PROSIDING PERKEM VI, JILID 2 (2011) 48 – 57
ISSN: 2231-962X

A Comparative Statics, Partial Equilibrium, Multi-Commodity Model for Malaysian Agriculture

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Abstract

Most models for the analysis of Malaysian agricultural policies have been partial equilibrium and econometric-based. Such models have their own unique strength but they are not capable of examining factor markets, outputs, trade, and policy linkages across sub-sectors, explicitly and simultaneously. The aim of this paper is to develop a multi-commodity, comparative statics model for the Malaysian agricultural sector that links explicitly factor markets, related outputs and agri-environment policy linkages. An illustration of the effects of a change in export tax for Malaysian crude palm oil is presented.

Key Words: Malaysian agriculture, Comparative statics, Agri-environment policies

BACKGROUND AND OBJECTIVES

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 ignore 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 repercusions 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.

Contemporary Malaysian agriculture is faced with a number of daunting challenges, such as scarcity of land supply, labor shortages, public awareness on biodiversity loss, environmental quality degradation and food safety. Aggregate land supply into agriculture has been virtually on a standstill since the mid 1990s, due to strict environment-forest policy enforcement, in light of global and domestic concerns on large scale deforestation and climate change effects. However, clear shifts in the allocation of existing agricultural land use can be seen across the major cultivated crops. Oil palm expansion continues steadily over the years, while the decline in other crops has been less gradual, especially from the early 2000 (see Figure 1). This somewhat suggests that oil palm expansion to some extent has been fueled by deforestation. Casson (2000) and Corley and Tinker (2003) asserted that the oil palm expansion in Malaysia has been at the expense of both forest area and shifts in pre-existing crops. Additionally, Koh and Wilcove (2008) argued that during the period 1990 to 2005, 55–59 percent of oil palm expansion in Malaysia was at the expense of forests where the conversion of pre-existing cropland such as rubber accounted for 41 – 45 percent of land that went into oil palm plantation. Consequently, they suggested that the significant land cover change was a cause of significant biodiversity loss. To date, researchers are yet to empirically quantify the linkages between landuse allocation, output markets and policy changes.

The second major issue relates to labor shortages. While it has been evident that the contribution of agricultural employment (including livestock, forestry and fishing) has declined very substantially from 26 percent of total employment in 1990 to 12 percent in 2008, there also has been a clear shift in terms of employment proportion within the various agricultural sub-sectors. For instance, the proportion of labor employed in oil palm sub-sector increased remarkably, while the number of employment in other sub-sectors (rubber, cocoa, and other crops including pepper and tobacco)

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declined pronouncedly (Ministry of Plantation Industries and Commodities, 2010). A related issue is the potential imposition of minimum wage policy and immigration reforms within the agricultural sector, especially in the oil palm and rubber sub-sectors. How such policy affects Malaysian agricultural competitiveness is virtually not known empirically.

The third daunting challenge relates to the increasing public concerns on biodiversity loss, environmental degradation, as well as food safety. The haze externalities, changes from chemical-based fertilizers to organic supplies, and the well debated food-fuel dilemma are some of the notable examples. Again, to what extent these issues affect the competitiveness of Malaysian agriculture; especially the oil palm subsector is rather unknown.

Undoubtedly, there is a clear need to tract the inter sub-sectoral effects of agricultural policies (output, inputs and trade) and changes in other pertinent exogenous variables such as shifts in domestic and export demand on related markets. Contemporary agricultural policy issues, as noted earlier, encompass the rising public concerns on environmental degradation, food safety, as well as labor supply rigidity and minimum wage policy. Traditional econometric-based models are rather deficient to address such multifaceted issues and especially the sectoral or inter sub-sectoral effects. It will be a modelling challenge on how to model the simultaneous effects of policy and pertinent exogenous shifts on interrelated outputs and input markets, as well as on Malaysia's trade position. Such intricacies constitute the prime motivation of this paper. In short, this paper aims to construct and apply a comparative statics, multi-commodity, exogenous policy model for the Malaysian agricultural sector. In this paper we highlight the development of a two-commodity model and present an empirical illustration on the case of a tax on Malaysia's crude palm oil exports. As will be clear in the subsequent discussions, the model can easily be generalized to incorporate multiple commodities and captures a multitude of policy shocks and exgenous shifts.

THE DEVELOPMENT OF THE TWO COMMODITY MODEL

This study especially constructs a modelling framework where the use of primary inputs and outputs produced within and between agriculture subsectors are inter-linked. The model can be used to examine the inter sub-sectoral, comparative static effects of alternative agricultural support policies encompassing input, output and trade policies on the magnitude and direction of changes in a number of variables of interest, including land allocation, labor flows, agrochemical uses, commodity outputs, prices and trade.

In this paper we will first illustrate the development of the comparative static, exogenous policy, partial equilibrium model for two commodities with two subsequent stages of production. The framework can be generalized into a full fledge, multiple commodity model with multiple stages of production.

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. In this study, the basic Hertel's model is expanded to incorporate multiple commodities for a single country. Interested readers are referred to the papers for the detailed construction of the single commodity model.

Figure 2 depicts the conceptual framework that is used to guide the development of the model in this study. In a two-commodity framework, the Malaysian agricultural sector is represented by two competing sub-sectors. 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 sub-sectors that compete for the pre-existing resources including land, labor, agrochemicals, and other inputs. As noted in the figure, the primary outputs of the oil palm sub-sector and other sub-sectors are Fresh Fruit Bunches (FFBs), and other primary outputs (OPP), respectively.The primary output in the oil palm sub-sector (FFB) is destined to produce crude palm oil (CPO), while OPP is intended to produce Other Final Products in aggregate (OFP). Both CPO and OFP are tradable in the world market place. Since both outputs utilize the same inputs base, any policy shocks or exogenous changes affecting either sub-sector, will have repercussions in all related markets - primary inputs, primary and final outputs as well as trade.

Table 1 depicts the notations and descriptions of all the endogenous and exogenous variables in the two-commodity model. Table 2 presents the complete system of equations for a long run partial equilibrium for the model as derived from the basic Hertel's model and follows the general conceptual framework shown in Figure 2. 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, labor, agrochemicals, and an aggregate of other primary inputs (i, j =1, 2, 3, 4). Subscripts *y* and *q* denote the production of each agricultural subsector, while *k(y)* and *k (q)* refer to primary output being used in the production of the two final outputs, *y* and *q*, respectively. Additionally, it is important to note that the *hat* notation denotes percentage changes in variables.

Equation 1 and 2 in Table 2 represent the changes in demand for the two final outputs, $\hat{D}_y^M$ and $\hat{D}_q^M$, i.e, CPO and OFP, which are functions of domestic and export demand. Note that following Jamal (1997), the two equations incorporated shifts in both domestic and export demand schedules. Equation 3 and 4 describe the derived demand for primary outputs *k(y)* and *k (q)* being used in production of *y* and *q* respectively, while Equations 5 and 6 refer to the derived demand for primary inputs, $\hat{D}_{i,k(y)}$ and $\hat{D}_{i,k(q)}$, which goes into the production of *k(y)* and *k (q*). Equation 7 portrays the aggregated demand for primary inputs. Equations 8 through 11depicts the zero profit conditions for the production of primary and final outputs. Equations 11 and 12 describe the responsiveness of land and non land supply factors to a change in rents or return under the assumptions that $0 < v < \infty$. Equations 14 through 17 indicate the procedure in which the elasticities of transformation are calibrated into input supply elasticities. Equations 18 through 27 incorporate exogenous sectoral *ad valorem* output, input, and trade policy variables into the model. Here, $\hat{t} < 0$, $\hat{l} < 0$, $\hat{e} < 0$ reflect the percentage changes in output, input and export subsidies, respectively. The last six equations describe the market clearing conditions, where no surpluses or deficits in inventory of outputs and inputs were assumed.

One notable difference of this model, relative to Hertel's (1989) basic model, apart from its multi-commodity treatment, is the need for the explicit incorporation of Input Transformation Function (Equations 14 - 17). 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 sub-sector, is somewhat different from that of other crops in aggregate. In order to capture the varying rigidity of land supply across sub-sectors, a methodology which is able to capture such characteristic of 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 modeled 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 sub-sectors, input allocation is controlled through a CET function which determines the degree of input supply responsiveness to relative price changes between the subsectors.

Solving the Model

Mathematically, Equations 1 - 33, 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 linear independence equations. A convenient way of solving a linear equation system is by using 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 represent the matrix of 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 for the endogenous variables.

MODEL APPLICATION - A 10 PERCENT EXPORT TAX ON CPO EXPORTS

The constructed model is capable of apprasing a wide range of agri-environmental policy issues. This includes input, output and trade taxes (subsidies). Effects of shifts in domestic and export demand schedules due to some exogenous factors (e.g. changes in consumer preference and increases in disposable incomes) can also be simulated. As an illustration, this paper considers a 10 percent tax on

Malaysia's exports of CPO. Recall that in this paper, CPO is modeled as the only final output from the use of FFB. In reality this is never the case, as CPO is further processed into processed palm oil and oleo chemicals. This implies the model here will not show the effects of any policy changes on any CPO-derived products.

Before any simulation is performed, 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 shares, factor cost shares, and demand and supply elasticity values. These coefficients and parameters are extremely crucial as the quality of simulation results would depend entirely on the representativeness of the values. However, sensitivity analysis using some plausible ranges of baseline values will also be helpful in the absence of reliable estimates. Tables 3 and 4 present all the required baseline coefficients and parameters, including data sources.

Simulation results, i.e, effects of the policy change on the endogenous variables are listed in Table 7. It shall be noted here, that the major focus of this type of appraisals is on the direction and relative order of impacts. Given the uncertain nature of the various baseline values, examination of fine tune numbers will be immaterial.

The results generally show an inverse relation of long-run impacts among the endogenous variables representing each sub-sector. As FFB and CPO outputs fall due to export taxes, prices fall, consequently demand for the corresponding factors declines, thus depressing factor prices within the sub-sector. In a two sub-sector framework, inputs can be seen flowing into the competing sub-sector. Hence, output of the competing sub-sector (OPP) increases along with increases in demand for primary inputs. Total demand for inputs going into the agriculture can also be appraised. For instance, while demand for land going into the oil palm sub-sector declines by 0.22 percent and land demand in the competing sub-sector increases by 0.71 percent, total land demand within the entire agricultural economy remains unchanged. This is attributable to the much larger share of land use by the oil palm sub-sector.

Drawing upon the direction and order of impacts affecting the various endogenous variables, one can draw insights on the usefullness of the comparative statics, multi- commodity modelling framework, especially in providing tractable endogenous results for a set of closely related and/or competing commodities. More meaningful 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.

CONCLUSION AND FUTURE RESEARCH

Malaysia's agricultural sub-sectors are inevitably linked due to resource constraints, especially land and labor. Contemporary Malaysian agriculture is also associated with environmental issues such as loss of biodiversity, environmental degradation, and food safety. Additionally, the sector is subjected to a myriad of domestic and trade support measures. Changes in any of such policies in one sub-sector would affect inputs use, production, price of crops and exports within and other related sub-sectors. This study developed a two-commodity, comparative statics, partial equilibrium model which can be used to simulate the effects of alternative agricultural policies and pertinent exogenous shifts on output markets, inputs and trade. The model can be further generalized and expanded to consider multiple commodities or sub-sectors and also to incorporate policy changes and exogenous shifts associated with rising public concerns on biodiversity loss, climate change, minimum wages, immigration reforms and food-fuel issues. Welfare function representing the various interest groups can also be incorporated into the model framework.

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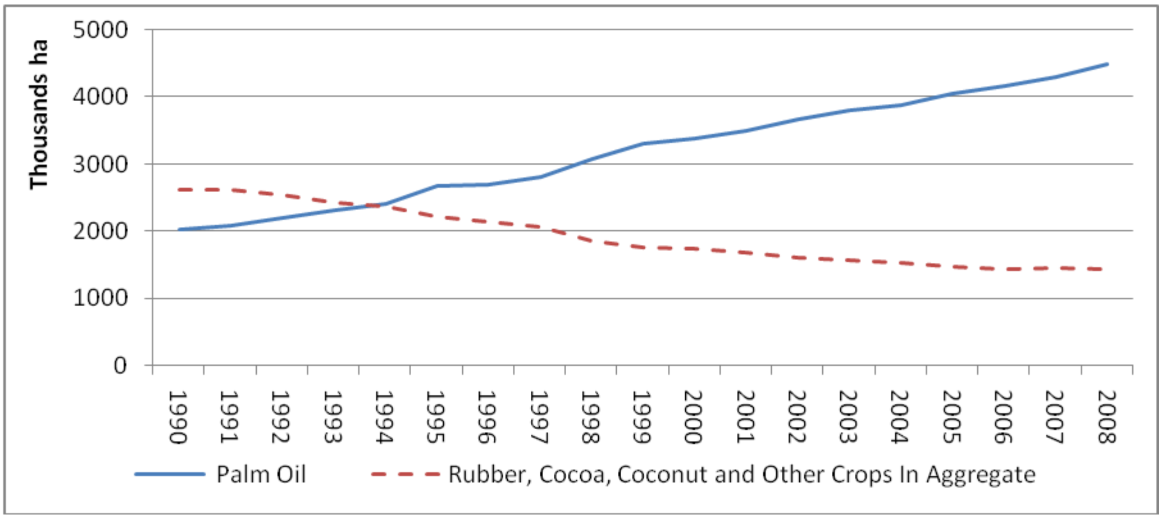

Data Source: Ministry of Plantation Industries and Commodities (2010).

Figure 1: Land Reallocation among the Main Agricultural Crops in Malaysia

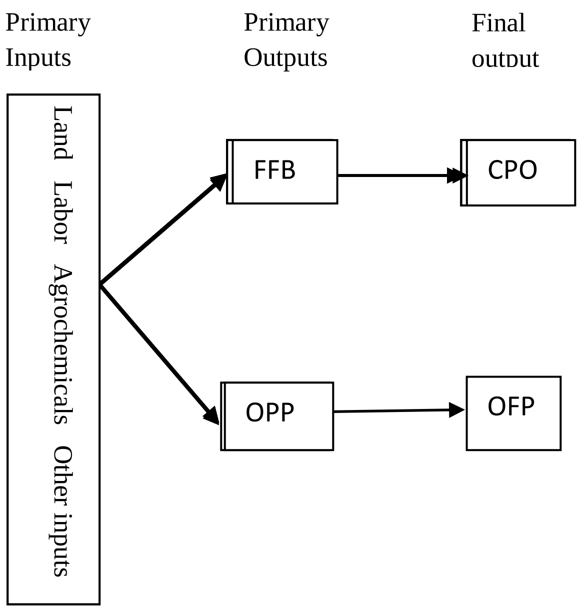

Figure 2: Schematic model of the Partial Equilibrium, Two Commodity Model for the Malaysian Agricultural Sector

Table 1: Definitions of Variables for the Two Commodity Exogenous Policy Model

Endogenous Variables	
D_y^M, D_q^M	Market demand for final outputs (y and q), e.g., CPO and OFP
$D_{k(y)}, D_{k(q)}$	Derived demand for primary outputs $k(y)$ and $k(q)$, e.g., FFB, OPP
D_y^E, D_q^E	Export demand for final outputs (y and q)
D_y^D, D_q^D	Domestic demand for final outputs (y and q)
$D_{i,k(y)}, D_{i,k(q)}$	Derived demand for i^{th} primary input being used in production of $k(y)$ and $k(q)$
S_y^D, S_q^D	Domestic supply of agricultural outputs (y and q)
$S_{i,k(y)}, S_{i,k(q)}$	Supply of i^{th} primary input being used in production $k(y)$ and $k(q)$
P_y^S, P_q^S	Supply price of agricultural outputs (y and q)
$P_{k(y)}^S, P_{k(q)}^S$	Supply price of $k(y)$ and $k(q)$
P_y^M, P_q^M	Market price of final outputs (y and q)
$P_{k(y)}^M, P_{k(q)}^M$	Market Price of primary outputs $k(y)$ and $k(q)$
P_y^E, P_q^E	Export price of final outputs (y and q)
Parameters	
$\varepsilon_{y,q}^D, \varepsilon_{q,y}^D$	Own price elasticity of domestic demand for final outputs (y and q) when ($y = q$) / Cross price elasticity of domestic demand for final outputs y and q) when ($y \neq q$)
$\varepsilon_{k(y)}^D, \varepsilon_{k(q)}^D$	Derived demand elasticity of $k(y)$ and $k(q)$
$\sigma_{ij,k(y)}, \sigma_{ij,k(q)}$	Allen substitution elasticity between input i and j being used in production of $k(y)$ and $k(q)$.
α_y^E, α_q^E	Share of export demand for y and q with respect to their market demand
α_y^D, α_q^D	Share of domestic demand for y and q with respect to their market demand
$C_{i,k(y)}, C_{i,k(q)}$	The cost share of i^{th} primary input with respect to total cost of producing $k(y)$ and $k(q)$
$\theta_{i,k(y)}, \theta_{i,k(q)}$	Share of i^{th} input employed in production of $k(y)$ and $k(q)$
$v_{i,k(y)k(q)}$, $v_{i,k(y)k(q)}$	Cross and own supply elasticity of i^{th} input in the production of $k(y)$ and $k(q)$
$\tau_{i[k(y),k(q)]}$	The constant elasticity of transformation of i^{th} input between $k(y)$ and $k(q)$

Exogenous Variables (Policy Shocks)

e_y, e_q	Export subsidy(tax) on y^{th} final output (ad valorem)
t_y, t_q	Output subsidy(tax) on y^{th} final output (ad valorem)
$t_{k(y)}, t_{k(q)}$	Output subsidy(tax) on production of primary outputs, k(y) and k(q), (ad valorem)
$l_{i,k(y)}, l_{i,k(q)}$	Inputs subsidy(tax) on i^{th} input being used in production of k(y) and k(q)
$l_{k(y)}, l_{k(q)}$	Input subsidy on use of k(y) and k(q) as an input in production of y and q
U_y^D, U_q^D	Shift in domestic demand schedules for y and q
U_y^E, U_q^E	Shift in export demand schedules for y and q

Table 2: Two Commodity Partial Equilibrium Model of the Agricultural Sector

Market Demand Equations

$$\hat{D}_y^M = \alpha_y^D \varepsilon_{y,y}^D (\hat{P}_y^M - \hat{U}_y^D) + \alpha_y^D \varepsilon_{y,q}^D (\hat{P}_q^M - \hat{U}_q^D) + \alpha_y^E \varepsilon_{y,y}^E (\hat{P}_y^E - \hat{U}_y^E) + \alpha_y^E \varepsilon_{y,q}^E (\hat{P}_q^E - \hat{U}_q^E) \quad 1)$$

$$\hat{D}_q^M = \alpha_q^D \varepsilon_{q,q}^D (\hat{P}_q^M - \hat{U}_q^D) + \alpha_q^D \varepsilon_{q,y}^D (\hat{P}_y^M - \hat{U}_y^D) + \alpha_q^E \varepsilon_{q,q}^E (\hat{P}_q^E - \hat{U}_q^E) + \alpha_q^E \varepsilon_{q,y}^E (\hat{P}_y^E - \hat{U}_y^E) \quad 2)$$

Derived Demand under Locally Constant Return to Scale Condition

$$\hat{D}_{k(y)} = e_{k(y)} \hat{P}_{k(y)}^D + \hat{S}_y^D \quad 3)$$

$$\hat{D}_{k(q)} = e_{k(q)} \hat{P}_{k(q)}^D + \hat{S}_q^D \quad 4)$$

$$\hat{D}_{i,k(y)} = \sum_{j=1}^{n} C_{j,k(y)} \sigma_{ij,k(y)} \hat{P}_{j,k(y)}^D + \hat{S}_{k(y)}^D \quad 5)$$

$$\hat{D}_{i,k(q)} = \sum_{j=1}^{n} C_{j,k(q)} \sigma_{ij,k(q)} \hat{P}_{j,k(q)}^D + \hat{S}_{k(q)}^D \quad 6)$$

$$\hat{D}_{i,T} = \theta_{i,k(y)} \hat{D}_{i,k(y)} + \theta_{i,k(q)} \hat{D}_{i,k(q)} \quad 7)$$

Zero Profit Condition

$$\hat{P}_{k(y)}^S = \sum_{i=1}^{n} C_{i,k(y)} \hat{P}_{i,k(y)}^D \quad 8)$$

$$\hat{P}_{k(q)}^S = \sum_{i=1}^{n} C_{i,k(q)} \hat{P}_{i,k(q)}^D \quad 9)$$

$$\hat{P}_y^S = C_{k(y),y} \hat{P}_{k(y)}^D \quad 10)$$

$$\hat{P}_q^S = C_{k(q),q} \hat{P}_{k(q)}^D \quad 11)$$

Input Supply Equations for Two Subsector

$$\hat{S}_{i,k(y)} = v_{i,k(y)k(y)} \hat{P}_{i,k(y)}^S + v_{i,k(y)k(q)} \hat{P}_{i,k(q)}^S \quad 12)$$

$$\hat{S}_{i,k(q)} = v_{i,k(q)k(y)} \hat{P}_{i,k(y)}^S + v_{i,k(q)k(q)} \hat{P}_{i,k(q)}^S \quad 13)$$

Modeling Input Transformation Function

$$v_{i,k(y)k(y)} = \theta_{i,k(y)} * \tau_{i[y,k(q)]} \quad 14)$$

$$v_{i,k(q)k(q)} = -\tau_{i[k(y),k(q)]} (1 - \theta_{i,k(q)}) \quad 15)$$

$$v_{i,k(y)k(q)} = \theta_{i,k(q)} * \tau_{i[k(y),k(q)]} \quad 16)$$

$$v_{i,k(y)k(y)} = -\tau_{i[k(y),k(q)]} (1 - \theta_{i,k(y)}) \quad 17)$$

Ad Valorem Equivalent Policies

Output policies

$$\hat{P}_y^S = \hat{P}_y^M - \hat{t}_y \quad 18)$$

$$\hat{P}_q^S = \hat{P}_q^M - \hat{t}_q \quad 19)$$

$$\hat{P}_{K(y)}^S = \hat{P}_{K(y)}^M - \hat{t}_{K(y)} \quad 20)$$

$$\hat{P}_{K(q)}^S = \hat{P}_{K(q)}^M - \hat{t}_{K(q)} \quad 21)$$

Input Policies

$$\hat{P}^{S}_{i,K(y)} = \hat{P}^{D}_{i,K(y)} - \hat{\iota}_{i,K(y)} \quad 22)$$

$$\hat{P}^{S}_{i,K(q)} = \hat{P}^{D}_{i,K(q)} - \hat{\iota}_{i,K(q)} \quad 23)$$

$$\hat{P}^{S}_{K(y)} = \hat{P}^{D}_{K(y)} - \hat{\iota}_{K(y)} \quad 24)$$

$$\hat{P}^{S}_{K(q)} = \hat{P}^{D}_{K(q)} - \hat{\iota}_{K(q)} \quad 25)$$

Export Policies

$$\hat{P}^{E}_{y} = \hat{P}^{M}_{y} - \hat{e}_{y} \quad 26)$$

$$\hat{P}^{E}_{q} = \hat{P}^{M}_{q} - \hat{e}_{q} \quad 27)$$

Factor Market Clearing Conditions

$$\hat{D}_{i,k(y)} = \hat{S}_{i,k(y)} \quad 28)$$

$$\hat{D}_{i,k(q)} = \hat{S}_{i,k(q)} \quad 29)$$

$$\hat{D}_{k(y)} = \hat{S}_{k(y)} \quad 30)$$

$$\hat{D}_{k(q)} = \hat{S}_{k(q)} \quad 31)$$

Commodity Market Clearing Conditions

$$\hat{D}^{M}_{y} = \hat{S}^{D}_{y} \quad 32)$$

$$\hat{D}^{M}_{q} = \hat{S}^{D}_{q} \quad 33)$$

Table 3: Allen Elasticities of Substitution between Primary Inputs in Oil Palm Plantation

	Land	Labor	Agro chemical	Capital
Land	*-0.3*	0.078	-0.042	0.645
Labor	*0.078*	-0.79	0.492	0.895
Agro chemical	-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 Romous (2006)

Table 4: Allen Elasticities of Substitution between Primary Inputs in Other Crops in Aggregate

	Land	Labor	Capital	Agrochemicals
Land	-4.2	0.3	O.1	2.7
Labor	0.3	-7.35	0.4	1.3
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 5: 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
Labor 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 6: 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	Statistic of Commodities, 2009
CPO domestic demand share	0.878	Statistic of Commodities , 2009
OFP export demand share	0.133	Agricultural Statistic Handbook, 2008
OFP domestic demand share	0.867	Agricultural Statistic Handbook, 2008
OPP own export and demand price elasticities	-0.19**	GTAP Database 2006
OPP Export Demand Elasticity	-0.19	GTAP Database 2006
OPP Domestic Demand elasticity	-0.19	GTAP Database 2006
Elasticity of transformation for land input	0.6	OECD PEM model 2003
Elasticity of transformation for non land inputs	1	

* 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 market.

Table 7: Effect of 10 Percent CPO Export Tax on Endogenous Variables

Notation	**Definition of Variables**	**Percentage Changes**
D^M_{FFB}	*Market Demand for FFB*	-0.249094
D^M_{OPP}	*Market Demand for OPP*	0.631106
$D_{land,FFB}$	*Demand for Land in Production of FFB*	-0.226975
$D_{land,OPP}$	*Demand for Land in Production of OPP*	0.710939
$D_{che,FFB}$	*Demand for Agro chemical in Production of FFB*	-0.28231
$D_{che,OPP}$	*Demand for Agro chemical in Production of OPP*	0.884261
$D_{lab,FFB}$	*Demand for Labor in Production of FFB*	-0.256174
$D_{lab,OPP}$	*Demand for Labor in Production of OPP*	0.802398
$D_{oth,FFB}$	*Demand for Other inputs in Production of FFB*	-0.244377
$D^D_{oth,OPP}$	*Demand for Other inputs in Production of OPP*	0.765446
$D_{land,T}$	*Total Demand for Land*	-0.0000001880
$D_{che,T}$	*Total Demand for Agro Chemical*	-0.0968254
$D_{lab,T}$	*Total Demand for labor*	-0.137403
$D_{oth,T}$	*Total Demand for Other inputs*	-0.0727072
P^S_{FFB}	*Supply Price of FFBs*	-0.533276
P^S_{OPP}	*Supply Price of OPP*	0.779143
$P^M_{land,FFB}$	*Market Price of Land in Production of FFBs*	-0.743611
$P^M_{land,OPP}$	*Market Price of Land in Production of OPP*	0.819579
$P^M_{che,FFB}$	*Market Price of Agro chemical in Production of FFBs*	-0.271839
$P^M_{che,OPP}$	*Market Price of Agro chemical in Production of OPP*	0.894732
$P^M_{lab,FFB}$	*Market Price of Labor in Production of FFBs*	-0.441611
$P^M_{lab,OPP}$	*Market Price of Labor in Production of OPP*	0.616961
$P^M_{oth,FFB}$	*Market Price of Other Inputs in Production of FFBs*	-0.550194
$P^M_{oth,OPP}$	*Market Price of Other Inputs in Production of OPP*	0.459629
$S_{land,T}$	*Total Supply of Land*	-0.0000001880

$S_{che,T}$	*Total Supply of Agro Chemical*	-0.0968254
$S_{lab,T}$	*Total Supply of Labor*	-0.137403
$S_{oth,T}$	*Total Supply of Other Inputs*	-0.0727072
$P^D_{land,FFB}$	*Firm's Demand Price of Land in Production of FFBs*	-0.743611
$P^D_{che,FFB}$	*Firm's Demand Price of Agro chemical in Production of FFBs*	-0.271839
$P^D_{lab,FFB}$	*Firm's Demand Price of Labor in Production of FFBs*	-0.441611
$P^D_{oth,FFB}$	*Firm's Demand Price of Other Inputs in Production of FFBs*	-0.550194
$P^D_{land,OPP}$	*Firm's Demand Price of Land in Production of OPP*	0.819579
$P^D_{che,OPP}$	*Firm's Demand Price of Agro chemical in Production of OPP*	0.894732
$P^D_{lab,OPP}$	*Firm's Demand Price of Labor in Production of OPP*	0.616961
$P^D_{oth,OPP}$	*Firm's Demand Price of Other Inputs in Production of OPP*	0.459629
P^M_{FFB}	*Market Price of FFBs*	-0.533276
P^M_{OPP}	*Market Price of OPPs*	0.779143
$S_{land,FFB}$	*Supply of Land for FFBs Production*	-0.226975
$S_{land,OPP}$	*Supply of Land for OPP Production*	0.710939
$S_{che,FFB}$	*Supply of Agro chemical for FFBs Production*	-0.28231
$S_{che,OPP}$	*Supply of Agro chemical for OPP Production*	0.884261
$S_{lab,FFB}$	*Supply of Labor for FFBs Production*	-0.256174
$S_{lab,OPP}$	*Supply of Labor for OPP Production*	0.802398
$S_{oth,FFB}$	*Supply of Other Inputs for FFBs Production*	-0.244377
$S_{oth,OPP}$	*Supply of Other Inputs for OPP Production*	0.765446
S^D_{FFB}	*Domestic Supply of FFBs*	-0.249094
S^D_{OPP}	*Domestic Supply of OPP*	0.631106
D^E_{CPO}	*Export Demand for CPO*	-3.69202
D^M_{CPO}	*Market Demand for CPO*	-0.249094
D^D_{FFB}	*Domestic Demand for FFB*	-0.249094,
P^D_{FFB}	*Domestic Price of FFB*	-0.533276
P^S_{CPO}	*Supply Price of CPO*	-0.533276
P^M_{CPO}	*Market Price of CPO*	-0.533276
P^E_{CPO}	*Export Price of CPO*	9.46672
D^M_{OFP}	*Market Demand for OFP*	-0.148037
D^D_{OPP}	*Domestic Demand for OPP*	0.631106
P^S_{OFP}	*Supply price of OFP*	0.779143
P^M_{OFP}	*Market Price of OFP*	0.779143
P^E_{OFP}	*Export Price of OFP*	0.779143
P^D_{OPP}	*Domestic Price of OPP*	0.779143
S^D_{OFP}	*Domestic Supply of OFP*	-0.148037
D^D_{CPO}	*Domestic Demand for CPO*	0.229309
S^D_{CPO}	*Domestic Supply of CPO*	-0.249094