Trade Policy and the Welfare of Southeast-Asian Timber Exporters: Some Implications for Forest Resources

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ABSTRACT

An applied general equilibrium model of the global trade in forest products has been used to assess the impact of tariff and export tax reductions on forestry, the wood processing sector and the agricultural sector. The focus of this study is on Malaysia and Indonesia and the implications for their forest resources. Three key results have emerged: firstly, trade liberalisation does not necessarily lead to increased log production since the real producer's price does not always rise. Secondly, the Uruguay Round tariff changes may make forestry a less-attractive form of land use when compared with agriculture. Thirdly, the proliferation of log export barriers amongst tropical countries has a cartel-like effect; thus elimination of such barriers may be detrimental to tropical exporters.

1.0 INTRODUCTION

Forests perform important environmental and ecological functions: they help prevent soil erosion, provide a habitat for wildlife, and hold much of the world's biodiversity and carbon. In this way, forests are important elements in the process of climate change. With increased population pressure and rapid economic development, much of the world's forestlands have been altered. Although the rate of alteration has now stabilised in the temperate and boreal regions, deforestation continues to be a problem in the tropics. Given the essential environmental functions of natural forests – in particular their role in the preservation of biodiversity and the reversal of climate change – their destruction is of significant global concern.

In Southeast Asia and other tropical areas, the most important cause of tropical deforestation is the conversion of forests for agricultural use. Tropical forestry helps to hasten the process of land conversion by providing access into the forests. The practice of logging itself, with its destructive timber extraction techniques and regenerative investments, also contributes to the overall rate of deforestation. Whether a piece of forestland will be used in forestry or converted for agricultural use depends on which land use option yields the greatest net returns (Hyde et al., 1996). However, since government policies distort the relative returns between different land use options, they can lead to varying forestland alterations. Misguided government policies have often been blamed for hastening deforestation in the tropics. Although the adverse effects may be obvious for policies such as subsidies for timber mills and for conversion of forestland for agricultural use, it is less obvious why certain macro policies, such as trade restrictions, should have a negative effect on forest resources more often than they protect them. Since there are many trade policy distortions in the economy that affect both the returns and relative returns across land-based sectors, it is useful to examine together some of these distortions and their implications for forestland use. In this paper, an applied general equilibrium model is used to examine the effect of a simultaneous reduction in trade taxes in selected forest sectors and the agricultural sector. A general equilibrium model is useful for capturing inter-sectoral interactions such as these. The focus of this study is on Southeast-Asian exporters, namely Malaysia and Indonesia, and the wood sectors analysed are the log, sawnwood and plywood sectors, which are amongst the most important in these countries.[1]

Two types of trade barriers are examined: tariffs and export taxes. In general, trade barriers are perceived to be welfare-decreasing since they distort the allocation of resources away from an efficient level.[2] Environmentalists have also been vocal about intensified deforestation brought about by decreasing trade barriers. They fear that the decline in trade barriers will increase the demand for tropical logs and put further pressure on forest resources. Whether this claim is justifiable is an empirical issue that will be examined in this paper.

Another trade policy that has become pervasive in tropical regions over the last thirty years is that of log export barriers. A variety of export restrictions such as taxes, bans and quotas have been imposed on tropical logs to encourage investments in the downstream wood processing sectors – this policy is also known as 'forest-based industrialisation'. Previous studies on log export barriers have found that these are detrimental to the exporting country because the implicit subsidy to the milling sector is extremely large and the policy therefore tends to perpetuate inefficient milling operations. In this way, the value-added to wood does not offset the loss in the value of wood as the processing sector expands, leading to a huge loss in foreign exchange income (see Bourke, 1988; Gillis, 1988; and Constantino, 1990). However, most of these studies have examined the effect of unilateral imposition of export barriers, and not the effect of simultaneous imposition by several tropical countries. Thus, they have failed to take into account the market power incurred through a simultaneous restriction of the tropical log supply. By comparing the status-quo export barriers on tropical logs with the hypothetical case of all log export barriers being removed, it is possible to discern this effect.

Since the independence of both Malaysia and Indonesia, forestlands in these countries have become state property. Some of these lands are concessioned out to timber companies for harvesting purposes. Although both

[1] Although secondary forest products, e.g. furniture and joinery, are becoming increasingly important as Southeast-Asian exports, they are not considered explicitly in the model due to lack of consistent data.

[2] Privately efficient resource allocation may not necessarily coincide with the socially efficient level if the former does not incorporate the effect of environmental externalities into the decision process. In this paper, we do not attempt to quantify the environmental value of the forest, but instead concentrate on the timber benefits, which are easily identified. However, the discrepancy between privately and socially efficient production must be borne in mind.

countries formulate land use plans by allocating a proportion of forestlands for protection (hydrological), conservation, timber production and so on, there is little or no demarcation of reserved areas in most regions. With the shortage of forestry personnel and a weak political stance against powerful interest groups (particularly in Indonesia), much illegal logging continues. In this way, forestland use is driven by the market forces. In this model, the effect of trade policy changes on the aggregate log production in each region can be discerned. This, in turn, signals the changes in the pressure on the forest resulting from trade policy. Although the model does not incorporate land use decisions explicitly in the agricultural and forestry sectors, it captures the changes in the returns to each land-based sector as trade policy changes. These returns likewise have implications for forestland use. The forestland use conceptual framework from Hyde et al. (1996) is applied to analyse the land use alterations as the returns across the forestry and agricultural sectors change (see Section 8.0 for more discussion). According to Hyde et al. (1996), an increase in the returns to forestry would lead to more logs being extracted. The rise in the log supply may be met through an expansion of the marginal forestland and/or more intensive extraction of secondary forests. If trade policy results in a greater increase in the long-term returns to forestry relative to those of agriculture, then there would be more investment in forestry and further establishment of plantations.

A multi-country, multi-sectoral general equilibrium model such as this is useful for examining the changes in welfare, production, prices and relative returns across the forestry and agricultural sectors that result from a shift in trade policy. However, it is less useful for analysing goods without well-defined markets and prices, such as the environment. Although estimates do exist, their values vary widely. For simplicity, this study disregards the environmental values of forests and concentrates on the economic value of timber only. Thus, this model is restricted to answering the following questions:

1. Does the Uruguay Round 1994 tariff reduction for forest products lead to increased pressure on forest resources through a rise in log production?

2. How do the Uruguay Round changes affect the relative returns between agriculture and forestry? Which type of land use do the changes favour?

3. Do tropical countries benefit from restricting log export supplies? If so, by how much? Could they improve upon this policy?

4. Could tropical exporters gain from free trade?

According to the model, when the Uruguay Round changes are implemented on the log, sawnwood and plywood sectors, both tropical and temperate wood exporters benefit from increased exports. As the Uruguay Round weakens tariff escalation, exports of higher-processed forest products overtake log exports. The most substantial gain goes to Indonesia, the world's top plywood exporter. However, when the Uruguay Round agricultural policy changes are incorporated, the change in the welfare of tropical countries is reversed so that they are in a worse situation than before. Originally, some of these countries had extremely high agricultural import taxes, but the Uruguay Round dictates a 24% reduction in the agricultural tariffs in these regions, and thus a significant fall in tariff revenue ensues. Harvesting rent for the tropical region generally deteriorates because increased agricultural activity puts strain on the unskilled labour market and raises wages. In turn, agriculture becomes more attractive as a land use option compared to forestry. This indicates increasing pressure from agriculture on forest resources following the Uruguay Round policy changes, assuming other factors remain the same (that is, no other policy changes, nor changes in preference and/or technological structure).[3]

When all tropical log export taxes are eliminated, the welfare of tropical regions falls because the large-scale expansion of the tropical log supply depresses the world price. This suggests that tropical regions may be benefiting from the widespread use of log export restrictions. Free trade results in an overall rise in world welfare as expected. However, the gains are very unevenly distributed across regions: while importing regions benefit from such a move through the reduction in consumer prices, the tropical exporting regions suffer significant losses. Despite trade being stimulated, fierce competition leads to a decline in world prices for many exporting regions.

Since the results suggest that tropical countries fare worse under complete trade liberalisation, optimal taxes must exist for these countries. This study carries out simulations for optimal taxes to discern the potential welfare gain for Malaysia and Indonesia both with and without other regions imposing optimal countervailing taxes. The results show that when other regions do not retaliate, Malaysia can benefit from imposing unilateral export taxes, particularly on logs and plywood. The same is true for Indonesia. The improvements are equivalent to approximately 7.8% and 5.3% of agricultural and forest sector income in Malaysia and Indonesia respectively. Given that the main importers of Southeast-Asian forest products are in East Asia, namely, Japan, China, Hong Kong, Taiwan and Korea, these countries suffer the greatest welfare loss from the export restraints. Both Malaysia and Indonesia can benefit from harmonising their export policy on forest products. However, when other regions retaliate, Malaysia and Indonesia are in a worse position than under free trade conditions. Thus, the possibility of a trade war may act as a deterrent to exercising an optimal tax policy.

Forest sector models loosely fall into two types: demand-side and supply-side models. The first type of model has a multi-country, multi-sectoral structure and is typically used for trade policy analysis. The model used in this study

[3] According to Hyde et al. (1996), the forest category that would be affected by the change in the relative returns between forestry and agriculture are forestlands located near to extensive agricultural land and plantations.

belongs to this type. However, the treatment of forestry is often rudimentary (for example, assuming an inelastic supply of logs), so these models are not useful for analysing issues related to forest resource management. The supply-side type of model has a sophisticated timber supply structure, and typically has a dynamic structure with an endogenous harvest decision. Earlier versions assumed that the forest was an exhaustible resource and the optimal harvest path was calculated using the Hotelling framework. However, more recent models use an optimal control approach, with endogenous stand ages, investment decision and forestland use decision (see Adams and Haynes, 1993; Sedjo and Lyon, 1990; and Sohngen et al., 1999). These later models are thus useful for addressing resource management questions. However, demands for forest products in these models are extremely simplified – usually being aggregated into a single global demand – so, they cannot be used to examine the effect of trade policy changes on the global timber supply and its management.

Ideally, to analyse the effect trade policy has on resource management, the first and second types of model should be combined. However, due to the complexity and lack of comprehensive data on stand ages, and on harvest and transportation costs in the tropics, this is not possible. Instead, a simple increasing-cost timber supply function is used to ascertain the implications of the effect trade policy has on forest resources. The model structure used here not only allows the impact of trade policy on log production to be shown for each country, but also discerns its impact on the returns to forestry and the agricultural sector. By recognising the potential effect on production and land use incentives, governments can take measures to prevent further deforestation. It is important, however, to note the drawbacks of this approach. A static model such as this does not take into account changes in technology or consumption that may occur during the implementation of trade policy. Moreover, the harvesting agents are assumed to behave in a myopic fashion. Although there have been no major changes in timber processing technology over the last ten years, some changes to the consumption pattern are likely to have occurred with the creation of synthetic substitutes for wood products. As yet there is no empirical evidence to support this, however. While a static trade model is attractive because it is easy to work with and analytically tractable, proper consideration of resource management issues requires a dynamic framework (more on this in Section 3.1).

The model structure used in this study is closest to the Global Trade Model (GTM) developed by IIASA (1987) which depicts the interaction between several regions engaging in trade in forest resources and wood products. However, the agricultural sector has also been included, due to its important role in the rate of deforestation in Southeast Asia. In this way, implications on forestland use may be drawn from the model. Similar to the GTM, the cost of timber supply is assumed to be increasing with the amount of timber produced; the reason being that as timber output increases, harvesters have to go further into the forests – perhaps into less-hospitable forest regions – so that the access cost increases. The model presented here is, however, different from the GTM in several ways:

1. Given the study's focus on tropical timber and Southeast Asia, the countries have been grouped into regions according to their trading relationship with Southeast-Asian exporters. In addition, only the three forest product sectors deemed most important for Southeast-Asian trade are included in the model: these are the log, sawnwood and plywood sectors.

2. Substitutions between tropical and temperate forest products have been permitted, unlike in previous forest trade models. Empirical evidence shows that tropical and temperate forest sector markets are not separate, as opposed to the assumptions made by the previous models (such as the GTM, 1987 and Sohngen et al., 1999). Thus, these models are likely to have overstated the tropical exporters' market power. This model also assumes some small but positive substitution elasticities between tropical and temperate products.

3. Unlike the GTM, timber supply is endogenised for all regions in this model, capturing the pressure on the forest in each region following tariff changes. In this way, trade policy that affects the supply of tropical logs would have an impact over temperate forest resources, and vice versa.

4. This model is static. By disregarding the dynamic framework, the model is much simpler to deal with. However, there are some drawbacks to this method. Without the dynamic structure, investments in timber regeneration and the associated flows of benefits are not considered explicitly in the model. Furthermore, since the ability to plan and capture the flow of timber benefits is a crucial element that differentiates a private/state property regime from an open-access regime, a static model does not provide a good framework for analysing the issue of property rights. In a static forestry model where the log-harvesting sector is perfectly competitive, the open-access harvest equilibrium will coincide with that of the private-property regime (P=MC=MR). This result is an outcome of the model setup. If the model were dynamic or if environmental costs were incorporated, then the open-access harvest equilibrium would differ from the private-property equilibrium.[4] The issue of property rights is discussed in more detail in Section 3.1.

This study concentrates on modelling the demand side, which is important for trade policy analysis. Since only four sectors of the economy are examined here, this analysis neglects the impact of the Uruguay Round changes on the rest of the economy, and consequently their repercussions on the forest and

[4] With the setup of this model, the only difference between the two regimes comes from the resource rent which may be dissipated through rent-seeking in the open-access regime. This is because each firm in the open-access case perceives its marginal revenue as equal to the price (i.e. average revenue). Thus, each one ignores the negative effect an increased number of firms has on the forest, such as congestion cost, land degradation, soil fertility loss, extensive harvesting, and so on.

agricultural sectors.[5] Although it has been assumed that each sector produces one output, in reality many types and qualities of product exist within each sector. These details are omitted in the aggregation but could be incorporated at the cost of a much bigger and more complicated model. Where necessary, the ad valorem equivalent of non-tariff barriers has been used. However, the agricultural sector is particularly problematic since the base levels for tariff cuts have been inflated for many countries so that the agreed reductions are from these high levels, not from the actual tax levels of 1994. In this way, the calculated gains in tariff reductions may have been exaggerated. It is important to note that the model incorporates only one of the many benefits of the forest. By focusing on the economic value of timber, other values, including environmental benefits, fruits and medicines, have been missed. Thus the equilibrium log production reached is not the socially efficient level, and it is likely to be larger than the socially preferred outcome. These inadequacies must be borne in mind when interpreting the results. Nonetheless, this paper serves to illustrate how changes in trade policy can alter production and forestland use patterns through changes in the returns and relative returns of various land use sectors, such as agriculture and forestry. Understanding these effects is useful for tropical countries where property rights over large areas of forests are not properly defined or enforced.

The remainder of the paper is organised as follows: Section 2.0 gives a brief overview of the global forest products trade and the role of Southeast Asia accordingly. Section 3.0 outlines the model, while the data used in the model is discussed in Section 4.0. The results of the tax reductions are presented and discussed in Section 5.0, focusing primarily on trade flows, outputs, relative returns between different land use activities, terms-of-trade effects and the welfare of various regions. Section 6.0 presents the results and analysis of optimal tax. A number of sensitivity analyses are carried out on the model parameters in Section 7.0, and the paper concludes in Section 8.0 with a discussion of the progress towards trade liberalisation and its implications for the forest sector.

2.0 THE GLOBAL FOREST PRODUCTS TRADE AND THE ROLE OF MALAYSIA AND INDONESIA

Although many countries are involved in the international trade of forest products, the majority of imports and exports can be attributed to only a few countries (see Table 1). In 1996, five countries accounted for 53.6% of the world exports of forest products; while on the import side, five countries accounted for 49.2%. The USA and Japan alone were responsible for almost 30% of the

[5] The biggest reductions in the Uruguay Round take place in the manufacturing sector (e.g. voluntary export restraints and the Multifibre Arrangement (MFA) to be phased out over ten years), with ASEAN countries, such as Malaysia and Indonesia being expected to gain significantly from the MFA abolition through increased exports. This is likely to put strain on the unskilled labour market and thus introduce upward pressure on wages. Timber rent would fall and a negative impact on forest and agricultural production is probable.

world's total forest products imports. On the whole, the developed countries dominate the overall trade in forest products. This is particularly true for trade in pulp, paper/ packaging, and paper/paperboard. Malaysia is the largest exporter of tropical logs, but it ranks third in terms of exports of all logs, after the USA and Russia. Malaysia also dominates the exports of tropical sawnwood (3.7 million m^3 exported in 1996), making it the fifth-largest exporter of all sawnwood. Indonesia has been a key exporter of tropical sawnwood, but its exports declined between 1995 and 1996 to 440,000 m^3 due to high export levies. The only wood export category that is dominated by developing countries is plywood: Indonesia alone accounts for 46% of world exports, while Malaysia and Brazil account for a further 17% and 4% respectively. Since Malaysia and Indonesia play a major role in the trade of logs, sawnwood and plywood, this model will concentrate on these forest sectors only. In addition, although Malaysia and other Southeast-Asian countries are becoming significant exporters of furniture products, this sector will not be examined in this paper because the data is neither routinely provided by the FAO, nor is it reliable for these products as yet.

Table 1: Top 10 Importers and Exporters of Forest Products in 1996

Importers	*1000 US$*	*(%)*	*Exporters*	*1000 US$*	*(%)*
USA	22,147,000	(16.7)	Canada	25,333,000	(19.1)
Japan	15,424,000	(11.6)	USA	16,974,000	(12.8)
Germany	11,370,000	(8.6)	Finland	10,997,000	(8.3)
UK	9,627,000	(7.2)	Sweden	10,301,000	(7.8)
China	6,761,000	(5.1)	Germany	7,555,000	(5.7)
France	6,650,000	(5.0)	Indonesia	5,207,000	(3.9)
Netherlands	5,363,000	(4.0)	France	4,193,000	(3.2)
Italy	5,291,000	(4.0)	Malaysia	4,158,000	(3.1)
Belgium-Lux	3,803,000	(2.9)	Austria	4,150,000	(3.1)
Spain	3,464,000	(2.6)	Brazil	3,235,000	(2.4)
World Total	132,884,000	(100.0)	World Total	132,884,000	(100.0)

The main export market for Malaysian and Indonesian wood products is in the Asia-Pacific region. Japan, the key importer in this region, imported just over 50% of Malaysian log exports and slightly less than 50% of Indonesian sawnwood exports in 1996. The precise distribution of Malaysian log exports in 1996 was as follows: Japan (50.1%), Taiwan (17.7%), Korea (6.5%), and China (1.9%). Thailand was the largest importer of Malaysian sawnwood (28.6%), followed by Japan (13.9%), Korea (11.2%), the Philippines (9.3%), Taiwan (8.3%), and China (5.3%). For Indonesia, the major importers of its sawnwood were Japan (46.8%), Malaysia (24.4%), and China (18.5%). Japan was also the largest importer of Indonesian plywood (41.3%), followed by the USA (9.1%), Korea (8%) and China (5.5%). Thus, the major consumers of Southeast-Asian primary wood products are Japan, China, Taiwan, Korea, Thailand, the Philippines and the USA. In this model, Japan, China, Taiwan and Korea have been aggregated into one region. This is partly due to their trading position with Southeast-Asian exporters and partly because they are located in the same eco-floristic zone. The Philippines and Thailand, on the other hand, are grouped with the other tropical regions.

3.0 MODEL SPECIFICATION

3.1 Applied General Equilibrium (AGE) model

Countries involved in forest products trade have been grouped into different regions according to their trading relationship with Malaysia and Indonesia, and their eco-floristic zone. There are five regions as follows:

1. Malaysia
2. Indonesia
3. Asian Importers (Japan, China, Taiwan, Hong Kong and Korea)
4. Other Tropical Region (consists of both exporters and importers from tropical regions, such as Brazil, Papua New Guinea, Cameroon, Côte d'Ivoire, Thailand and the Philippines)
5. Other Temperate Region (the rest of the world)

The model consists of four sectors: three wood product sectors and the agricultural sector. The wood product sectors are logs (or the harvest sector), sawnwood and plywood, which are the main forest product exports of Malaysia and Indonesia. By explicitly incorporating the agricultural sector, the resultant returns to the agricultural sector and to forestry following trade policy changes can be compared. All four products are assumed to be tradable, and an Armington trade structure has been adopted so that each product is differentiated across the regions. This assumption allows for intra-industry trade amongst countries, which is observed in forest sector trade (Vincent et al., 1991). There is one representative consumer of these four products in each region.[6] For simplicity, it was assumed that the tax revenue accrued to the government in each region is transferred to the representative consumer in the respective region. In this way, the government need not be modelled explicitly. The various agents and firms in different sectors of the economy are connected through a 'circular flow': the productive sectors are assumed to purchase inputs (labour and capital) from a representative household in each region and generate a value-add by using

[6] It may be more intuitive to think of the representative consumer as a downstream productive sector, consuming intermediate goods such as logs, sawnwood, plywood, and agricultural goods; this does not alter the results. This issue is discussed in more detail in Section 3.3.

them in the production process. In turn, households receive income by supplying factor services. It is assumed that there are no savings, so households spend all their income on goods. Finally, all productive sectors are assumed to be perfectly competitive. Such production and consumption decisions yield supplies and demands in various product and factor markets. These supplies and demands are equalised through relative price adjustments.

The general equilibrium model is made up of three sets of structural equations: production, consumption and market equilibrium. To facilitate the presentation of the model, diagrams have been used (Figures 1, 2 and 3) to illustrate the production and demand structure, details of which are given in Sections 3.2 to 3.4. The treatment of trade taxes is described in Section 3.5 and Section 3.6 discusses the limitations of the model.

3.2 Production Structure

All regions have the same production structure for each output. The structure varies from a simple nested function for the agricultural sector to a three-level nested function for the wood-processing sectors[7] (see Figure 1). Constant elasticity of substitution (CES) production is assumed at each nest, which allows for a certain degree of substitution between various inputs.[8] The production function at each nest is thus

$$Q = \gamma \cdot \left[\Sigma_i (\alpha_i \cdot D_i)^{(\sigma-1)/\sigma} \right]^{(\sigma/(\sigma-1))}, \text{ for all regions} \qquad (1)$$

where

Q is the output or the composite input

i is the index for inputs into Q

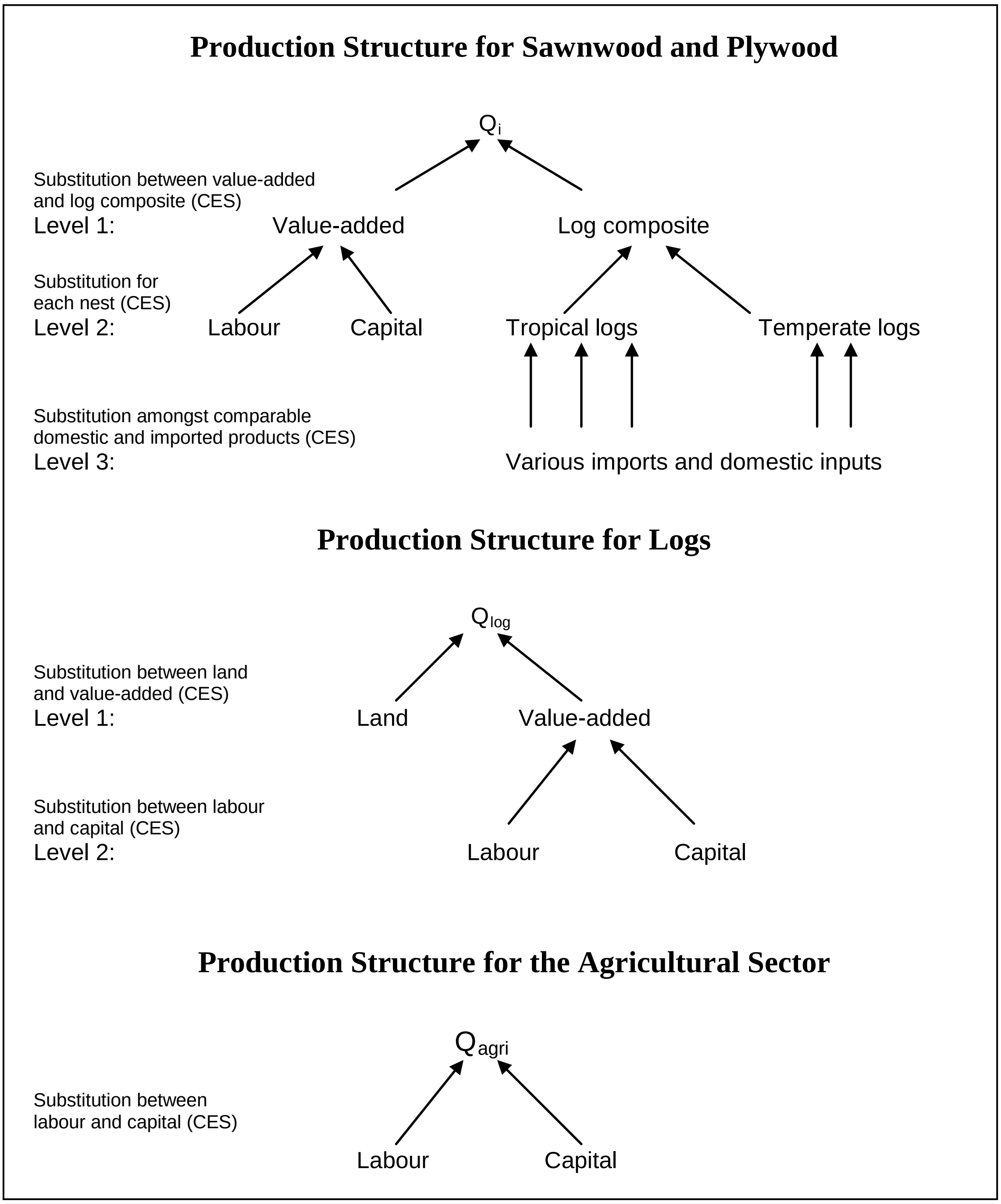
D_i is the demand for input i

α_i is the input share parameter, where $\Sigma_i \alpha_i = 1$

σ is the elasticity of substitution.

[7] Since the focus here is the effect had on the forest sector by trade policy, a more complex production structure has been used for this sector.
[8] CES is more flexible than the Cobb-Douglas function since it allows own price elasticities of demand for inputs to be different from one.

Figure 1: Representation of Supply for the Model, for Each Region



The demand for inputs at each nest is derived through the process of production cost minimisation. For a CES production function, the demand for input is,

$$D_i = \gamma^{-1} \cdot Q \cdot [\alpha_i + (1-\alpha_i)[\alpha_i \cdot D_i / (1-\alpha_i) \cdot D_j]^{(1-\sigma)}]^{(\sigma/(\sigma-1))}, \quad \text{where } j \neq i. \qquad (2)$$

As mentioned, the production structure of sawnwood and plywood is the most complex in the model since there are three levels of nests. The multi-level nesting structure enables the differences in the elasticity of substitution between different inputs to be incorporated into the same production. Level 1 is a CES function between two composite inputs: value-added (that is, a labour-capital composite) and a log composite. Level 2 is a CES function between hardwood and softwood logs, and Level 3 captures the substitution amongst logs of the same type (tropical type and temperate type), or 'substitution by origin'. Softwood is assumed to come from temperate regions, while hardwood comes from tropical regions. These assumptions are reasonable given the actual production and trade flows data. Thus, the second-level nest essentially accounts for the substitution possibility between tropical and temperate logs. Treating tropical and temperate wood products as substitutes is novel in forest products trade models. However, this structure provides a better representation of the actual market since previous empirical studies have found that the elasticities of substitution across wood types (tropical and temperate woods) are positive – although the values are much smaller than the elasticities of substitution by origin (Vincent et al., 1991).

Logs are used as intermediate inputs into sawnwood and plywood production. As this is a static model, it is unable to solve for the optimal rate of harvesting over time; thus agents are assumed to be myopic.[9] An increasing cost function similar to the GTM is used to capture the interaction between the supply of timber and the changes in government policy.[10] There are various reasons for this: for example, harvesters may have to go further into the forests, maybe into a less-hospitable part of the region or lower-quality forestland to increase production. The increasing marginal cost of harvesting is represented by:

$$MC(Q_{log}) = \eta \cdot Q_{log}^{\omega}, \qquad \eta, \omega > 0 \qquad (3)$$

where

Q_{log} is the quantity of logs produced

η is the scale parameter

$1/\omega$ is the short-run elasticity of log supply.

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[9] Abstracted from a feature of forestry, that is "forest inventory is a productive capital" (Hyde, 1991). In dynamic models, this issue would have been dealt with using an optimal control approach.

[10] A traditional way of setting up this type of problem in AGE is to use an activity matrix. In the activity matrix, forestlands are divided into different land classes – they may be differentiated by productivity, topology, proximity to roads and rivers, outputs, etc. Each forest land class in turn requires its own fixed combinations of inputs per unit of timber production, thus a leontief production function is used. However, due to limited data availability on the quality of forestland and cost of harvesting in many regions, this study has opted for the GTM harvesting specification. Although less theoretically rigorous, it is easily implemented with a minimal data requirement.

Since $MC(Q_{log}) > 0$, the harvesting cost is an increasing function of the volume of logs produced. Differentiating $MC(Q_{log})$ with respect to the volume of log production gives

$$\partial MC(Q_{log})/\partial Q_{log} = \eta \cdot \omega \cdot Q_{log}^{\omega-1} > 0, \qquad (4)$$

so the harvesting cost rises more than proportionately as more logs are produced. Note that $MC(Q_{log})$ is also the supply curve for logs. Similar to the GTM, this model assumes that all of the ω are invariant with respect to the harvest level. Most of the existing data on the elasticity of log supply is out of date, nonetheless it is the best estimates currently available. There are independent estimates of these elasticities for the USA and Sweden only (Adams and Haynes, 1980 and Hultkrant, 1985). For all the other countries, the model uses the GTM's estimates which have been derived from the advice of GTM collaborators and their own judgement as to whether the stumpage supply in a particular region tends to be more or less elastic than in North America and Scandinavia. The weighted average ω has been calculated for each region using log production weights. The values of ω are presented in Table 2.

The difference between the price per unit of log[11] and the harvesting and access cost for that unit is known as the "stumpage value". Since the cost of logging increases as more logs are produced, the stumpage value declines as the volume of logs rises. The revenue-maximising harvesters will harvest up to where the returns from harvesting one more unit of timber is equal to the marginal cost of harvesting that unit, that is:

$$P^{p}_{log} / P^{uc} = \eta \cdot Q_{log}^{\omega} + \pi / Q_{log} \qquad (5)$$

where

- P^{p}_{log} is the producer's log price
- P^{uc} is the unit cost of log production, included to ensure there is money neutrality in the harvesting decision
- π is the risk and profit factor which is assumed to be constant.

Equation 5 gives the equilibrium harvest output. This equilibrium is illustrated in Figure 2. From $MC(Q_{log})$, we derive the total harvest cost, TC:

$$TC = [\ (\ \eta \cdot Q_{log}^{(\omega+1)}) / \omega+1\ \ ] + \pi \qquad (6)$$

It is assumed that labour and capital provide harvesting services in a fixed ratio in this sector and that the total harvest cost net of the risk and profit cost is

$$TC - \pi = w \cdot L + r \cdot K \qquad (7)$$

[11] Although log prices vary between species and log quality, one type of log with an average log price has been assumed for each region.

where

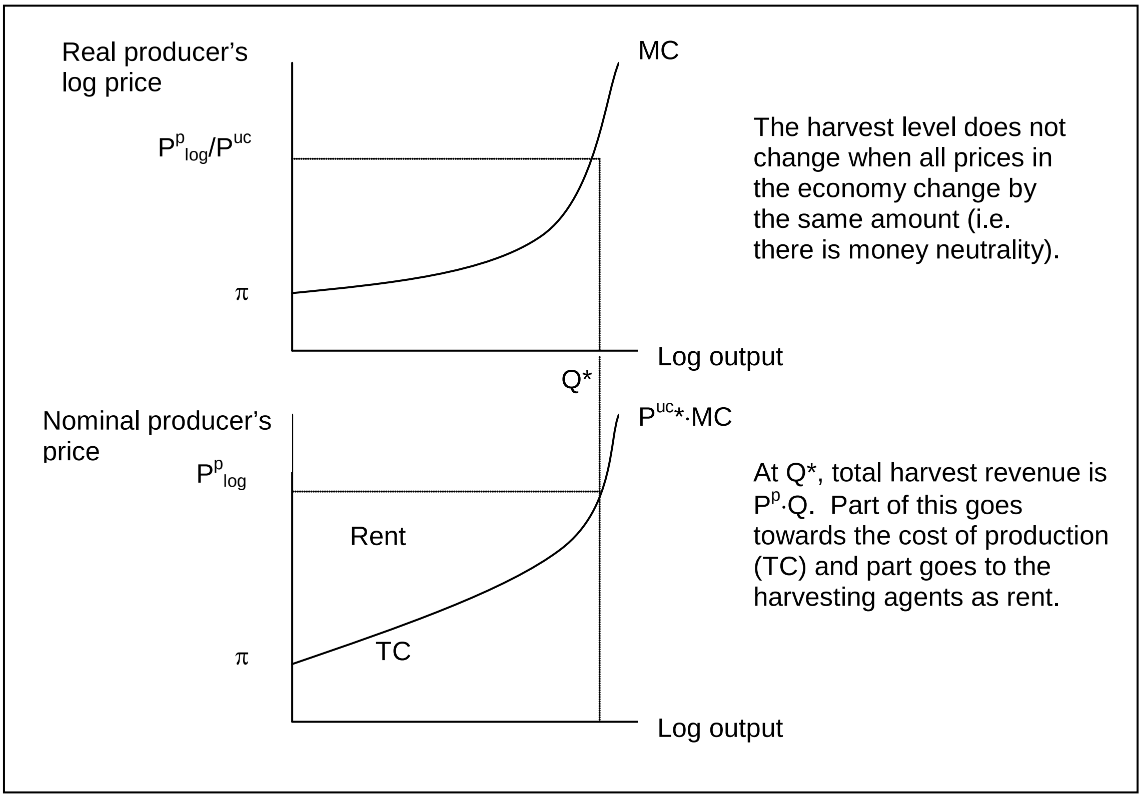
w is the cost per unit of labour

r is the cost per unit of capital

and the harvesting rent is

$$RENT = P_{log} \cdot Q_{log} - TC \tag{8}$$

Figure 2: The Equilibrium Harvest Level, Q*



The issue of property rights has not yet been raised. In general, when property rights are well-established, each competitive harvester will harvest up to where the marginal revenue from extracting one more unit of timber is equal to the marginal cost, as shown above. The difference between the total revenue and total cost of production is the resource rent that accrues to the concessionaire. However, as Hyde et al. (1996) point out, sometimes the cost of establishing property rights is too high (for example, in remote parts of the forests), so that property rights are absent and the forests are treated as open-access resources. In an open-access regime, each firm in a competitive industry would harvest up to where the average revenue (AR) or the producer's log price, is equal to the marginal cost (MC). When property rights are enforced, the profit-maximising producer would harvest up to where MR = MC. Since AR = MR in a perfectly competitive industry, the log production equilibrium in an open-access regime is the same as the equilibrium in the state/private-property regime in this model.

The only difference between the two regimes lies in the resource rent in this setup. If open access brings about rent-seeking costs (through congestion, land degradation and so on), the total resource rent would be lower under the open-access regime (that is, the MC curve shifts up in Figure 2).[12] In an extreme scenario, rent would be driven to zero. The harvesting equilibrium under both the open-access and private-property regimes coincides because of the assumption here on the structure of the timber market (being a perfectly competitive market) and because the model is static. The latter implies that the uncertainty over future timber revenues associated with open-access forestry is not captured in this model. In a dynamic model, an open-access regime implies an insecure land tenure. This, in turn, destroys incentives to manage forest resources over time because leaving potential rents behind would only risk others benefiting from them. Thus too many forests are logged too quickly, leading to land degradation, loss of soil fertility and rapid conversion of marginal land, among other negative consequences. These 'cut and run' forest practices, due to insecure land tenure, are the main cause of inefficiency.[13] Since the static model used in this study cannot provide great insight into the question of property rights, this issue is not dealt with in this paper.

The agricultural sector is assumed to have a simple CES value-added production function with labour and capital services as inputs. Land input is subsumed in the capital component. In this way, the model does not capture the possibility of forestland conversion to agricultural use explicitly. The forestry sector is, however, linked to the agricultural sector through other inputs, such as labour and capital.

3.3 Consumption Structure (Or 'Downstream Productive Sector')

As already mentioned, an assumption has been made of each region having one representative household with a Cobb-Douglas utility function subject to a household budget constraint. All regions have a three-level nested demand structure. In the top nest, the utility of each region is defined over composites of domestic and comparable imports for consumption: these are sawnwood, plywood and agricultural composites. All the other nests are represented by a CES demand function (see Figure 3). The second-level nests capture the allocation of demand between imports and domestically comparable products in the plywood and agricultural sectors. To model the effect of hardwood and softwood substitution in sawnwood, an extra nest has been added to the sawnwood demand structure. This nest represents the allocation of demand between the two sawnwood composites – hardwood and softwood –

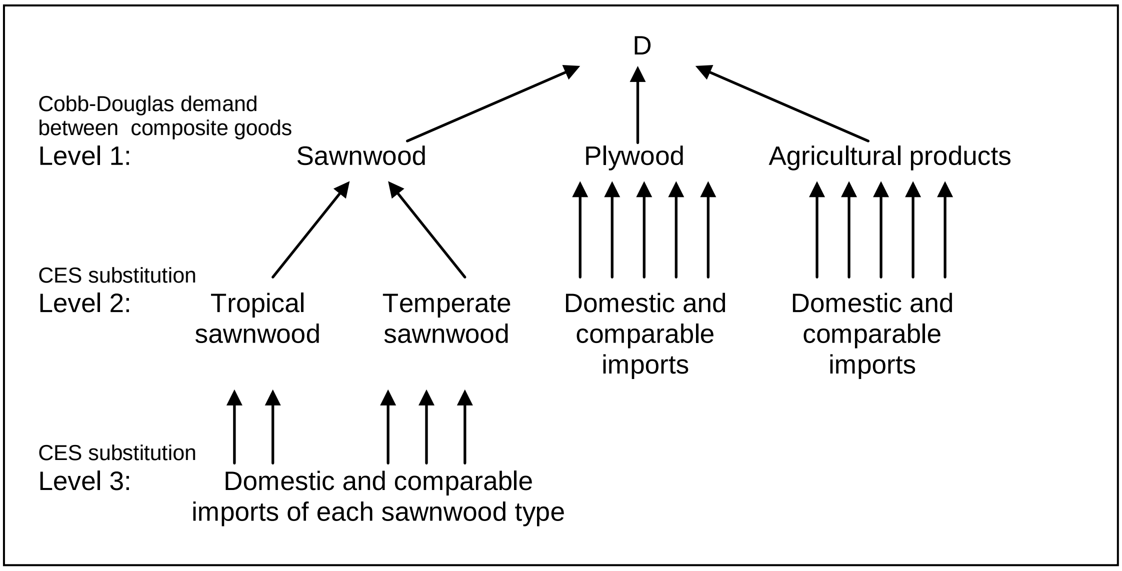
[12] Here, each firm continues to harvest, while ignoring the cost it imposes on other firms through congestion.

[13] Note, however, that even with secure land tenure (i.e. property rights are present), if private and social benefits do not coincide, then without government intervention, a socially efficient harvest level would not be reached. This is the case if there are externalities, such as biodiversities, carbon sequestration, etc. With positive environmental externalities from the forests, private agents are likely to harvest beyond the socially optimal level.

followed by a lower nest which captures the demand allocation between imports and domestically comparable sawnwood in each composite.

Intuitively, the representative consumer in each region is equivalent to a downstream productive sector that employs sawnwood, plywood, or agricultural goods, or any combination of the three, as intermediate inputs. In this way, only a subsection of the economy is modelled. This subsection is, however, characterised by its employment of land-based inputs. Data limitations have prevented further downstream industries, such as furniture production, from being modelled. Unfortunately, this means that the interaction between the four sectors represented in the model and the rest of the economy is not captured. Thus, when welfare changes are referred to, they are those of the sectors that use the four intermediate inputs under consideration and not of the rest of the economy.

Figure 3: Representation of Demand for the Model, for Each Region



The final demand for each of the representative households in each region is generated by maximising a nested Cobb-Douglas utility function, subject to the household budget constraint as follows:

$$U = \Pi_i \, [D_i^{\alpha i}] , \quad \text{for all regions} \tag{9}$$

where $\Sigma_{i,} \ \alpha_i = 1$, and expenditure must be less than or equal to the total disposable income.

$\Sigma_i \ D_i \cdot P_i \leq \Sigma_f \ w_f \cdot L_f$ + total harvest tax revenue + total import and export tax revenue (10)

where

i is an index for different consumer goods

$D_i \cdot$ is the demand for goods

P_I is the consumer price of goods

$\Sigma_f \; w_f \cdot L_f$ is income from endowment of capital and labour.

As it is more intuitive to think of the representative consumer as another downstream productive sector using agricultural and forest products as intermediate inputs, the utility will be an output (U = Q), and the income constraint becomes a zero profit condition, in which the total revenue is captured by $\Sigma_i \; D_i \cdot P_i$. This term must be equal to the total expenditure, which is represented by the total wage bill ($\Sigma_f \; w_f \cdot L_f$) plus tax to the government.

3.4 Market Equilibrium Conditions

The AGE model is based on the neo-classical economic theory of producer and consumer behaviour: that is, markets are assumed to be perfectly competitive, demand and supply functions are homogenous of degree zero in prices, and Walras's law of demand is assumed to hold in the equilibrium. Thus the following conditions must be satisfied:

a) Producers' income in each industry must be equal to the cost of production for all regions (zero profit condition).

b) The demand for goods must be equal to the supply of goods in each industry for all regions.

c) International market clearing conditions require that the export supply equals the total imports for all traded products in each region.

3.5 Treatment of Trade Taxes

Export taxes reduce income to producers by an amount that is proportional to the extent of the tax. Total income from exports to a producer is thus:

$$P^p \cdot X = (1 - t^x) \cdot P^w \cdot X \qquad (11)$$

where

P^p is the producer's price

P^w is the world price

t^x is the export tax

X is the quantity of exports.

Thus $t^x \cdot P^w$ is the tax revenue accrued to the government. In a partial equilibrium framework, an export tax reduces the producer's price. Therefore, its elimination is expected to raise the producer's price and the supply of the product. In a general equilibrium framework, however, the inter-market interactions make the direction of change of the producer's price ambiguous, and thus the effect on the production supply uncertain.

Import tariffs, on the other hand, raise the price faced by consumers above the world price, as follows:

$$P^d = (1+ t^m) \cdot P^w \qquad (12)$$

where

P^d is the consumer's price

t^m is the import tax.

In this way, import tariffs tend to reduce the domestic demand for imports. The reduction of tariffs is therefore likely to make imports more competitive relative to domestic products.

3.6 Limitations of the Model

The model structure presented in this paper is typical of the Applied General Equilibrium class of simulation models. These models are very stylised, and their structures are kept theoretically consistent to make the analysis tractable. Perfectly competitive forest and agricultural markets have been assumed here, and consequently production and trade data has had to be adjusted in several ways to make it consistent with the neo-classical model. For example, consumer expenditure had to be equal to consumer income, total demand had to equal the total supply of goods with zero profit, and so on. Since only four sectors are included in the model, a partial view of the economy is provided. Within these four sectors, several product types have been aggregated to simplify the analysis. However, product aggregation makes the analysis insensitive to the diversity of products and policies within the log, sawnwood, plywood and agricultural industries. Furthermore, many countries have been aggregated into regions. While this should not affect the Uruguay Round analysis, it is likely to exaggerate the market power of the aggregated region in the optimal tax simulations in Section 6.0. Nonetheless, the current setup is sufficient to provide an overview of the effect trade policy has on these industries.

Finally, given that the model is static, the log supply specification is rather crude and environmental values of the forests are not taken into account, the model cannot be used to address the issue of forest management directly. However, it can be used to make some inferences from the changes in log and agricultural production resulting from trade policy shifts.

(See Appendix 1 for details of how the model could be improved.)

4.0 BASE YEAR DATA

Data used in the model is divided into four groups: (1) production and trade, (2) input-output, (3) elasticities of substitution, and (4) trade barrier data. The sources of each group are outlined below. Only the data on substitution elasticities and trade barriers is presented in this paper, with the rest of the data being available from the author.

4.1 Production and Trade Data

The year 1996 has been chosen for the analysis to avoid the results being affected by the Asian economic crisis, which began in mid-1997. The main source of data on the production, trade and direction of trade in logs, sawnwood and plywood is the FAO Yearbook of Forest Products (1997), supplemented by the UNCTAD-TRAINS Database which has a more detailed account of bilateral trade flows. The term 'log' used refers to sawlogs and veneerlogs, which are entered as inputs into the production of sawnwood and plywood. However, as there is no trade flow data for sawlogs and veneerlogs, the trade flow shares of industrial roundwood[14] have been used to calculate the trade flows of sawlogs and veneer logs. The total demand for sawlogs and veneer logs for each country is calculated by using the log conversion ratio (CR = log input(m^3)/processed output (m^3)) in the sawnwood and plywood production. Let Q_{sw} and Q_{pw} be the sawnwood and plywood production respectively, thus

$$\text{Total demand for sawlog input in region r } (m^3) = CR^r_{sw} \cdot Q^r_{sw} \ (m^3) \qquad (13)$$

and

$$\text{Total demand for veneerlog input in region r } (m^3) = CR^r_{pw} \cdot Q^r_{pw} \ (m^3) \qquad (14)$$

The log conversion rates were taken from secondary sources (for example, the Forestry Research Institute of Malaysia; Cardellichio et al., 1989; Pfeiffer, 1980; etc.). A weighted-average conversion ratio was then calculated for each region using production weights.

The FAO agricultural website was the main source of production and trade data for the agricultural sector, while the Handbook of International Trade and Development Statistics (1996/97) was consulted on the direction of agricultural trade.

4.2 Input-Output Data

Statistics on labour, capital and log inputs into industries were calculated using the data from the GTAP database, supplemented by data from the Forestry Department, Peninsular Malaysia and Malaysian Timber Council publications, together with company data from Indonesia.

[14] The regional bilateral trade flow shares are calculated by dividing each bilateral trade flow by the total exports of that region.

4.3 Elasticity Specifications

Secondary sources were consulted for the elasticity values. Several price elasticity estimates of supply and demand for Southeast-Asian timber are listed in Barbier (1995) and in Hyde et al. (1991). These were converted into substitution elasticities using the following formula presented in Shoven and Whalley (1992):

$$P.E.D \quad = \quad -\sigma - \frac{b_i \cdot (1-\sigma)}{p_i^{(\sigma-1)} \cdot \sum_j b_j p_j^{(1-\sigma)}} \qquad (15)$$

where

σ is the substitution elasticity and

b_i is the share or weighting parameter of the CES production function.

p_i is the consumer price of goods in the relevant nest.

Various econometric studies have attempted to estimate the elasticities of substitution for different forest products. There is a consensus amongst the studies that the elasticities of substitution across species groups (that is, between tropical and temperate regions) are significant but relatively low, whereas elasticities of substitution within a species group for tropical sawnwood and plywood are very high (see Constantino, 1988 and Vincent et al., 1991). This suggests that the markets for tropical and temperate forest products are somewhat distinct. Elasticity values for forest products trade are thus compiled with these results in mind.

Turning to the elasticities of substitution between productive inputs, these are found in Whalley (1985) and Kallio (1987, p.149). All the elasticities have been scaled up or down about unity to aid computation. Table 2 displays the elasticity values used in the model.

4.4 Trade Barriers on Forest Products

Various sources have been consulted for data on tariff barriers; for example, Bourke and Leitch (1998), UNCTAD (TRAINS Database), Barbier (1999), the Malaysian Timber Council and the WTO (1994). In turn, import-weighted average tariff rates were calculated for each region. The details of the import and export taxes and their anticipated effects are discussed below.

Table 2: Elasticities

	Malaysia	Indonesia	Asian Importers	Other Tropical Region	Other Temperate Region
Consumer's demands: elasticity of substitution					
Between composite final goods	0.86	0.86	0.78	0.88	0.78
Between temperate and tropical sawnwood	1.15	1.15	1.15	1.15	1.15
Between sawnwood from temperate region	2.5	1.19	2.2	1.89	2
Between sawnwood from tropical region	2.5	2.5	2.5	2.93	2.34
Between plywood from all sources	1.106	1.106	1.106	1.106	1.106
Between agricultural products from all sources	1.66	1.66	1.66	1.66	1.66
Sawnwood production: elasticity of substitution					
Between value-added and logs	0.64	0.61	0.63	0.68	0.64
Between labour and capital	0.5	0.5	0.4	0.5	0.4
Between tropical and temperate log composite	0.75	0.73	0.85	0.87	0.93
Between temperate logs	2.25	2.2	1.52	1.51	1.84
Between tropical logs	2.25	2.2	1.52	1.51	1.84
Plywood production: elasticity of substitution					
Between value-added and logs	0.62	0.64	0.63	0.65	0.66
Between labour and capital	0.5	0.5	0.4	0.5	0.4
Between tropical and temperate log composite	0.75	0.73	0.85	0.87	0.93
Between temperate logs	1.8	1.9	1.3	1.3	1.8
Between tropical logs	1.8	1.9	1.3	1.3	1.8
Agricultural production: elasticity of substitution					
Between labour and capital	0.4	0.4	0.3	0.4	0.3
Log production					
Inverse elasticity of log supply (ω)	2.67	2.67	2.68	2.03	2.69

4.4.1 Import Taxes

Most tariffs on forest products had already reached low levels before the Uruguay Round, being less than 5% for most products. The Uruguay Round is expected to have a limited impact on imports such as logs and sawnwood. Wood-based panels and higher-processed products, such as plywood and furniture, which previously faced tariff rates of 10% and above, are likely to benefit most. Many exporters from developing economies have been able to avoid the full MFN rates through special preference schemes, such as the

Generalised System of Preferences (GSP).[15] This is reflected in the lower import tariffs for some regions in Tables 4, 5 and 6. It is expected that the competitive benefit of GSPs to developing countries such as Malaysia and Indonesia, and 'Other Tropical' timber exporters will be reduced as the MFN tariffs decline through the Uruguay Round measures. When carrying out the model simulations, it has been assumed that there are no changes in the GSP tariffs. Given that most tropical countries faced the GSP rates prior to the Uruguay Round, the trade-weighted changes in tariffs facing these countries post-Uruguay Round are expected to be smaller than those faced by the developed countries. In turn, there could be some trade diversion away from developing countries towards developed countries' imports. The elasticity of substitution between wood products from different sources will be crucial in determining the extent of such trade diversion. The pre-Uruguay Round weighted average tariff rates for each region and each production category are displayed in Tables 3 to 5. Not only are they substantially higher in developing countries than in developed countries, but in general, tariffs on wood products tend to escalate with the degree of processing.

Note: In tables below, columns represent exporters and rows represent importers.

Table 3: Tariff Rates for Logs (percentages)

	Malaysia	*Indonesia*	*Asian Market*	*Other Tropical*	*Other Temperate*
Malaysia		0.0	0.0	0.0	0.0
Indonesia	0.0		0.0	0.0	0.0
Asian Market	0.5	0.6		0.7	0.4
Other Tropical	0.2	0.0	0.0		7.5
Other Temperate	0.3	0.8	0.3	0.1	

No change here since developed countries' import tariffs are already zero, while developing countries have opted for higher bound rates post-Uruguay Round.

Table 4: Tariff Rates for Sawnwood (percentages)

	Malaysia	*Indonesia*	*Asian Market*	*Other Tropical*	*Other Temperate*
Malaysia[1]		0.0	0.0	0.0	0.0
Indonesia[2]	1.0		10.0	10.0	10.0
Asian Market[3]	3.1	2.4		2.5	7.5
Other Tropical[4]	0.3	2.6	0.2		8.4
Other Temperate[5]	0.3	0.7	0.8	0.5	

1. No change since Malaysia already has zero tariffs.
2. No change since Indonesia has opted for a uniform high rate for all forest products.
3. Malaysia, Indonesia and the Other Tropical region face a 10% reduction in tariffs, while the Other Temperate region faces a 30% reduction in the MFN tariffs. This is because most developing countries have been facing GSP rates for exports to Japan.

[15] Under this scheme, a developed importing country offers lower tariffs to selected developing countries without requiring reciprocal benefits. However, Taiwan, Korea, China, Hong Kong and Singapore have had GSP privileges removed by many developed countries.

4. No change for Other Tropical exporters since most are opting for higher bound rates.

5. No change because most of the exports to the Other Temperate region were facing GSP rates originally.

Table 5: Tariff Rates for Plywood (percentages)

	Malaysia	*Indonesia*	*Asian Market*	*Other Tropical*	*Other Temperate*
Malaysia[1]		45.0	45.0	45.0	45.0
Indonesia[2]	20.0		20.0	20.0	20.0
Asian Market[3]	8.1	8.1		6.0	6.0
Other Tropical[4]	11.8	14.1	13.3		17.4
Other Temperate[5]	7.1	7.6	6.0	7.0	

1. Malaysia is reducing the tariff rate on plywood to 20% from 45% (i.e. a 55% reduction).

2. No change because tariffs are bounded at higher rates.

3. Japan is a major importer in this region. According to the FAO, it is reducing tariffs by 20% and is used here to represent the tariff reduction for the region. Note that there were no GSP rates for Japan pre-Uruguay Round.

4. No change given most tropical countries are imposing a higher bound tariff rate post-Uruguay Round

5. The USA is a major importer in this region. Since it previously had a GSP rate of 0%, the change in the trade-weighted tariffs for developing countries is less than for the developed countries. This reduction is approximated to 20% across all tropical exporting regions, and a reduction of 25% on exports from the Asian importing region (most developing countries in this region had their GSP rates removed pre-Uruguay Round).

4.4.2 Export Taxes

Over the past thirty years, there has been a trend amongst major timber exporters to impose various types of barriers on log exports (such as export taxes, quotas and bans) in order to encourage domestic timber-processing activities. Indonesia was one of the first countries to have banned log exports, however in 1985 it replaced the ban with prohibitive export taxes, ranging between US$500-US$4,800/m^3. Since 1989, specific export taxes have been imposed on sawnwood to promote plywood exports, which are exempted from all taxes.

As for Malaysia, both Peninsular Malaysia and Sabah have prohibited the export of logs since 1994; while Sarawak imposes an export tax of 15%. Export tax rates were introduced on sawnwood and plywood in 1996. Another major exporter in Southeast Asia is Papua New Guinea who imposed a 13% log export tax in 1995.

In Africa, Cameroon and Côte d’Ivoire imposed log export restrictions by way of a quota (30% of the annual logs cut) and an outright ban respectively. Ghana has banned the export of certain commercial species altogether and introduced export levies of 20% on several other species of logs. The government in Gabon also plans to phase in log export reductions.

Brazil, on the other hand, has imposed a two-year ban on several popular commercial log species. The government of Colombia was the only government, as reported in the ITTO Annual Review 1996, to have encouraged timber production that year through a tax reimbursement scheme. More details of tropical countries' log export policies can be found in the Annual Review, ITTO (1996/97/98) and Barbier (1994/95). The weighted average export tax on each wood product was calculated for each tropical region and, where necessary, the tariff equivalent of the quota and export ban was computed. This equivalent is taken to be the proportionate difference between the world price and the domestic price of each country. Table 6 presents the export tax estimates used in the simulations.

Table 6: Export Taxes on Forest Products Used in the Model (percentages)

	Malaysia	*Indonesia*	*Other Tropical*
Logs	20.0	30.0	20.0
Sawnwood		20.0	
Plywood	0.04		

4.5 Trade Barriers on Agricultural Products

Data on agricultural barriers has been taken from "Developing Countries and the Uruguay Round: An Overview" (1994), and "Post-Uruguay Round Tariff Regimes: Achievements and Outlooks" (OECD, 1999). In general, the most significant gain in the agricultural sector comes from the fact that countries have agreed to convert virtually all agricultural non-tariff barriers into tariffs and subject them to the maximum agreed rates or tariff bindings (Martin and Winters, 1995). Tariff rates on agricultural products are to be reduced by a simple average of 36% over six years in developed countries and 24% in developing countries. On top of this, the Uruguay Round imposes requirements on export subsidy reductions; minimum access commitments; and reductions in domestic support, known as the 'Total Aggregate Measure of Support' (Total AMS). This covers all domestic support provided on either a product-specific or non-product-specific basis that does not qualify for exemption. Given that data on the Total AMS is unreliable and scarce, and that the focus of this study is on forest products trade, the effect of the AMS is not considered in the model. The estimated average agricultural tariffs and export subsidies pre- and post-Uruguay Round for each region are presented in Table 7.

Table 7: Tariff Rates and Export Subsidies for Agricultural Products (percentages)

	Pre-UR tariffs	*Post-UR tariffs*	*% Change*	*Pre-UR subsidies*	*Post-UR subsidies*	*% Change*
Malaysia	19.7	15.0	-24.0	0		
Indonesia	72.8	55.3	-24.0	0.9	0.7	-24.0
Asian Market	15.8	10.1	-36.0	0		
Other Tropical	55.5	42.2	-24.0	4.2	3.2	-24.0
Other Temperate	17.8	11.4	-36.0	10.3	6.5	-36.0

5.0 THE SIMULATION EXPERIMENTS

A GAMS/MINOS solver was used to simulate four different policy scenarios:

I Full implementation of the Uruguay Round tariffs on forest products only.

II Full implementation of the trade policy as implied by the Uruguay Round on forest and agricultural products.

III All of the above plus zero log export taxes in tropical regions.

IV Complete liberalisation of agricultural and forest products trade.

Firstly, as a check of the model's consistency for the 1996 base year, the base case was run to determine if the simulation output matched the actual 1996 data. Once all the errors had been detected and the base simulation matched the actual data, this solution became the benchmark for comparison with the output obtained after the model was run with tax changes.

(See the changes in bilateral trade flows in Appendix 2 for the results.)

5.1 Simulation I: Reductions in the Uruguay Round Tariffs on Forest Products Only

As can be seen in Table 8, there is a small increase in the welfare of all tropical exporters, as well as 'Other Temperate' exporters. This is brought about by a rise in the world price of products from these regions and an overall rise in exports. Although the Asian Importing region benefits from the decline in consumer prices, domestic wood production contracts as domestic consumers substitute towards cheaper imports of sawnwood and plywood. Indonesia enjoys the most favourable terms of trade following tariff changes because the tariffs on plywood experience the largest decline when compared to logs and sawnwood. There is evidence of substitution by origin (that is, substitution between goods from the same forest zone) and, to a limited extent, between tropical and temperate sawnwood (see Appendix 2). Given that the Asian Importing region implements differential tariff reductions which favour temperate wood processors, there is a large increase in imports from this region. This, together with an increase in the world price of Indonesian and Malaysian sawnwood, means that other regions substitute away from sawnwood exports of these countries. Although the price of Indonesian plywood rises, a more significant fall in tariffs causes Indonesian plywood exports to increase overall.

As already mentioned, tariff escalation is reduced post-Uruguay Round. As a consequence, the proportion of imports of higher-processed products increases relative to log imports. Since logs enter as intermediate inputs into the milling sector, the changes in trade flows of logs are dictated by the demand from these industries. In all tropical regions, increased plywood production (brought about by increased exports) raises domestic demand for logs. On the other hand, increased sawnwood production raises the domestic log consumption in the Other Temperate region. The world log price appreciates due to the increase in domestic demand for logs in the timber-producing regions and a general decline in log exports. As a consequence, logs become more expensive relative to other inputs into the milling sector, leading to a substitution away from the logs input. Thus, the intensity of log use per unit of sawnwood and plywood in the milling sector decreases. Despite the fall in exports, log production rises in all producing regions, so there is likely to be more pressure on forest resources. While harvesting rent increases in Malaysia and Indonesia, it decreases in the Other Tropical and Other Temperate regions, despite a rise in the producer's price of timber, due to a higher input cost.

5.2 Simulation II: Full Implementation of the Uruguay Round Trade Policy on Forest and Agricultural Products, i.e. Simulation I with Agricultural Policy Changes

Table 9 presents the results from Simulation II. Two additional policy changes are captured here:

1) A fall in tariff rates on agricultural products.
2) A fall in agricultural export subsidies.

These policy changes have opposing effects. The fall in tariff rates leads to a reduction in import prices and consequently an expansion in the trade of agricultural products. However, a cut in agricultural export subsidies tends to reduce agricultural production and thus raises consumer prices. The results show a rise in agricultural exports in all regions, even for those regions with cuts in agricultural subsidies, that is, Indonesia, the Other Tropical and Other Temperate regions. As the agricultural sector expands, so does the demand for factor inputs. This is noteworthy because the agricultural sector is much larger than the forest products sector, so the increase in factor demand has a repercussion on the forest sector through factor price-rises. The price of labour is particularly affected, since it is employed more intensively in the agricultural sector. In turn, timber rent and production fall in all regions as the *real* producer's timber price declines.

Forest rent falls in all tropical regions, while the returns to agricultural producers rise (the producer's price was used to represent this). Thus, the returns to forestry fall further than those to the agricultural sector. The decline in log production means that forestry is likely to exert less pressure on forest resources post-Uruguay Round. However, increased real returns to the agricultural sector, and increased agricultural returns relative to timber harvesting means that the pressure to convert forestlands for agricultural use is likely to increase. The appreciation of factor prices results in logs becoming less expensive relative to other inputs into the processing sector. Consequently, there is greater intensity of log use in the milling sector.

Table 8: Results from Simulation I – Reductions in the UR tariffs on Forest Products only (in % change)

	Malaysia	*Indonesia*	*Asian M*	*O-Trop*	*O-Temp*
Welfare change, %	0.06	0.20	-0.05	0.01	+0.00
EV, Billion US$	0.02	0.06	-0.09	0.03	0.03
Terms of trade[a], %	0.10	0.33	-0.06	0.02	0.01
Factor prices, %					
Forestland rent	0.47	1.21	0.03	-0.00	-0.00
Labour wage	-0.02	-0.03	0.01	0.00	[b]
Capital rent	0.08	0.27	-0.09	0.01	0.01
SW conversion ratio, %	-0.01	-0.13	-0.01	-0.16	-0.03
PW conversion ratio, %	-0.02	-0.10	-0.00	-0.08	-0.03
Rtns to forestry: rtns to agriculture ratio	0.43	1.05	0.09	-0.02	-0.01
Producer's prices, %					
Logs	0.19	0.68	-0.17	0.26	0.07
Sawnwood	0.18	0.41	-0.06	0.02	0.03
Plywood	0.17	0.47	-0.05	0.13	0.02
Agriculture	0.05	0.16	-0.05	0.01	0.00
World price, %					
Logs	0.19	0.68	-0.17	0.26	0.07
Sawnwood	0.18	0.41	-0.06	0.02	0.03
Plywood	0.17	0.47	-0.05	0.13	0.02
Agriculture	0.05	0.16	-0.05	0.01	0.00
Production, %					
Logs	0.04	0.15	-0.03	0.12	0.02
Sawnwood	-0.22	-0.23	-0.24	0.04	0.29
Plywood	1.18	0.84	-0.07	0.33	0.17
Agriculture	-0.05	-0.16	0.06	-0.01	-0.01
Exports, %					
Logs	-0.41	-0.73	0.87	-0.15	-0.38
Sawnwood	-0.34	-0.90	0.17	0.05	4.04
Plywood	1.20	0.96	0.95	1.23	0.99
Agriculture	-0.10	-0.27	0.10	-0.01	-0.02

Table 9: Results from Simulation II – Reductions in the UR Tariffs on Forest and Agricultural Products (in % change)

	Malaysia	*Indonesia*	*Asian M*	*O-Trop*	*O-Temp*
Welfare change, %	-0.79	-0.62	0.42	-0.05	0.37
EV, Billion US$	-0.20	-0.18	0.69	-0.21	2.71
Terms of trade[a], %	1.47	-0.17	2.63	1.73	-0.02
Factor prices, %					
Forestland rent	-0.20	-2.17	-0.98	-0.85	+0.00
Labour wage	2.24	1.52	3.84	2.05	[b]
Capital rent	1.83	-0.14	2.68	1.74	-0.01
SW conversion ratio, %	0.12	0.43	1.17	2.04	0.12
PW conversion ratio, %	0.22	0.34	1.06	1.02	0.13
Rtns to forestry: rtns to agriculture ratio	-2.11	-2.60	-3.96	-2.62	0.01
Producer's prices, %					
Logs	0.46	-1.29	0.28	-1.30	-0.25
Sawnwood	0.66	-0.51	1.92	1.69	-0.09
Plywood	0.81	-0.68	1.76	0.27	-0.08
Agriculture	1.96	0.45	3.11	1.81	-0.01
World price, %					
Logs	0.46	-1.29	0.28	-1.30	-0.25
Sawnwood	0.66	-0.51	1.92	1.69	-0.09
Plywood	0.81	-0.68	1.76	0.27	-0.08
Agriculture	1.96	0.67	3.11	2.80	3.47
Production, %					
Logs	-0.51	-0.43	-0.88	-1.48	-0.09
Sawnwood	-0.90	-4.02	-1.72	-3.38	-0.15
Plywood	0.82	1.80	-1.51	-3.05	-0.42
Agriculture	0.18	0.88	0.68	0.40	0.01
Exports, %					
Logs	-1.02	2.63	-1.89	1.22	-0.10
Sawnwood	-0.41	3.75	-5.78	-2.59	6.96
Plywood	0.84	2.57	-3.47	0.30	1.22
Agriculture	4.51	6.53	2.27	2.80	1.85

[a] Terms of trade here refers to the change in the production-weighted-average producer's price of all tradables. This definition is used in Whalley (1985).

[b] The price of labour in the Other Temperate region is fixed as a numeraire price, therefore does not change.

On the whole, the welfare of all tropical countries declines due to the fall in the timber rent and agricultural tariff revenues. Originally, Indonesia and the Other Tropical region had extremely high agricultural import taxes, at 72% and 55% respectively. The Uruguay Round imposes a 24% cut in agricultural tariffs, resulting in a significant reduction of tariff revenues accordingly. Although both regions have agreed to reduce export subsidies on agricultural products, these were small in the first place, so the reduction will not be sufficient to compensate for the huge loss in tariff revenues.

5.3 Simulation III: Elimination of Log Export Taxes in Tropical Countries

Table 10 presents the results of Simulation III. Since the Uruguay Round policy changes have already been agreed upon, this section discusses whether the tropical exporters could improve their situation by eliminating export barriers on logs. The results of Simulation III are compared to those of Simulation II.

The elimination of log export barriers is found to have a mixed effect on the welfare of tropical regions. The policy worsens the welfare of Malaysia and the Other Tropical region, but slightly improves the welfare of Indonesia. As expected, the producer's log price rises and log exports increase in all tropical regions. However, the large surge in tropical log exports sends the world price of tropical logs spiralling downwards (between 18.72% and 29.58%). This also dampens the world price of temperate logs, although to a much lesser extent.

There is an overall increase in log production in Malaysia and Indonesia. Thus, lifting log export barriers is likely to add to the pressure on forest resources in these countries. The harvesting rent in both Malaysia and Indonesia also increases, rendering forestry more attractive as a land use option compared to agriculture. Log production in the Other Tropical region is found in fact to fall following the elimination of log export taxes. Although the nominal producer's log price rises, the input cost increases more quickly leading to a fall in the real producer's timber price, and so to a corresponding fall in the timber production.

There is an improvement in the conversion ratio for sawnwood and plywood in both Malaysia and Indonesia as the domestic log price rises relative to other inputs (that is, less intensity of log use in the milling sector).

Table 10: Results from Simulation III – Elimination of Log Export Tax in Tropical Regions (in % change)

	Malaysia	*Indonesia*	*Asian M*	*O-Trop*	*O-Temp*
Welfare change, %	-2.00	-0.49	0.72	-0.08	0.37
EV, Billion US$	-0.52	-0.14	1.18	-0.32	2.67
Terms of trade [a], %	2.51	0.58	2.37	1.78	-0.04
Factor prices, %					
Forestland rent	7.43	1.80	-1.03	-0.85	+0.00
Labour wage	1.60	1.53	3.75	2.04	[b]
Capital rent	1.90	-0.01	2.82	1.74	-0.01
SW conversion ratio, %	-0.58	-0.18	1.89	0.58	0.46
PW conversion ratio, %	-0.56	-0.14	1.66	0.29	0.52
Rtns to forestry: rtns to agriculture ratio	5.52	1.26	-4.06	-2.61	0.01
Producer's prices, %					
Logs	4.75	0.85	0.18	0.91	-0.40
Sawnwood	2.87	0.48	0.89	1.76	-0.41
Plywood	2.85	0.55	0.54	1.35	-0.36
Agriculture	1.81	0.54	3.16	1.81	-0.01
World price, %					
Logs	-21.05	-29.58	0.18	-18.72	-0.40
Sawnwood	2.87	0.48	0.89	1.76	-0.41
Plywood	2.85	0.55	0.54	1.35	-0.36
Agriculture	1.81	0.76	3.16	2.80	3.47
Production, %					
Logs	1.04	0.32	-0.97	-0.40	-0.15
Sawnwood	-5.02	-4.89	-0.58	-3.32	0.12
Plywood	-1.36	0.50	-0.14	-4.13	-0.08
Agriculture	-0.14	0.81	0.57	0.37	0.01
Exports, %					
Logs	15.15	90.86	-2.04	20.53	-0.11
Sawnwood	-5.44	1.54	-4.29	-2.53	6.55
Plywood	-1.32	1.22	-2.12	-0.86	1.58
Agriculture	4.78	6.35	2.12	2.78	1.85

Table 11: Results from Simulation IV – Trade Liberalisation in the Agricultural and Forest Sectors (in % change)

	Malaysia	*Indonesia*	*Asian M*	*O-Trop*	*O-Temp*
Welfare change, %	-4.48	-5.12	1.59	-2.00	1.82
EV, Billion US$	-1.15	-1.49	2.62	-8.31	13.20
Terms of trade[a], %	3.17	-4.34	7.07	1.76	-0.10
Factor prices, %					
Forestland rent	5.66	-7.76	-2.71	-1.07	0.01
Labour wage	3.07	0.48	11.24	2.73	[b]
Capital rent	3.17	-5.27	7.65	1.80	-0.04
SW conversion ratio, %	-0.28	0.47	4.56	6.31	1.03
PW conversion ratio, %	-0.16	0.36	4.08	3.15	1.12
Rtns to forestry: rtns to agriculture ratio	2.45	-4.66	-10.71	-3.02	0.04
Producer's prices, %					
Logs	4.12	-6.12	-0.38	-7.12	-1.35
Sawnwood	2.28	-5.10	3.94	1.64	-0.79
Plywood	2.53	-5.29	3.21	-2.57	-0.70
Agriculture	3.14	-3.22	8.97	2.01	-0.03
World price, %					
Logs	-21.52	-34.45	-0.38	-25.19	-1.35
Sawnwood	2.28	-23.47	3.94	1.64	-0.79
Plywood	2.53	-5.29	3.21	-2.57	-0.70
Agriculture	3.14	-2.33	8.97	6.29	10.27
Production, %					
Logs	0.34	-0.34	-2.85	-4.42	-0.49
Sawnwood	-10.17	-20.31	-4.28	-9.36	-0.22
Plywood	9.18	10.32	-3.46	-14.42	-0.84
Agriculture	-0.04	3.14	2.01	1.17	0.04
Exports, %					
Logs	13.06	113.68	-7.61	30.89	-0.87
Sawnwood	-8.62	101.51	-19.97	-3.94	22.09
Plywood	9.37	14.80	-8.70	7.36	5.41
Agriculture	18.02	28.25	6.58	11.14	6.10

[a] Terms of trade here refers to the change in the production-weighted-average producer's price of all tradables. This definition is used in Whalley (1985).
[b] The price of labour in the Other Temperate region is fixed as a numeraire price, therefore does not change.

5.4 Simulation IV: Complete Trade Liberalisation in Both Agricultural and Forest Sectors

Table 11 shows the results of Simulation IV. As expected, free trade in the agricultural and forest sectors leads to an overall improvement in world welfare, however the gain is very unevenly distributed across the regions. Asian Importers and the Other Temperate region benefit from such a move, while all the tropical regions are found to suffer a significant loss (more so than in all previous scenarios). This is not so surprising, given that the Asian Importers and the Other Temperate region consist of some key forest and agricultural products importers, who tend to benefit most from the increased consumer surplus through the reduction in consumer prices. Since the base tariffs are highest in the plywood and agricultural sectors, trade expansion is greatest in these sectors post-liberalisation. Exports of plywood and agricultural goods from all tropical producers and Other Temperate producers increase. Although the proportionate change in agricultural exports of the Other Temperate region is less than the change in agricultural exports of Malaysia and Indonesia, the actual value of exports is much higher in the Other Tropical region, and thus the actual benefit is greater.

Similar to Simulation III, the world tropical log price experiences a significant fall (between 21.52% and 34.48%) due to a large influx of exports in the absence of log export barriers. This in turn has a negative repercussion on the prices of temperate logs. The producer's timber price (both in nominal and real terms) is found to fall in all regions, apart from Malaysia. In all other regions, this decline then leads to a fall in log production. Timber becomes less expensive when compared to other inputs, and so the milling industries in these regions substitute towards timber, leading to a higher log conversion ratio (a more intensive use of logs). However, the reverse applies to the Malaysian milling industry, where the real producer's price rises. Given that logs become more expensive compared to other factor inputs, the intensity of log use falls in Malaysia.

In Indonesia and the Other Tropical region, the fall in forest rent and in the relative returns of forestry compared to agriculture make the latter a more attractive form of land use post-liberalisation. Malaysia, by contrast, experiences an increase in forest rent, as well as a rise in the relative returns of forestry, rendering this a more attractive land use option. With the rise in log production in Malaysia, more pressure on its forest resources from forestry is expected under this scenario.

These findings are compared to Barbier (1999) who carried out a partial analysis on the impact of the Uruguay Round 1994 on the forest products trade. This study's estimates of the percentage gain in the value of trade and those of Barbier are shown in Table 12.

Table 12: Percentage Gain in the Value of Trade for Selected Forest Products

	This study	*Barbier (1999)*
Logs	-0.16	0.40
Sawnwood	0.13	1.00
Plywood	1.52	3.30-5.00

In both studies, the logs sector gains the least (in fact it is negative in these findings), followed by sawnwood and plywood. As mentioned, the reduction in tariff escalation is of more benefit to processed products and hence the plywood sector expands the most. This study's results show that trade in logs decreases as countries substitute away from log exports towards higher-processed products. The estimated gains in this study are much lower than in Barbier's because the economy-wide impacts that dampen trade gains, such as increased input prices, are not captured in the partial equilibrium model.

The results suggest that tropical countries fare worse under a complete trade liberalisation of the forest products and agricultural sectors. This means that some positive optimal taxes must exist for these countries. In the next section, the optimal forest product taxes for Malaysia and Indonesia and their associated welfare gains will be examined. The effects of optimal countervailing tariffs by importing regions will also be studied. Although optimal taxes and tariffs on tropical forest products have been analysed by Vincent (1989), his model does not allow for tropical-temperate product substitution. Thus, the market power of tropical countries would have been exaggerated.

6.0 OPTIMAL TAXES AND TARIFFS

This section examines whether Malaysia and Indonesia can improve their welfare through restrictive wood export regimes. Five optimal tax simulations are carried out, as follows:

V Indonesia optimises export taxes on forest products, with the taxes of other regions set at zero.

VI Like V, but for Malaysia.

VII Indonesia and Malaysia select optimal forest taxes independently; other regions set taxes at zero.

VIII Indonesia and Malaysia harmonise export taxes on forest products; other regions set taxes at zero.

IX Nash equilibrium (all regions set optimal taxes on forest products independently).

Simulations V and VI are single-country optimisations. The export taxes on logs, sawnwood and plywood are allowed to vary so as to maximise each country's welfare. These simulations provide a measure for the potential welfare gains for Malaysia and Indonesia in the absence of retaliation.

In Simulation VII, both Malaysia and Indonesia optimise export taxes independently without any policy response from other countries.

In Simulation VIII, Malaysia and Indonesia set the same export taxes for each forest product. By harmonising their tax policy, it is anticipated that Malaysia and Indonesia could increase their market power in the world market and so improve their joint welfare. The welfare results from Simulation VIII are compared with those from Simulation VII to ascertain the gain to be had from harmonisation.

In Simulation IX, each region selects optimal taxes on forest products. Export taxes are allowed to vary so as to maximise the welfare of each tropical region; while import tariffs are allowed to vary to maximise the welfare of temperate regions. Since the Other Tropical region consists of some key importers of forest products from Malaysia and Indonesia, the countervailing tariffs are also simulated for this region. Simulation IX indicates the effect retaliation would have on the welfare of Malaysia and Indonesia. A GAMS/Conopt solver is used to solve for the optimal forest taxes, by maximising one region's welfare at a time. The process is repeated iteratively until the tax results converge. All the results reported in Table 13 are compared to the free trade level.

The results of these simulations indicate that Malaysia and Indonesia can indeed improve their welfare by imposing optimal taxes when there is no retaliation. The improvement is equivalent to 5.3% of the agricultural and forest sectors' income for Indonesia and 7.8% for Malaysia. If Malaysia sets optimal taxes, Indonesia could improve its situation by likewise imposing its own optimal taxes. However, by doing so, both countries would be in a worse situation than if they were imposing optimal taxes on their own (compare Simulation VII with Simulations V and VI).

If both Malaysia and Indonesia were to instigate an optimal export policy on forest products, it would be in the interest of these countries to harmonise their export policies because the welfare gain through harmonisation is extremely large (compare results in Simulation VIII with those in VII). Given that the main importer of Southeast-Asian forest products is the Asian Importing region, this region would suffer the most welfare loss from the export restraints. When other regions retaliate, Malaysia and Indonesia fare worse than under free trade conditions. Although most regions lose out in the event of a trade war, some actually benefit, for example, the Other Temperate region in this case. This may act to deter Malaysia and Indonesia from implementing optimal taxes. In 1996 (before the onset of the Asian economic crisis), some co-operation is known to have existed between Malaysia and Indonesia on forest product exports. However, when comparing the optimal taxes under harmonisation with the actual export tax levels in 1996, the taxes on logs and plywood are found to fall well below the optimal level.

This study's findings on optimal export taxes are comparable to those reported in Vincent (1989): for example, the estimate here of the optimal log tax for Malaysia is 72.4%, while that of Vincent is 76.6%. However, this study's estimate of the welfare loss to Malaysia from a trade war is much higher at 30.7% of the forest products and agricultural sector income, compared to Vincent's figure at 11.8% of forest products trade.[16] The difference comes about because tropical-temperate product substitution is omitted in Vincent's model. Accordingly, the market power of tropical producers is exaggerated. When substitution is allowed, both the trade and welfare of tropical countries are more adversely affected through a resulting trade war.

[16] Forest products trade in both studies refers to logs, sawnwood and plywood only.

Table 13: Optimal Tax Results

	EV in Billion US$	*EV as % of Income*	*% Change in Log Output*	*Optimal Log Tax*	*Optimal SW[1] Tax*	*Optimal PW[2] Tax*
Simulation V: Indonesia optimising sawnwood, plywood and log export taxes simultaneously, no retaliation						
Malaysia	0.02	0.10	-0.02			
Indonesia	1.07	5.31	-7.46	14.24	9.02	50.85
Asian M	-1.44	-0.87	-0.05			
O-Trop	-0.10	-0.03	0.01			
O-Temp	-0.10	-0.01	-0.01			
Simulation VI: Malaysia optimising sawnwood, plywood and log export taxes simultaneously, no retaliation						
Malaysia	1.81	7.76	-14.26	72.38	19.52	75.51
Indonesia	-0.02	-0.12	-0.48			
Asian M	-3.78	-2.28	0.29			
O-Trop	-0.03	-0.01	1.67			
O-Temp	0.31	0.04	0.18			
Simulation VII: Indonesia and Malaysia select optimal forest taxes individually, other regions set taxes equal to zero.						
Malaysia	-0.49	-2.07	-55.28	59.80	26.30	87.57
Indonesia	0.28	1.37	-56.13	6.76	20.04	87.22
Asian M	-11.59	-7.00	3.60			
O-Trop	0.13	0.04	1.86			
O-Temp	-1.96	-0.28	2.15			
Simulation VIII: Indonesia and Malaysia harmonise export taxes on forest products, no retaliation by other regions.						
Malaysia	1.86	7.97	-14.03	72.17	20.22	75.06
Indonesia	1.48	7.36	-14.72	72.17	20.22	75.06
Asian M	-6.65	-4.02	0.27			
O-Trop	-0.09	-0.03	2.09			
O-Temp	-0.24	-0.03	0.21			
Simulation IX: Nash equilibrium (each region sets taxes independently so as to maximise own welfare).						
X taxes:						
Malaysia	-7.22	-30.57	-56.14	70.0	59.0	29.0
Indonesia	-8.99	-44.71	-56.69	51.0	23.0	86.0
O-Trop	-155.44	-51.26	-36.48	34.0	42.0	78.0
M taxes:						
Asian M	-65.94	-39.88	22.51	132.80	179.91	151.44
O-Trop				92.87	286.55	196.44
O-Temp	15.04	2.14	31.57	266.52	260.59	222.54

[1] = sawnwood; [2] = plywood.

7.0 SENSITIVITY ANALYSIS

Given the key role played by the substitution elasticities in this study's results, a number of sensitivity analyses have been conducted to check how sensitive the welfare and terms-of-trade results are to these parameters. In the first sensitivity check, elasticities of substitution between tropical and temperate products, and between imports and domestic products for logs, sawnwood, plywood and agricultural products are increased by 50%. In the second sensitivity check, the same set of elasticities is decreased by 50%. The results are reported in Table 14.

Table 14: Welfare and Terms-of-Trade Effect when the Elasticities of Substitution Increase or Decrease by 50%

	50% Increase in the Elasticities of Substitution				50% Decrease in the Elasticities of Substitution			
	EV as a % of Income				*EV as a % of Income*			
	I	II	III	IV	I	II	III	IV
Malaysia	0.05	-0.64	-1.72	-3.99	0.10	-1.09	-2.77	-5.74
Indonesia	0.18	0.13	0.38	-2.22	0.26	-1.96	-2.00	-10.24
Asian M	-0.05	0.47	0.77	1.62	-0.06	0.43	0.77	2.06
O-Trop	0.01	0.24	0.22	-0.96	0.01	-0.37	-0.42	-3.08
O-Temp	0.01	0.38	0.36	1.62	0.00	0.39	0.40	1.98
	Terms-of-Trade Effect				*Terms-of-Trade Effect*			
	I	II	III	IV	I	II	III	IV
Malaysia	0.08	1.64	2.82	4.01	0.15	0.99	1.34	1.08
Indonesia	0.32	0.39	1.42	-1.00	0.43	-1.68	-1.13	-11.07
Asian M	-0.06	2.65	2.30	6.92	-0.06	2.67	2.57	8.08
O-Trop	0.02	1.80	1.87	2.45	0.02	1.62	1.65	1.04
O-Temp	0.01	0.00	-0.04	-0.10	0.01	-0.04	-0.02	-0.06

When Table 14 is compared with the welfare results in Tables 10, 12 and 13, the direction of welfare change is found to be robust for the first and fourth simulations only (that is, tariff changes in forest products trade and the free trade simulation). Therefore, given the sensitivity of the study results to the elasticity values, they should be treated as indicative only.

8.0 CONCLUSIONS

In progressing towards trade liberalisation of the forest products and agricultural sectors, mixed effects on the forest rent and timber production in different regions can be detected. Therefore, a reduction in trade barriers does not always lead to increased log production as feared by some non-governmental organisations. Amongst other things, the direction of change in log production depends on the general equilibrium effects on world log prices and factor prices.

When the Uruguay Round policy changes are implemented in the forest sector alone, the welfare and terms of trade of all tropical regions improve. Moreover, log production increases in these regions. This is due to a heightened demand for logs by the downstream processing sectors as the processed exports, particularly plywood, increase. However, the picture changes dramatically when the Uruguay Round policy changes are incorporated by the agricultural sector. The welfare of tropical countries deteriorates and the terms of trade fall in some countries, due to a fall in the timber rent and agricultural tariff revenue. Certain tropical countries, such as Indonesia, had extremely high agricultural tariffs prior to the Uruguay Round. Although tariff cuts are higher in developed countries in percentage terms, the actual depth of the tariff cuts is greater in some developing countries so that a large fall in tax revenue ensues. Agricultural expansion increases factor demand, which in turn leads to an appreciation of factor prices, particularly of wages. The rise in factor prices then has a negative effect on the harvesting rent. On the whole, log production declines so that pressure on forest resources from forestry is reduced. Given that the returns to forestry decline further than those to the agricultural sector, the latter is likely to become a more attractive form of land use post-Uruguay Round.

The results in Simulation II should be viewed as the worst-case scenario for the tropical regions. The adverse welfare results in this simulation may have been exaggerated for two reasons: (1) Many agricultural barriers are non-tariff barriers, however the simulations were conducted using their tariff equivalents. This means that the actual fall in tariff revenue should be smaller. (2) The base-line agricultural tariffs (against which tariff reductions would take place) have been exaggerated for many countries. Therefore, the actual reductions in the agricultural tariffs should be less, leading to lower gains for the agricultural sector (Martin and Winters, 1995).

The model demonstrates that the elimination of log export barriers post-Uruguay Round generally worsens tropical countries' welfare. The widespread use of log export barriers reduces the world's supply of tropical logs and in turn raises the terms of trade of tropical log exporters. However, a simultaneous lifting of the log export barriers increases supply and consequently sends the world log price down. Importing countries, such as Japan, Korea and China then benefit through an increased consumer surplus. The elimination of log export barriers was shown to have a mixed effect on log production: increasing it in

Malaysia and Indonesia but lowering it in the Other Tropical region. Although the nominal producer's log price rises in all tropical regions, the real producer's price falls in the Other Tropical region, and its log production falls accordingly. Since the returns from forestry in Malaysia and Indonesia show a larger increase relative to the returns from agriculture, the elimination of log export barriers is expected to promote forestland use in these countries. On the other hand, logs are likely to be used less intensively in the milling sector, as the domestic log price increases more relative to other factor inputs.

Since log export liberalisation was found to have an adverse effect on the welfare of tropical regions, the optimal tax levels were examined for these regions. The findings showed that the pre-Uruguay Round export tax levels in 1996 were lower than the optimal levels for Malaysia and Indonesia; particularly the export tax on plywood. It may be that the threat of retaliation has prevented these countries from implementing their optimal tax policies.

Complete trade liberalisation in the agricultural and forest sectors makes tropical countries' welfare deteriorate even further than in all previous scenarios, for similar reasons as discussed in Simulations II and III. However, the tariff and export tax cuts are much larger in this scenario, so the impact is greater.

Figures 4 to 11 show the actual production and export statistics for logs, sawnwood and plywood in Indonesia and Malaysia between 1989 and 1999. The production of logs and sawnwood experienced an overall decline in both countries during this period. There was a significant fall between 1997 and 1998, which coincided with the start of the Asian economic crisis, and thereafter the outputs have not recovered. Between 1992 and 1997, plywood production in Indonesia was fairly stable, but fell dramatically between 1997 and 1998 as a result of the financial crisis. The production of Malaysian plywood, on the other hand, rose substantially over the decade but experienced a mild fall between 1997 and 1998, also due to the economic crisis. The trend in Malaysian forest product exports corresponds to the trend in their production. The same is true for Indonesian plywood exports. However, given the high export barriers imposed on logs and sawnwood, the exports of these products remained fairly low and stable throughout this period.

While the results from Simulation II closely match the actual production and export trends for Malaysian forest products, they do not correspond so well to the Indonesian forest production and export figures. In any case, it is extremely difficult to gauge how much the fall in log and sawnwood production between 1995 and 1999, or how much the rise in plywood production in Malaysia during this period, was driven by trade policy changes. There is, however, no doubt that the Asian economic crisis contributed substantially to the downward trend in log and sawnwood production. In addition, political instability is likely to have exacerbated the downward trend in Indonesia. Since the implementation of the Uruguay Round measures is not yet complete (this is intended to take place over ten years), it would be premature at this point to compare the results of the model with the actual production and trade data.

Although the model presented does not incorporate land use explicitly in the agricultural and forestry sectors, it can be used to quantify the changes in the returns to each of these land-based sectors as trade policy changes. The changes in the returns to each land-based activity have been applied to the conceptual model of forestland use of Hyde et al. (1996) where forestlands are classified into five categories according to each's distance from the market. These are listed below starting with the category furthest from the market:

1. Economically inaccessible mature natural forestland (that is, forestland where the cost of harvest and transport to the market exceeds the value of timber).

2. Marginal forestland or mature natural forests from which timber is currently harvested. This land area is highly responsive to changes in prices, harvest and access costs, and forest sector policies.

3. Secondary forests or those that support repeated harvests. Access to the resources in this region remains open since the cost of engaging in property rights exceeds the potential returns to forest management.

4. Forestland located near to extensive agriculture. Here the expected in-situ returns on forest investments exceed the costs of protecting rights to forest property.

5. Plantations. The in-situ forest product price justifies the cost of trees being managed as an agricultural crop.

As trade policy changes, the boundaries between these different forestland categories are altered. The model predicts that the Uruguay Round changes will result in forestry becoming a less-attractive land use option when compared to agriculture. Accordingly, it is expected that timber plantations and forestlands located near extensive agricultural areas will decline (categories 4 and 5). Even secondary forests (category 3) may be converted for agricultural use if the cost of clearing forestland and establishing property rights in those lands exceeds the potential returns to forest management post-Uruguay Round. The actual data shows a slight increase in agricultural land area in Malaysia and Indonesia by 0.11% and 0.02% per annum respectively between 1995 and 1998 (see Table 15). Given the long-term decline in the relative returns to forestry, the total land area devoted to forestry is expected to fall. The actual combined areas of land opened for logging and plantations in Peninsular Malaysia rose between 1994 and 1996 but fell between 1997 and 1998 (see Table 16). However, it is very difficult to discern to what degree the changes in land use in Peninsular Malaysia and Indonesia have been brought about by trade policy changes. Again, the Asian economic crisis is likely to have had a significant impact during this

Figure 4: Production of logs (m3)

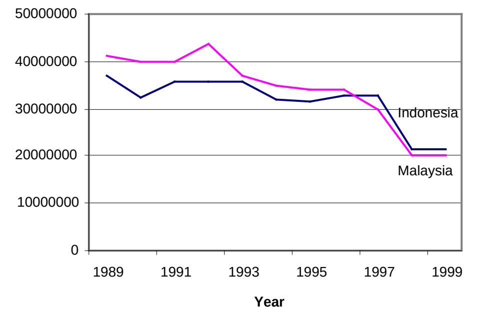


Figure 5: Production of sawnwood (m3)

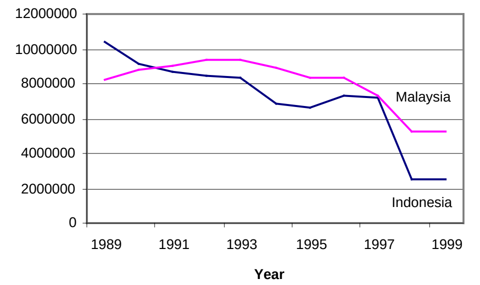


Figure 6: Production of plywood (m3)

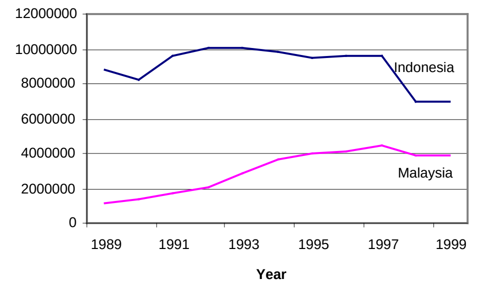


Figure 7: Agricultural production indices

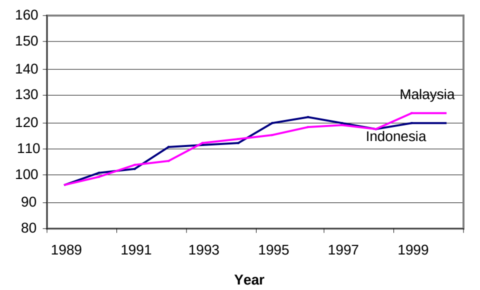


Figure 8: Exports of industrial roundwood, WIR NC (m3)

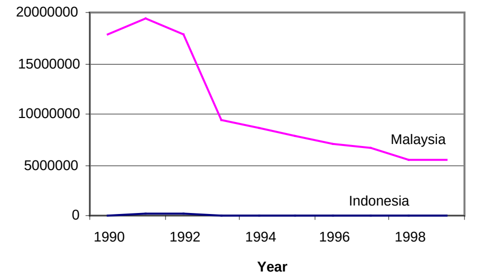


Figure 9: Sawnwood exports (m3)

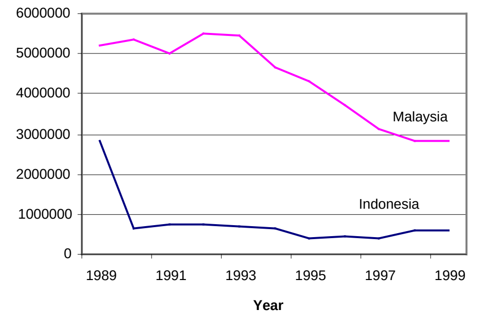


Figure 10: Plywood exports (m3)

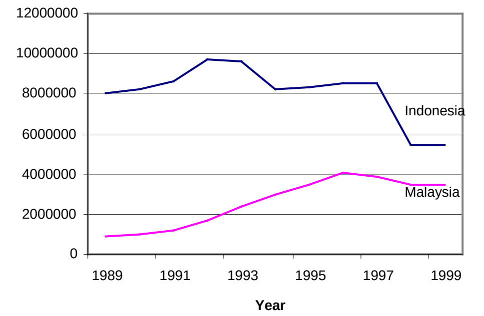
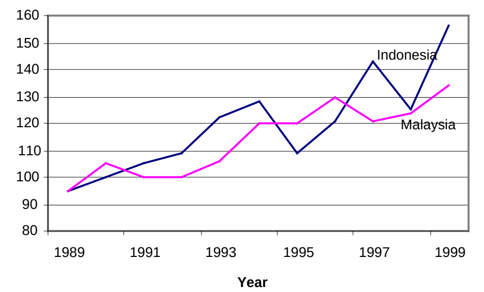


Figure 11: Agricultural export indices



period, since these countries tried to promote primary outputs and exports in response to the currency depreciation. Nonetheless, as the full implementation of the Uruguay Round is still not complete, the full effects have yet to be felt.

Table 15: The Average Annual Change in Agricultural Land Area in Peninsular Malaysia and Indonesia, 1995-1999 (percentages)

	% Change in Land Area, per annum
Peninsular Malaysia	0.11
Indonesia	0.02

Source: FAO agricultural statistics.

Table 16: Total Forestland in Peninsular Malaysia, 1994-1998 (hectares)

	Plantation	*Area Opened for Logging*	*Total Area Under Forestry*	*% Change Year-on-Year*
1994	61525	160222	221747	
1995	62535	168265	230800	4.08
1996	66754	164245	230999	0.09
1997	73060	139686	212746	-7.90
1998	73735	114998	188733	-11.29
Average % Change p.a.	4.69	-7.5	-3.76	

Source: Forest statistics Peninsular Malaysia 1994, 1995, 1996, 1997, 1998.

Although previous literature on the subject finds the forest products trade to be a minor cause of deforestation, trade policy itself, such as the log export policy, has wider implications than on the changes in trade value alone. Trade policy alters the returns to the whole of the timber industry, and thereby alters the incentives to produce, as well as affecting the land allocation between forestry and agriculture. Thus, it is the trade policy rather than the volume of forest products trade that is likely to have a significant impact on land use patterns and deforestation. Once the data becomes available, a more quantitative research project to establish the significance of trade policy on forestland use patterns would be of great benefit. In the meantime, governments should be extremely cautious of introducing trade policy changes that may affect the incentives for activities competing for forestland use.

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APPENDIX 1

Limitations of the Model

There are several ways in which the model could be improved:

1. The model presented in this paper represents a sub-section of the economy. This makes the factor market equilibrium condition unrealistic, which may have interfered with the results to some extent, leading to a bias in the implications for forestland use. For a more complete analysis, the remainder of the economy should be included. Nonetheless, tariff reductions, such as the Uruguay Round policies, are likely to lead to trade expansion, so the direction of change in factor prices is expected to be the same.

2. A specification for the harvest sector was used similar to the one in the Global Trade Model (1987). The specification is attractive because it is easily implemented and requires a minimum amount of data, unlike the activity matrix approach that is normally employed by AGE modellers. However, this specification is rather crude and the results are highly dependent on the elasticity of the log supply, and thus cannot be interpreted too precisely. Nonetheless, once better micro forest data (on forestry revenue and cost for the different classifications of forestland) becomes available, an activity matrix analysis would be extremely useful since it would enable the effects of trade policy on different types of forestlands to be predicted. In this way, governments could be forewarned about which forest areas were prone to development, among other things.

3. A further supply-side issue is that as the current harvest specification has no dynamics, nor does it take into account the stand ages of timber, investments or technological changes, the impact of trade policies on forest management has not been analysed in this paper. It has only been possible to discuss the effects of trade policy on incentives governing forestland use, and to draw some conclusions over possible alterations in forestland use. Once better data for Indonesia and Malaysia becomes available, a more complete supply-side structure can be incorporated to explicitly link trade policy with forest management decisions. For now, there is a case for pursuing the GTM's approach and making the specification more sophisticated and robust.

4. Since the only benefit accrued from the forests is timber in the model presented, the equilibrium log production reached is not the socially optimal outcome, given that non-timber benefits exist which have not been taken into account in the harvesting decision (for example, ecological functions of the forests and other externalities that might be associated with inefficient land use due to the attenuation of property rights). Thus, the log production

equilibrium derived in this paper is larger than the socially preferred outcome. It would have been useful to have incorporated non-timber benefits into the model, but finding reliable estimates of non-timber values, such as environmental benefits of forests, remains a major obstacle.

5. Countries have been aggregated into regions and several product types in order to simplify the analysis. While regional aggregation is likely to exaggerate the market power of the aggregated region, product aggregation (that is, each industry is assumed to produce one output) makes the analysis insensitive to the diversity of products and policies within the log, sawnwood and plywood industries. Thus, for a more detailed analysis, the output from each industry must be disaggregated. Although this analysis has excluded secondary processed forest products altogether, some are gaining prominence in Southeast-Asian exports. Therefore, these sectors should be included in the model for a more complete analysis of the Southeast-Asian forest products trade. Unfortunately, to date there is no reliable production and trade data available for these products.

APPENDIX 2

Bilateral Trade Flows (% change)

SIMULATION	From: / To:	*Percentage change in trade flows of logs*					*Percentage change in trade flows of sawnwood*					*Percentage change in trade flows of plywood*					*Percentage change in trade flows of agriculture*				
		Ma	Indo	A-M	Trop	Temp	Ma	Indo	A-M	Trop	Temp	Ma	Indo	A-M	Trop	Temp	Ma	Indo	A-M	Trop	Temp
I	Ma	0.30	-0.72	0.78	0.36	0.32	-0.12	-0.69	0.21	0.30	0.01	-0.81	[a]	[a]	24.15	22.08	0.01	-0.17	0.18	0.07	0.08
I	Indo	1.18	0.18	0.93	1.07	0.45	0.39	-0.19	0.41	0.80	0.31	0.15	-0.18	0.40	0.20	0.31	0.23	0.05	0.40	0.30	0.30
I	A-M	-0.41	-1.12	-0.05	-0.50	-0.40	-0.16	-0.89	-0.25	0.11	4.32	1.28	0.95	-0.15	0.91	1.03	-0.24	-0.42	-0.07	-0.17	-0.17
I	Trop	-0.22	[a]	0.60	0.16	0.29	-0.47	-1.14	0.11	0.01	-0.05	-0.16	-0.49	0.08	-0.12	0.00	-0.06	-0.25	0.11	0.00	0.01
I	Temp	-0.10	-0.65	0.68	0.12	0.25	-0.39	-0.92	0.14	0.00	-0.03	1.24	1.01	1.59	1.27	-0.08	-0.08	-0.26	0.09	-0.01	-0.01
II	Ma	-0.22	3.52	-0.64	3.70	0.52	-1.29	1.62	-3.75	-3.77	1.18	-2.25	[a]	[a]	23.01	21.45	-3.85	4.99	0.90	1.40	0.31
II	Indo	-4.00	-0.52	-1.95	-0.33	-0.89	-7.23	-4.50	-7.42	-9.56	-5.19	-6.23	-4.67	-7.20	-5.67	-5.30	5.22	-9.64	3.28	3.79	2.68
II	A-M	-1.01	1.60	-0.86	1.62	-0.08	1.63	4.44	-1.65	-1.07	7.66	1.36	3.04	-1.35	1.55	1.94	5.48	7.72	-4.78	4.04	2.92
II	Trop	-4.62	[a]	-3.39	-1.9	-2.69	-3.29	0.05	-6.92	-6.13	-3.34	-5.28	-3.71	-6.26	-4.72	-4.35	4.06	6.28	2.14	-10.10	1.54
II	Temp	-2.65	0.89	-1.06	0.91	-0.09	-0.48	2.25	-4.64	-2.83	-0.75	-0.43	1.32	-1.36	0.14	-0.92	4.24	6.47	2.32	2.82	-1.89
III	Ma	-6.95	112.55	-2.49	1.01	-1.18	-4.69	1.09	-3.08	-2.07	0.11	-5.35	[a]	[a]	20.34	20.61	-4.73	3.62	-0.36	0.23	-0.85
III	Indo	51.26	-2.30	-2.11	47.47	-0.94	-10.71	-5.29	-5.93	-8.25	-4.47	-7.89	-5.57	-5.55	-6.39	-4.61	5.80	-9.50	3.51	4.11	3.00
III	A-M	15.09	48.81	-0.95	21.62	-0.09	-3.50	2.18	-0.52	-0.99	7.23	-0.82	1.69	0.02	0.39	2.30	5.80	7.63	-4.81	4.10	2.98
III	Trop	42.88	[a]	-3.17	-3.61	-2.39	-9.02	-2.53	-5.62	-6.09	-3.28	-7.29	-4.95	-4.93	-5.77	-3.98	4.30	6.11	2.03	-10.11	1.53
III	Temp	18.28	53.11	-1.24	19.61	-0.17	-5.26	0.11	-2.97	-2.82	-0.42	-2.59	-0.03	-0.01	-1.01	-0.59	4.50	6.31	2.23	2.82	-1.88
IV	Ma	-6.86	142.42	-2.81	20.70	-0.27	-11.41	82.91	-14.96	-9.99	-4.45	-12.86	[a]	[a]	44.39	36.28	-16.92	22.60	2.21	6.52	0.22
IV	Indo	29.84	-3.64	-8.2	48.59	-6.37	-12.06	-27.87	-27.25	-22.86	-23.24	-14.91	-27.42	-19.02	-13.11	-15.73	25.67	-43.66	14.73	19.57	12.49
IV	A-M	13.05	61.86	-2.76	34.28	-0.76	-0.17	106.86	-4.04	-0.06	24.66	11.37	16.22	-3.04	10.22	7.93	20.52	31.95	-13.78	14.64	7.85
IV	Trop	21.20	[a]	-17.3	-9.83	-7.27	-29.07	103.53	-32.85	-28.33	-14.91	-16.45	-11.11	-19.55	-25.32	-12.65	17.83	29.01	7.54	-42.34	5.44
IV	Temp	9.85	62.70	-1.39	28.17	-0.27	-6.33	89.87	-9.37	-4.50	-2.10	5.92	11.11	-0.62	7.02	-2.77	16.90	28.01	6.70	11.20	-6.20

Where Ma = Malaysia; Indo = Indonesia; A-M = Asian Importers; Trop = Other Tropical countries; and Temp = Other Temperate countries.
[a] No bilateral trade or trade too small to be captured in the model