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Malaysian Palm-Based Biodiesel Mandate: What is the Likely Impact on Palm Oil Refining Industry's Capacity?

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ABSTRACT

The rise in the world crude oil prices, coupled with heightened interest in the abatement of greenhouse gas emissions and concerns about energy security have motivated Malaysia to produce palm-based biodiesel and has started to export it since 2006. The policy mandate of B5 blend of palm-based biodiesel into diesel in all government vehicles was implemented in February 2009 and it is expected to be implemented nationwide in the future. It is also expected that the blend of B5 will be increased to B10 in future. The increased usage of crude palm oil (CPO) as a feedstock for biodiesel industry is expected to worsen the existing problem of excess refining capacity in the refining sub-sector of the Malaysian palm oil industry. The expansion of domestic production of CPO has been constrained by land and labour shortages. The import of CPO from Indonesia is expected to be reduced since refinery industries in Indonesia is expected to increase their capacity from 45 million tons per year by the end of 2014, up from 30.7 million (2013), and more than double the 21.3 million tons in 2012. Thus, this paper seeks to examine the possible impact of implementation of B10 on the Malaysian palm oil market especially on the capacity utilization. A structural econometric model consisting of nine structural equations and four identities was proposed in this study. The model has been estimated by two-stage least squares method using annual data for the period 1976-2013. The study indicates that counterfactual simulation of an increase from B5 to B10 predicts a positive increase (16.24 per cent) in palm oil domestic consumption for biodiesel usage, 4.78 per cent reduction in domestic consumption for the other than biodiesel usage, 0.38 per cent reduction in capacity utilization and a marginal (0.08 percent) increase in production. As palm oil has been identified as one of the core focus of the National Key Economic Area (NKEA) this resource-based industries simulation results would be suggesting Malaysia increase the collaboration efforts to set up more joint venture refining companies in Indonesia and Thailand.

Keywords: Biodiesel blend mandate, Excess refining capacity, Malaysian palm oil market, Simultaneous equations, Two stage least squares

ABSTRAK

Kenaikan harga minyak mentah dunia, ditambah dengan faedah yang memuncak dalam pengurangan pelepasan dan kebimbangan mengenai keselamatan tenaga gas rumah hijau telah mendorong Malaysia untuk menghasilkan biodiesel berasaskan sawit dan ia telah mula dieksport sejak 2006. Mandat dasar B5 campuran biodiesel berasaskan sawit ke dalam diesel dalam semua kenderaan kerajaan telah dilaksanakan pada bulan Februari 2009 dan ia dijangka dilaksanakan di seluruh negara pada masa akan datang. Ia juga dijangka bahawa campuran B5 akan meningkat kepada B10 pada masa akan datang. Peningkatan penggunaan minyak sawit mentah (MSM) sebagai bahan mentah bagi industri biodiesel dijangka memburukkan lagi masalah yang sedia ada iaitu kapasiti penapisan

yang berlebihan dalam sub-sektor penapisan bagi industri minyak sawit Malaysia. Pengembangan pengeluaran domestik minyak sawit mentah telah dikekang oleh kekurangan tanah dan tenaga kerja. Import minyak sawit mentah dari Indonesia dijangka berkurangan kerana industri penapisan di Indonesia dijangka meningkatkan keupayaan mereka daripada 45 juta tan setahun pada akhir tahun 2015, meningkat dari 30.7 juta (2014), dan lebih daripada dua kali ganda 21.3 juta pada tahun 2013. Oleh itu, kertas kerja ini bertujuan untuk mengkaji kesan yang mungkin dari pelaksanaan B10 di pasaran minyak sawit Malaysia terutamanya kepada kapasiti penggunaan. Model struktur ekonometrik yang terdiri daripada sembilan persamaan struktur dan empat identiti telah dicadangkan dalam kajian ini. Model ini telah dianggarkan oleh dua peringkat kaedah kuasa dua terkecil dengan menggunakan data tahunan bagi tempoh 1976-2013. Kajian ini menunjukkan bahawa simulasi counterfactual peningkatan daripada B5 kepada B10 meramalkan peningkatan yang positif (16.94 peratus) dalam penggunaan minyak kelapa domestik untuk kegunaan biodiesel, 4.79 peratus pengurangan dalam penggunaan domestik untuk selain daripada penggunaan biodiesel, 0.38 peratus pengurangan dalam penggunaan kapasiti dan marginal (0.02 peratus) peningkatan dalam pengeluaran. Minyak sawit telah dikenal pasti sebagai salah satu fokus teras Bidang Ekonomi Utama Negara (NKEA), maka hasil simulasi industri berasaskan sumber mencadangkan Malaysia meningkatkan usaha kerjasama untuk menubuhkan syarikat penapisan perkongsian di Indonesia dan Thailand.

Kata kunci: mandat campuran biodiesel, kapasiti penapisan yang berlebihan, pasaran minyak sawit Malaysia, persamaan serentak, kuasa dua terkecil dua peringkat

INTRODUCTION

Indonesia and Malaysia are the major producers of palm oil in the world. Both countries contribute almost 88 percent of the total world production in 2014 (Malaysian Oil Palm Statistics 2014). The largest producer of palm oil in the world is Indonesia with 33.5 million tons and this is followed by Malaysia with 20.3 million tons in 2014. Malaysia was the main exporter of palm oil since 1970-2006 while Indonesia was the second. However, this situation has changed when Indonesia took over Malaysia as main exporter in year 2009 (Malaysian Oil Palm Statistics 2013). Malaysia palm oil export on that particular year was RM36.795 million. This significant figure portrays palm oil as one the important source of Malaysia's export incomes.

Palm oil industry in Malaysia has grown to more diversified downstream products which have higher value-added from merely concentrated on simple cultivation and crude oil processing during early 1980s. As far as the potential of palm oil related industrial sector is concerned, Malaysian palm oil has been identified as one of the main raw materials for many high end products that have universal demand. Currently, it is a major source of sustainable and renewable raw material for the world's biodiesel industries. This demand is in line with the rise in the world crude oil prices, coupled with heightened interest in the abatement of greenhouse gas emissions and concerns about energy security. Malaysia produced palm-based biodiesel and has started to export it since 2006. The policy mandate of B5 blend of palm-based biodiesel into diesel in all government vehicles was implemented in February 2009 and it is expected to be implemented nationwide in the future. It is expected that the blend of B5 will be increased to B10 in future.

Capacity utilisation in the palm oil refining industry is defined as the ratio of actual output to capacity output. It measures the output gap that exists when actual output differs from capacity output (Rasiah and Shahrin, 2006). There has been a noticeable reduction in palm oil capacity utilization in the late 1980s till now. We can simplify that if capacity utilization is less than 1 it is considered that the country is facing excess capacity problem. Refining capacity in operation for year 2000 was 14.6 million tonnes of crude palm oil (CPO) with CPO production at only 10.8 million tonnes. The refining capacity in operation has increased to 26.1 million tonnes with CPO production of 19.6 million tonnes in year 2014. The increase is mainly due to the development of downstream processing to further expand the activities of the industries. The gap between the production and capacity output can be filled up either by producing more CPO locally or importing more of CPO. In terms of local production of CPO, increase in production is constrained by land and labor shortages. Another way to enhance the local supply of palm oil is through import liberalization.

Even though, the import of CPO has experienced upward and downward trend since 1980 to 2010, the trend since 2011 till 2014 clearly shows significant downward trend. This scenario contributes to worsen the existing problem of excess of refining capacity. Excess refining capacity problem needs to be solved. Indonesia, on the other hand, started to participate in refining activities in 1975 when the need to develop its own downstream activities arose. There has been dramatic changes

to the composition of Indonesia's palm oil exports, which are now dominated by production in downstream operations in the republic as well as the increase in domestic biofuel consumption (Star, 2015). The refinery industries in Indonesia are expected to increase their capacity from 45 million tons per year by the end of 2014, up from 30.7 million tons (2013), and more than double the 21.3 million tons in 2012. This will definitely affect Malaysian palm oil market especially the palm refining industries which are already experiencing excess refining capacity. The implementation of palm-based biodiesel mandate will further increase the usage of CPO as a feedstock for biodiesel industry. This will be an additional factor that will contribute to worsen the existing problem of excess refining capacity in the refining sub-sector of the Malaysian palm oil industry besides the reduction of import from Indonesia. Thus, this paper seeks to examine the possible impact of implementation of biodiesel mandate from B5 to B10 on the Malaysian palm oil market especially on the palm oil capacity utilization in Malaysia.

LITERATURE REVIEW

Previous work on the Malaysian palm oil market that is related to this study was done by Mad Nasir, Fatimah and Fauziah (1997). They investigated the effect of the imposition of export duty on palm oil export by the Malaysian government to stimulate the downstream processing of palm oil. Mohammad, Mohd Fauzi dan Ramli (1997) indicated that a sustained reduction of 100,000 tonnes in refining capacity led to a positive impact on domestic price, matured area, production of estate and smallholder sectors, while there is a negative impact on domestic consumption. The development of downstream processing was aimed at further expanding the activities of the industry especially the refining sub sector (Mohammad, Mohd Fauzi dan Ramli, 1999). These authors also analyzed the import liberalization effect of Indonesian CPO on Malaysian palm oil industry. The finding indicated that liberalization raises capacity utilisation and CPO price. Shri Dewi et al. (2011) examined the link between biodiesel demand and Malaysian palm oil market which indicated that biodiesel demand has significant effect on palm oil prices. This effect also has linkages to Malaysian palm oil production, domestic consumption and excess supply and to world palm oil stock, price, excess demand, import and excess supply. The most current study by Shri Dewi, Anizah and Mohammad (2014a & b) examined the impact of biodiesel blend mandate (B10) on the Malaysian palm oil industry. Even though there are few studies on capacity utilisation (Mohammad et al. 1997; Mohammad et al. 1999) and biodiesel mandate (Shri Dewi et al. 2011; Shri Dewi et al. 2014a & b) but this study did not consider the implication from the implementation of biodiesel mandate on Malaysian palm oil market especially towards capacity utilization in the refining sector.

Following the introduction, we will briefly explain the structural model of the Malaysian palm oil industry in the Methodology sub section. Data sources and definitions of variables and empirical results will follow. The direct and indirect effects of palm-based biodiesel mandate on palm refinery industry capacity utilization are analysed. The final section gives the policy recommendations.

METHODOLOGY

The impact of biodiesel blend mandate on Malaysian palm oil refining industries measured by a system of equations that consists of structural econometric model of nine behavioral equations and five identities. A further explanation of the model are given in Mohammad et al. (1999), Shri Dewi et al. (2007), Shri Dewi et al. (2011a), Shri Dewi et al. (2011c) and Shri Dewi et al. (2014 a & b). The behavioural equations describe the determination of Malaysian palm oil supply, domestic consumption which has been segregated to palm-based biodiesel purpose and other than biodiesel purpose, 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 (see Table 1).

It is useful to check the order and rank conditions of a model. Once the order and rank conditions are fulfilled, then the stationarity and cointegrating test will be carried out. All the variables in each of the equations are tested for stationarity and order of integration using Augmented Dickey-Fuller (1979), Phillips and Perron (1988) and Kwiatkowski, Phillips, Schmidt and Shin (1992) test. 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 (Hsiao, 1997). Since the long run equilibrium is observed in the real world, there

must be a cointegration when the time series are integrated together with the satisfaction in rank and order condition. As such, the Malaysian palm oil market model will be estimated using the procedures mentioned.

The direct effect of an increase from B5 to B10 on the Malaysian palm oil industry is through the domestic consumption of palm oil for biodiesel purpose (DCCPOBDD). We postulate a positive relationship between biodiesel blend mandate (BDDMAND) and DCCPOBDD. With an increase in the biodiesel blend mandate from B5 to B10, indirect effects on the Malaysian palm oil industry are through the market clearing equation (ending stock). The increase in domestic consumption for biodiesel purpose in turn decrease the Malaysian palm oil stock. A decrease in palm oil stock will lead to an increase in the palm oil prices which in turn leading to an increase in current CPO production. At the same time a decrease in Malaysian palm oil stock would also lead to a decrease in world ending stock. These changes resulted in an increase in the world CPO prices. Hence, import will reduce. In terms of capacity utilisation in palm oil refining industries expected to reduce. The price for CPO is determined in the world market and the inclusion of BDDMAND is to test the significance of increasing in the biodiesel blend mandate on Malaysian palm oil market model especially in on the refining capacity to capture the downstrem industries impact due to biodiesel mandate implimentation. Dynamic responses are modelled using partial adjustment mechanisms.

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 1976-2013 were used in this study.

RESULTS AND DISCUSSION

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 Pindyck and Rubinfeld, 1991 and Ramanathan, 1992) 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. All the estimated coefficients in the specified equations have the expected signs (see Table 3). Since the focus of this paper is on the counterfactual analysis; to gauge the increase of biodiesel mandate on the capacity utilization of palm oil refineries so the explanation of the 2SLS results will focus on the domestic demand equation for biodiesel purpose (DDCPOBDD). The equation was based on Marshallian demand function. The domestic demand for biodiesel purpose was empirically affected by the price of CPO, price of crude oil biodiesel blend mandate and time trend. Biodiesel mandate variable found to be highly significant at 1 percent level.

SIMULATION ON AN INCREASE IN THE BIODIESEL BLEND MANDATE FROM B5 TO B10

A counterfactual simulation of our model has been carried out to analyze the impact of an increase in the biodiesel blend mandate from B5 to B10 on the Malaysian palm oil domestic demand. To gauge the impact of increasing trend in Malaysian biodiesel blend mandate, a counterfactual of 10 percent blend of Malaysian biodiesel demand from year 2006 to 2013 was imposed on the model. The counterfactual simulation of the model was carried out. The simulated values of all the endogeneous variables were compared to the baseline solutions. The counterfactual results are given in Table 4.

The model is able to simulate the impact of increase from B5 to B10 in palm-based biodiesel blend mandate. The directions of response are in general, consistent with the predictions of the theory. The increase in biodiesel blend mandate leads to an increase in domestic consumption for biodiesel purpose by about 16.24 percent. The Malaysian palm oil stock (stock availability) would decrease by 734.3 percent. The domestic price is expected to increase about 25.45 percent. The production response was low with an increase of 0.08 percent. The relatively low response was because of low price elasticity of supply. A decrease in Malaysian stock would also lead to a decrease in the world stock.

This eventually would increase the palm oil world price by 27.44 percent. There is a decrease in capacity utilisation about 0.38 percent due to low increase in production and decrease in import.

CONCLUSIONS AND POLICY RECOMMENDATIONS

The econometric simulations suggest that the increase in the biodiesel mandate demand does bring positive economic impact on selected sub-sectors of the palm oil industry especially the producers because of the significant increase in the domestic price of palm oil. It cannot be denied that the results in the counterfactual simulation of an increase in the blend mandate predicts an increase in CPO domestic price (25.45 per cent), a decrease in CPO import about 6.62 per cent, a marginal increase in production (0.008 per cent) and a decrease (0.38 per cent) in the capacity utilisation of palm oil refineries.

The high price will be a boon to the industry participants, in particularly farmers who are smallholder palm oil producers. They will benefit from the high prices of palm oil. Since the smallholder sector which makes up 40 percent of oil palm planted areas in Malaysia, it is among crucial components in the country's palm oil industry. The efforts to improve productivity and income are in line with the goal of the Economic Transformation Programme to transform Malaysia into a high-income nation by 2020.

However, the increase in the biodiesel blend mandate indirectly decreased the CPO import. This will definitely reduce the supply of palm oil to be channeled for downstream industries especially on refineries. The existing excess capacity problem in the palm oil industry will be severely affected due to the increase in the biodiesel blend mandate rate. Indonesia, on the other hand, showed a dramatic change to the composition of Indonesia's palm oil exports, which are now dominated by production in downstream operations in the republic as well as the increase in domestic biofuel consumption. Since the refinery industries in Indonesia are expected to increase their capacity to nearly double so Malaysia does not have the choice to increase its import from Indonesia. Future expansion may be hindered because of land constraint and increasing cost of inputs such as labour, fertiliser and services.

Since palm oil has been identified as one **of** the core focus of the National Key Economic Area (NKEA) this resource-based industries simulation results would be suggesting Malaysia to increase the collaboration efforts to set up more joint venture refining companies in Indonesia and Thailand. Another way to increase local supply in Malaysia in to enhance its research and development (R&D) activities in palm oil related industries. To achieve this, the government should enhance the existing research institutes to generate better product innovation and process innovation. This is a crucial driver for achieving higher product values, hence may reduce the severity of excess capacity problem.

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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 for Biodiesel Purpose

[4] $DCCPOBDD_t = f_4 (CPOP_t, GDP_t, PSB_t, MPOP_t, PCO_t, BDDMAND_t, DCCPO_{t-1})$

Domestic Consumption for Nonbiodiesel Purpose

[5] $DCCPONBDD_t = f_4 (CPOP_t, GDP_t, PSB_t, MPOP_t, DCCPO_{t-1})$

Palm Oil Exports

[6] $EXDD_t = f_5 (POWP_t, PSB_t, PRSOt, WGDP_t, ER_t, WPOPt, EXDD_{t-1})$

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

[7] $ROWEXCSS_t = f_6(POWP_t, ROWPOQ_t, ROWEXCSS_{t-1})$

CPO Domestic Prices

[8] $CPOP_t = f_7 (STOCK_t, POWP_t, CPOP_{t-1})$

CPO World Prices

[9] $POWP_t = f_8 (PSB_t, WGDP_t, WSTOCK_t, POWP_{t-1})$

Identities

Malaysian Palm Oil Ending Stock

[10] $STOCKPO_t = STOCKPO_{t-1} + POQ_t + CPOM_t - DCCPOBDD_t - DCCPONBDD_t - EXDD_t$

Capacity Utilization

[11] $CU_t = (POQ_t + CPOM_t) / REF_t$

Malaysian Excess Supply

[12] $MEXCSS_t = POQ_t - DCCPOBDD_t - DCCPONBDD_t$

World Excess Supply

[13] $WEXCSS_t = MEXCSS + ROWEXCSS_t$

World Stock

[14] $WSTOCK_t = STOCKPO_t + ROWSTOCK$

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

Definition of Variables			
a.	**Endogenous Variables**		
1.	POQ_t	=	Palm oil production (tonnes)
2.	$CPOM_t$	=	Palm oil import (tonnes)
3.	$WEXCDD_t$	=	World excess demand (tonnes)
4.	$DCCPOBDD_t$	=	Domestic consumption of palm oil for biodiesel purpose (tonnes)

TABLE 2: Definition and Classification of Variables

5.	$DCCPONBDD_t$	=	Domestic consumption of palm oil for nonbiodiesel purpose (tonnes)
	Supply		
6.	$EXDD_t$	=	Export demand of palm oil (tonnes)
7.	$ROWEXCSS_t$	=	Rest of the world excess supply (tonnes)
8.	$CPOP_t$	=	Real domestic price of CPO (RM/tonne)
9.	$POWP_t$	=	Real world price of CPO (USD/tonne)
10.	$STOCK_t$	=	Malaysian ending stock (tonnes)
11.	$MEXCSS_t$	=	Malaysian excess supply (tonnes)
12.	$WEXCSS_t$	=	World excess supply (tonnes)
13.	$WSTOCK_t$	=	World stock (tonnes)
b.	**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)
c.	**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)

Malaysian Import

$$LPOQ_t = 2.7005 + 0.0262LCPOPNRP_{t-3} + 0.0182T_t + 0.2904LPOQ_{t-1} + 0.3765LPOQ_{t-2}$$
$$(3.08)*** \quad (0.45) \quad (2.32)** \quad (1.83) \quad (2.57)**$$
$$R^2 = 0.9904 \quad F\text{-stat} = 776.43 \quad n = 42$$

$$LCPOM_t = 12.7648 - 0.7511LPOWP_t + 0.11461 - 1.3672LSTOCKPO_t + 0.7696LCPOM_{t-1}$$

TABLE 3: Estimated Structural Equations

(1.76) (-0.88) (1.74)* (-1.58) (7.11)***
R^2 = 0.8719 F stat=51.07 h=2.25

World Excess Demand (World Import)

$WEXCDD_t = -4453.17 + 191.1357\ WGDP_t + 0.9254WEXCDD_{t-1}$
(-1.58) (1.68)* (9.84)***
R^2= 0.9784 F stat= 724.81 h=-2.67

Domestic Consumption for Biodiesel Purpose

$DCCPOBDD_t = 0.4714 - 0.0001CPOP_t + 0.0059PCO_t + 0.2285T_t + 0.2500BDDMAND_t$
(1.52) (-1.07) (1.55) (17.70)*** (3.75)***
R^2 =0.9723 F stat= 263.07 DW= 2.380

Domestic Consumption for nonBiodiesel Purpose

$DCCPONBDD_t = 746.6096 – 1.1303CPOP_t + 104672.3GDPM_t$
(3.51)*** (-4.68)*** (28.35)***
R^2 =0.9862 F stat= 1141.06 DW= 2.380

Export Demand

$LEXDD_t = 8.5009 – 0.3851LPOWP_t + 0.0660T + 0.2251LPSB_t + 0.0371LER_t$
(31.58)*** (-4.98)*** (30.06)*** (2.42)** (1.52)
R^2 =0.6994 F stat= 16.29 DW=2.4170

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

$LROWEXCSS = -2.1224 - 0.0268LPOWP_t + 0.6426LROWPOQ_t + 0.6768LROWEXCSS_{t-1}$
(-1.52) (-0.21) (2.30)*** (5.31)***
R^2 =0.9435 F stat=161.28 h=-3.45

Domestic Price

$CPOP = -221.894 – 582.786CU_t + 2.5164POWP_t + 37.4649T$
(-1.11) (-2.06)** (15.54)*** (11.55)***
R^2 =0.9595 F stat=244.98 h= 3.86

World Price

$POWP = -46.3292+0.7120PSB_t+2.3794WGDP_t - 0.0297WSTOCK_t + 0.1440POWP_{t-1}$
(-0.51) (12.84)*** (0.71) (-1.94)* (1.70)
R^2 =0.9462 F stat=131.80 h= 2.87

Identities

$STOCKPO_t = STOCKPO_{t-1} + POQ_t + CPOM_t – DCCPOBDD_t – DCCPONBDD_t - EXDD_t$
$MEXCSS_t = POQ_t - DCCPO_t$
$WEXCSS_t = MEXCSS_t + ROWEXCSS_t$
$WSTOCK = STOCKPO_t + ROWSTOCK_t$

Note: Number in parenthesses are t-values. *** Significant at 1 percent level ** Significant at 5 percent level * Significant at 10 percent level

TABLE 4: Simulation Average Value (1976 – 2013) for all the Endogenous Variables and Baseline Compared to Blend Mandate of B10

Variables	Baseline	Increase Due to increase in Biodiesel Blend Mandate	Percentage Change
Domestic Demand for Biodiesel Purpose	5.2723	6.1284	16.24
Domestic Demand for Nonbiodiesel Purpose	8991.2	8560.9	-4.78

Malaysian Palm Stock	1127.2	-7151.4	-734.3
CPO Domestic Price	1496	1876.7	25.45
Palm Oil Supply	9628.2	9635.7	0.08
World CPO Price	548.8	699.4	27.44
Palm Oil Import	250.4	233.8	-6.62
Capacity Utilisation	0.7718	0.7689	-0.38