$CPOP_{t-1}$	=	Domestic price of CPO lag one year (RM/tonne)
8.	$POWP_{t-1}$	=	World price of palm oil lag 1 year (USD/tonne)
9.	$STOCK_{t-1}$	=	Stock one period lag (tonnes)

for identification, the structural equations satisfy both the order and rank conditions. The basic rule of thumb is that, the entire model is identified but it is usual for model to pass the order condition but not the rank [29].

Cointegration: Once the order and rank conditions are fulfilled, then the cointegrating test will be carried out. Exogenous variables are generated by an integrated process. In the case of nonstationary exogenous variables, this will result to nonstationarity in endogenous variables too. Also endogenous variables are generated by autoregression linear or nonlinear function of lags of endogenous variables and levels of exogenous variables when they have cointegration relations in a simultaneous equation models. The endogenous variables are nonstationary if exogenous variables are nonstationary [30]. This study also showed that, the least square estimator for the long run reduced form is consistent in the 2SLS and 3SLS estimators. It is optimal to estimate the long run simultaneous equation by 2SLS if there are G (endogenous variables) cointegrating relations and integrated variables. The cointegration and nonstationarity do not call for new estimation method or statistical inference. The conventional 2SLS methods for estimating and testing simultaneous equation models are still valid for structural models [30]. According to [30-32] their models were improvement to the Cowles Commission's structural approach which incorporates the advances in time series regression analysis taking into account non-stationarity and cointegration. According to these studies it is shown that even if the variables are non-stationarity, the standard Simultaneous Equation Model (SEM) estimation methods like 2SLS testing procedures can be applied provided the variables are cointegrated.

RESULTS AND DISCUSSION

Results of Unit-Root Test: This section presents the empirical results of the analysis which begins with the summary of the unit root test of the variable used for the empirical study in Table 3. Thus, both the Augmented [33, 34] tests are employed. The results shows that some of the variables (LPOQ, LDCCPO, LEXD and LROWEXCSS1) expressed at level are stationary and the other rest of the variables are found to be non-stationary but when these variables are first differenced there is evidence that all the variables are stationary. Since the variables n the model follow a mixed order of I(0) and I(1) process the next step is to test if there is a long run relationship exist among the variables using bound test.

Results of Cointegration: The endogenous variables will also be integrated of order one if the exogenous variables are integrated of order one and the structural equations are essentially cointegrating relations [32], [35] and [36]. Presence of a long-term equilibrium relationship is tested using Bound test as there are mixed orders of I(0) and I(1). The fitted structural equation is treated as the desired cointegrating relation and the residuals are tested for stationarity according to Hsiao's recommendation. According to [37] there exist a long-run cointegration relationship if the coefficients between lag one variables are jointly fall above the upper bound critical value. However, since the sample size is relative small in this study these F-statistics were compared with [38]. Table 4 summarises the results of the bounds test across the 8 equations.

Results of 2SLS Estimation: Since the bound test also showed that exist long run relationship among the variables used. All the behavioural equations satisfied the order and condition for identification. The simultaneous equation framework was carried out to estimate the coefficients. The 2SLS estimates obtained from this study are quite satisfactory in terms of high R^2, significance of the coefficients of the variables and the correct signs (see Table 3). A modified 2SLS-Cochrane Orcutt procedure (see [26] and [39]) was subsequently used to estimate all equations because autocorrelation was found to be present. To detect heteroscedasticity, autocorrelation, non-normality other possible forms of model mis specification were conducted in the various test. Disturbance terms in all equations were homoscedastic. Finally, the relevant Durbin Watson statistics (DW) and h-statistics showed that there was no autocorrelation problem.

The results suggest that the production of crude palm oil in Malaysia was determined by the ratio of its price with rubber, time trend and lagged palm oil production. All of the estimated coefficients in the supply equation of palm oil have the expected signs. Only the time trend variable and lagged two years of production found to be significant. Eventhough the ratio of palm oil price with rubber found not to be significant but the sign shows the correct direction. This reflects the importance of this variable at the time the investment is made. Oil palm, rubber and cocoa are competitors in terms of land use in the Malaysian context. In this study, the relative price of palm oil with respect to the price of rubber was chosen as it is the main substitute crop. The increase in this relative price will increase the palm oil production due to higher price in palm oil. This finding is consistent with the finding in [40], [14] and [17] study on supply response of Malaysian palm oil producers and a study by [41] on Malaysian cocoa supply response.

The estimates obtained for the import demand are consistent with *a priori* expectations. The coefficients for time trend is significant at 10 percent level, while lagged import at 1 percent level. As expected, Malaysian imports of CPO was negatively related to the price of world palm oil and Malaysian palm oil stock but positively related to time trend and CPO imports lagged one year.

The empirical estimates of world excess demand (world import) suggests that the primary factors affecting changes in world imports are world income and lagged one year of world import. The world income was significant at 5 percent level and had the expected sign. The coefficient on lagged world import demand is significant at 1 percent level with the adjustment coefficient being approximately 0.1550 indicating a relatively slow adjustment to the equilibrium level.

Table 3: Unit -Root Tests Results for the Variables Used in the Analyses

	Augmented Dickey-Fuller (ADF)				Phillips-Perron (PP)				Conclusion
	Level		First		Level		First		
	Constant	Constant and Trend	Constant	Constant and Trend	Constant	Constant and Trend	Constant	Constant and Trend	I(0) orI(1)
LPOQ	-3.50**	-3.00	-2.43	-4.82***	-6.81***	-3.17	-8.20***	-10.56***	I (0)
LCPOPNRP3	-1.75	-1.87	-6.42***	-6.35***	-2.79*	-2.89	-10.22***	-9.9***	I (1)
LPOQt-1	-3.45**	-2.74	-2.28	-4.69***	-7.39***	-2.66	-7.88***	-10.16***	I (1)
LPOQt-2	-3.13**	-3.09	-2.70*	-4.66***	-5.89***	-3.39*	-8.28***	-10.43***	I (1)
LCPOM	-1.81	-1.79	-4.24***	-4.43***	-1.85	-1.77	-5.34***	-5.78***	I (1)
LPOWP	-1.69	-2.60	-3.37**	-7.13***	-2.02	-1.92	-5.66***	-10.09***	I (1)
LSTOCKPO	-0.25	-1.83	-5.39***	-5.23***	-2.83*	-7.31***	-9.32***	-14.71***	I(1)
LCPOM1	-1.79	-1.99	-2.00	-1.47	-1.81	-1.76	-5.3***	-5.71***	I (1)
WEXCDD	4.19	0.14	-0.75	-6.86***	4.88	0.35	-4.64***	-6.80***	I (1)
WGDP	1.88	-1.40	-4.56***	-1.36	3.02	-1.18	-4.50***	-5.69***	I (1)
WEXCDD1	4.28	1.06	-0.71	-6.93***	5.41	0.77	-4.57***	-6.83***	I (1)
LDCCPO	-3.08**	-4.09**	-4.83***	-4.07**	-6.41***	-13.49***	-4.93***	-5.68***	I (0)
CPOP	0.84	-0.85	-7.08***	-7.58***	-0.26	-2.01	-6.69***	-9.03***	I (1)
GDPM	2.67	-1.29	-4.89***	-6.06***	2.78	-1.26	-4.91***	-6.11***	1 (1)
BDDMAND	-0.76	-1.56	-5.81***	-5.76***	-0.76	-1.78	-5.82***	-5.77***	I (1)
LEXDD	-2.17	-5.41***	-10.82***	-11.56***	-2.21	-5.41***	-10.89***	-11.56***	I (0)
LPRSO	-0.25	-1.24	-5.77***	-6.04***	-1.09	-1.74	-5.49***	-8.49***	I (1)
LER	-1.26	-2.17	-6.20***	-6.13***	-1.23	-2.23	-6.23***	-6.17***	I (1)
LROWEXCSS	-0.23	-3.01	-9.04***	-6.08***	-0.28	-4.71***	-22.56***	-21.63***	I (1)
LROWPOQ	-0.07	-4.15	-6.29***	-6.19***	-0.26	-4.33***	-11.05***	-10.96***	I (1)
LROWEXCSS1	1.76	-3.77**	-8.43***	-8.38***	2.00	-3.81**	-14.28***	-18.69***	I (0)
LCPOP	0.24	-1.97	-8.02***	-8.31***	-1.12	-2.68	-7.00***	-10.21***	I (1)
LCPOP1	0.29	-1.86	-7.88***	-8.22***	-1.52	-2.83	-7.38****	-10.27***	I (1)
POWP	-1.01	-1.09	-3.26**	-6.88***	-1.15	-1.63	-5.35***	-7.03***	I (1)
PSB	0.47	-0.31	-6.05***	-6.56***	-0.35	-1.04	-5.57***	-8.23***	I (1)
WSTOCK	2.87	-0.88	-6.20***	-4.60***	5.93	-0.43	-6.20***	-8.05***	I (1)
POWP1	-1.01	-1.09	-3.26**	-6.88***	-1.15	-1.63	-5.35***	-7.03***	I (1)

Source: Compiled by authors from unit root test.

Note: *, **,*** represent significance at 10, 5 and 1 percent respectively.

Table 4: F-Statistics for Testing the Existence of Long-run Relationships

Variables	ρ	F-Statistic
F(LPOQ/ LCPOPNRP, LGOVDE, LIR, T)	3	3.5700[b]*
F(LCPOM/LPOWP, T, LSTOCKPO)	2	16.8200[b]***
F(WEXCDD/WGDP)	1	6.4898[b]***
F(LDCCPO/CPOP, GDPM, BDDMAND)	1	3.5137[b]*
F(LEXDD/LPOWP, T, LPSB, LER)	1	7.2904[a]**
F(LROWEXCSS/LPOWP, LROWPOQ)	1	4.6835[b]*
F(LCPOP/LSTOCKPO, LPOWP, T)	1	4.2300[b]*
F(POWP/PSB, WGDP, WSTOCK)	3	5.0424[b]*

a = Table critical values Case V: Unrestricted intercept and unrestricted trend (Narayan, 2005)

b= Table critical values Case III: Unrestricted intercept and no trend (Narayan, 2005)

Asterisks*, ** and *** denote 10%, 5% and 1% significance levels respectively.

Table 5: Estimated Structural Equations

Supply

$$LPOQ_t = 3.2919 + 0.0106LCPOPNRP_{t-3} + 0.0244T_t + 0.24831LPOQ_{t-1} + 0.3371LPOQ_{t-2}$$

(3.42)*** (0.23) (2.74)** (1.53) (2.23)**

R^2= 0.9900 F stat=694.74 h= -2.47

Malaysian Import

$$LCPOM_t = 12.2073 - 0.6643LPOWP_t + .1260T - 1.3873LSTOCKPO_t + 0.7593LCPOM_{t-1}$$

(1.59) (-0.74) (1.84)* (-1.55) (6.82)***

R^2 = 0.8723 F stat=47.81 h=2.25

World Excess Demand (World Import)

$$WEXCDD_t = -5263.67 + 240.1019WGDP_t + 0.8450WEXCDD_{t-1}$$

(-2.16)** (2.34)** (9.04)***

R^2= 0.9814 F stat= 789.81 h=-2.67

Domestic Consumption

$$LDCCPO_t = 7.5930 - 0.0002LCPOP_t + 7.1723LGDPM_t + 1.0771BDDMAND_t$$

(54.17)*** (-2.11)** (2.11)** (2.65)***

R^2 =0.9316 F stat= 131.73 DW= 2.380

Export Demand

$$LEXDD_t = 7.5820 - 0.8908LPOWP_t + 0.0325T + 0.7650LPSB_t + 1.1127LER_t$$

(3.62)*** (-1.48) (1.80)* (1.06) (1.52)

R^2 =0.6994 F stat= 16.29 DW=2.4170

Rest of the World Excess Supply (Rest of the world Export)

$$LROWEXCSS = -2.3088 - 0.0131LPOWP_t + 0.6596LROWPOQ_t + 0.6733LROWEXCSS_{t-1}$$

(-1.50) (-1.09) (2.26)** (5.11)***

R^2 =0.9435 F stat=161.28 h=-3.45

Domestic Price

$$LCPOP = 1.9084 - 0.0246LSTOCKPO_t + 0.7868LPOWP_t + 0.0258T + 0.0001LCPOP_{t-1}$$

(3.94)*** (-0.45) (13.43)*** (7.61)*** (0.0001)***

R^2 =0.9612 F stat=173.37 h= 3.86

World Price

$$POWP = -232.531 + 0.9166PSB_t + 10.5853WGDP_t - 0.0752WSTOCK_t + 0.1911POWP_{t-1}$$

(-1.76)* (13.03)*** (1.91)* (-2.59)** (2.21)**

R^2 =0.9411 F stat=111.92 h= 2.87

Identities

$$STOCKPO_t = STOCKPO_{t-1} + POQ_t + CPOM_t - DCCPO_t - EXDD_t$$

$$MEXCSS_t = POQ_t - DCCPO_t$$

$$WEXCSS_t = MEXCSS_t + ROWEXCSS_t$$

$$WSTOCK = STOCKPO_t + ROWSTOCK_t$$

Note: Number in parentheses are t-values.

*** Significant at 1 percent level

** Significant at 5 percent level

* Significant at 10 percent level

The results of the domestic demand indicate that the own price, Malaysian GDP and biodiesel mandate (B5) are important determinants of the demand for palm oil in the domestic market. An increase in the own price by 1 percent would decrease domestic utilization by 0.0002 percent. The major determinant of domestic demand is found to be the level of economic activity which is proxied by Malaysian GDP. The coefficient on biodiesel mandate is significant at 1 percent level indicating that implementation of mandate significantly affect the domestic consumption. It is estimated that an increase in 1 percent of B5 will increase the domestic consumption about 1.0771 percent.

The estimates obtained for export demand are consistent with a prior expectation. Only time trend variable found to be significant at 10 percent level. Eventhough other variables, own price, price of soyabean and exchange rate found not to be significant but they are consistent with a prior expectations findings by [42, 7, [43] that the export demand for agricultural demand is inelastic.

The 2SLS analysis indicates that the coefficients for the rest of the world production and lagged rest of the world excess supply were positive and significant at least at 5 percent level in explaining rest of the world excess supply. However, the palm oil world price was not significant in determining the rest of the world excess supply even though it had the expected sign. All the estimated coefficients in the domestic price equation have the expected signs. The price flexibilities with respect to stock and world price are -0.0246 and 0.7868, respectively. The coefficients on lagged prices indicate that the adjustment price to the equilibrium is extremely fast (0.9999). The results are consistent with the finding of [7] and [44] that stock disequilibrium is determines the changes in primary commodity prices and also the speed of adjustment is generally faster for agricultural commodities.

In the case of the equation for the palm oil world price, it was found that all the variables could explain the variation; price of soybean, world GDP, world stock and lagged dependent variable. All the variables are significant at least at 10 percent level. This confirms the belief that the palm oil and soybean are substitutes and they compete in terms of price variations. Thus, a 1 percent increase in the price of soybean would result a 0.9166 percent increase in the palm oil price.

Overall, the estimation results of the Malaysian palm oil market model were statistically acceptable. Some of the coefficients were found not to be significant but we retained them on a priori ground, *i.e.* we believe that the variables were relevant, but because of possible data and econometric problem, accurate estimates were not possible.

CONCLUSIONS

This study examines the supply, demand and price movements in the Malaysian palm oil industry over the years of 1976 to 2011, in an attempt to develop an econometric model for this industry by taking into consideration of implementation of biodiesel blend mandate (B5). Results suggest that biodiesel blend mandate has a positive effect on the Malaysian palm oil domestic demand. Thus, the implementation of biodiesel blend mandate (B5) is important in explaining Malaysian palm oil domestic demand. This finding also could be important for marketing strategies such as differentiation of product from food base for fuel use. In terms of government policy, the blend mandate (B5) should be implemented by the Malaysian government if the objective is to boost domestic consumption. However, it should be noted that biodiesel price highly depend on palm oil price and crude oil price. It is economically feasible to implement biodiesel blend mandate (B5) can only be answered by conducting an economic feasibility study of biodiesel.

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