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EFFECTS OF COOKING OIL SUBSIDY REMOVALS ON RELATED MARKETS IN MALAYSIA: A COMPARATIVE STATIC, MULTI-COMMODITY, MULTI STAGE PRODUCTION APPROACH

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Abstract

Malaysia is contemplating removal of most of her subsidy support measures including subsidies on cooking oil which is largely palm oil based. This paper aims to examine the effects of cooking oil subsidy removals on the competitiveness of the oil palm subsector and related markets. This is done by developing and applying a comparative static, multi-commodity, partial equilibrium model with multi-stages of production function for the Malaysian perennial crops subsector which explicitly links different stages of production, primary and intermediate input markets, trade, and policy linkages. Results partly suggest that export of cooking oil will increase by 0.2 per cent due to a 10 per cent cooking oil subsidy reduction, while domestic output of cooking oil may eventually see a net decline of 1.97 per cent. The results clearly point out that the effect of reducing cooking oil subsidies is relatively small at the upstream levels and therefore it only induces minute effects on factor markets. Consequently, the market for other agricultural crops is projected to change very marginally.

Keywords: *Multicomodity, comparative statics, partial equilibrium model, output supply-factor markets linkages, effects of cooking oil subsidy removals.*

Introduction

The government of Malaysia is considering removing most of her subsidy measures including the one on palm-based cooking oil or Refined Bleached Deodorized Palm Olein - RBD Palm Olein. In

2010, the cooking oil price was capped at RM1.7 per kg while the unsubsidized market price was RM2.7 per kg (Hanim, 2010). Hence, it is estimated that consumers of cooking oil are enjoying a price subsidy of about 37 per cent (ad valorem).

The subsidy was designed to benefit domestic households, particularly the low-income group and the rural population. However, there are concerns by the government and industry players that the subsidy has benefited certain non-target groups. The Malaysian Palm Oil Association (MPOA) reported that the Cooking Oil Subsidy Scheme (COSS) appears to benefit some neighbouring countries (MPOA Annual Report, 2008). There are claims that there have been rampant illegal trade activities, where cooking oil was bought in bulk by traders and exported to neighbouring countries. Consequently, non-target groups are able to obtain cooking oil at half the market price (Hanim, 2010). Further, those involved in the industrial and food-manufacturing sectors have been purchasing the subsidized cooking oil in large quantities while many did not pass the subsidy to consumers in the form of reduced food prices (Hanim, 2010). At the same time, the government is burdened with ever increasing cooking oil subsidy payments. As indicated in Table 1, from a mere RM26 million in 1995, subsidy payments have increased to a mammoth RM1.7 billion in 2010 following steady increases in crude palm oil (CPO) prices.

Table 1

Cooking Oil Price and Its Subsidy (1995–2011)

Year	Total Subsidy (RM)	Market Price (RM per tonne)
1995	26 Million	1,700
2009	1.3 Billion	2,700
2010	1.7 Billion	2,700

Source. Hanim Adnan (2010, 2011a, 2011b).

The Malaysian Palm Oil Association (MPOA), which has been supportive of cooking oil subsidy, has called on the government to review the COSS (MPOA Annual Report, 2008). The Government is reported to be considering reviewing the cooking oil subsidy following the call and other concerns. However, there has been no indication whether it will be a complete removal or some reduction in the levels of the subsidy.

The removal of cooking oil subsidies may have considerable impacts on domestic cooking oil outputs and related markets including biofuel and other non-edible products, which use the same CPO intermediate input as cooking oil. The policy may also have a significant impact on the demand for the primary output of the oil palm farm subsector, i.e., Fresh Fruit Bunches or CPO. Consequently this may result in changes in the production of other subsectors in the long run, as the competing agricultural subsectors in Malaysia are firmly linked through resource constraints especially land and labour resources.

Economic models that have been used to appraise Malaysia's agricultural policy issues have been mainly partial equilibrium and econometric-based. Such models have focussed mainly on a single commodity and ignored related markets, including factor markets. Most of the models are associated with the analyses of demand and supply of the major agricultural commodities, such as palm oil, rubber, rice, and cocoa. While such models have a distinct advantage in explaining and predicting demand and/or supply factors, they lack the capability to examine related markets simultaneously. General equilibrium models, on the other hand, are able to examine the repercussions in the entire economy due to a certain policy change; however, the results are oftenly minute and intractable, due to the emphasis on multi-sectoral aggregation.

This study examines the inter-subsectoral long run effects of reduction in palm-based cooking oil subsidies in Malaysia by formulating and employing a comparative static, multi-commodity, multi-stage production approach which explicitly links primary and intermediate inputs, output markets, trade and policy-price linkages.

Methodology

Figure 1 depicts the conceptual framework that is used to formulate the multi-commodity model for the Malaysian agricultural sector. In a multi-commodity framework, the Malaysian agricultural sector is represented by two competing subsectors. The first sector represents the oil palm sub-sector which is Malaysia's most important agricultural subsector. The other is an aggregate of all other subsectors that compete for the pre-existing resources including land, labour, agrochemicals, and other inputs. As noted in the figure, the primary outputs of the oil palm subsector and other subsectors are Fresh Fruit Bunches (FFBs), and other primary outputs (OPP), respectively. The primary output in the oil palm subsector (FFB) is destined to produce crude palm oil (CPO), while OPP is intended to produce Other Final

Products in aggregate (OFP). The first level intermediate output in the oil palm subsector (CPO) can be further processed to Processed Palm Oil (PPO), which itself is used to produce CPO-based food, CPO-based chemical, and biofuel products. Both the intermediate products including the CPO and the OPP and the final products including CPO-based food, CPO-based chemical, and biofuel and OFP are tradable in the world market place.

Since both outputs utilize the same input base, any policy shocks or exogenous changes affecting either subsector, will have repercussions in all related markets - primary inputs, primary and final outputs as well as trade.

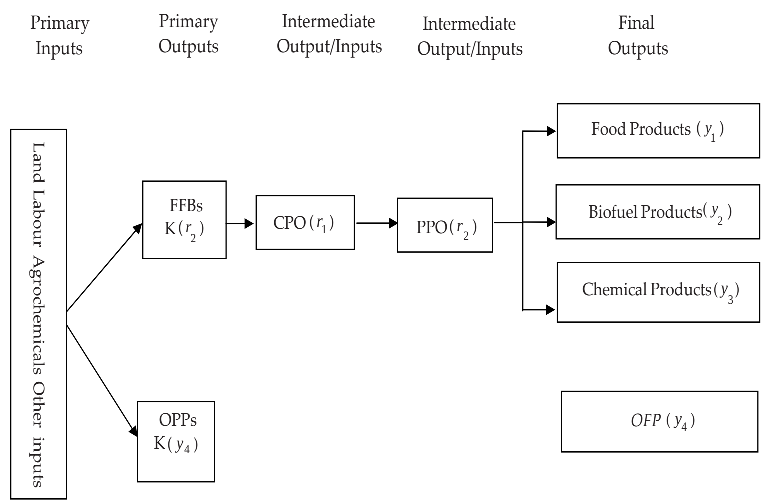

Figure 1. Schematic model of the partial equilibrium, multi-commodity model for the Malaysian agricultural sector.

Mathematical Framework

The basic framework for our two-commodity model stems from the theoretical construct of Hertel's (1989) partial equilibrium, comparative statics, and single commodity model for one country. Jamal (2003) extended the model to incorporate multiple countries. However, Jamal's model is still essentially single commodity-based. Interested readers are referred to the papers for the detailed construction of the single commodity model. Jamal and Yaghoob (2011) further innovated the model into a two-commodity framework. In this study, the model is expanded even further to incorporate different downstream activities and multiple stages of production for a single country.

Table 2 depicts the notations and descriptions of all the endogenous and exogenous variables in the Multi-commodity model (generic case of two commodities). Specifying a specific *n* commodity model from this generic construct is quite straight forward once the conceptual framework (as in Figure 1) is delineated. Table 2 presents the complete system of equations for a long run partial equilibrium for the generic model as derived from the Hertel's basic model (1989), and Jamal and Yaghoob (2011), and follows the general conceptual framework shown in Figure 1. The superscripts *M* and *E* respectively, represent the market and export demand for commodities while superscript *D* denotes the domestic demand for or supply of commodities. Scripts *D, S* and *P* refer to the demand, supply and price of inputs or outputs respectively, while scripts *t, e* and *l* refer to the output, export and input subsidies (taxes), correspondingly. Subscripts *i and j* signify primary factors of production including land, labour, agrochemicals, and an aggregate of other primary inputs (i, j = 1, 2, 3, 4). Subscripts y_f and y_q denote the production of final outputs, r_1 and r_2 denote the production of intermediate outputs in subsequent stages of production, while k (y_f) and k (r_1) refer to the primary output being used in the production of the two final outputs, y_f and r_1, respectively. Additionally, it is important to note that the *hat* notation denotes percentage changes in variables.

Table 2

Definitions of Variables for the Generic Multi-commodity Exogenous Policy Model

Endogenous Variables	
$D^M_{y_f}, D^M_{y_q}$	Market demand for final outputs (y_f, y_q), e.g., food product, chemical product, biofuel and OFP
$D^M_{r_2}, D^M_{r_2}$	Market demand for intermediate outputs/ inputs (r_1, r_2), e.g., CPO and PPO
$D_{k(y_f)}, D_{k(y_4)}$	Derived demand for primary outputs $k(r_1)$ and $k(y_4)$, e.g., FFB, OPP
$D^E_{y_f}$, $D^E_{y_q}$	Export demand for final outputs (y_f, y_q)
$D^E_{r_1}$, $D^E_{r_2}$	Export demand for intermediate outputs/ inputs (r_1, r_2)
$D^D_{y_f}, D^D_{y_q}$	Domestic demand for final outputs (y_f, y_q)
$D^D_{r_1}$, $D^D_{r_2}$	Domestic demand for intermediate outputs/ inputs (r_1, r_2)

(continued)

Endogenous Variables	
$D_{\mathrm{i,k(r_1)}}, D_{\mathrm{i,k(y}}$	Derived demand for i^{th} primary input being used in production of $k(\mathrm{r_1})$ and $\mathrm{k(y_4)}$
$S^D_{y_f}, S^D_{y_q}$	Domestic supply of final outputs $(\mathrm{y_f}, \mathrm{y_q})$
$S^D_{r_1}, S^D_{r_2}$	Domestic supply of intermediate outputs $(\mathrm{r_1}, \mathrm{r_2})$
$S_{i,k(r_1)}, S_{i,k(y_4}$	Supply of i^{th} primary input being used in production $k(\mathrm{r_1})$ and $\mathrm{k(y_4)}$
$P^S_{\mathrm{y_f}}, P^S_{\mathrm{y_q}}$	Supply price of final outputs $(\mathrm{y_f}, \mathrm{y_q})$
$P^S_{\mathrm{r_1}}, P^S_{\mathrm{r_2}}$	Supply price of intermediate outputs $(\mathrm{r_1}, \mathrm{r_2})$
$P^S_{k(r_1)}, P^S_{k(y_4)}$	Supply price of $k(\mathrm{r_1})$and k $(\mathrm{y_4})$
$P^M_{y_f}, P^M_{y_q}$	Market price of final outputs $(\mathrm{y_f}, \mathrm{y_q})$
$P^M_{r_1}, P^M_{r_2}$	Market price of intermediate outputs $(\mathrm{r_1}, \mathrm{r_2})$
$P^M_{k(\mathrm{r_1})}, P^M_{k(\mathrm{y_4})}$	Market price of primary outputs $k(\mathrm{r_1})$ and $\mathrm{k(y_4)}$
$P^E_{\mathrm{y_f}}, P^E_{\mathrm{y_q}}$	Export price of final outputs $(\mathrm{y_f}, \mathrm{y_q})$
$P^E_{\mathrm{r_1}}, P^E_{\mathrm{r_2}}$	Export price of intermediate outputs $(\mathrm{r_1}, \mathrm{r_2})$
Parameters	
$\varepsilon^D_{\mathrm{y_f,y_q}}, \varepsilon^D_{\mathrm{y_f,y_q}}$	Own price elasticity of domestic demand for final outputs $(\mathrm{y_f}$ and $\mathrm{y_q})$ when $(\mathrm{f = q})$/ Cross price elasticity of domestic demand for final outputs $(\mathrm{y_f}$ and $\mathrm{y_q})$ when $(\mathrm{f \neq q})$
$\varepsilon^E_{\mathrm{y_f,y_q}}, \varepsilon^E_{\mathrm{y_f,y_q}}$	Own price elasticity of export demand for final outputs $(\mathrm{y_f}$ and $\mathrm{y_q})$ when $(\mathrm{f = q})$ / Cross price elasticity of export demand for final outputs $(\mathrm{y_f}$ and $\mathrm{y_q})$ when $(\mathrm{f \neq q})$
$\varepsilon^E_{\mathrm{r_1}}, \varepsilon^E_{\mathrm{r_2}}$	Own price elasticity of export demand for intermediate outputs $(\mathrm{r_1}, \mathrm{r_2})$
$\varepsilon^D_{\mathrm{r_1,r_2,}}$	Own price elasticity of export demand for intermediate outputs $(\mathrm{r_1}, \mathrm{r_2})$
$\varepsilon^E_{\mathrm{r_{2,y_f}}}$	Derived demand elasticity of intermediate input $\mathrm{r_2}$ for use in production of final output $\mathrm{y_f}$
$\varepsilon^D_{k(\mathrm{r_1})}, \varepsilon^D_{k(\mathrm{y_4})}$	Derived demand elasticity of $k(\mathrm{r_1})$and $\mathrm{k(y_4)}$
$\sigma_{ij,k(\mathrm{r_1})}, \sigma_{ij,k(\mathrm{y}}$	Allen substitution elasticity between input i and j being used in production of $k(\mathrm{r_1})$and $\mathrm{k(y_4)}$.

(continued)

Parameters	
$\alpha^E_{y_f}, \alpha^E_{y_q}$	Share of export demand for y_f and y_q with respect to their market demand
$\alpha^E_{r_1}, \alpha^E_{r_2}$	Share of export demand for r_1 and r_2 with respect to their market demand
$\alpha^D_{y_f}, \alpha^D_{y_q}$	Share of domestic demand for y_f and $y_q$with respect to their market demand
$\alpha^D_{r_1}, \alpha^D_{r_2}$	Share of domestic demand for r_1 and r_2 with respect to their market demand
$C_{i,k(r_1)}, C_{i,k(y_4)}$	The cost share of i^{th} primary input with respect to total cost of producing $k(r_1)$ and $k(y_4)$
$\theta_{i,k(r_1)}, \theta_{i,k(y_4)}$	Share of i^{th} input employed in production of $k(r_1)$ and $k(y_4)$
$v_{i,k(r_1)k(y_4)}$, $v_{i,k(r_1)k(y_4)}$	Cross and own supply elasticity of i^{th} input in the production of $k(r_1)$ and $k(y_4)$
$\tau_{i[k(r_1),k(y_4)]}$	The constant elasticity of transformation of i^{th} input between $k(y)$ and $k(q)$

Exogenous Variables (Policy Shocks)	
e_{y_f}	Export subsidy(tax) on y^{th} final output (ad valorem)
e_{r_1}, e_{r_2}	Export subsidy(tax) on intermediate outputs (r_1, r_2) (ad valorem)
t_{y_f}	Outputs subsidy(tax) on y^{th}final output (ad valorem)
t_{r_1}, t_{r_2}	Outputs subsidy(tax) on intermediate outputs (r_1, r_2)(ad valorem)
$t_{k(r_1)}, t_{k(y_4))}$	Outputs subsidy(tax) on production of primary outputs, $k(r_1)$ and $k(y_4)$, (ad valorem)
$l_{i,k(r_1)}, l_{i,k(y_4)}$	Inputs subsidy(tax) on i^{th} input being used in production of $k(r_1)$ and $k(y_4)$
l_{r_1,r_2}	Inputs subsidy(tax) on r_1 input being used in production of r_2
l_{r_2,y_f}	Inputs subsidy(tax) on r_2 input being used in production of y_f
$l_{k(y)}, l_{k(y_4)}$	Input subsidy on use of $k(r_1)$ and $k(y_4)$ as an input in production of r_1 and y_4
$U^D_{y_f}, U^D_{y_q}$	Shift in domestic demand schedules for y_f and y_q
$U^E_{y_f}, U^E_{y_q}$	Shift in export demand schedules for y_f and y_q

Equation 1 in Table 3 represents the changes in demand for the four final outputs, $\widehat{D}^{M}_{y_f}$, i.e., food product, biofuel product, chemical product and OFP, which are functions of domestic and export demand. Note that following Jamal (1997), the two equations incorporated shifts in both the domestic and the export demand schedules. Equations 2 and 3 represent the changes in export demand for intermediate inputs, $\widehat{D}^{M}_{y_f}$, i.e., CPO and PPO. Equation 5 shows the derived demand for intermediate inputs which is being used in production of final outputs, $\widehat{D}^{D}_{r_2,y_f}$, i.e., derived demand for PPO being used in production of food, chemical and biofuel products. Equation 6 describes the aggregated derived demand for intermediate inputs, $\widehat{D}^{D}_{r_2,T}$, i.e., total domestic demand for PPO. Equation 7 denotes the total market demand for intermediate inputs, $\widehat{D}^{D}_{r_2,T}$, i.e., PPO. Equation 7 represents the derived demand for the first stage intermediate outputs, $\widehat{D}^{D}_{r_1}$, i.e., CPO while Equation 8 represents its total market demand. Equations 9 and 10 describe the derived demand for primary outputs k (r_1) and k (y_4) being used in production of (r_1) and (y_4) respectively, while Equations 11 and 12 refer to the derived demand for primary inputs, $\widehat{D}_{i,k(r_1)}$ and $\widehat{D}_{i,k(y_4)}$, which goes into the production of k (r_1) and k (y_4) . Equation 13 portrays the aggregated demand for primary inputs. Equations 14 through 19 depict the zero profit conditions for the production of primary, intermediate and final outputs. Equations 20 and 21 describe the responsiveness of land and non-land supply factors to a change in rents or return under the assumptions that $0 < v < \infty$ According to Jamal and Yaghoob (2011), Equations 22 through 25 indicate the procedure in which the elasticities of transformation are calibrated into input supply elasticities. Equations 26 through 39 incorporate exogenous sectoral *ad valorem* outputs, inputs, and trade policy variables into the model. Here, $\check{r} < 0$, $\acute{\imath} < 0$, $\grave{e} < 0$ reflect the percentage changes in outputs, inputs and export subsidies, respectively. The last seven equations describe the market-clearing conditions, where no surpluses or deficits in inventory of outputs and inputs were assumed.

Table 3

Multi-commodity (Generic) Partial Equilibrium Model of the Agricultural Sector

Market Demand Equations	
$\widehat{D}^{M}_{y_f}=\sum_{q=1}^{4} \alpha^{D}_{y_f}\varepsilon^{D}_{y_f,y_q} (\widehat{P}^{M}_{y_q} - \widehat{U}^{D}_{y_q})+\sum_{q=1}^{4} \alpha^{E}_{y_f}\varepsilon^{E}_{y_f,y_q} \left(\widehat{P}^{E}_{y_q} - \widehat{U}^{E}_{y_q}\right)$	*1*

(continued)

Export Demand for Intermediate Inputs	
$\widehat{D}^{E}_{\mathrm{r}_1} = \varepsilon^{\mathrm{E}}_{\mathrm{r}_1,\mathrm{r}_1}\widehat{P}^{E}_{\mathrm{r}_1}$	*2)*
$\widehat{D}^{E}_{\mathrm{r}_2} = \varepsilon^{\mathrm{E}}_{\mathrm{r}_2,\mathrm{r}_2}\widehat{P}^{E}_{\mathrm{r}_2}$	*3)*
Derived Demand under Locally Constant Return to Scale Condition	
$\widehat{D}^{D}_{\mathrm{r}_2,\mathrm{y_f}} = \varepsilon_{\mathrm{r}_2}\,\widehat{P}^{D}_{\mathrm{r}_2} + \widehat{\mathrm{S}}^{\mathrm{D}}_{\mathrm{y_f}}$	*4)*
$\widehat{D}^{D}_{\mathrm{r}_2,\mathrm{T}} = \sum_{f=1}^{4}\widehat{D}^{D}_{\mathrm{r}_2,\mathrm{y_f}}$	*5)*
$\widehat{D}^{M}_{\mathrm{r}_2} = \alpha^{\mathrm{D}}_{\mathrm{r}_2}\widehat{D}^{D}_{\mathrm{r}_2,T} + \alpha^{\mathrm{E}}_{\mathrm{r}_2}\widehat{D}^{E}_{\mathrm{r}_2}$	*6)*
$\widehat{D}^{D}_{\mathrm{r}_1} = \varepsilon_{\mathrm{r}_1}\,\widehat{P}^{D}_{\mathrm{r}_1} + \widehat{\mathrm{S}}^{\mathrm{D}}_{\mathrm{r}_2}$	*7)*
$\widehat{D}^{M}_{\mathrm{r}_1} = \alpha^{\mathrm{D}}_{\mathrm{r}_1}\widehat{D}^{D}_{\mathrm{r}_1} + \alpha^{\mathrm{E}}_{\mathrm{r}_1}\widehat{D}^{E}_{\mathrm{r}_1}$	*8)*
$\widehat{D}_{k(\mathrm{r}_1)} = \varepsilon_{k(\mathrm{r}_1)}\,\widehat{P}^{D}_{k(\mathrm{r}_1)} + \widehat{\mathrm{S}}^{\mathrm{D}}_{\mathrm{r}_1}$	*9)*
$\widehat{D}_{k(\mathrm{y}_4)} = \varepsilon_{k(\mathrm{y}_4)}\,\widehat{P}^{D}_{k(\mathrm{y}_4)} + \widehat{\mathrm{S}}^{\mathrm{D}}_{\mathrm{y}_4}$	*10)*
$\widehat{D}_{i,k(\mathrm{r}_1)} = \sum_{\mathrm{j}=1}^{\mathrm{n}}\mathrm{C}_{\mathrm{j},k(\mathrm{r}_1)}\sigma_{\mathrm{ij},k(\mathrm{r}_1)}\,\widehat{P}^{D}_{j,k(\mathrm{r}_1)} + \widehat{\mathrm{S}}^{\mathrm{D}}_{k(\mathrm{r}_1)}$	*11)*
$\widehat{D}_{i,k(\mathrm{y}_4)} = \sum_{\mathrm{j}=1}^{\mathrm{n}}\mathrm{C}_{\mathrm{j},k(\mathrm{y}_4)}\sigma_{\mathrm{ij},k(\mathrm{y}_4)}\,\widehat{P}^{D}_{j,k(\mathrm{y}_4)} + \widehat{\mathrm{S}}^{\mathrm{D}}_{k(\mathrm{y}_4)}$	*12)*
$\widehat{D}_{i,T} = \theta_{i,k(\mathrm{r}_1)}\,\widehat{D}_{i,k(\mathrm{r}_1)} + \theta_{i,k(\mathrm{y}_4)}\,\widehat{D}_{i,k(\mathrm{y}_4)}$	*13)*
Zero Profit Condition	
$\widehat{P}^{S}_{k(\mathrm{r}_1)} = \sum_{\mathrm{i}=1}^{\mathrm{n}}\mathrm{C}_{i,k(\mathrm{r}_1)}\widehat{P}^{D}_{i,k(\mathrm{r}_1)}$	*14)*
$\widehat{P}^{S}_{k(\mathrm{y}_4)} = \sum_{\mathrm{i}=1}^{\mathrm{n}}\mathrm{C}_{i,k(\mathrm{y}_4)}\widehat{P}^{D}_{i,k(\mathrm{y}_4)}$	*15)*
$\widehat{P}^{S}_{\mathrm{r}_1} = \mathrm{C}_{k(\mathrm{r}_1),\mathrm{r}_1}\widehat{P}^{D}_{k(\mathrm{r}_1)}$	*16)*
$\widehat{P}^{S}_{\mathrm{r}_2} = \mathrm{C}_{\mathrm{r}_1,\mathrm{r}_2}\widehat{P}^{D}_{\mathrm{r}_1}$	*17)*
$\widehat{P}^{S}_{\mathrm{y_f}} = \mathrm{C}_{\mathrm{r}_2,\mathrm{y_f}}\widehat{P}^{D}_{\mathrm{r}_2,\mathrm{y_f}}$	*18)*
$\widehat{P}^{S}_{\mathrm{y}_4} = \mathrm{C}_{k(\mathrm{y_f}),\mathrm{y}_4}\widehat{P}^{D}_{k(\mathrm{y_f})}$	*19)*

(continued)

Input Supply Equations for Two Subsector	
$\hat{S}_{i,k(y)} = v_{i,k(\mathrm{r}_1)k(\mathrm{r}_1)}\hat{\mathrm{p}}^{\mathrm{S}}_{\mathrm{i},k(\mathrm{r}_1)} + v_{i,k(\mathrm{r}_1)k(\mathrm{y}_4)}\hat{\mathrm{p}}^{\mathrm{S}}_{\mathrm{i},k(\mathrm{y}_4)}$	*20)*
$\hat{S}_{i,k(\mathrm{y}_4)} = v_{i,k(\mathrm{y}_4)k(\mathrm{y}_4)}\hat{\mathrm{p}}^{\mathrm{S}}_{\mathrm{i,k}(\mathrm{y}_4)} + v_{i,k(\mathrm{y}_4)k(\mathrm{r}_1)}\hat{\mathrm{p}}^{\mathrm{S}}_{\mathrm{i},k(\mathrm{r}_1)}$	*21)*
Modelling Input Transformation Function	
$v_{i,k(\mathrm{r}_1)k(\mathrm{r}_1)} = \theta_{i,k(\mathrm{r}_1)} * \tau_{i[k(\mathrm{r}_1),k(\mathrm{y}_4)]}$	*22)*
$v_{i,k(\mathrm{y}_4)k(\mathrm{y}_4)} = -\tau_{i[k(\mathrm{r}_1),k(\mathrm{y}_4)]}\ (1 - \theta_{i,k(\mathrm{y}_4)})$	*23)*
$v_{i,k(\mathrm{r}_1)k(\mathrm{y}_4)} = \theta_{i,k(\mathrm{y}_4)} * \tau_{i[k(y),k(\mathrm{y}_4)]}$	*24)*
$v_{i,k(\mathrm{r}_1)k(\mathrm{r}_1)} = -\tau_{i[k(\mathrm{r}_1),k(\mathrm{y}_4)]}\ (1 - \theta_{i,k(\mathrm{r}_1)})$	*25)*
Ad Valorem Equivalent Policies	
Output policies	
$\hat{P}^S_{\mathrm{y_f}} = \hat{P}^M_{\mathrm{y_f}} - \hat{t}_{\mathrm{y_f}}$	*26)*
$\hat{P}^S_{\mathrm{r}_2} = \hat{P}^M_{\mathrm{r}_2} - \hat{t}_{\mathrm{r}_2}$	*27)*
$\hat{P}^S_{\mathrm{r}_1} = \hat{P}^M_{\mathrm{r}_1} - \hat{t}_{\mathrm{r}_1}$	*28)*
$\hat{P}^S_{K(\mathrm{r}_1)} = \hat{P}^M_{K(\mathrm{r}_1)} - \hat{t}_{K(\mathrm{r}_1)}$	*29)*
$\hat{P}^S_{K(\mathrm{y}_4)} = \hat{P}^M_{K(\mathrm{y}_4)} - \hat{t}_{K(\mathrm{y}_4)}$	*30)*
Input Policies	
$\hat{P}^S_{\mathrm{r}_1} = \hat{P}^D_{\mathrm{r}_1} - \hat{l}_{\mathrm{r}_1}$	*31)*
$\hat{P}^S_{\mathrm{r}_2} = \hat{P}^D_{\mathrm{r}_2,\mathrm{y_f}} - \hat{l}_{\mathrm{r}_2,\mathrm{y_f}}$	*32)*
$\hat{P}^S_{i,K(\mathrm{r}_1)} = \hat{P}^D_{i,K(\mathrm{r}_1)} - \hat{l}_{i,K(\mathrm{r}_1)}$	*33)*
$\hat{P}^S_{i,K(\mathrm{y}_4)} = \hat{P}^D_{i,K(\mathrm{y}_4)} - \hat{l}_{i,K(\mathrm{y}_4)}$	*34)*
$\hat{P}^S_{K(\mathrm{r}_1)} = \hat{P}^D_{K(\mathrm{r}_1)} - \hat{l}_{K(\mathrm{r}_1)}$	*35)*
$\hat{P}^S_{K(\mathrm{y}_4)} = \hat{P}^D_{K(\mathrm{y}_4)} - \hat{l}_{K(\mathrm{y}_4)}$	*36)*
Export Policies	
$\hat{P}^E_{\mathrm{y_f}}=\hat{P}^M_{\mathrm{y_f}} - \hat{e}_{\mathrm{y_f}}$	*37)*
$\hat{P}^E_{\mathrm{r}_2}=\hat{P}^M_{\mathrm{r}_2} - \hat{e}_{\mathrm{r}_2}$	*38)*
$\hat{P}^E_{\mathrm{r}_1}=\hat{P}^M_{\mathrm{r}_1} - \hat{e}_{\mathrm{r}_1}$	*39)*

(continued)

Factor Market Clearing Conditions	
$\widehat{D}_{i,k(\mathrm{r}_2)} = \hat{S}_{i,k(\mathrm{r}_2)}$	40)
$\widehat{D}_{i,k(\mathrm{y}_4)} = \hat{S}_{i,k(\mathrm{y}_4)}$	41)
$\widehat{D}_{k(\mathrm{r}_2)} = \hat{S}_{k(\mathrm{r}_2)}$	42)
$\widehat{D}_{k(\mathrm{y}_4)} = \hat{S}_{k(\mathrm{y}_4)}$	43)
$\widehat{D}_{\mathrm{r}_1} = \hat{S}_{\mathrm{r}_1}$	44)
$\widehat{D}_{\mathrm{r}_2} = \hat{S}_{\mathrm{r}_2}$	45)
Commodity Market Clearing Conditions	
$\widehat{D}^{M}_{\mathrm{y_f}} = \hat{S}^{D}_{\mathrm{y_f}}$	46)

Similar to Jamal and Yaghoob (2011), a notable difference of this model, as compared to Hertel's basic model (Hertel, 1989), is the need for the explicit incorporation of Input Transformation Function (Equations 22-25). These equations are especially formulated to capture the heterogeneity of land inputs. Land inputs are heterogeneous in the sense that they have their own biological characteristics which are crop specific. Agricultural land under the cultivation of perennial crops, in this case the oil palm subsector, is somewhat different from that of other crops in aggregate. In order to capture the varying rigidity of land supply across subsectors, a methodology which is able to capture such characteristics of the land is incorporated into the model. The standard version of Global Trade Analysis Project (GTAP) of Hertel (1997) addresses this need by determining the supply of land across different uses through a Constant Elasticity of Transformation (CET) supply function. In the standard GTAP model, the only type of land explicitly modelled is agricultural land, and it is distributed across uses with a one-level constant CET function. Therefore, to capture the rigidity of primary inputs among subsectors, inputs allocation is controlled through a CET function which determines the degree of inputs supply responsiveness to relative price changes between the subsectors. Another notable difference relates to the explicit incorporation of competition of final outputs for intermediate inputs (Equation 5). This equation is especially formulated to capture the competition of food, biofuel and chemical products for the PPO intermediate inputs as these final products use PPO intermediate inputs in common.

Baseline Coefficients of the Endogenous Variables in the Model

Before any simulation can be performed on the model, it is imperative that the baseline parameters or coefficients for the endogenous variables are obtained. This includes the Allen elasticities of substitution between inputs for the various primary outputs, factor cost shares, and demand and supply elasticity values. It is important to be mentioned here that due to the unavailability of reliable econometric or empirical estimates, most of these baseline coefficients for the endogenous variables are determined based on various guided assumptions. Such coefficients and parameters are extremely crucial as the quality of simulation results would depend entirely on the representativeness of the said values. Nevertheless, provided that a meaningful sign is accorded to the substitution or complementary possibilities, appraisals of the direction and relative magnitude of impacts which is the focus of our analysis would still be meaningful and useful. More indicative insights and implications of the results shall be derived by conducting sensitivity analyses to examine the effects of varying assumptions of the baseline coefficients of the endogenous variables in the model. Tables 4 - 7 present all the required baseline coefficients and parameters, including data sources.

Table 4

Allen Elasticities of Substitution between Primary Inputs in Oil Palm Plantation

	Land	Labor	Agrochemicals	Capital
Land	*–0.3*	0.078	–0.042	0.645
Labour	*0.078*	–0.79	0.492	0.895
Agrochemicals	–0.042	0.492	–1.007	0.378
Capital	*0.645*	0.895	0.378	–4.147
Factor cost share	*0.36*	0.31	0.19	0.14

Source. Mahendra Rhomous (2006).

Table 5

Allen Elasticities of Substitution between Primary Inputs in Other Crops in Aggregate

	Land	Labor	Capital	Agrochemicals
Land	–4.2	0.3	0.1	2.7
Labour	0.3	–7.35	0.4	1.3

(continued)

	Land	Labor	Capital	Agrochemicals
Capital	0.1	0.4	–2.27	0.6
Agrochemicals	2.7	1.3	0.6	–1.322
Factor cost share *	0.3	0.1	0.15	0.45

**Crop shares Parameter values are used in the Austrian bread grains model and OECD PEM model (OECD 2003; Salhofer 2000).*
***Cross own price elasticities are taken from OECD model (OECD 2003; Salhofer 2000). Consequently, own price elasticities are calibrated and the Allen Elasticities of Substitution are calculated based on Binswanger (1974).*

Table 6

Table Distribution Share of Primary Inputs between Oil Palm Plantation and Plantation of Other Crops in Aggregate

Primary Inputs	Oil Palm	Other Crops in Aggregate	Source
Land use share	0.758	0.242	Statistics on Commodities, 2009
Labour use share	0.8878	0.1122	Economic Census, 2006
Agrochemicals	0.841	0.159	Mohammad Ali Sabri (2009)
Capital	0.83	0.17	Economic Census, 2006

Table 7

Sources of Baseline Parameters

Parameter description	Value	Sources
CPO export elasticity	–0.39 *	Shri Dewi A/P Applanaidu et al.(2011) & Basri Abdul Talib & Zaimah Darawi (2002)
CPO domestic demand elasticity	–0.43	FAPRI elasticities database
CPO export demand share	0.122	Statistics of Commodities, 2009
CPO domestic demand share	0.878	Statistics of Commodities, 2009
OFP export demand share	0.133	Agricultural Statistics Handbook, 2008
OFP domestic demand share	0.867	Agricultural Statistics Handbook, 2008
OPP own export and demand price elasticities	–0.19**	GTAP Database 2006

(continued)

Parameter description	Value	Sources
OPP export demand elasticity	–0.19	GTAP Database 2006
OPP domestic demand elasticity	–0.19	GTAP Database 2006
Elasticity of transformation for land inputs	0.6	OECD PEM model 2003
Elasticity of transformation for non-land inputs	1	OECD PEM model 2003& Hertel (1997)
Food products own export and demand price elasticities	–0.38**	FAPRI elasticities database
Biofuel own export and demand price elasticities	–0.1**	FAPRI elasticities database
Oleo-chemicals own export and demand price elasticities	–0.38**	Beckman and Hertel (2008)***
Share of food product in domestic use of CPO	0.8	Salmiah (2000), and Chalmers and Walden (2009)
Share of Oleo chemical product in domestic use of CPO	0.15	Salmiah (2000), and Chalmers and Walden (2009)
Share of biofuel product in domestic use of CPO	0.05	Salmiah (2000), and Chalmers and Walden (2009)
Elasticity of domestic demand for PPO product for use in food	–0. 43	Food and Agricultural Policy Research Institute (FAPRI), elasticities database http://www.fapri.iastate.edu/
Elasticity of domestic demand for PPO product for use in chemical	–0.43	Food and Agricultural Policy Research Institute (FAPRI), elasticities database http://www.fapri.iastate.edu/
Elasticity of domestic demand for PPO product for use in biofuel	–0. 13	Food and Agricultural Policy Research Institute (FAPRI), elasticities database http://www.fapri.iastate.edu/
Elasticity of export demand for PPO product	–0.457***	Basri Abdul Talib & Zaimah Darawi (2002)
CPO-based food domestic share	0.576	MPOB(2008a,2008b)
CPO-based chemical domestic share	0.271	MPOB (2008a)

(continued)

Parameter description	Value	Sources
Domestic demand share for biofuel	0.268	MPOB (2008a)
PPO export share	0.52	MPOB(2008a,2008b)
PPO domestic share	0.48	MPOB(2008a,2008b)

**The value is simple average of -0.3236 (Shri Dewi A/P Applanaidu et al., 2011) and – 0.457 (Basri Abdul Talib & Zaimah Darawi, 2002).*
*** The aggregated elasticity is assumed to be normally distributed between foreign and domestic markets.*
**** The value is the export price elasticity of palm oil products in aggregate.*

Solving the Model

Mathematically, Equations 1 - 46, form a linear system that can be solved given the non-singularity of coefficients matrix condition. The necessary and sufficient condition for non-singularity of the matrix is that the matrix shall satisfy the squareness and the linear independence equations. A convenient way of solving a linear equation system is to use the well-known Cramer's rule. The system of equations in the model can be written in a matrix form, so that the general system of algebraic equations can be represented compactly as follows:

$$AX = C$$

Here A is the Jacobean matrix (coefficient of the endogenous variables of the model), X represents the matrix of the endogenous variables (prices and quantities) while the right-hand side matrix denotes the exogenous variables (Policy Shocks). Thereafter, we can apply Cramer's rule to solve the endogenous variables.

Simulation Results - A 10 per cent Reduction in Cooking Oil Consumption Subsidies

The constructed model is capable of appraising a wide range of agri-environmental policy issues. This includes inputs, outputs and trade taxes (subsidies). Effects of shifts in the domestic and the export demand schedules due to some exogenous factors (e.g. changes in consumer preference and increases in disposable incomes) can also be simulated. However, this paper focuses on simulating a 10 per cent reduction in cooking oil subsidies in Malaysia. Since the production of cooking oil from CPO accounts for the greatest portion (80 per cent) of the edible palm oil market in Malaysia (Cottrell & Raymond), the consumption of CPO-based food products is used as a proxy for the domestic consumption of cooking oil. Consequently a 10 percent reduction in cooking oil subsidies is modelled by shifting upwards the inverse demand schedule for food products by 10 per cent (Equation 1). Simulation results, i.e, effects of the policy change on the endogenous variables are listed in Table 7. It shall be recalled here, that the focus of this type of appraisals is on the direction and relative order of the magnitudes/impacts. Given the uncertain nature of the various baseline values, examination of the fine tune numbers will therefore be immaterial.

The results generally show an inverse relation of long-run impacts among the endogenous variables representing each subsector. As can be seen in Table 8, a reduction in cooking oil consumption subsidies by 10 per cent increases the price of cooking oil (food products) by 9.4 per cent, decreases the domestic demand (–3.6 per cent) and hence the market supply of such products (–1.97 per cent). Consequently, the market demand for PPO (–0.71 per cent) as intermediate input will also decline.

Decrease in demand for PPO in cooking oil markets augments the outputs of competing activities i.e, chemical and biofuel products as they are faced with relatively lower prices of PPO than before. Besides, the increase in export demand for cooking oil (0.2 per cent) is unable to outweigh the reduction in CPO domestic demand, as the domestic demand portion for CPO is substantially higher than that of exports. Additionally, the lack of ability of other competing sectors and the foreign markets to absorb the undemanded (excess supply) portion of PPO which was previously used for cooking oil production induces a fall in the demand for PPO. This is generally in line with expectation as cooking oil production constitutes the highest portion of the total use of PPO compared to other competing uses. Consequently, the market demand for CPO, which is being used as intermediate inputs for PPO production decreases. Henceforth, the demand for FFBs will also decline.

The fall in demand for FFBs is estimated to provoke a decline in the demand for primary factors of production. However, the relative percentage changes in the demand for primary factors are very small especially when it comes to land and labour inputs. On the other hand, the lower demand for primary inputs in the oil palm subsector is associated with a decline of market price for the respective primary inputs within the subsector. Consequently, factor owners will reallocate their inputs to other subsectors to obtain higher factor returns. Further, changes in the price of primary factor inputs leads to changes in input combinations in each subsector. These linkages are provided through the Allen elasticities of substitution. As shown in Table 7, the use of primary factors in the oil palm subsector is projected to decline (about 0.3 per cent). The decline in the use of primary inputs in the oil palm subsector will provoke an increase in the use of primary inputs in other subsectors.

Increases in the use of primary factors in other subsectors stimulate the production of OPPs and OFPs outputs. As indicated in Table 7, the effect of cooking oil subsidy reduction on the production of these products is relatively smaller than that of oil palm, as the other subsectors in aggregate and oil palm subsector are not close substitutes in terms of land use.

Generally, the results of the study demonstrate an opposite relation of long-run impact amongst variables that signify each subsector. Owing to the reduction in cooking oil subsidies, PPO, CPO, and FFB outputs decrease, prices drop, demand for the related primary factors falls, and finally factor prices decline. In a multi-subsector framework, inputs may shift into the competing subsectors, therefore, along with increases in demand for primary inputs, outputs of the competing subsectors like rice, rubber, and other agricultural crops in aggregate (OPP) also increase.

The result also demonstrates a clear converse relationship between the variables representing the competing activities within the same sector. For example, while a reduction in cooking oil subsidies leads to a decline in cooking oil output, the outputs of competing uses, e.g. biofuel and chemical products expand.

Table 8

Effect of 10 Per cent Reduction in Cooking Oil Subsidies on Endogenous Variables

Notation	Definition of Variables	Percentage Changes
D^M_{FFB}	*Market Demand for FFB*	-0.330329
D^M_{OPP}	*Market Demand for OPP*	0.836923
$D_{land,FFB}$	*Demand for Land in Production of FFB*	-0.300997
$D_{land,OPP}$	*Demand for Land in Production of OPP*	0.942791
$D_{che,FFB}$	*Demand for Agrochemical in Production of FFB*	-0.374378

(continued)

Notation	Definition of Variables	Percentage Changes
$D_{che,OPP}$	*Demand for Agrochemical in Production of OPP*	1.17264
$D_{lab,FFB}$	*Demand for Labour in Production of FFB*	-0.339719
$D_{lab,OPP}$	*Demand for Labour in Production of OPP*	1.06408
$D_{oth,FFB}$	*Demand for Other Inputs in Production of FFB*	-0.324074
$D^{D}_{oth,OPP}$	*Demand for Other Inputs in Production of OPP*	1.01507
$D_{land,T}$	*Total Demand for Land*	-4.20264×10^{-17}
$D_{che,T}$	*Total Demand for Agrochemical*	-0.128402
$D_{lab,T}$	*Total Demand for labour*	-0.182213
$D_{oth,T}$	*Total Demand for Other Inputs*	-0.0964187
P^{S}_{FFB}	*Supply Price of FFBs*	-0.707189
P^{S}_{OPP}	*Supply Price of OPP*	1.03324
$P^{M}_{land,FFB}$	*Market Price of Land in Production of FFBs*	-0.986118
$P^{M}_{land,OPP}$	*Market Price of Land in Production of OPP*	1.08686
$P^{M}_{che,FFB}$	*Market Price of Agrochemical in Production of FFBs*	-0.360492
$P^{M}_{che,OPP}$	*Market Price of Agrochemical in Production of OPP*	1.18652
$P^{M}_{lab,FFB}$	*Market Price of Labour in Production of FFBs*	-0.585631
$P^{M}_{lab,OPP}$	*Market Price of Labour in Production of OPP*	0.818165
$P^{M}_{oth,FFB}$	*Market Price of Other Inputs in Production of FFBs*	-0.729624
$P^{M}_{oth,OPP}$	*Market Price of Other Inputs in Production of OPP*	0.609524
$S_{land,T}$	*Total Supply of Land*	-4.20264×10^{-17}
$S_{che,T}$	*Total Supply of Agrochemical*	-0.128402
$S_{lab,T}$	*Total Supply of Labour*	-0.182213
$S_{oth,T}$	*Total Supply of Other Inputs*	-0.0964187
$P^{D}_{land,FFB}$	*Firm's Demand Price of Land in Production of FFBs*	-0.986118
$P^{D}_{che,FFB}$	*Firm's Demand Price of Agrochemical in Production of FFBs*	-0.360492
$P^{D}_{lab,FFB}$	*Firm's Demand Price of Labour in Production of FFBs*	-0.585631

(continued)

Notation	Definition of Variables	Percentage Changes
$P^{D}_{lab,FFB}$	*Firm's Demand Price of Other Inputs in Production of FFBs*	-0.729624
$P^{D}_{land,OPP}$	*Firm's Demand Price of Land in Production of OPP*	1.08686
$P^{D}_{che,OPP}$	*Firm's Demand Price of Agrochemical in Production of OPP*	1.18652
$P^{D}_{lab,OPP}$	*Firm's Demand Price of Labour in Production of OPP*	0.818165
$P^{D}_{oth,OPP}$	*Firm's Demand Price of Other Inputs in Production of OPP*	0.609524
P^{M}_{FFB}	*Market Price of FFBs*	-0.707189
P^{M}_{OPP}	*Market Price of OPPs*	1.03324
$S_{land,FFB}$	*Supply of Land for FFBs Production*	-0.300997
$S_{land,OPP}$	*Supply of Land for OPP Production*	0.942791
$S_{che,FFB}$	*Supply of Agrochemical for FFBs Production*	-0.374378
$S_{che,OPP}$	*Supply of Agrochemical for OPP Production*	1.17264
$S_{lab,FFB}$	*Supply of Labour for FFBs Production*	-0.339719
$S_{lab,OPP}$	*Supply of Labour for OPP Production*	1.06408
$S_{oth,FFB}$	*Supply of Other Inputs for FFBs Production*	-0.324074
$S_{oth,OPP}$	*Supply of Other Inputs for OPP Production*	1.01507
S^{D}_{FFB}	*Domestic Supply of FFBs*	-0.330329
S^{D}_{OPP}	*Domestic Supply of OPP*	0.836923
D^{E}_{CPO}	*Export Demand for CPO*	0.275804
D^{M}_{CPO}	*Market Demand for CPO*	-0.330329
D^{D}_{FFB}	*Domestic Demand for FFB*	-0.330329
P^{D}_{FFB}	*Domestic Price of FFB*	-0.707189
P^{S}_{CPO}	*Supply Price of CPO*	-0.707189
P^{M}_{CPO}	*Market Price of CPO*	-0.707189
P^{E}_{CPO}	*Export Price of CPO*	-0.707189
D^{M}_{OFP}	*Market Demand for OFP*	-0.196315

(continued)

Notation	Definition of Variables	Percentage Changes
D^{D}_{OPP}	*Domestic Demand for OPP*	0.836923
P^{S}_{OFP}	*Supply Price of OFP*	1.03324
P^{M}_{OFP}	*Market Price of OFP*	1.03324
P^{E}_{OFP}	*Export Price of OFP*	1.03324
P^{D}_{OPP}	*Domestic Price of OPP*	1.03324
S^{D}_{OFP}	*Domestic Supply of OFP*	-0.196315
D^{D}_{CPO}	*Domestic Demand for CPO*	-0.414552
S^{D}_{CPO}	*Domestic Supply of CPO*	-0.330329
P^{D}_{Food}	*Consumer Price of Food Products*	9.43425
$P^{D}_{Oleo-Chemical}$	*Consumer Price of Ole-Chemical Products*	-0.106078
$P^{D}_{Biofuel}$	*Consumer Price of Biofuel Products*	-0.0353594
P^{E}_{Food}	*Export Price of Food Products*	-0.565751
$P^{E}_{Oleo-Chemical}$	*Export Price of Ole-chemical Products*	-0.106078
$P^{E}_{Biofuel}$	*Export Price of Biofuel Products*	-0.0353594
P^{M}_{Food}	*Market Price of Food Products*	-0.565751
$P^{M}_{Oleo-Chemical}$	*Market Price of Ole-chemical Products*	-0.106078
$P^{M}_{Biofuel}$	*Market Price of Biofuel Products*	-0.0353594
P^{S}_{Food}	*Supply Price of Food Products*	-0.565751
$P^{S}_{Oleo-Chemical}$	*Supply Price of Ole-chemical Products*	-0.106078
$P^{S}_{Biofuel}$	*Supply Price of Biofuel Products*	-0.0353594
D^{D}_{fOOD}	*Domestic Demand for Food Products*	-3.58501
$D^{D}_{Oleo-Chemical}$	*Domestic Demand for Ole-chemical Product*	0.0403098
$D^{D}_{Biofuel}$	*Domestic Demand for Biofuel Product*	0.00353594
D^{E}_{Food}	*Export Demand for Food Products*	0.214985
$D^{E}_{Oleo-Chemical}$	*Export Demand for Ole-chemical Products*	0.0403098
$D^{E}_{Biofuel}$	*Export Demand for Biofuel Product*	0.00353594
D^{M}_{Food}	*Market Demand for Food Products*	-1.97381

(continued)

Notation	Definition of Variables	Percentage Changes
$D^{M}_{Oleo-Chemical}$	*Market Demand for Ole-chemical Products*	0.0403098
$D^{M}_{Biofuel}$	*Market Demand for Biofuel Products*	0.00353594
S^{D}_{Food}	*Domestic Supply of Food Products*	-1.97381
$S^{D}_{Oleo-Chemical}$	*Domestic Supply of Ole-chemical Products*	0.0403098
$S^{D}_{Biofuel}$	*Domestic Supply or Biofuel Products*	0.00353594
$D^{D}_{PPO,FOOD}$	*Demand for PPO in Production of Food Products*	-1.66972
$D^{D}_{PPO,Oleo-Chemical}$	*Demand for PPO in Production of Oleo-Chemical Products*	-1.66972
$D^{D}_{PPO,Biofuel}$	*Demand for PPO in Production of Biofuel Producst*	-1.88188
$D^{D}_{PPO,T}$	*Total Domestic Demand for PPO*	-1.68033
D^{E}_{PPO}	*Export Demand for PPO*	0.323185
D^{M}_{PPO}	*Market Demand for PPO*	-0.718643
$P^{D}_{PPO,FOOD}$	*Firms Price of PPO in Production of Food Products*	-0.707189
$P^{D}_{PPO,Oleo-Chemical}$	*Firms Price of PPO in Production of Oleo-chemical Products*	-0.707189
$P^{D}_{PPO,Biofuel}$	*Firms Price of PPO in Production of Biofuel Products*	-0.707189
P^{M}_{PPO}	*Market Price of PPO*	-0.707189
P^{E}_{PPO}	*Export Price of PPO*	-0.707189
P^{D}_{PPO}	*Firm Price of CPO*	-0.707189
P^{S}_{PPO}	*Supply Price of PPO*	-0.707189
S^{D}_{PPO}	*Domestic Supply of PPO*	-0.718643

Source. Simulation Results.

Conclusion and Policy Implications

This study does not attempt to evaluate the merits or demerits of cooking oil subsidy reduction to the economy. Rather, it focuses on examining the inter-subsectoral impact of reduction in the said subsidies on domestically-produced cooking oil, and its related markets such as biofuel, CPO, PPO, FFBs, OPPs, OFPs, oleo-chemicals and prices as well as Malaysia's trade position. The effects of such a policy change on the demand for the primary factors of production including land, labour, agrochemicals and other inputs have also been presented.

While the results suggest that the export of cooking oil will increase (0.2 per cent) due to a 10 per cent cooking oil subsidy reduction, domestic output of cooking oil may eventually see a net decline (-1.97 per cent). This is attributed to the relatively greater decline in domestic demand for cooking oil (-3.6 per cent). Results also indicate that while liberating the domestic cooking oil market poses negative long-run impacts on domestic cooking oil outputs, PPO and CPO, the production of biofuel and chemical products from palm oil may increase, albeit very small. The magnitude of such increases would ultimately depend on the quantum of subsidy reduction. The results clearly point that the effect of reducing cooking oil subsidies is relatively small at the upstream levels and therefore it only induces minute effects on factor markets. Consequently, the market for other agricultural crops is projected to change very marginally.

For future work, there is a clear need to incorporate the welfare function representing the various domestic interest groups (producers, consumers, and taxpayers) into the model framework. This will enable the appraisals of welfare gains and loss and especially the net welfare effect of subsidy reduction to the entire economy.

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