Linking Factor Markets, Environment and Trade: The Case of Oil Palm in Malaysia

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ABSTRACT

Contemporary issues and policy debate related to the environment or immigration reforms have the potential to affect Malaysia's factor supplies and consequently agricultural production and trade. Likewise, changes in Malaysia's export demand through trade policy reforms or income changes in importing countries can also affect domestic factor markets. However, to date very little is known empirically about the nature and extent of Malaysia's factor markets-trade linkages. This paper employs a partial equilibrium commodity model to analyze the impacts of shifts in factor supplies and export demand in the Malaysian oil palm sub-sector. Given the data used in the study, factor supply shifts are shown to have smaller effects on output production relative to exports demand shifts.

ABSTRAK

Isu-isu semasa dan perbincangan dasar berkait dengan alam sekitar dan reformasi tenaga kerja asing berpotensi menjejaskan pasaran faktor di Malaysia dan seterusnya pengeluaran dan perdagangan pertanian negara. Begitu juga, perubahan dalam permintaan eksport Malaysia akibat reformasi dasar perdagangan dan perubahan pendapatan di negara-negara pengimport boleh juga memberi kesan kepada pasaran faktor domestik. Namun, sehingga kini amat sedikit sekali diketahui secara empiris mengenai bentuk dan darjah hubungan antara pasaran faktor dan perdagangan Malaysia. Rencana ini menggunakan model keseimbangan separa komoditi untuk menganalisis impak anjakan dalam penawaran faktor dan permintaan eksport dalam sub-sektor kelapa sawit Malaysia. Tertakluk kepada data yang digunakan dalam kajian, anjakkan dalam penawaran faktor memberikan kesan yang lebih kecil terhadap pengeluaran output minyak sawit berbanding dengan anjakan dalam permintaan eksport.

INTRODUCTION

Contemporary issues and policy debate related to the environment
and immigration reforms have the potential to affect Malaysia's
factor supplies, agricultural production, and trade competitiveness.
Likewise, changes in Malaysia's export demand under freer
agricultural trade or income changes in importing countries can
also affect domestic demand for factors of production. However,
very little is known empirically about the nature and extent of these
impacts and linkages. This paper attempts to model both the long-
run impacts of changes in domestic factor markets on Malaysia's
agricultural trade and vice versa. Specifically, this paper employs a
partial equilibrium commodity model to analyse the following
effects; (1) shifts in factor supplies in the Malaysian oil palm sub-
sector, (2) changes in palm oil export demand, and (3) simultaneous
changes in palm oil export demand and factor supplies. Subsequent
sections present the theoretical framework and model construction,
model application, simulation results, and policy implications as
well as suggestions for further research.

THEORETICAL FRAMEWORK AND MODEL CONSTRUCTION

ELEMENTS OF FACTOR MARKETS-ENVIRONMENT-TRADE LINKAGES

Changes in factors of production affect agricultural trade through
their impact on output production and the cost of production
within and across countries. Demand for factors of agricultural
production is derived from the demand for the agricultural output.
The link between output demand and factor demand is the
production function. The production function defines the transfor-
mation technology of factors into output. The market demand for
output has both domestic and export components. As a result,
analysis of the interactions between factor markets, output markets,
and international trade requires a knowledge of factor supply and
substitution elasticities as well as the impact of shifts in factor
supply on output supply.

　　Shifts in factor supplies may be caused by, (1) policies designed
to affect output through changing input prices, such as input
subsidies or taxes, and/or (2) policies designed primarily to affect

inputs but have indirect effects on output markets, such as environmental policies in the form of limitations or reductions on the use of certain factors such as chemicals or land and immigration/labor reforms or minimum wage policy which may enhance or restrict labor supplies.

A broad theoretical setting in modeling agricultural trade-natural resource linkages is found in Sutton (1988). However, very few empirical models that explicitly treat factor markets exist in the agricultural trade literature. Muth (1964) developed an output supply model with endogenous input equations, assuming first degree homogenous production functions, competitive markets, and constant demand and substitution elasticities. The Muth model permits analysis of impacts from shifts in factor supplies on equilibrium industry output, and on factor rental rates and demand. Muth's model also allows analysis of the impact of shifts in domestic output demand on factor demand and rental rates. This model does not, however, include an export sector, thus analysis of the impact of export demand shifts on output and factor markets is not possible.

Hertel's (1989) output supply model is perhaps to date the most comprehensive model with explicit treatment on production technology and factor markets. The foundation of Hertel's model goes back to Muth. Important developments in Hertel's model include the introduction of policy variables and an export sector. While these advancements permit analysis of impacts of input, output, or trade subsidies or taxes on factor and output prices and quantities, Hertel's model does not directly allow for exogenous shifts in factor supplies (factor policies type 2 as noted earlier) and output demand. Rather than shifting factor supply schedules, the taxes or subsidies included in Hertel's model create price wedges between supply and demand prices for factors of production.

The model employed in this study combines the strengths of the models developed by Muth and Hertel. The combined model permits analyzes of output and factor policies, as addressed by Hertel's model, and exogenous shifts in factor supplies and output demand, as addressed by Muth's model.

HERTEL'S OUTPUT-SUPPLY MODEL

Hertel's system of equations for a long-run partial equilibrium model of the farm sector are presented in Table 1. The *hat* notation

TABLE 1. Hertel's equations for a long-run partial equilibrium model of the farm sector

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(1) $\quad \hat{q}_O^M = (1 - \alpha)\varepsilon_D^D \, \hat{p}_O^M + \alpha\varepsilon_D^E \, \hat{p}_O^E.$

Commodity demand

(2) $\quad \hat{q}_j^F = \displaystyle\sum_{i=1}^{N} c_i\sigma_{ji} \, \hat{p}_i^F + \hat{q}_O^F.$

Derived factor demands under constant returns to scale technology

(3) $\quad \hat{p}_O^F = \displaystyle\sum_{i}^{N} c_i \, \hat{p}_i^F.$

Zero profits

(4) $\quad \hat{p}_j^M = 0 \; (j \neq L).$

Non-land inverse factor supplies

(5) $\quad \hat{q}_L^M = v_L \, \hat{p}_L^M.$

Land supply

(6-1) $\quad \hat{p}_O^F = \hat{p}_O^M - \hat{t}_O.$

Ad valorem - output subsidy

(6-2) $\quad \hat{p}_j^F = \hat{p}_j^M - \hat{s}_j, \quad j = 1, \; ......, \; N.$

Ad valorem - input subsidy

(6-3) $\quad \hat{p}_O^E = \hat{p}_O^M + \hat{e}_O.$

Ad valorem - export subsidy

(7) $\quad \hat{q}_O^M = \hat{q}_O^F.$

Commodity market clearing

(8) $\quad \hat{q}_O^L = \hat{q}_L^F.$

Land market clearing

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represents the percentage change in the relevant variable. The superscript M denotes a market quantity or price, while F refers to the farm sector. Superscripts D and E refer to domestic and export demands. The first equation explains the price responsiveness of market-level demand, $q_0{}^M$, for an aggregate agricultural commodity. The aggregate farm-level demand elasticity, $\epsilon_D = [(1-\alpha)\epsilon_D{}^D + \alpha\epsilon_D{}^E$ is a weighted sum of the farm-level domestic and export demand elasticities, where α is the quantity share of exports in total demand. Note that the subscript 0 refers to the aggregate agricultural commodity being modeled.

Equation (2) describes the derived demand of a competitive agricultural sector operating under locally constant returns to scale. The variables c_i and σ_{ji} represent cost share of an input and an Allen partial elasticity of substitution (AES), respectively. Equation (3) portrays the assumption of zero profits for the aggregate farm sector. Factor mobility is addressed in equations (4) and (5). Equation 4 depicts non-land factors being supplied to agriculture at an exogenously determined price while equation 5 describes the responsiveness of total farmland supply to a change in rents under the assumptions that $0 < v_L < \infty$. Equations 6-1 through 6-3 incorporate exogenous sectoral *ad valorem* output, input, and trade policy variables into the model. The policy variables – output subsidy (tax), export subsidy (tax), and input subsidy (tax), are represented by $\hat{t}_0$, $\hat{e}_0$, and $\hat{s}_j$, respectively. The last two equations describe the market clearing conditions for output and land. Interested readers are referred to Hertel (1989) for a detailed presentation of the model.

MODEL EXTENSIONS

Hertel's model treats fixed and variable inputs separately, with separate supply equations for fixed and variable inputs and separate symbolic results for each input type. The need for separate supply equations for fixed and variable inputs can be eliminated, however, by defining factor supply elasticities (V_j) with a range from 0 for an input with a fixed supply to ∞ for an input with perfectly elastic supply. Elimination of separate equations for the supply of fixed and variable inputs is accomplished by replacing equations 4 and 5 with:

(9) $\hat{q}_j^M = v_j \, \hat{p}_j^M \ (j = 1, 2, \ldots, n)$.

This generalization of the factor supply equations is useful in the process of modifying Hertel's model to accommodate factor supply shifts. Policies such as environmental or labor regulations may shift input supply schedules, and the factor supply equations (9) may be modified to allow for shifts in factor supply. Following Muth, we define shifts in factor supplies in the direction of the price axis:

$$\hat{p}_j = \frac{1}{V_j}\hat{q}_j + \hat{d}_j,$$

where $\hat{d}_j$ stands for percent shift in the supply of factor j to the industry. Equation 9 is then modified to become:

(10) $\hat{q}_j = v_j(\hat{p}_j - \hat{d}_j).$

A positive shift parameter represents an increase in the price of a given quantity of the input, which is consistent with a decrease in the supply of the factor.

Hertel's output demand equation (1) consists of two major components, domestic demand and export demand. By some simple manipulation of this equation, shifts in domestic and export demand for farm output can also be expressed as shifts in the direction of price axis. Shifts in domestic and export demand can be expressed,

(11) $\hat{p}_O^M = \dfrac{\hat{q}_O^M - \alpha\varepsilon_D^E\, \hat{p}_O^E}{(1-\alpha)\varepsilon_D^D} = \hat{d}_O^D,$

respectively, by:
and

(12) $\hat{p}_O^E = \dfrac{\hat{q}_O^M - (1-\alpha)\hat{p}_O^M\, \varepsilon_D^D}{\alpha\varepsilon_D^E} = \hat{d}_O^E.$

By solving equations 11 and 12 for $\hat{q}_o{}^M$, the demand equation (1) can be generalized to permit shifts in domestic and or export demand,

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

where $\hat{d}_o^D$ and $\hat{d}_o^E$, represent percentage shifts in domestic output and export demand schedules, respectively. A positive shift parameter represents an increase in either domestic or export demand for the output.

The revised version of Hertel's model, presented in Table 2, retains the assumptions and capabilities of the original model, but generalizes the input supply functions and permits analysis of input supply, export demand, and domestic demand shifts. The elasticities, factor shares, and base export shares are model parameters. Output and input prices and quantities are endogenous variables. Output, input, and trade policies, and input supply, export demand, and domestic demand shifts are the policy shocks which may be analyzed. The system of equations specified in Table 2 can be compactly written as $QX = B$ where X is a matrix of endogenous variables and B is a matrix of policy shock variables. Since Q is a square matrix and non-singular, the solution for X is $Q^{-1} B$, and any element x_i in the X matrix can be determined using Cramer's rule.

Both Hertel's basic model and the revised version are capable of analyzing the effects of policy shocks on input and output prices and quantities for one country only. An application of the revised model on the U.S. agricultural sector is found in Jamal and Gunter (1994a). Jamal (1994b) provides further advancement of the model to consider multiple countries and endogenous policy formation in a game theoretic framework. A recent work by Gunter, Jeong and White (1996) also employs a multi-country Hertel-based model to analyze trade and factor markets interaction with empirical illustration on the world wheat market.

MODEL APPLICATION

Although the extended Hertel's model has the capacity to handle output, input, and export subsidies or taxes, this paper will focus on illustrating the potential long-run impacts of factor supply and export demand shifts for the Malaysian oil palm sector.

The aggregate farm level demand for palm oil, that is oil palm fresh fruits bunches (FFB) is determined by both domestic and export demand for the derived oil. Therefore, palm oil is modeled as a homogenous good, implying no distinction between FFB, crude, and refined palm oil.

TABLE 2. Partial equilibrium model with output demand and input supply shifts (Hertel's extended model)

(14) $\hat{q}_O^M = (1 - \alpha)(\hat{p}_O^M - \hat{d}_O^D) \, \varepsilon_O^D + \alpha(\hat{p}_O^E - \hat{d}_O^E) \, \varepsilon_D^E.$

Commodity demand

(15) $\hat{q}_j^F = \sum_{i=1}^{N} c_i \sigma_{ji} \, \hat{p}_i^F + \hat{q}_O^F.$

Derived factor demands under constant returns to scale technology

(16) $\hat{p}_O^F = \sum_{i=1.}^{N} c_i \, \hat{p}_i^F.$

Zero profits

(17) $\hat{q}_j^M = v_j \, (\hat{p}_j^M - \hat{d}_j), \quad (j = 1, \, 2, ..., \, n).$

Factor supplies

(18-1) $\hat{p}_O^F = \hat{p}_O^M - \hat{t}_O.$

Ad valorem - output subsidy

(18-2) $\hat{p}_j^F = \hat{p}_j^M - \hat{s}_j, \quad (j = 1, \, 2, \, ..., \, n).$

Ad valorem - input subsidy

(18-3) $\hat{p}_O^E = \hat{p}_O^M + \hat{e}_O.$

Ad valorem - export subsidy

(19) $\hat{q}_O^M = \hat{q}_O^F.$

Commodity market clearing

(20) $\hat{q}_O^L = \hat{q}_l^F.$

Factor market clearing

The parameter values required for the study are estimates of long-run (LR) and short-run (SR) domestic and export demand elasticities; farm level factor shares and supply elasticities; Allen partial elasticities of substitution for FFB production; and the base share of Malaysia's FFB production exported. The oil palm farm sector is assumed to exhibit constant returns to scale production technology with four main factors of production – land, labor, chemicals (fertilizers, weedicides, etc), and other aggregate factors (durables, capital, etc). The oil palm farm sector is further assumed to earn normal profits in the long-run.

Farm production factor shares are adapted from a study by PORIM (Malek Mansor 1992). Land factor share especially refers to the per unit ratio of opportunity cost of land relative to total economic cost for the production of FFB for a farm size of at least 200 hectares. The opportunity cost of land is assumed to be equal to the total accounting cost for the production of FFB.

Most empirical studies find the supply of Malaysian palm oil to be very inelastic, ranging from 0.12 - 0.18 (Mad Nasir Shamsuddin, et al. 1988, 1994). The SR palm oil supply elasticity is therefore set to be equal to 0.12. This estimate is used to generate the underlying AES for FFB production. It is found that the relationships between the various inputs are very low, between -0.04 to 0.5. These findings are consistent with expectations since oil palm is a perennial crop. Maisom (1987) finds the substitution elasticity between labor and capital in the oil palm milling sector is rather high (1.67). As oil palm cultivation is inevitably labor intensive, the substitution elasticity between labor and other inputs (mainly capital and durables) is expected to be very much lower. In this study, the substitution elasticity between labor and other factors is therefore set arbitrarily at 0.5. Following Hertel, all non-land factor supply elasticities except land and labor are assumed to approach infinity in the LR. In the *SR*, only supply of other inputs is modeled as fixed, while the elasticities for both land and labor supplies are set at 0.2. In the LR, land and labor supply elasticities were set at 0.8 and 0.5, respectively. These low values, which are a little higher than the SR estimates are based on the assumption that new agricultural land supply would be much restricted in the future as a result of issues related to the environment and sustainable forest management.[1] The remaining factor (chemicals) is assumed to be perfectly elastic in the SR. Based on these assumptions on factor mobility, factor

shares and AES, SR and LR values of Malaysia's FFB supply elasticities (E^s) are 0.12 and 1.08, respectively.[2]

With respect to domestic demand elasticity (ϵ_D^D), an estimate of -0.273 taken from Mad Nasir Shamsuddin, M. Zainalabidin and M.A. Fatimah, (1988) is employed in both the SR and LR. For palm oil export demand elasticity (ϵ_D^E), a value of -0.184, also taken from the same study is utilized. Given the unavailability of LR estimates for (ϵ_D^E) in the literature, the parameter is set equal to 0.46. This is based on a study in the U.S. which shows that LR export demand elasticities for most agricultural commodities are generally about 2.5 times higher than SR estimates (Jamal 1994b). The base year chosen for the study is 1992. The α, that is, Malaysia's FFB share of palm oil exports in total demand in 1992 is around 0.8 or 80 percent. Tables 3 and 4 summarize the sets of parameter values used in this study.

TABLE 3. Allen partial elasticities of substitutions and factor shares for Malaysia's FFB production

	Land	Labor	Chemicals	Other Inputs
Land	-0.04	-0.05	0.1	0.1
Labor	-0.05	-0.525	0.1	0.5
Chemicals	0.1	0.1	-1.9	0.1
Other Inputs	0.1	0.5	0.1	-0.62
Factor Shares	*0.5*	*0.2*	*0.05*	*0.25*

SIMULATION RESULTS

As noted, the focus of the study is on estimating the LR impacts of factor supply and export demand shifts. Ten percent shifts in the factor supply schedules ($\hat{d}_j = 10$), and export demand ($\dot{d}_O^E = 10$) are simulated with the model. A positive shift for factor supply and export demand schedules in the direction of price axis represents, respectively, a decrease in factor supplies and an increase in export demand. The LR effects of these shifts on output quantity and price, factor quantities and rents are reported in Table 5.

TABLE 4. Parameter values for the model

Exogenous Variables	Short-Run	Long-Run
Domestic demand elasticity[1]	-0.273	-0.273
Export demand elasticity[2]	-0.184	-0.46
Land supply elasticity	0.2	0.8
Labor supply elasticity	0.2	0.5
Chemical supply elasticity	4	4
Other inputs supply elasticity	0	4
Output supply elasticity[3]	0.125	1.08
Base export share of FFB production	0.8	0.8

Source: Short-run estimates for 1, 2, and 3 are from Mad Nasir Shamsuddin et al. (1988). Long-run estimates for (2) is assumed to be 2.5 times that of short-run, while long-run output supply elasticity is obtained from the generated production function (see footnote 2).

Although the empirical analysis reported here only considers arbitrarily ten percent shifts in input supplies and export demand, a feature of this type of model is that estimated impacts of larger shifts are simple multiples of those reported. It does not, however, quite apply for very 'large' changes. As Muth and Hertel both noted, results of this linearized model are only strictly correct for analyzing small perturbations.

IMPLICATIONS OF A 10 PERCENT SHIFT IN EXPORT DEMAND

The first exogenous shock analyzed is a 10 percent upward shift (other factors remain constant) in export demand for Malaysian palm oil, which might be caused by freer edible oil trade under WTO rules or by faster income growth in importing countries.[3]

A ten percent increase in export demand causes an increase in output price of 2.44 percent in the LR while Malaysia's production increases by 2.65 percent. The increase in price is accompanied by a relatively strong increases in equilibrium exports (3.48 percent).

The effect of an increase in export demand on factor rents and usage depends strongly on factor supply elasticities used in the analysis. The largest increase in factor usage as a result of the ten

TABLE 5. Long-run effects of factor supply and export demand shifts

Parameters	10 Percent Shifts in					
	Land	Labor	Chemicals	Other Factors	Export Demand	Export Demand and Land Supply
Percent						
Production	-1.46	-0.49	-0.17	-0.93	2.65	1.19
Output Price	3.45	1.15	0.39	2.19	2.44	5.89
Export	-1.59	-0.53	-0.18	-1.01	3.48	1.89
Factor Demands						
Land	-1.59	-0.55	-0.11	-0.67	2.54	0.95
Labor	-1.37	-1.26	-0.09	0.28	2.12	0.75
Chemicals	-1.12	-0.37	-1.13	-0.71	2.89	1.78
Other Factors	-1.33	0.23	-0.14	-2.46	3.23	1.89
Factor Rents						
Land	8.01	-0.69	-0.14	-0.84	3.18	11.18
Labor	-2.75	7.49	-0.19	0.57	4.25	1.50
Chemicals	0	0	0	0	0	0
Other Factors	0	0	0	0	0	0

percent increase in export demand is registered in the *other input* category, estimated to increase by 3.23 percent. The export demand shift results in an increase in LR land rents of 3.18 percent while rent increases for labor is 4.25 percent.

IMPLICATIONS OF 10 PERCENT SHIFTS IN FACTOR SUPPLIES

Simulations of shifts in factor supplies assume a ten percent decrease (upward shifts) in the supply schedules for land, chemicals, labor, and *other factors*. A decrease in land supply might be the

result of Malaysia's firm commitment towards forest conservation and to meet the International Tropical Timber Organization (ITTO) year 2000 objective to achieve sustainability. Owing to the lesser dependency of the country's economy on ex-situ agricultural development, Malaysia's commitment towards forest conservation is likely to sustain. The vast conversion of forest in the 1960s, 1970s and 1980s for agricultural expansion would now no longer be possible, especially in West Malaysia. This scarcity in land supply is modeled as an upward shift in the supply schedule for land in the oil palm sub-sector. Upward shifts in chemical supply schedule might be the result of increased consumer concerns on the impact of excessive use of chemicals on the environment as well as more effective enforcement of regulations affecting the use of chemicals in agriculture. Labor supply might be affected by immigration policy reforms, or greater rural-urban migration for better working conditions. Each factor supply shift is simulated individually.

Production and export decrease resulting from factor supply decreases are generally greater for inputs with larger factor shares especially land, although these effects are confounded with effects related to factor substitutability and supply elasticity. Substitution effects can be observed by examining the effects of a reduction in the supply of labor and other factors. Although production decreases in response to the reduction in the supply of labor, other factors are relatively good substitutes for labor, thus their use increases.

The effects of factor decreases on land prices vary with the factor share of the input that is reduced and with the substitutability of each input with land. For example, labor has a relatively high factor share and is complementary with land. Given this, a decrease in the supply of labor and other factors results in a decrease in the demand for land, resulting in a reduction in land prices. Reductions in the supply of inputs do not increase land demand as none of the inputs are strong substitutes for land.

The final scenario simulates a simultaneous 10 percent upward and downward shifts in palm oil export demand and land supplies, respectively. This models the impact of a simultaneous increase in palm oil export demand and a decrease in land supply. Relative to all other scenarios, output price in this scenario registers the highest increase of 5.89 percent. This is followed by an increase in output production and exports by 1.19 and 1.89 percent, respectively. Demand for all factors of production also shows a fairly strong but

smaller increase relative to the impacts of shifts in export demand alone.

The model results demonstrate the different responses of the output, export and factor markets to the various shifts analyzed. The projected impacts of reductions in factor supply are complex since they are directly influenced by factor shares, factor supply elasticities, and substitution elasticities, as well as by output demand characteristics. Generally, FFB or palm oil production and price will be affected most by decreases in the supply of inputs with the greatest factor shares.

The effects of decreases in the supply of one factor on other factors depend both on the magnitude of reduction of output and the specific substitution relationship with the factor which is reduced in supply. A ten percent reduction in the supply of land as might be caused by sustainable development issues would reduce equilibrium land demand by 1.59 percent and have a strong production effect, provoking a LR decrease in Malaysia's FFB and palm oil production of as much as 1.46 percent. A reduction in the supply of both labor and other factors have comparable effects on production, and factor demands and prices. Given the assumed model parameters used in this study, decreasing the supply of chemicals scenario would have the smallest production and factor effects than decreasing the supply of any of the other input categories. The export demand shift scenario, *ceteris paribus*, is found to provoke the most pronounced responses in output and input markets. Even when land supply is modeled to decrease, an upward shift in export demand shift would still induce significant increases in output production, exports, factor demands and rents.

POLICY IMPLICATIONS

This study portrays explicit linkages between Malaysia's agricultural trade, output production and factor markets. The framework developed in this study can directly be applied to any single commodity as well as the agricultural sector in aggregate.

Model simulations suggest that individual factor supply shifts, *ceteris paribus*, have rather small effects on Malaysia's oil palm production and exports. For instance, a 10 percent decrease in land and labor supply results in a reduction of FFB production by only 1.46 and 0.46 percent, respectively. An individual change in export

demand would provoke pronounced effects on factor markets where a 10 percent increase is found to induce an increase in equilibrium factor demands to the range of 2.12 – 2.89 percent.

Market reforms in Eastern Europe and Central Asia, trade liberalization under the auspices of WTO, and increase in consumer income in traditional importing countries all have the potential to radically increase Malaysia's palm oil export demands. Malaysia's palm oil is enjoying a dominant cost advantage over its competitors in world vegetable oils trade. Exports of substitute vegetable oils by some of the main producers, EU and the U.S. have been heavily subsidized. Thus, the end of subsidized EU and US exports under WTO rules would make Malaysian palm oil even more competitive. This would trigger a momentous pressure on demand for new agricultural lands in the long run. However, the potential surge in export demand for Malaysian palm oil is expected to be accompanied by a decrease in land supply, as forest conservation has become a major concern. Nevertheless, the model results suggest that oil palm production and factor demands could well increase substantially, though to a much lesser degree relative to the impacts of shifts in export demand, individually. East Malaysia, where land is relatively more in abundant is expected to see a significant rise in planted oil palm area. Other resources may also be shifting into palm production and processing in East Malaysia.

Knowledge of the magnitude of these linkages are useful for policy-makers to formulate appropriate policies pertinent to both factor markets and trade to enhance Malaysia's agricultural production and trade competitiveness. For instance, a reduction in labor supply will have a smaller impact on production and trade if the substitution between labor-capital is increased through greater adoption of appropriate technologies.

The direction and magnitude of impacts of the various shifts in this study are contingent on the reliability of assumptions of substitution or complementary relationships between the various inputs. The validity of the AES and the assumptions regarding factor supply elasticities are critical for the robustness of the model employed. This study generates the underlying AES based on available empirical estimates of palm oil output supply elasticity and reasonable assumptions regarding factor supply elasticities. Thus, the AES estimates employed in the model are only second best. Empirical studies on AES for Malaysia's agricultural sector in

aggregate or the oil palm sub-sector are to date non-existent. Further research is needed to estimate the true AES parameters directly, both for Malaysia's major agricultural commodities and the agricultural sector in aggregate.

ACKNOWLEDGEMENT

NOTES

[1] Malaysia is committed towards forest conservation policy and to meet the International Tropical Timber Association (ITTO) objective to achieve sustainability by the year 2000 (Jamal, 1996). Owing to the lesser dependency of the country's economy on ex-situ agricultural development, Malaysia's commitment towards forest conservation is likely to sustain. Thus, the vast conversion of forest (as in the 1960s, 1970s and 1980s) for ex-situ agricultural development would now no longer be possible, especially in Peninsular Malaysia. In this context land supply in the LR is modeled as inelastic (less than 1) but a little higher than that of the SR.

[2] The general form for output supply elasticity (E^s) is:

$$E^s = -[1_N^T \textstyle\sum_{NN}^{-1} 1_N]^{-1},$$

where $\sum_{NN}$ is the matrix of AES, with diagonals equal to ($\alpha_{ii} - c_i^{-1} v_i$). The notations 1_N and 1^T_N are respectively, vector 1's with length 4 (four inputs) and its transpose. The supply elasticities (v_i) can be set to indicate the extent of elasticities, that is, a value of 0 for fixed supply of input i and ∞ for perfect elasticity supply of that input. Given short-run $E^s = 0.12$, the underlying AES and v_i can therefore be extrapolated/generated. Putting back the generated AES and v_i into the E^s equation above will reproduce back the value of $E^s = 0.12$. Using the generated AES and assumption of v_i in the LR, the E^s in the *LR* is found to be equal to 1.08.

[3] Malaysia's palm oil is cost competitive relative to its chief competitor, soybean oil in world trade. The U.S. and EU which are among the world's main exporters of soybean oil subsidise their exports heavily. Therefore, under freer trade in vegetable oils, Malaysia's world market share of vegetable oils is expected to increase substantially.

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