Linking Agricultural Trade, Land Demand and Environmental Externalities: Case of Oil Palm in South East Asia

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Linking Agricultural Trade, Land Demand and Environmental Externalities: Case of Oil Palm in South East Asia

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Abstract

Reduction of support measures affecting soybean oil in the major soybean producing countries, as a consequence of WTO rules, coupled with rising demand for palm oil in non-traditional palm oil importing countries may lead to pronounced increases in agricultural land demand for oil palm expansion in Malaysia and Indonesia – two main palm oil producing and exporting countries. However, it is expected that the effects on agricultural land demand and consequently impact upon the environment will depend much on existing governance affecting environmental and forestry management in the two countries. Given the relatively more prevalent policy and institutional failures in Indonesia, it is anticipated that deforestation consequences and open burnings in the country will be stronger, inevitably giving rise to recurring haze externalities in the region. This study employed single and multi-country output supply exogenous policy models with explicit factor markets to examine agricultural land demand-trade linkages in the world vegetable oil markets. Shifts in export demand for palm oil and reductions of support measures affecting soybean production were simulated and effects on land use in Malaysia and Indonesia were observed under varying assumptions of environmental and forestry policy regimes in the two countries. Inferences on environmental effects are also provided.

INTRODUCTION

Unlike acid rains, which characterized the trans-boundary environmental problems in many industrial regions of the world, the Southeast Asian region is rather prone to an international environmental pollution of a peculiar kind, the haze. Haze is the accumulation of fine particles in the air, which are hardly visible to the naked eye. The particles may result from natural phenomena and/or human activities. The main natural source of haze is forest fires, while haze from deliberate forest burnings, open burnings, emissions from factories and motor vehicles represent conscious human activities. Persistent accumulation of haze particles in the air reduces sun's rays and visibility while imposing health repercussions.

For some parts of Malaysia and Indonesia, haze is quite an annual phenomenon, which normally occurs in the months of August - October with varying scales. While there have been five major haze episodes since 1982, the haze of 1997 -1998 was unprecedented in terms of intensity, duration and coverage. It started in early August and the sky remained dull until some three months later. The haze led to marked increases in the incidence of respiratory diseases, a decline in agricultural crop and fishing yields, and disruption to industrial output, tourism and transport services. A state of emergency was declared for 10 days in Sarawak, a Malaysian state neighboring the Indonesian Kalimantan. The value of the 1997 haze damages to the country was estimated at some RM800 million or US$320 million (based on exchange rates at the time). This amounted to some US$15 of damage per capita for the country (Shahwahid and Jamal 1999).

The prime cause of the haze was suspended smoke particulate from large-scale forest and plantation fires, particularly in Riau Province, Sumatra and Central Kalimantan, both in neighboring Indonesia. The 1997 to 1998 forest fire destroyed an estimated land and forest area of more than 9 million hectares in Indonesia (Asian Development Bank, 2001). Much of the literature pointed that these fires were mainly attributed to open burnings practices for conversion of forestland to alternative land uses, most notably oil palm cultivation (for example, Aditjondro 2000; Tampubolon1998; Casson 1999; World Rainforest Movement 2001).

Palm oil is a major agro-industrial commodity (so-called "green gold") for the economies of Malaysia and Indonesia. Malaysia has been the world's largest producer of palm oil (a share of 51 percent in 2001) followed by Indonesia (32 percent) (Oil World Annual 2002; MPOB 2002). In 2001, Malaysia and Indonesia, respectively, had some 3.5 and 3 million hectares of oil palm planted areas[1]**.** Of thirteen major vegetable oils produced by the world, palm oil (2001) accounts for 25 per cent of world production - an increase of 5 percent from 20 percent in 1995. For the same period, soybean oil (palm oil's main rival) production experienced only a 2 percent change (from 27 to 29 percent). Given expanding demand and increasing per capita consumption, palm oil looms to be the world's leading vegetable oil in a few years time.

In recent years, suitable land for oil palm cultivation in Peninsular Malaysia has become increasingly rigid due to the commitments of the country on sustainable resource and forest management. The oil palm industry has thus expanded to the land-rich states of Sabah and Sarawak. Indonesia, with a land area six times larger than Malaysia and a more abundant labor resource will undoubtedly dwarfed Malaysia in the near future, in terms of palm oil production and exports. In 1996, the Indonesian government has made known of its intent to overtake Malaysia as the world's largest palm oil producer by the year 2000 (Casson 1999). It has been reported that each year about 200,000 hectares of forestland was converted into new oil palm plantations in Indonesia (Aditjondro 2000). Foreign investments in the Indonesian oil palm subsector, most notably from Malaysian companies had been particularly active, due to the dwindling land supply and rising farm wages in Malaysia. By 1996, a year before the Asian Financial Crisis, forty-five Malaysian companies along with their Indonesian partners had been able to secure land banks totalling some 1.3 million hectares (Casson 1999).

Given freer agricultural trade under WTO rules, palm oil is expected to benefit considerably, as production and exports of its main competitor, soybean oil, has been heavily subsidized (Jamal,

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[1] For Indonesia, the figure was a conservative estimate based on the Indonesian Direktorat Jenderal Perkebunan (Directorate General of Plantation Estates) official statistic of 2.9 million hectares in 1999. It is also worthy to note here that oil palm statistics for Indonesia oftently varies, for instance, Barlow (2003) reported a statistic of 3.7 mill. ha for 2000.

Fauzi and Mohammad 1998). Reduction of support measures affecting soybean oil in the major soybean producing countries, as a consequence of WTO, coupled with rising demand in non-traditional palm oil importing countries and depressed currencies (vis a vis the US dollar) may lead to pronounced expansion in oil palm cultivation in Malaysia and Indonesia, the two main palm oil producing and exporting countries. However, it is thought that the effects of freer trade and shifts in export demand on agricultural land and consequently haze impact will depend much on the existing governance (environmental policies and enforcement capacities) affecting forestry and environmental management in the two countries. Of the two countries, Indonesia is more land and labor abundant while its forest and environmental management regime is more susceptible to institutional failures. For instance, while both Malaysia and Indonesia had imposed a regulatory ban on open burnings for land clearance, enforcement capacities of the latter have been relatively weaker. Operationally, plantation firms in Indonesia have been free to use open burnings to clear land with impunity (Asian Development Bank 2001).

Institutional and policy failures had been widely established as a dominant factor for the rampant conversion of forest in Indonesia (Barbier et. al. 1995). Tampubolon (1998) had also pointed that given a multitude of factors which essentially constitute policy and institutional failures in Indonesia, the expansion of private sector investments in the oil palm subsector in the country may lead to even more severe forest fires in the next several years ahead. Unless there are quick legal and institutional reforms in Indonesia, it is anticipated that the trans-boundary haze pollution will continue to engulf the Southeast Asian region in the near future.

This study employs output supply exogenous policy models with explicit factor markets to examine land factor demand - trade linkages in the world vegetable oil markets. Specifically, this study simulates shifts in export demand for palm oil and reduction of support measures affecting soybean production and effects on land demand in Malaysia and Indonesia are observed under varying assumptions of environmental management regimes in the two countries. Inferences on haze externalities and possible strategic solution for Malaysia and Indonesia are then deliberated.

LINKING TRADE EXPANSION AND ENVIRONMENT: THEORETICAL FRAMEWORK

The Basic Framework

The idea of agricultural or industrial production processes giving rise to negative externalities has long been an integral subject in the study of resource and environmental economics. This subsection lays the basic framework in examining the linkages between agricultural output supply, trade and haze externalities. In the subsection that follows, formal treatment of these linkages is provided.

Analysis of agricultural trade-environmental linkages requires knowledge of; i) the underlying agricultural production function which links factor use, type of technology and output supply, ii) how the demand for output is affected by shifts in export demand and related trade policies imposed by producing and competing countries, and iii) how changes in production factors, particularly land, result in externalities, in this case the production of haze. The following equations illustrate these linkages.

Demand for agricultural output

$$q_O^D = f(p_O^D(d_O^D) + p_O^E(d_O^E)) \quad \text{(i)}$$

Demand for land input

$$X_L^D = f(q_O^S) \quad \text{(ii)}$$

Supply of land input

$$X_L^S = v_L * r_L \quad \text{(iii)}$$

Production of environmental externalities

$$E_h = \gamma * X_L^D \quad \text{(iv)}$$

Market clearing condition

$$q_O^S = q_O^D \quad \text{(v)}$$

Land market clearing condition

$$X_L^D = X_L^S \quad \text{(vi)}$$

The notations *q, d* and *p* in the above equations denote quantity, demand, and prices, respectively. The superscripts *D, E,* and *S* denote domestic demand, export demand and supply, respectively, while subscript *O* refers to the agricultural output which is being modeled.

Equation (i) expresses the demand for agricultural output (q_O^D) which is a function of domestic demand ($p_O^D(d_O^D)$) and export demand ($p_O^E(d_O^E)$). Equation (ii) describes the derived demand for land input (X_L^D) that goes into the production of agriculture (q_O^S). Equation (iii) portrays the supply of land factor, where V_L and r_L represent respectively, land supply elasticity and land rents. Equation (iv) depicts the production of environmental externalities, in this study the haze E_k, where its scale and magnitude are determined by the haze coefficient (γ) and the size of new agricultural land (X_L^D) that goes into the production of new outputs. Equation (v) and (vi) describe the market clearing conditions, where no surpluses or deficits in inventory of outputs and inputs were assumed.

From the above simplified equations, linkages between trade expansion, output and land demand as well as environmental impacts can be traced. It is clear that the direction of impact on land demand as a result of changes in export demand, output supply, and consequently the resulting impact of the haze can be determined, i.e., $\frac{\partial X_L^D}{\partial q_O^S} \succ 0$, $\frac{\partial X_L^D}{\partial d_O^E} \succ 0$, and $\frac{\partial E_k}{\partial X_L^D} \succ 0$ if $\gamma \succ 0$.

The parameters V_L in Equation (iii) and γ in (iv) are critical in determining the likelihood and magnitude of haze externalities (marginal propensity of haze), i.e., $\frac{\partial E_k}{\partial X_L^D} = \gamma$ and $\frac{\partial E_k}{\partial V_L} \succ 0$. It is obvious that ∂E_k would not only be contingent on γ, but also on X_L^D which is in turn affected by land supply elasticity (V_L). Thus, V_L and γ may both reflect the relative degree of institutional and environmental policy failures in a country, the higher the parameters, the greater the failures and the resulting haze externalities.

In this study, no attempt was made to establish explicit causality links between deforestation or agricultural land expansion and the production of haze externalities in either Malaysia or Indonesia. Moreover there were other factors contributing to haze. We rather presume that the likelihood for deliberate open burnings and forest fires for land clearance and consequently the resulting environmental externalities is higher in the case of countries which exhibit greater policy and institutional failures in environmental management.

This study focuses on examining the impacts of; i) shifts in export demand of palm oil, and ii) reductions of US-EU soybean oil export subsidies on land factor demand in Malaysia and Indonesia.

The Formal Framework – Hertel's Comparative Static Model

There has been virtually no known attempt in the literature to examine theoretically and empirically the association between agricultural expansion and haze externalities. Perhaps, the most appropriate framework to date to examine such linkages is the Hertel's model of the farm sector (Hertel 1989). Hertel's model is single country, comparative static, and partial equilibrium. It relates factor markets, output supply, demand and trade through a system of equations.

The repercussions of domestic and trade policy shocks are examined by the model explicitly via policy-price linkages (interested readers are advised to refer to the paper for the detailed construction of the model). Hertel's model, however, is not capable to examine the impact of shifts in export demand on factor markets. To overcome this weakness, we manipulated Equation 1 of Hertel's model to incorporate shifts in domestic and export demand for farm output. The complete system of equations for the enhanced Hertel's model is presented in Table 1. Note that with the exception of Equations 1 and 4, all others are Hertel's original equations. All notations – *p, q, d, D, S, E*, and *O* are as defined earlier while the *hat* notation represents the percentage change in the relevant variable.

Equation 1 was an extension of Hertel's original formulation to incorporate shifts in domestic and export demand. The original Hertel equation for output demand consists of two components – domestic and export demand. By some simple manipulation of this equation, shifts in domestic and export demand can be expressed, respectively, as shifts in the direction of price axis,

$$\hat{p}_O^D = \frac{\hat{q}_O^D - \alpha \in_D^E \hat{p}_O^E}{(1-\alpha) \in_D^D} + \hat{d}_O^D, \text{ and}$$

$$\hat{p}_O^E = \frac{\hat{q}_O^D - (1-\alpha)\hat{p}_O^D \in_D^D}{\alpha \in_D^E} + \hat{d}_O^E$$

where $\hat{d}_O^D$ and $\hat{d}_O^E$ represent percentage shifts in domestic output and export demand schedules, respectively. The aggregate farm-level demand elasticity, $\epsilon_D = [(1-\alpha)\varepsilon_D^D + \alpha\varepsilon_O^E]$ is a weighted sum of the farm-level domestic and export demand elasticities, where α is the quantity share of exports in total demand. By solving the two equations above, Equation 1 is generated.

Equation (2) describes the derived demand of a competitive agricultural sector operating under locally constant returns to scale. The variables C_k and σ_{kj} represent cost share of an input and an Allen partial elasticity of substitution (AES), respectively. Equation (3) represents the assumption of zero profits for the aggregate farm sector. Factor mobility including land is addressed in equation (4). The notation V_k denotes supply elasticity for factor *k*. Specifically, it describes the responsiveness of production factors to a change in rents under varying assumptions of factor mobility. By specifying factor supply this way, varying levels of factor supply elasticities can be modeled. Equations 5-7 incorporate exogenous sectoral *ad valorem* output, input, and trade policy variables into the model. The last two equations explain the market clearing conditions for output and inputs.

The above extended version of Hertel's model to incorporate shifts in output demand as well as factor supply schedules has been developed and applied to examine the inter-linkages between factor markets, currency depreciation, and trade for the case of oil palm in Malaysia (Jamal 1997, 2000). In the current study the basic exogenous parameters used in the model came from this study.

We had earlier postulated that the effects of shifts in commodity demand on agricultural land demand would not only be contingent on whether land is in abundance (through deforestation or conversion of other land uses to agriculture), but are also influenced by factors such as the existence of policy or institutional failures. This implies that given the same relative endowment of land, a country that exhibits greater policy and institutional failures will see more pronounced increases in land going into agriculture.

Institutional and policy failures are especially caused by the lack of appropriate environmental regulations and instruments or when these regulations are not adequately enforced – inevitably resulting in unsustainable production practices. This includes perverse public investment incentives, which accelerates the pace of environmental resource degradation. In this study, to what extent these factors affect land mobility is modeled by assuming varying levels of land supply elasticities (V_k – Equation 4). Higher supply elasticities (elastic) would denote greater mobility of land factor from forest conversion due to the existence of the above factors. Although not directly modeled, this study assumes that the value of γ (marginal propensity of haze – see Equation iv) is positive and greater for the case of Indonesia.

All parameters relating to factor substitutions, factor shares and demand elasticities for Malaysia are taken from Jamal (1997, 2000). The same parameters are assumed for Indonesia. This assumption would not, however, alter the course and implications of model results, as this study is more interested to observe the directions and relative extent of changes in land demand and haze externalities (rather than fine-tune the magnitude of the impact) as a result of policy and institutional failures - represented by varying levels of land supply elasticities.

In the model simulation, varying values of land supply elasticities in Indonesia, i.e., 0.2 (baseline), 0.7, 1.2 and 2.0 are employed with a 10 percent change in export demand. The model is solved for the endogenous variables of interest using Cramer's Rule.

To examine the impacts of reduction of US-EU soybean oil export subsidies, the one-country framework above was further extended to consider multiple countries. Table 3 depicts the system of equation for the multi-country model. Detailed construction of the model can be found in Jamal (1994). Gunter, Jeong and White (1996) had also constructed similar multi-country framework based on Hertel's one-country model. The unique strength of this model is its allows modeling of *N* countries exercising exogenous strategic policies simultaneously.

In the multi-country framework, palm oil and soybean oil were considered as a homogenous aggregate good where perfect substitution is implicitly assumed. World palm and soybean oil trade was assumed to be divided into four countries – i) Malaysia, ii) Indonesia, both countries being the main producers and exporters of palm oil, iii) US-EU - soybean oil exporter aggregate, and iv) ROW importer aggregate. A reduction of 10 percent of soybean oil export subsidies in the US-EU was also simulated with varying assumptions of land supply elasticities for Indonesia. This is done by assigning a value of $\hat{t}_i$ = -10 in Equation 4 (Table 2) for the relevant country. Table 4 reports the basic exogenous parameters used in the single and multi-country models. Like the single-country model, the multi-country model is solved for the endogenous variables of interest using Cramer's rule.

SIMULATION RESULTS

Impact of a 10 Percent Shifts in Export Demand

A 10 percent shifts in export demand was simulated along with varying levels of land supply elasticities to model varying assumptions of policy and institutional failures in a country. The results are presented in Table 5.

A range of land supply elasticities were employed, from 0.2 (base line), 0.7, 1.2, and 2.0. Recall that higher land supply elasticities denote greater prevalence of policy and institutional failures, *ceteris paribus*, and hence the less rigid will be land supply to agriculture from forest conversion, given the same level of economic incentives.

Results (Table 5) show that the impact of shifts in export demand in a country became more pronounced when a more elastic land supply was assumed, *ceteris paribus*. With increasing land supply elasticity, the model especially shows more significant increases in land demand. For instance, using an elastic land supply of 2.0, land use is expected to increase by a high 8 percent. This compares to 3.0 percent when land supply elasticity was 0.2. The impact on domestic prices is also greater which leads to greater effects on output and export markets.

Higher values for land supply elasticities (1.2 – 2.0) in this study represent a mix of unsustainable agriculture/forest management and less adherents to best practices environmental regulations, given the implicit assumption that γ >0. The results clearly suggest that if policy failure is more prevalence, shifts in export demand will pose more pronounced impact on land use and hence the haze consequences. Higher land supply elasticities in this study are thought to represent the case of Indonesia, hence it is expected that given the same magnitude of palm oil export shifts and the value of γ relatively greater in the country, more pronounced oil palm expansion and haze externalities will be seen in Indonesia.

Impact of 10 Percent Reduction of US-EU Soybean Oil Export Subsidies

The simulated impact of a 10 percent reduction in US-EU soybean oil export subsidy on Malaysia and Indonesia are shown in Table 6a and 6b, respectively. Note that in this simulation, land supply elasticity in Malaysia was set to remain unchanged at the baseline level (0.2), while varying land supply elasticities for Indonesia were simulated. This was to discern and contrast the impacts of varying degree of policy and institutional failures in the country.

In the multi-country model, both Malaysia and Indonesia were not insulating its domestic prices from external shocks, hence, the change in world price as a result of US-EU reduction of export subsidy is transmitted fully (transmission elasticity equal to one) into the domestic market resulting in an increase in domestic price (consumer and producer price). Increases in domestic prices induce increases in output and consequently oil palm acreage expands.

As expected, results show that as land supply elasticities in Indonesia are raised (reflecting increasing policy and institutional failures), increases in output and factor (land and labor) demand in Malaysia became less prominent (Table 6a). Although the impacts of US-EU reduction of export subsidy on output prices in Malaysia and Indonesia are the same, declining world and domestic prices which resulted from production expansion in Indonesia and the sticky land supply in Malaysia inhibits local output expansion and consequently factor demands in the country. On the other hand, land rents dropped and demand expanded markedly in Indonesia, as institutional and policy failures became more prevalence in the country. This induces increases in domestic palm oil production.

As in the case of exports shifts, the model has clearly shown that freer trade in vegetable oils will provoke greater increases in land demand and output in Indonesia. Further, as γ is greater in the country, more pronounced haze externalities can be expected to emanate from the country. This may recur until the Indonesian Government is able to effectively enforce all environmental regulations affecting forest clearance and land preparation.

SUMMARY AND POLICY IMPLICATIONS

This study examines the impact of shifts in export demand for palm oil and reductions of support measures affecting soybean production on agricultural land use in Malaysia and Indonesia. The results from the model show that the impact on land use is dependent on whether or not there exists related policy or institutional failures in the country. Malaysia is likely to demonstrate its commitment towards sustainable forest and environmental management; hence palm oil demand enlargement and freer trade are expected to result in smaller deforestation impact and less detrimental land preparation practices for agricultural expansion. On the other hand, Indonesia will inevitably see larger changes in oil palm land-use due to the more availability of land from forest conversion, while less enforced environmental policies will lead to recurrence of haze externalities. However, the extent of haze would also be dependent on whether other factors, which contributed to the 1997 haze are present, for instance, forest fires that resulted from weather calamities.

While the impact of freer trade and demand enlargement on land use in Malaysia may be relatively smaller, land factor has always been crucial in generating oil palm growth in Malaysia. Technical progress is yet to be a growth factor. This implies, Malaysia may inevitably encroach into environmentally sensitive forest areas should it continue to rely on land expansion to sustain industrial growth and exports. It is therefore clear that domestic R&D efforts should focus more on improving factor productivity and cost effectiveness in the face of dwindling land supply for oil palm expansion.

The implementation of regional autonomy or decentralization of federal powers in Indonesia may or may not lead to greater institutional failures and consequently deforestation/haze impacts. Much depends on the extent local administrators are resolute in addressing the institutional failures and legal distortions that have long been entrenched in the country. It is also affected by how local policymakers view the relative importance of agriculture and forest resources as engine of economic development *vis a vis* other sectors in the economy. A move towards reduction of haze externalities will require among others, an extended socio-economic evaluation of all land-use options to identify the most socially desirable resource use plan in the affected region.

The negative impact of large-scale oil palm mono cropping includes biodiversity loss, agrochemical runoffs from fertilizers and insecticides, and land erosion besides generating haze. Some competing vegetable oil producers and importers have regarded these environmental impact as sort of "environmental subsidy" for oil palm production. In a trading world charged with green consumerism issues, this perception, if not adequately addressed, may pose detrimental trade impact on palm oil, a vital commodity for both Indonesia and Malaysia.

It is commendable that ASEAN has formulated a Regional Haze Action Plan (RHAP) in 1997 to prevent and mitigate the damage from recurrent fires and haze (Asian Development Bank 2001). However, from a game theoretic perspective, it will be to the best interest of both Malaysia and Indonesia to address the haze pollution by identifying a comprehensive and sustained "cooperative solution" in oil palm investment. This perspective has been rather understated in the ASEAN RHAP and the subsequent ministerial negotiations. It has been obvious that Malaysia is relatively land and labor scarce while possessing a distinct advantage in capital and related technology. It will be important for Indonesia, through the provincial or regional governments to espouse more flexible and transparent procedures on matters governing land procurement and to further demonstrate strict adherence to best practices environmental regulations and enforcements. Successful land-socio development models of Malaysia, for instance the Federal Land Development Authority (FELDA) model may also be employed and/or adapted in Indonesia to take into consideration the distinctive cultural setting and needs of local communities. Increased Malaysian investments in Indonesia may also help reduce the flow of illegal workers from Indonesia to Malaysia.

Table 1: Partial Equilibrium Model of the Farm Sector With Output Demand and Input Supply Shifts (Hertel's Extended Model)

Commodity Demand

$$\hat{q}_O^D = (1-\alpha(\hat{p}_O^D - \hat{d}_O^D)\varepsilon_O^D + \alpha(\hat{p}_O^E - \hat{d}_O^E)\varepsilon_O^E \quad (1)$$

Derived Factor Demands Under CRS Technology

$$\hat{x}_k^D = \sum_{k=1}^{N} C_k \sigma_{jk} \hat{r}_k^D + \hat{q}_O^S \quad (2)$$

Zero Profits

$$\hat{p}_O^S = \sum_{k=1}^{N} C_k \hat{r}_k^D \quad (3)$$

Factor Supplies

$$\hat{x}_k^S = v_k(\hat{r}_k^S) \quad (4)$$

Ad valorem – Output Subsidy

$$\hat{p}_O^S = \hat{p}_O^D - \hat{O}_O \quad (5)$$

Ad valorem – Input Subsidy

$$\hat{r}_k^D = \hat{r}_k^S - \hat{i}_k, \quad (k = 1,2,..n) \quad (6)$$

Ad valorem – Export Subsidy

$$\hat{p}_O^E = \hat{p}_O^D + \hat{t}_O \quad (7)$$

Commodity Market Clearing

$$\hat{q}_O^S = \hat{q}_O^D \quad (8)$$

Factor Market Clearing

$$\hat{x}_k^D = \hat{x}_k^S \quad (9)$$

Table 2: Definitions of Variables for the Multi-Country Exogenous Policy Model

Endogenous Variables

$\hat{q}_i^D$	Percentage change in demand for output produced by country *i*
$\hat{q}_i^S$	Percentage change in supply of output produced by country *i*
$\hat{p}_i^D$	Percentage change in demand (consumer) price of output in country *i*
$\hat{p}_i^S$	Percentage change in supply (producer) price of output in country *I*
$\hat{p}^W$	Percentage change in world price of output
$\hat{x}_{ki}^D$	Percentage change in input *k* demand in country *i*
$\hat{x}_{ki}^S$	Percentage change in input *k* supply in country *i*
$\hat{r}_{ki}^S$	Percentage change in input *k* supply price in country *i*
$\hat{r}_{ki}^D$	Percentage change in input *k* demand price in country *i*

Exogenous Variables

q_i^C	Base level of consumption in country *i*
q_i^S	Base level of production in country *i*, $(q_i^S = q_i^D)$
q_t^S	Base level combined production across countries, $(q_t^S = q_t^D)$
E_i^D	Consumer demand elasticities in country *i*
C_{ki}	Factor share for input *k* in country *i*
σ_{jki}	Allen partial elasticity of substitutions between inputs *j,k* in country *i*
V_{ki}	Factor supply elaticities for input *k* in country *i*

Ad-Valorem Policies

$\hat{O}_i$	Percentage change in ad valorem subsidy (tax) on output in country *i*
$\hat{t}_i$	Percentage change in ad valorem export subsidy (tax) imposed by country *i*
$\hat{i}_i$	Percentage change in ad valorem input subsidy (tax) imposed by country *i*

Table 3: The Multi-Country Exogenous Policy Trade Model

Output Demand (N equations)

$$\hat{q}_i^D = \frac{q_i^C}{q_i^D} E_i^D \hat{p}_i^D - \sum_{n=1(n\neq i)}^{N} (E_n^D \hat{p}_n^D - E_n^D \hat{p}_n^S), \quad (i = 1,\ldots,N) \quad (10)$$

Input Demand ($\sum I_n$ equations)

$$\hat{x}_{nj}^D = \sum_{k=1}^{I_n} C_{nk} \sigma_{nkj} \hat{r}_{nk}^D + \hat{q}_n^S \quad (j = 1,\ldots,I_n; n = 1,\ldots,N) \quad (11)$$

Zero Profits (N equations)

$$\hat{p}_n^S = \sum_{k=1}^{I_n} C_{nk} \hat{r}_{nk}^D, \quad (n = 1,\ldots.,N) \quad (12)$$

Input Supplies ($\sum I_n$ equations)

$$\hat{x}_{nk}^S = V_{nk}(\hat{r}_{nk}^S), \quad (k = 1,\ldots,I_n; n = 1,\ldots,N) \quad (13)$$

Input Market Clearing ($\sum I_n$ equations)

$$\hat{x}_{nk}^D = \hat{x}_{nk}^S, \quad (k = 1,\ldots,I_n; n = 1,\ldots,N) \quad (14)$$

Input Subsidies/taxes ($\sum I_n$ equations)

$$\hat{r}_{nk}^D = \hat{r}_{nk}^S - \hat{i}_{nk}, \quad (k = 1,\ldots,I_n; n = 1,\ldots,N) \quad (15)$$

Output Subsidies/taxes (N equations)

$$\hat{p}_i^D = \hat{p}_i^S - \hat{O}_i, \quad (i = 1,\ldots,N) \quad (16)$$

Trade Subsidies/taxes – exporters (E equations)

$$\hat{p}^W = \hat{p}_i^D - \hat{t}_i, \quad (i = 1,\ldots,N) \quad (17)$$

Trade Subsidies/taxes – importers (N-E equations)

$$\hat{p}^W = \hat{p}_i^D + \hat{t}_i, \quad (i = E+1,..N) \quad (18)$$

World Market Clearing (1 equation)

$$\sum_{i=1}^{N} (q_i^S / q_t^S) \hat{q}_i^S = \sum_{i=1}^{N} (q_i^C / q_t^S) E_i^D \hat{p}_i^D \quad (19)$$

Table 4: Base Exogenous Parameter Values Used in the Model

Variables	Short-Run
Domestic demand elasticity (Malaysia and Indonesia)	-0.27
Output supply elasticity – baseline (Malaysia and Indonesia)	0.39
Land supply elasticity (V_L) - base line (Malaysia and Indonesia)	0.2
Labor, chemical, durables and other inputs supply elasticities (Malaysia and Indonesia)	0.5 (labor), ∞
Factor shares – land, labor, chemicals, durables, other inputs (Malaysia and Indonesia)	0.5, 0.2, 0.05, 0.1, 0.15
US-EU domestic demand elasticity [+]	-0.50
ROW importers demand elasticity[+]	-0.5
US-EU and ROW output supply elasticity[+]	1.4
Base exports – Malaysia	80 percent
Base exports - Indonesia	60 percent
Base exports – US-EU	40 percent
Base imports - ROW	80 percent

[+] Data for US soybean oil domestic demand and supply elasticities came from Gardiner, W.H., V.O. Roningen, and K, Liu. *Elasticities in the Trade Liberalization Database*. Econ. Res. Service., USDA 1989.
The same values are assumed for US-EU aggregate and ROW.

Table 5: Impact of 10 Percent Shift in Export Demand under Varying Land Supply Elasticities (V_L)

	$V_L = 0.2$	$V_L = 0.7$	$V_L = 1.2$	$V_L = 2.0$
Land Demand	2.8	5.8	7.0	8.0
Labor Demand	2.3	4.8	5.9	6.7
Domestic Price	7.8	6.0	5.3	4.7
World Price	7.8	6.0	5.3	4.7
Domestic Output	3.1	6.0	7.3	8.2
Export	4.4	7.9	9.4	10.6

Table 6a: Impact of 10 percent Reduction of US-EU Soybean Oil Trade Subsidies on Malaysia under Varying V_L for Indonesia

	$V_L = 0.2$	$V_L = 0.7$	$V_L = 1.2$	$V_L = 2.0$
Land Demand	1.04	0.95	0.89	0.85
Labor Demand	0.90	0.83	0.79	0.74
Land Rents	5.23	4.71	4.48	4.26
Domestic Price	2.98	2.70	2.55	2.43
World Price	2.98	2.70	2.55	2.43
Domestic Output	1.16	1.06	1.00	0.95

Note that V_L for Malaysia was set to remain constant at the baseline level (0.2)

Table 6b: Impact of 10 percent Reduction of US-EU Soybean Oil Trade Subsidies on Indonesia under Varying V_L

	$V_L = 0.2$	$V_L = 0.7$	$V_L = 1.2$	$V_L = 2.0$
Land Demand	1.04	2.52	3.30	3.98
Labor Demand	0.90	2.25	2.96	3.58
Land Rents	5.23	3.49	2.75	1.99
Domestic Price	2.98	2.70	2.55	2.43
World Price	2.98	2.70	2.55	2.43
Domestic Output	1.16	2.64	3.41	4.09

Note that V_L for Malaysia was set to remain constant at the baseline level (0.2)

References

Aditjondro, G.J. "The Driving Force of Indonesia's Catastrophic Forest Fires". <http://forests.org/archive/indomalay/drforind. htm>. (2000)

Asian Development Bank. *Fire, Smoke, and Haze. The ASEAN Response Strategy*. Manila: ASIAN Development Bank, 2001.

Barbier, E.B., N. Bockstael, J.C. Burgess, and I. Strand. "The Linkages Between Timber Trade and Tropical Deforestation – Indonesia". *World Economy* 18, no. 3 (1995).

Barlow, C. "Palm Oil Policies and Intervention". In *Globalisation and its Impact on the Palm Oil Industry*, edited by E. Pushparajah and Chee K.H. Proceedings of an International Planters Conference, 16-18 June, 2003.

Casson, Anne. *The Hesitant Boom: Indonesia's Oil Palm Sector in an Era of Economic Crisis and Political Change*. Program on the Underlying Causes of Deforestation, Bogor Indonesia, Center for International Forestry Research, 1999.

Direktorat Jenderal Perkebunan. *Statistik Perkebunan Indonesia,* 1980-2003. Jakarta.

Gardiner, W.H., V.O. Roningen, and K, Liu. *Elasticities in the Trade Liberalization Database*. Econ. Res. Service. USDA, 1989.

Gunter, L., Jeong, K., and F.W. White. "Multi-Policy Goals in a Trade Model with Explicit Factor Markets". *Amer. J. Agr. Econ*. (May 1996): 313-30.

Hertel. T.W. "Negotiating Reductions in Agricultural Support: Implications of Technology and Factor Mobility". *Amer. J. Agr. Econ*. (August 1989): 559-73.

Jamal Othman. *A Comparative Static, Game Theoretic Trade Model with Explicit Cross-Country Policy Linkages.* Ph.D Dissertation, Department. of Agriculture and Applied Economics, University of Georgia, Athens, 1994.

________. "Linking Factor Markets, Environment and Trade: The Case of Oil Palm in Malaysia". *Jurnal Ekonomi Malaysia* 31, (1997): 53-69.

________, Mohd Fauzi Mohd Jani, and Mohammad Haji Alias. "World Palm Oil Market Under Freer Trade: Implications for Malaysia. *ASEAN Economic Bulletin***.** Vol. 15. No. 2 (1998):168-83.

________. "Linking Exchange Rates, Market Failures and Agricultural Land Demand". *Jurnal Ekonomi Malaysia* 34, (2000): 21-37.

Malaysian Palm Oil Board (MPOB) and Ministry of Primary Industries. *Malaysian Palm Oil Statistics, 2001*. Bangi, Selangor. 2002.

Oil World. *Annual 2002*, Hamburg: ISTA Mielke GmbH, 2002.

Shawahid H.O. and Jamal Othman. “Malaysia”. In *Indonesia’s Fires and Haze: The Cost of Catatrophe*, edited by David Glover and Timothy Jessup, Singapore: Institute of Southeast Asian Studies, and Ottawa: International Development Research Centre, 1999.

Tampubolon, S.M.H. 1998. “Land–Use Planning and Management To Reduce the Impacts of Transboundary Pollution from Fires in South East Asia: Key Policy and Resource Management Stakeholders Perceptions”. Center for Development Studies, Institute for Research, Bogor University of Agriculture. <http://www.icsea.or.id/sea-span/scipol2/STUDY123.htm>.

World Rainforest Movement. *The Bitter Fruit of Oil Palm*. Montevideo: World Rainforest Movement, 2001.