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FOREST TAXATION AND THE WOOD PRODUCTS INDUSTRY IN INDONESIA

by

Yetti Rusli

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The undersigned certify that they have read, and recomend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled **FOREST TAXATION AND THE WOOD PRODUCTS INDUSTRY IN INDONESIA** submitted by Yetti Rusli in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE** in **FOREST ECONOMICS.**

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This thesis is dedicated to my parents, my husband,

and my children

ABSTRACT

Indonesia's forest sector is important, occupying about 109 million hectares of land. The contribution of Indonesia's forestry sector to the country's economic development is remarkable. Indonesia's forest products have a significant share of the international market for tropical timber products. In 1988, fifty percent of the plywood in international market was supplied by Indonesia. The government of Indonesia is aware of the significance of the forestry resource industry. Regulations and management systems in the forestry sector have been increasing rapidly. Some of the most important mechanisms for affecting resource allocation and collecting rents in the forestry sector have been reforestation fees, product royalties and export taxes.

The purpose of this study is to investigate the economic impacts of forest taxation on the sawmill and plymill industries of Indonesia. A partial equilibrium model of the sawmill and plymill industries is developed. Economic impacts on the industry of policy changes in reforestation fees, product royalties and export taxes are simulated for the sawmilling industry. There is no export tax variable used in the plywood simulation, therefore only the fee and royalty

variables are simulated.

The analysis of the impact of forest taxation is carried out in two stages. The first stage involves the econometric estimation of parameters for log supply functions, cost functions with share equations, and domestic and export demand relations for final products. The second stage includes simulations of policy changes in taxes and royalties based on the models established in the first stage.

Five scenarios of policy simulations are developed. The impacts of policy changes are evaluated through recovery factors of the industries (wood productivity), employment levels, government revenues, domestic price of final products, and foreign exchange earnings. These economic variables have been adopted by the Indonesian Government as key measures of economic development and well being for the forestry sector. The results show that recent government policies of increasing the sawnwood export taxes increase the recovery factor, thus saving wood, increasing government revenues, and maintaining domestic prices of the final products. The employment level, as well as the foreign exchange earnings, however, decline slightly. The impact of government policies regarding reforestation fees and product royalties are very dependent on the nature of assumptions of supply elasticity of logs.

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CHAPTER I

INTRODUCTION

Forestry is among the more important sectors of economic activity in Indonesia. Forest related activities employ about 5.4 percent of the total labour force. It is second to the oil industry in foreign exchange earnings which in 1988 amounted to more than 3 billion U.S. dollars from forest products exports. Indonesia is now a dominant supplier of forest products in international markets. In 1988, Indonesia's share of world trade in hardwood plywood was about 50 percent and its share of sawnwood trade was about 17 percent.

Forest land occupies about 109 million hectares, all publicly owned. Nearly 47 million hectares of forest land are classified as production forests (Directorat General of Forest Utilization, Ministry of Forestry, Government of Indonesia, and Food and Agriculture Organization of the United Nations, 1990, volume 1, p.10). Government assigns rights to utilize this land to concessionaires. The concession rights are given for a period of 20 years and they can be extended. The concessionaires have to manage the forests according to the Indonesian Selective Cutting and Replanting System (TPTI). It is a management system especially designed for uneven aged mixed species stands.

The forest revenue system is the mechanism for collecting economic rents from public forests utilized by the private sector. However, this revenue system also affects the concessionaires' behaviour, as the various taxes levied reduce firm profits. Ultimately, there are two major issues in forest taxation: the amount of resource rents that are collected, and the concessionaires' response behaviour in allocating resources.

It has been claimed by various authors, for example, Repetto and Gillis (1988), and Ingram (1989), that the current forest revenue system in Indonesia neither captures full economic rent, nor ensures forest sustainability and efficiency in wood utilization. Sustainability is an explicit public forest management goal. It implies continuous production from the forests with an approximate balance between net growth and harvest (Directorat General of Forest Utilization, Ministry of Forestry, Government of Indonesia, and Food and Agriculture Organization of the United Nations, 1990, volume 1, p.21). The problematic symptoms are inefficient industrial processing and logging operations, particularly in the conversion of forests into end products, and high levels of wastage. These lead to a decrease in government revenues in the short term and to a depletion of forest resources in the long term (Repetto R. and M. Gillis, 1988). Taxes could be a powerfull tool for correcting these problems.

The purpose of this study is to investigate the economic impacts of forest taxation in Indonesia on the wood products industry. Forestry taxation usually has three aims: (1) to capture the economic rents generated by forest activities, when forests are publically owned; (2) to provide an incentive to the private sector to behave consistently with public objectives; and (3) to collect a charge for services provided by the public sector.

Forest taxation is therefore a complex issue. The charges levied on timber are both a way of collecting rents and a means for government to affect private activities. Any analysis of efficiency of the forestry revenue system must therefore look at the following dimensions : (1) how efficient it is in capturing the economic rent, and (2) how efficient it is in meeting government objectives of (a) reducing waste and improving utilization, (b) promoting economic development, (c) conserving environmental values, and (d) sustaining the forest, that is, ensuring that the production potential of the forest is not negatively affected.

The focus of this thesis is on points (2a) and (2b), that is, how different taxation levels might affect wood recoveries, employment, foreign exchange earnings, and government revenues. Although important, no attempt is made to calculate the efficiency of rent capture. The issues of sustainability and environmental conservation are not dealt with formally either.

The firms' behaviour have been hypothesized to change with increases in taxes and royalties. Taxes and royalties on input factors increase costs per unit of production. Hence for a given level of price firms will reduce output. When all firms reduce output, aggregate supply will decrease and the next effect is that the equilibrium price increases and the equilibrium quantity decreases. An increase in tax on final product changes relative prices received by producers and paid by consumers. The impacts of tax and royalty changes on the economic indicators are examined in this study.

The methodology used to analyse the impacts of forest taxation is carried out through an econometric model developed to compare domestic and international markets for sawnwood and plywood, and examine the processing and logging industries. It is carried out in two stages. The first stage involves econometrically estimating the supply of logs, the cost functions of sawnwood and plywood production, and the demand for final products. The second stage involves simulating the impact of tax and royalty changes on resource allocations and the economy as a whole employing the estimation results of the first stage.

The thesis is organized as follows. The first section contains a brief overview of the Indonesian forest industry. The second section contains a description of the forestry revenue system in Indonesia. The third section outlines relevant theory and model specifications, and describes the data utilized. Section four contains the empirical results and analysis of same. The fifth part presents tax policy simulation outcomes. Finally, in the sixth part, conclusions and policy implication are presented.

CHAPTER II

THE WOOD PRODUCTS INDUSTRY: AN OVERVIEW

Logging, sawmilling, and plymilling are the main forest industries in Indonesia. They contribute to the economic welfare of the country through job creation, supply of wood materials for domestic use, and foreign exchange earnings.

Utilization of forests on a commercial scale began in 1967. Initially, the main activity was logging which was mostly done by foreign companies because of the lack of domestic capital. In order to increase value added in the sector, to conserve the resource, and to improve the forest industry, the government phased out log exports in 1981, with a ban introduced in 1985, and required concessionaires to build industrial complexes.

II.1. THE FOREST CONCESSIONS

Forest concessions play an important role in forest exploitation and processing. The current concession system has been applied since 1970 based on government regulation number 21/1970. Forest Concession (HPH) is defined in this regulation as follows (Gray and Hadi, 1989 b, p.4):

> "A right to exploit the forest in a designed forest area, through cutting of timber, regenerating and caring for forest, and processing, marketing of forest products, in accordance with existing regulations, and on the basis of conservation and sustainable production."

This right may be given to state or regional corporations (Badan Usaha Milik Negara), and to private corporations.

Concessions are awarded for a period of twenty years and can be extended under several criteria stated in the decree of the Minister of Forestry number 027/Kpts-II/1988:

1. A good evaluation of company performance on the forest concession operation and forest utilization activities.
2. The feasible conditions of an area and its potential for forest concession operation;
3. Submission of an airphoto and a long range development plan;
4. Submission of the last three years of the company balance sheet; and
5. Submission of the last three years of the industrial activities.

In 1985 there were 187 sawmills in concessions with a total annual capacity of 5,999,191 cubic meters of sawnwood (Ingram et al, 1989). This number had increased to 300 units with a total annual capacity of 8,767,100 cubic meters in 1988

(REPELITA V, 1988). In 1989, there were 561 forest concessions covering more than 60 million hectares of forests (Directorate General of Forest Utilization and FAO, 1990, volume 2, p.155).

The charges levied on concessionaires, such as Concession Licence Fee, Forest Product Royalty, and Reforestation Fee, are the tools of government to collect economic rent from the producing agents. The government may also use these tools to correct market failure, by influencing the concessionaires' behaviour in order to meet public interests.

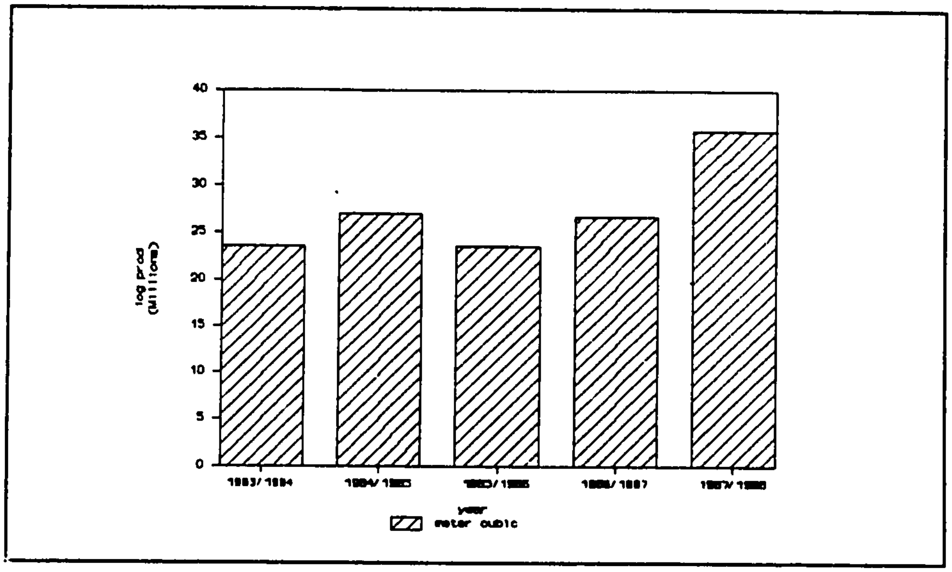
II.2. LOGGING INDUSTRY

As mentioned earlier, logging activities before 1967 were on a small scale. Foreign investment in the sector increased under Foreign Capital Investment Law number 1/1967. Under this law the foreign company could operate as an independent concessionaire or jointly with a local concessionaire. Most production was exported as logs to Japan, Korea, Taiwan, Singapore, and Hongkong. In 1979/1980 the government shifted emphasis to the local wood industries. Concessionaires were required to set up forest industrial facilities. This policy culminated with a log export ban first announced in 1981 and implemented over a 5 year transition period.

Raw materials for downstream industries are collected from 47 million hectares of production forests. To ensure sustainability, Indonesia's Selective Cutting System (TPTI - Indonesian Selective Cutting with Replanting) was introduced. It is designed for mixed tropical forests. The TPTI system imposes restrictions on the minimum diameter of timber that can be cut which is not less than 50 cm. A 35 year cutting cycle was adopted. Based on the data of REPELITA V, 1988, the average volume of commercial timber with a diameter of 50 cm and up is about 50 cubic meters per hectare. An Annual Allowable Cut constraint is introduced by assuming 1/35 of each area will be cut each year.

Log production in the period 1983/1984 to 1987/1988 is presented on Figure 2.1. The average annual increase in log production in this period is about 12.4 percent. Most log production in the period after the log export ban supplies the sawmill and plymill industries as well as other wood working industries.

Figure 2.1. Indonesian log production.

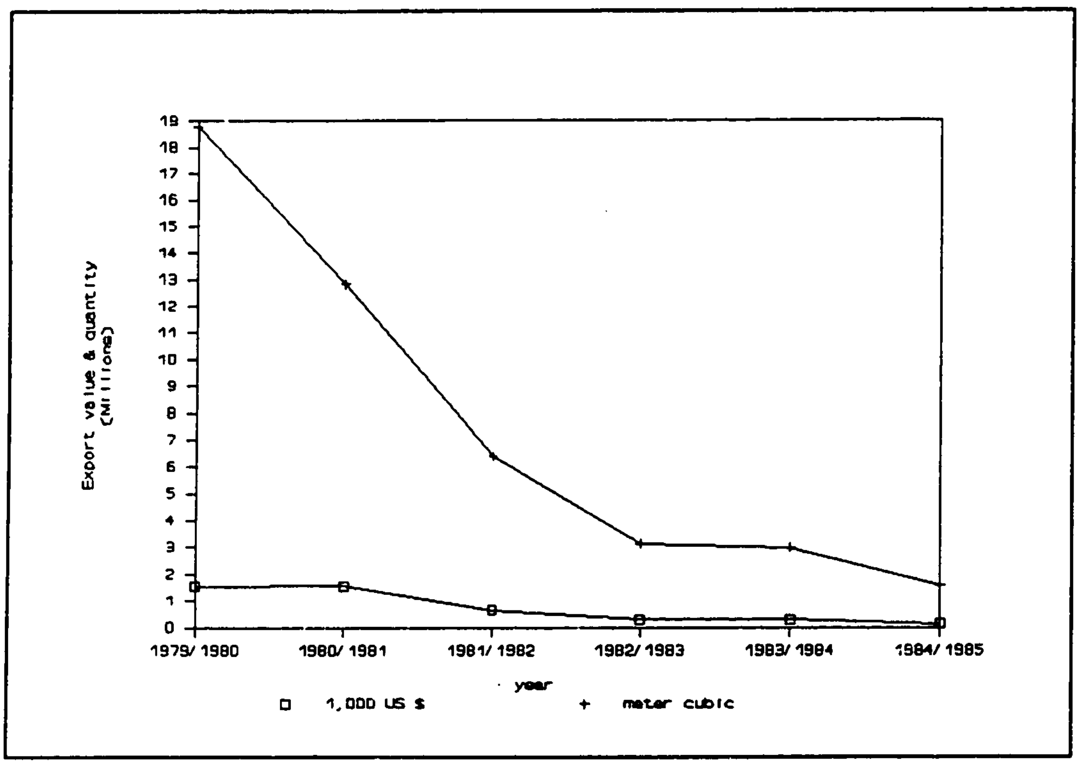


Source : REPELITA V, 1988.

The current timber exploitation system generates considerable wood wastage in the forest. Mordeno and Tinambunan (1989) mentioned that the logging operation under the current concession system left an enormous amount of wood as wastage in the forest. Their estimate was about 8 to 12 cubic meters per hectare of log production area. To correct this problem they proposed the alternative of imposing a tax on wastage left in a forest. However, this policy has not been implemented to date.

The log export ban supported domestic industrial development. It also reduced foreign exchange earnings. After the log export ban, log export volume and foreign exchange earnings from log exports decreased drastically . Figure 2.2 displays the log export volume and foreign exchange earnings. In 1979/1980, revenue from log exports was 1,551.32 million U.S. dollars, and in 1984/1985 it had decreased to 150.05 million U.S. dollars. However, sawnwood and plywood exports increased as discussed in the following section.

Figure 2.2. Volume and value of log exports (1979/1980 - 1985/1985).



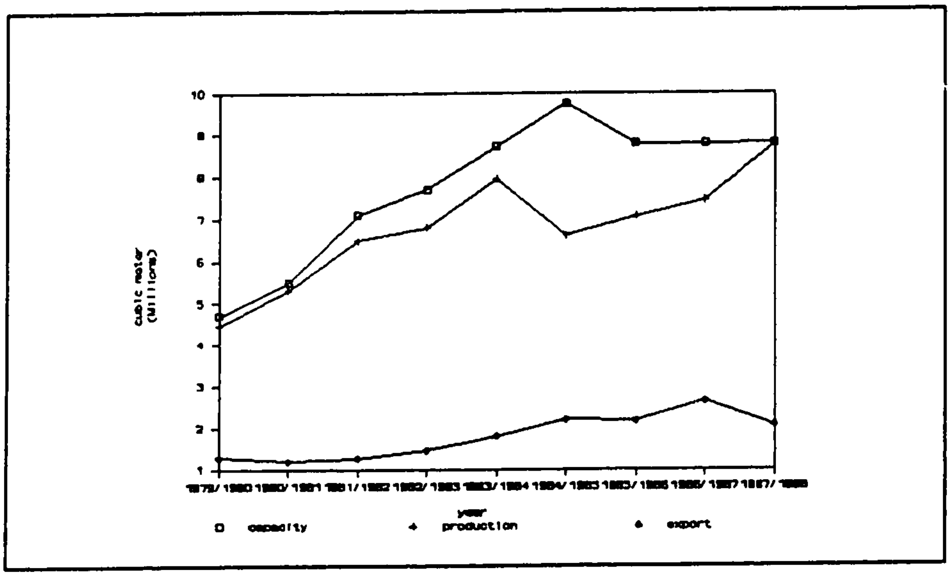
Source: REPELITA V, table 31, 1988

II.3. SAWNWOOD INDUSTRY

In association with the log export ban, the government encouraged an expansion of wood industries, especially plymilling and sawmilling. In Indonesia there are two kinds of sawmilling industries. The first kind consists of sawmills in concessions. These are usually large scale, export oriented industries. The second kind consists of non-concession sawmills, which are usually small scale operations supplying domestic markets.

In 1987/1988, there were 2,503 non-concession sawmills with a total capacity of 6,809 thousand cubic meters, and 300 concession sawmills with a total capacity of 8,767 thousand cubic meters per year (REPELITA V, 1988). The capacity, production, and export of concession sawmills based on data from REPELITA V, 1988, are presented in Figure 2.3. Sawnwood exports from 1979/1980 to 1987/1988 amounted to 26 percent of total production, with most production going to domestic markets.

Figure 2.3. Capacity, production, and exports of concession's sawmills.

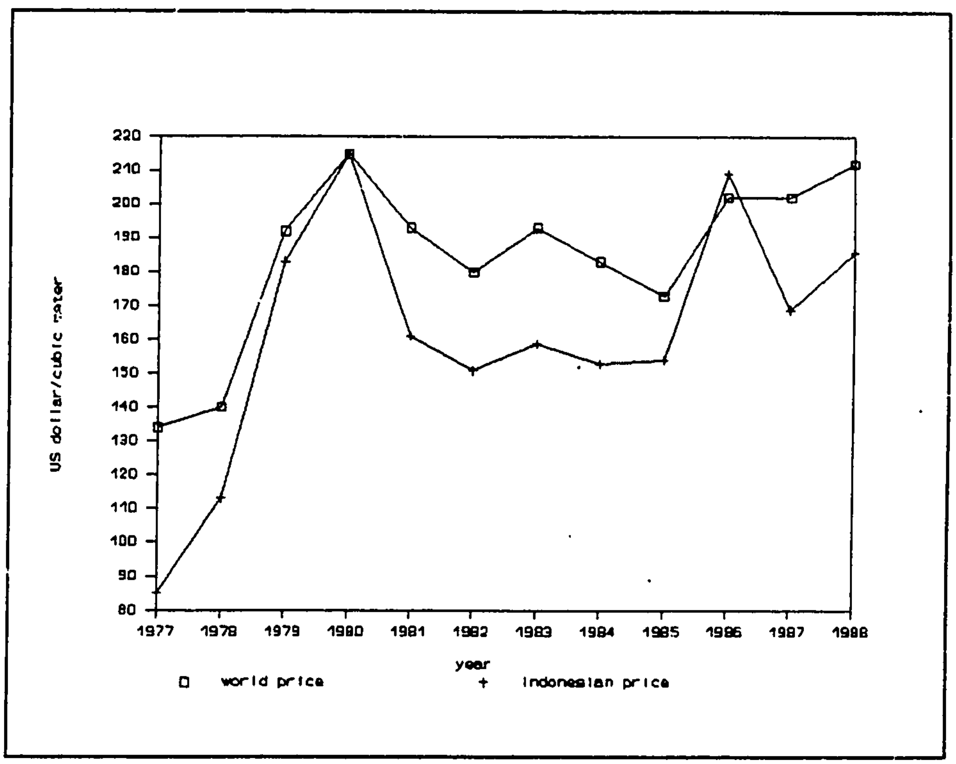


Source: REPELITA V, 1988.

Figure 2.4. shows that the average Indonesian export price is below the average world price for hardwood. In the period 1977 to 1988, the average world price was 184.9 U.S. dollars, while the average Indonesian price was 161.5. This fact led the government to impose a tax on sawntimber export.

In October 1989 the Government announced a relative high sawntimber export tax of 250 U.S. dollars to 2,400 U.S. dollars per cubic meter. The 2,400 U.S. dollar sawntimber export tax is assessed on fancy wood, such as Ebony (Ingram, 1989). One of the objectives of this policy was to promote the processing and export of further processed products. The other objective was to generate government revenues. However, it is too early to know the impacts of the tax increase on the use of timber resources and on manufacturing efficiency in both the plywood and sawnwood industries.

Figure 2.4. The average world and Indonesian sawnwood export price.



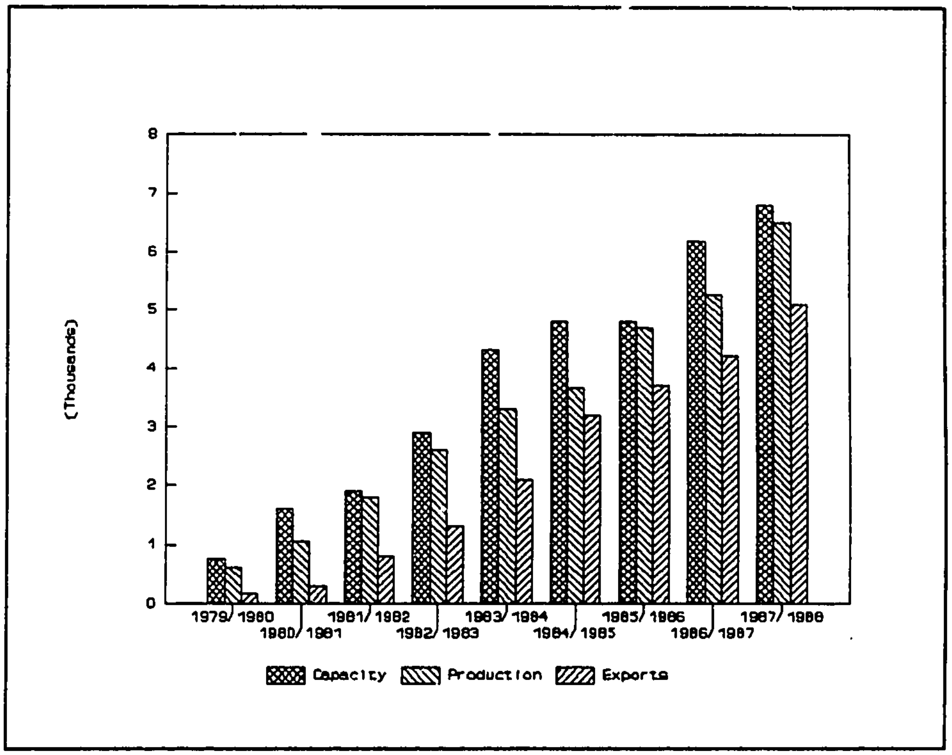
Source: FAO, Forest Products Prices 1969-1988.

II.4. PLYWOOD INDUSTRY

Almost 20 percent of Indonesian plywood (all hardwood) production in 1983/1984 was sold in foreign markets. This figure increased to 78 percent in 1987/1988. The major importing countries are Japan, United States, and China (FAO,1988). In the context of all plywood production (i.e. both hardwood and softwood) Indonesia is now the second largest plywood producer after the United States (Directorate General of Forest Utilization and FAO, volume 1, p.55, 1990). The log export ban stimulated the export of Indonesian wood products, especially plywood. Plywood exports increased from 13 thousand cubic meters in 1976 to 3 million cubic meters in 1985 (Constantino, 1988, p.10).

The number of plymills has risen from 80 units in 1983/1984 to 102 units in 1987/1988 (REPELITA V,1988). Fifteen plymill units with a total capacity of 831,000 cubic meters per each year are under construction and they will launch their first production in 1991 (Jayabhanu and Hymans, 1989). Figure 2.5 shows the capacity, production and export of Indonesian plywood firms for the period 1979/1980 to 1987/1988.

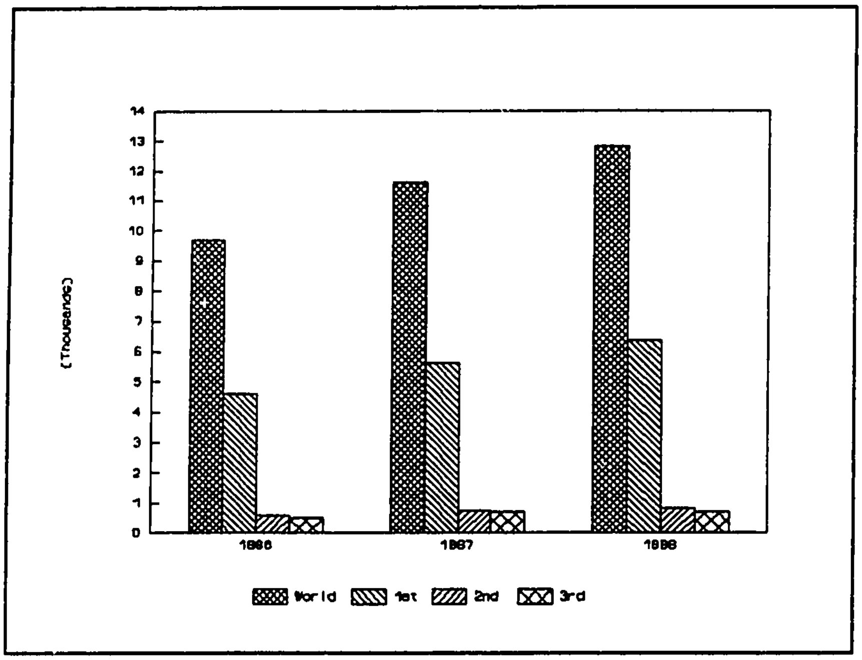
Figure 2.5. The capacity, production, and exports of Indonesian plywood in thousand cubic meters.



Source : REPELITA V, 1988.

Figure 2.6 shows world, Indonesian, and the two following leading hardwood plywood exporting countries. In 1986, Indonesia supplied almost 48 percent of the total world volume for hardwood plywood. This number increased to 49 percent and 50 percent in 1987 and 1988 respectively.

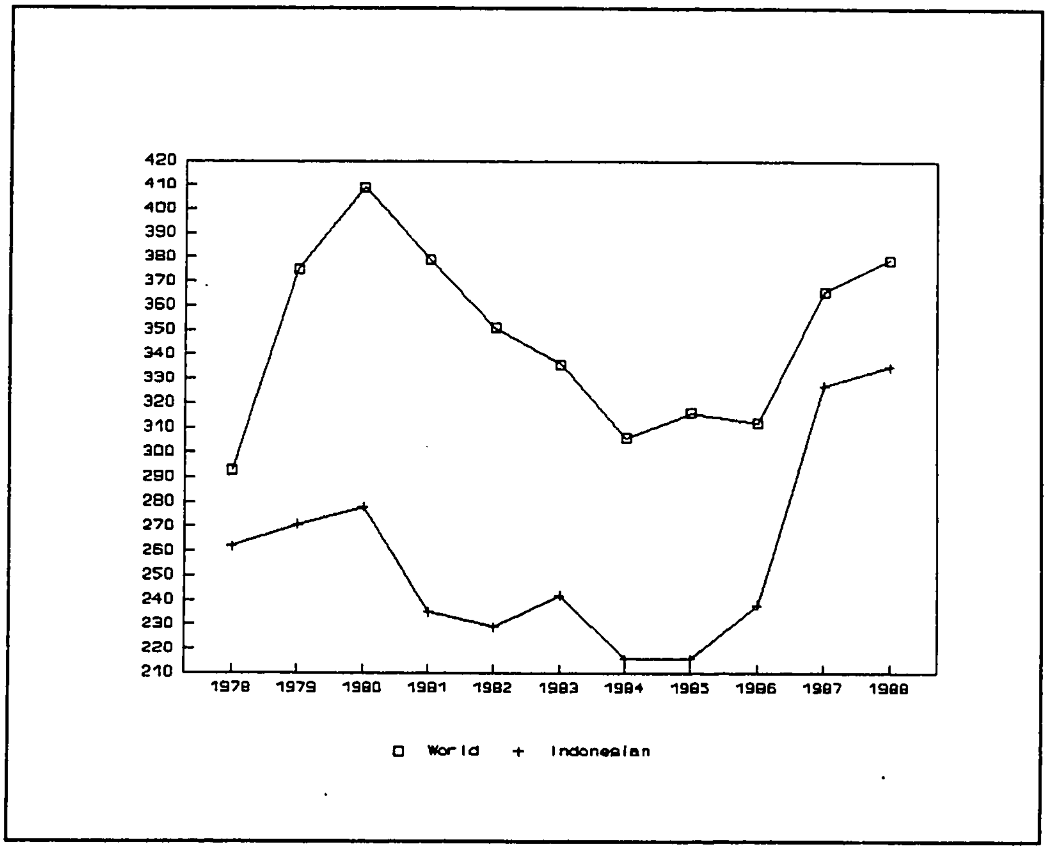
Figure 2.6. Total World, Indonesia, and other leading plywood exporting countries exports in thousand cubic meters.



Note: For 1986 : 1st - Indonesia; 2nd - Singapore; 3rd - China
For 1987 : 1st - Indonesia; 2nd - Malaysia;3rd - Singapore
For 1987 : 1st - Indonesia; 2nd - Malaysia; 3rd - Singapore
Source: FAO, Year Book of Forest Products, 1988.

From 1979 to 1986, Indonesian export prices were lower than international prices, but Indonesian prices started to approach world prices during the past two years. Figure 2.7 shows both world and Indonesian prices of plywood exports.

Figure 2.7. World and Indonesian plywood export prices in US dollar per cubic meter.



Source: FAO, Forest Products Prices 1969-1988.

In spite of Indonesia's success in plywood marketing so far, the reality is that the recovery in the production process has been very low. The average recovery factor of the plymill industry ranged between 45 to 52 percent (Jayabhanu and Hymans, 1989) in recent years.

The forest revenue system is primarily based on the wood products industries. The above review provides background information for analysing the effects of taxes and royalties. The logging industry, prior to the log export ban, was a major contributor to the foreign exchange earnings of the country. Although Indonesia's log exports did contribute significant revenues, the value added generated from downstream industries took precedence. The first expansion was in the sawmill industry, followed by the plymill industry. This shift in policy had a significant impact on Indonesia's forest products markets and on international markets, particularly plywood. The following chapter will expand on the revenue system applied to the logging, sawmilling, and plymilling industries.

CHAPTER III

THE FORESTRY REVENUE SYSTEM

III.1. FORESTRY REVENUE IN INDONESIA

Ingram (1989) defined the revenue system " as a series of charges or fees applied to the users of the resource for extraction and production." The fees and charges on forestry should capture the value of the standing timber and support the sustainable production of forests and related industries.

Forestry revenue in Indonesia at the present time includes the Forest Concession Licence Fee (IHPH), the Land and Improvement Tax (PBB), the Forest Product Royalty (IHH), the Additional Royalty (IHHT), the Reforestation Fee (DR), the Scaling and Grading Fees, and the Sawntimber Export Tax.

The Forest Consession Licence Fee is charged once at the time that the licence is issued. Currently the amount of this fee is Rp.3,000 per hectare except in Irian Jaya where it is Rp.1,500 (note: Rp. is the Indonesian currency where 1 U.S. dollar is equal to Rp.1,770 in 1989). The Land and Improvement Tax is collected every year for the areas outside the annual cutting area. The amount is Rp.1,000 per hectare. This charge is paid annually. Another charge, the Additional Royalty, was implemented prior to 1985 (before the log export ban). The second major charge on forestry is the Forest Product Royalty set at a rate of 6 percent of the average domestic price of logs. This charge is levied on finished products by converting to a roundwood input basis. The next charge is the Reforestation Fee, which is currently assessed at 10.00 U.S. dollars per cubic meter of timber harvested. The Scaling and Grading Fee is Rp.400 per cubic meter for processed wood products. The last charge, the Sawntimber Export Tax, varies by species from 250 to 2400 U.S. dollars per cubic meter. This tax is relatively new and was imposed in November 1989. There is an additional legislation on export of sawntimber that the minimum export price should not be lower than 250 U.S dollars per cubic meter. The summary of current forestry charges and legislation are presented in Table 3.1.

Table 3.1. The Type of Charges Currently Levied on Forest Activities and Related Legislations

Charges	Legislation	Rate
1. Forest Concession Licence Fee	Decree of the Minister of Forestry No.086/Kpts-II/88	Rp.3,000 /ha., and Rp1,500/ha. for Irian.
2. Land and Improvement Tax	Decree of the Minister of Finance No.1324/KMK.04/ 1988.	Rp.1,000 / ha.

Continued

Charges	Legislation	Rate
3.Forest Product Royalty	Decree of the Minister of Agriculture No. 451/Kpts/Um/7/79	6 % of Establish Price
4.Additional Royalty	Decree of the Minister of Agriculture No. 396/Kpts/Um/8/72	Rp250-Rp625/m3
5.Reforestation Fee	Presidental Decree No. 31/1989	US $ 7.00/m3 logs & US $1/m3 Extracted chipwood
6.Scaling and Grading Fee	Decree of the Minister of Forestry No.397/Kpts-II/85	Rp400/m3 processed wood
7.Compulsory Contribution for Education & Training	Decree of the Minister of Manpower, Transmigration and Cooperatives No. 413/Kpts/Men/1974	U.S.100/person/ month
8.Sawntimber Export Tax	Decree of the Minister of Finance No. 1134/KMK.013/1989	US$250-US$2400/m3
9.Minimum FOB Price	Decree of the Minister of Trade No.292/Kp/IX/88 & No. 252a/Kp/X/1989	US$ 250/m3 sawnwood and processed wood

Gray and Hadi (1989a) have studied the effect of recent regulations on the forestry revenue system in Indonesia. They recommend several improvements in the revenue system as follows:

1. The rate of the Licence Fee should be increased to cover

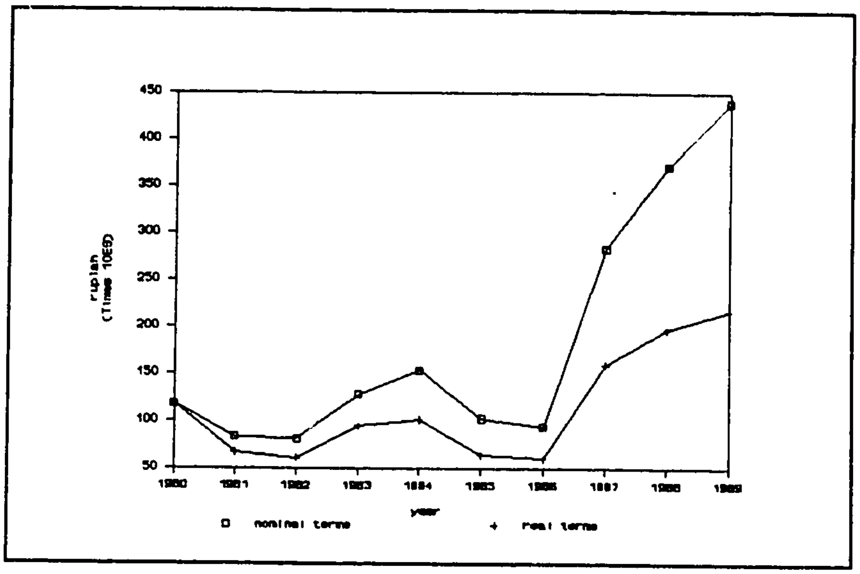
the administration costs;

2. An auction of new concessions by bonus bidding could stimulate competitiveness and revenue collection;
3. For simplification, the Land and Improvement Tax should be combined with an Annual Concession Fee, and the Reforestation Fee with the Forest Product Royalty;
4. Forest Product Royalty should be collected on logs rather than on final product to reduce wood wastage;
5. Strengthen scaling and wood administration; and
6. The level of forest charges should be increased.

Gray and Hadi (1989 a), and Ingram (1989) conclude that the current revenue system should be reviewed to achieve government objectives such as sustainable yield of production, industrial development, additional employment, and foreign exchange earnings. Both studies suggest several changes in the revenue system, however, none of these studies dicuss how industrial behaviour is likely to change if the revenue system is modified.

Figure 3.1 shows that revenue in nominal terms increased at a higher rate compared to real terms after 1985. Regular adjustment of the forestry charges is needed in order to compensate for inflation.

Figure 3.1. The Total Revenue from forestry activities period 1980 - 1989 in real and nominal terms.



Source : Gray and Hadi, 1989 a.

III.2. ECONOMIC IMPACTS OF SOME TAXES

Gregory (1972) argues that forest taxation should meet the following criteria : (1) taxes should contribute to optimal resource allocation, (2) the distribution of taxes collected should contribute to the desired income distribution, and (3) the cost of tax collection should be minimal.

Usually, taxes employed in the production process affect production decisions and therefore affect the level of output and prices. For example, a yield tax on forests increases the total costs of concessionaires. Profits are maximum where marginal cost equals marginal revenue which is a competitive market equals price. A tax altering the supply curve leads to a different profit maximization level of output and typically to a lower output level.

Figures 3.2 and 3.3 show how a lumpsum tax such as a tax on forest land in Indonesia affects equilibrium price and quantity. Figure 3.2. shows that the tax results in an increase in price and a decrease in quantity, but the price rises less than the amount of tax levied (Henderson, 1986, p. 154). In the case of a perfectly elastic supply curve, the equilibrium price increases by exactly the same amount of the tax and the equilibrium quantity depends on the elasticity of demand (Figure 3.3.). In another case, where the tax is proportional to quantity, such a tax will change the slope of the supply curve as shown in Figures 3.4 and 3.5.

Figure 3.2. Market equilibrium lumpsum tax case. (Based on Henderson, 1986).

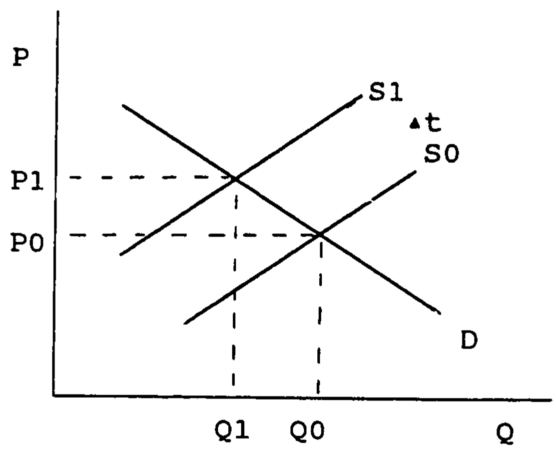


Figure 3.3. Market equilibrium lumpsum tax and a perfectly elastic supply.

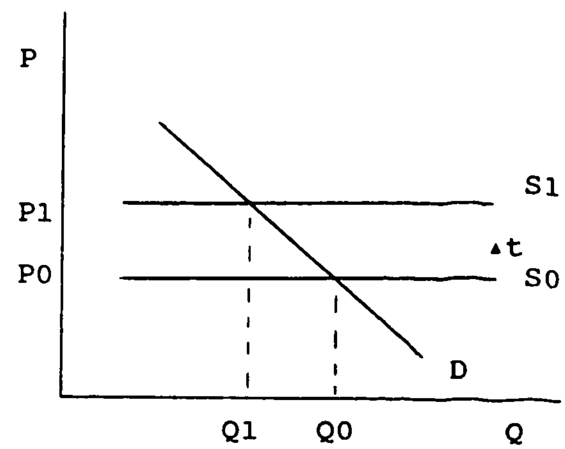


Figure 3.4. Market equilibrium proportional tax case.

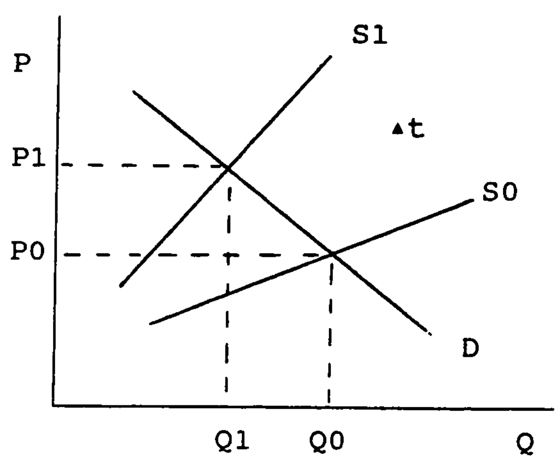
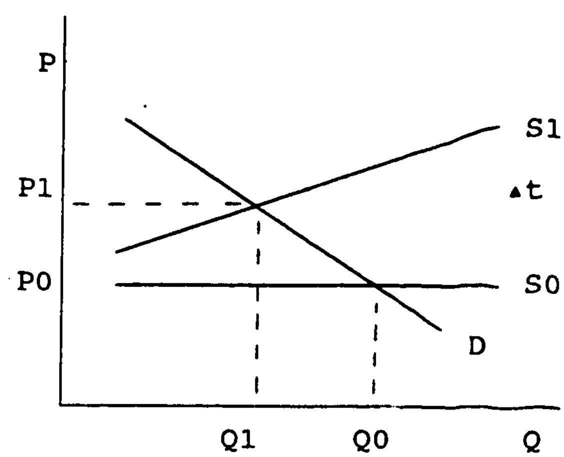


Figure 3.5. Market equilibrium poportional tax and a perfectly elastic supply.



The lumpsum tax in Indonesian forestry is very small, therefore it is not included in this study. The Reforestation Fee, the Product Royalty, and the Export Tax are the major sources of forestry revenues.

A Reforestation Fee charged at dollars per meter cubic changes the price of logs paid by log users. It enters the production decisions of sawmill and plymill owners. Indirectly, it affects the price and quantity demanded of final products. The other two charges - Product Royalty and Export Tax - affect the price of final products, since they are levied on final products.

CHAPTER IV

THEORETICAL DEVELOPMENT, MODEL SPECIFICATION AND DATA DESCRIPTION

There are no empirical studies investigating the impact of alternative forest taxes on the forest industry in Indonesia. Gray (1983), Gray and Hadi (1989a), Ingram (1989), and Repetto and Gillis (1988) reviewed the forestry revenue system, but did not evaluate how changes in the revenue system might affect the private sector. Different taxes or tax levels would impact the price of logs, costs of production, price of final products, supply and demand for final products, factor input demand, and recovery levels in the industry.

To investigate the impacts of alternative forms and levels of taxes on the industry, a system of demand and supply equations is developed below. The models developed cover the sawmilling and plymilling industries. Each model has three components: (1) processing industry, (2) log supply, and (3) final demands.

This chapter develops the theory on which demand and supply are based, specifies the econometric model and describes the data utilized for estimation.

IV.1. THEORETICAL DEVELOPMENT

The analysis of the impacts of policy changes in a revenue system is done in two stages. The first stage involves developing a model comprising a supply function for logs, factor demand and supply functions for the sawnwood and plywood industries, and demand relations for final products. This is the subject of this chapter. In the next chapter the second stage is presented where the equations from the econometric model are used to simulate tax and royalty changes as exogenous industry shocks and the resultant effects on government revenues and endogenous variables.

IV.1.1. PROCESSING INDUSTRY

In economic theory, producers choose technologies to minimize costs. Economic efficiency is achieved when firms minimize the costs of producing a given level of output by choosing the efficient combination of inputs.

In this study the processing industry is characterized through a cost function relating minimum production costs to input prices. The cost function is written as:

$$c^* = c^* \ (r_1, r_2, \ldots, r_n, q) \ ,$$

where q is the quantity of output, c^* is the total cost, and r_1, r_2, r_n are the input prices.

Firms will minimize their cost of production for a given level of output and prices of input. Thus, the input demand function can be derived from a cost function through Shepard's Lemma. Shepard's Lemma says that the partial derivative of the cost function with respect to the i'th input price yields the constant output demand function for input i (Young, 1987):

$$\partial c^* / \partial r_i = X_i^* \ ,$$

where c^* is costs, r_i is the price of input i, and X_i^* is the output demand. The cost minimizing function is therefore a function of input prices and output. According to Young, the cost function must satisfy the following regularity conditions:

1. Continuous with respect to input prices,
2. Homogeneous of degree one in input prices: when all input prices double, then the minimum cost of producing a given level of output will double.

3. Nondecreasing in input prices (monotonicity in input prices): the cost function, which is a nondecreasing function for input prices, requires that, when input prices increase, costs also increase.
4. Concave in input prices: when input prices rise, cost will rise at a decreasing rate.

The translog cost function has been widely used by researchers especially to determine production parameters and the elasticities of input demand. As suggested by Chou and Buongiorno (1983), a flexible functional form such as the translog is more appropriate to analyse substitution possibilities in forest products markets. From cost functions of sawmilling and plymilling with the assumption of constant returns to scale, the average costs are derived, which equal to sawnwood and plywood prices, respectively.

The translog cost function can be written as follows :

$$\ln C = a + \sum_{i=1}^{n} a_i (p_i) + 1/2 \sum_{i=1}^{n} \sum_{j=1}^{n} b_{ij} (\ln p_i)(\ln p_j),$$

where a, and b are the parameters, p_i is the input i price index, p_j is the input j price index. Under homogeneity of degree one in input prices, the cost function must satisfy the following restrictions:

$$\sum_{i=1}^{n} a_i = 1, \quad \sum_{i=1}^{n} b_{ij} = \sum_{j=1}^{n} b_{ji} = 0,$$

Factor demands in the form of share equation can be derived by taking the first derivative of the cost function with respect to prices :

$$\frac{\partial \ln c}{\partial \ln p_i} = S_i = \alpha_i + \sum_{j=1}^{n} \alpha_{ij} \ln p_j \quad ,$$

where S_i is the share of the input i, α's are the parameters to be estimated, p_i is the price index of the input i, and p_j is the price index of the input j.

The elasticity of substitution and elasticity of factor demand indicates the sensitivity of one factor input to changes in its own price or prices of other inputs. These can be obtained from the parameter of the share equations. For the translog cost function, the elasticities can be calculated as (Binswanger, 1974),

$$\sigma_{ij} = \frac{\alpha_{ij}}{S_i \, S_j} + 1$$

$$\sigma_{ii} = \frac{(\alpha_{ii} + S_i S_i - S_i)}{S_i S_i}$$

$$\eta_{ii} = \sigma_{ii}\, S_i$$

$$\eta_{ij} = \sigma_{ij}\, S_j\ ,$$

where σ_{ij} is the elasticity of substitution between input i and input j, σ_{ii} is the own elasticity of substitution, α's are the parameters from share equations, S_i and S_j are the shares of inputs $_i$ and $_j$, η_{ii} is the own price factor demand elasticity, and η_{ij} is the cross price factor demand elasticity.

IV.1.2. LOG SUPPLY

The supply of logs is primarily a function of its price, and prices of input factors. In the case of Indonesia, the supply of timber is also determined by the forest inventory which is reflected in the administratively set Annual Allowable Cut, and by the size of the inventory that is economically recoverable, such as density of logging roads and transportation distance.

The short run supply function indicates how much timber will be produced given prices and constant capital investment. In the short run, logging producers can only alter their production by changing their variable inputs. In the long run and under constant returns to scale, supply is perfectly elastic and yields the average production costs equal the price of logs.

The ownership of the forests must also be considered. For example, a horizontal supply curve up to the point of maximum allowable cut has been hypothesized for timber from Federal land in the United States (Gregory, 1972, p. 354). Almost all forest area in Indonesia is owned by the government. Thus, one assumption of this study is that administrative costs of producing logs are constant and anticipated, at least for the short term. Therefore, the log supply curve is horizontal. In Indonesia the situation is more complex because the Indonesian government transfers the rights to harvest to concessionaires, and to the extent that these face the trade-off between cutting today and in the future, supply may be upward sloping. Since there is no literature available on the elasticity of log supply in Indonesia, this study employs two kinds of log supply elasticities: unit elastic and perfectly elastic. The unit elasticity assumption is likely more applicable to Indonesia's circumstances. Log supply was specified as :

$$P_l = f(Q_l\ ,\ P_{oth}\ ,\ AAC\ ,\ ROAD)\ ,$$

where P_l is the price of logs, Q_l is the quantity of logs, P_{oth}

is the price of other inputs, AAC is the Annual Allowable Cut, and ROAD is the total length of logging road in the country. The constant returns to scale and perfectly elastic supply implies the following model, given a Cobb Douglas cost function:

$$\ln P_1 = \ln AC_l = a_0 + a_1 \ln AAC + a_2 \ln ROAD + a_3 \ln P_{oth}$$

Given constant return to scale, Q_l is canceled.

In the second specification the assumption of constant return to scale is dropped and instead, an elasticity of average costs with respect to output of one is assumed:

$$\ln AC_l = a_0 + a_1 \ln Q_l + a_2 \ln AAC + A_3 \ln ROAD ,$$

where a_1 equals 1.

In both specifications a positive relationships between logging roads and average logging costs is expected.

IV.1.3. FINAL DEMANDS

The demand of the individual consumer is determined by the consumption choices and the consumers budget. The aggregate demand is a summation of individual demands. Demand for final products is derived from a utility function.

The final demand equation is a function of own price and prices of substitutes, and income. Domestic demand can be written as:

$$Q_{d1} = f(P_1, P_2, Y) ,$$

where Q_{d1} is the domestic demand for good 1, P_1 and P_2 are the price of good 1 and good 2, and Y is an income.

It is assumed that the industry is a price taker in international markets. The decision of importers to buy from Indonesia or elsewhere depend on relative world and Indonesian prices. Thus the export demand is presented as:

$$Q_{e1} = f(P_{d1}, P_{e1}, Y) ,$$

where Q_{e1} is the export demand for good 1, P_{d1} is a domestic price of good 1, P_{e1} is the world export price of good 1, and Y is world income.

IV.2. MODEL SPECIFICATION AND DATA DESCRIPTION

Although many alternative functional forms can be used, preference for a particular alternative is based on availability of data and economic behaviour of the model. This section presents the econometric models, which are consistent with a Cobb Douglas form for supply of logs and the demand for final products, and a translog form for the cost function for sawnwood and plywood. The data utilized in this model are justified later in this section.

IV.2.1 MODEL SPECIFICATION

A double-log model is utilized for the supply of logs and the demand of final products. The independent variables for the log supply function are the Annual Allowable Cut and the length of logging road. Domestic and foreign demands are presented in two equations.

The domestic demands for sawnwood and plywood are functions of own price and Gross Domestic Product (GDP), while export demands for sawnwood and plywood are determined by own prices and world price. GDP was also used by Baudin (1988) as an explanatory variable in his study on Long-term Economic Development and Demand for Forest Products. GDP is an indicator of domestic purchasing power.

The translog cost function is used to estimate production parameters on sawmilling and plymilling industries. The translog cost function yields considerable information on the production structure. The estimation of the translog cost function together with the share equations provides information from which the elasticity of factor demand can be derived.

The presence of right hand side endogenous variables in the model requires a simultaneous solution to the system of equations. Three stage least squares estimation is employed in this study. As stated by Pindyck and Rubinfield (1976, p.286), the three stage least squares procedure yields smaller variance of the coefficient parameters compared to the two stage least squares procedure, because it considers correlations between equations.

Due to poor results obtained initially, Producer Price Index, a proxy for the price of substitutes, was dropped from the supply of logs equation. The same problem occurred in the demand equation for final products, and the Consumer Price Index, a proxy for the price of substitutes, was excluded. The world income was also dropped from the equation. There was a high degree of multicollinearity among the right hand side variables.

The constant returns to scale assumption in logging implies a perfectly elastic supply curve of logs from public forests which shifts due to road development and government regulation on Annual Allowable Cut. In the long run, the average cost of producing the final product is the same as the marginal cost and price which implies that the assumption of free entry into the industry holds.

The models for estimating the supply of logs, the price of final products, the share of inputs, and the domestic and foreign demands for final products are expressed in the following system equations (sawnwood and plywood products are estimated separately):

1. Supply of logs :

   - Perfectly elastic supply of logs :

   $$\ln PLOG = a_0 + a_1 \ln AAC + a_2 \ln ROAD ,$$

   where PLOG is price of logs, AAC is the Annual Allowable Cut, and ROAD is the length of logging road.

   - Unit elastic supply of logs :

   $$\ln PLOG = a_0 + a_1 \ln QLOG + a_2 \ln AAC + a_3 \ln ROAD$$

   where QLOG is the quantity of logs supplied and a_1 equals one. Positive relationships between price of logs and AAC, and between price of logs and ROAD are expected for both perfectly and unit elastic supply of logs. For some reasons, AAC or ROAD can be a shifter of supply curve, and negative relationships between AAC and price or between ROAD and price are expected. Otherwise, change in AAC or ROAD assumes to cause movement along a given supply curve rather than shifting it. The positive sign of the parameter of QLOG is also expected. The dependent variable here should have been average costs but because data were not available the price of logs was used instead.

2. Average Cost function with assumption of constant returns to scale for the processing industries:

$$\ln ACFNL = b_0 + c_0 \ln LEN + c_1 (\ln LEN)^2/2$$

$$+ c_2 \ln LEN \ln CAPI + c_3 \ln LEN \ln LOG$$

$$+ d_0 \ln CAPI + d_1 (\ln CAPI)^2/2$$

$$+ d_2 \ln CAPI \ln LOG + e_0 \ln LOG + e_1 (\ln LOG)^2/2 ,$$

where ACFNL is the average cost of final product. LEN is the aggregate price of labour, energy and nonwood materials. A discrete divisia index used to calculate this price aggregate is explained in the section of data description later in this chapter. Aggregation is necessary due to the limited number of observations. CAPI and LOG are the price of capital and logs respectively. A study on demand for energy by Fuss (1977) utilized the same form of average cost function.

3. Share equations :

$$SHLEN = c_0 + c_1 \ln LEN + c_2 \ln CAPI + c_3 \ln LOG$$

$$SHCAPI = d_0 + d_1 \ln LEN + d_2 \ln CAPI + d_3 \ln LOG$$

$$SHLOG = e_0 + e_1 \ln LEN + e_2 \ln CAPI + e_3 \ln LOG \quad ,$$

where SHLEN, SHCAPI, and SHLOG are the share of labour, energy and nonwood materials, capital, and logs respectively. Because share equations add up to one, one of them must be deleted from the system. The linear homogeneity in prices implies the following restrictions :

$$c_0 + d_0 + e_0 = 1$$

$$c_1 + c_2 + c_3 = 0$$

$$d_1 + d_2 + d_3 = 0$$

$$e_1 + e_2 + e_3 = 0 \quad ,$$

and the symetry condition implies that:

$$c_1 + d_1 + e_1 = 0$$

$$c_2 + d_2 + e_2 = 0$$

$$c_3 + d_3 + e_3 = 0$$

4. Domestic demand :

$$\ln qdom = f_0 + f_1 \ln ACFNL + f_2 \ln GDP \ ,$$

where QDOM is the domestic demand for sawnwood or plywood, ACFNL is the predicted price of sawnwood or plywood, and GDP is the Indonesian Gross Domestic Product. A negative relationship between QDOM and ACFNL is expected. The sign of the parameter GDP is expected to be positive, since the demand for sawnwood or plywood increases with an increase in income.

5. Export demand :

$$\ln qexp = g_0 + g_1 \ln ACFNL + g_2 \ln WPRICERP ,$$

where QEXP is the foreign demand for sawnwood or plywood. ACFNL is the Indonesian price of sawnwood or plywood, and WPRICERP is the world price of sawnwood or plywood in Indonesian currency. The parameter on ACFNL is expected to be negative. Since WPRICERP is a proxy for substitutes for Indonesian sawnwood or plywood in international market, a positive sign of its coefficient is expected.

IV.2.3. DATA DESCRIPTION

The main source of data for input prices of sawmill and plymill industries utilized in this study was originally from Constantino, 1988 (pp.18-21). The price of labour, energy, nonwood materials, capital, and logs are in nominal indexes. The capital price series developed by Constantino represents the rental price of machinery capital.

Data for log production, logging roads, and Annual Allowable Cut are taken from Ingram et al, 1989. The quantity of final products and product prices are obtained from several sources such as, REPELITA V (1988), FAO Year Book of Forest

Products (various issues), and Forest Product Prices (1990).

The Gross Domestic Product for Indonesia is obtained from International Financial Statistics (1990). The variables and the sources of data are listed in Appendix 1.

The number of observations is 13 and covers the period from 1975 to 1987. Because of the small number of observations, the input prices of labour, energy, and nonwood materials were aggregated by using the discrete divisia price index technique as follows (White, 1990):

$$\ln Dt = 1/2\,(SHL_t + SHL_{t+1})\,(\ln PL_{t+1} / PL_t)$$

$$+ 1/2\,(SHE_t + SHE_{t+1})\,(\ln PE_{t+1} / PE_t)$$

$$+ 1/2\,(SHN_t + SHN_{t+1})\,(\ln PN_{t+1} / PN_t)\ ,$$

where D_t is the change in aggregate price of labour, energy and nonwood materials. SHL, SHE, and SHN are the share of labour, energy and non wood materials. PL, PE, and PN are the prices of labour, energy, and nonwood materials. t is a time. The divisia index has flexible weights which involve changes of shares through time and support the translog functional form (Allen 1975, and Diewert 1976).

The results obtained from three stage least squares procedures with the above data applied to sawmill and plymill industries are presented in the next chapter.

CHAPTER V

EMPIRICAL RESULTS OF MODEL ESTIMATION

This chapter contains the empirical results in the form of sawnwood and plywood model estimations. The models for sawnwood and plywood are treated independently from one another, whereby in the sawnwood model, the plywood industry is treated as a residual, and vice versa. In other words, they are estimated separately and therefore no log supply constraint has been imposed.

The estimation results under both perfectly and unit elastic supply of logs assumptions are presented. The more realistic case for Indonesia is the assumption of unit elastic supply of logs. When log producers expand the output, costs of production increase due to certain constraints, such as land and harvesting cost constraints. The unit elastic supply of logs assumption is more indicative of the forest industries in Indonesia.

V.1. ESTIMATION OF SAWNWOOD MODEL

There are six equations in the sawnwood estimation model: log supply, cost function, two share equations, and domestic and export demand for final products. The econometric results are presented in terms of the coefficient parameters, and t ratios.

The estimation of the supply of logs equation yielded the following results.

Table 5.1. Supply function of logs in the sawmilling model.

Variable	Coefficient	t ratio
A. Perfectly elastic supply curve :		
- Constant	-23.28000	-21.917
- Annual Allowable Cut	0.83214	11.432
- Logging Road	0.94649	11.827
B. Unit elastic supply curve :		
- Constant	-6.84070	-2.7801
- Quantity of logs	1.00000	0.208E+08
- Annual Allowable Cut	0.04644	0.2056
- Logging Road	-0.65617	-3.6309

All of the coefficient parameters are significant at the 99 % confidence level except for the Annual Allowable Cut under the unit elastic supply curve assumption. Both perfectly elastic and unit elastic supply cases show that the relationship between the Annual Allowable Cut and logging costs is inelastic. The relationship between logging road and logging costs is also inelastic. However, the Annual Allowable

Cut is insignificant under the unit elastic supply assumption. The sign of the logging road coefficient changes to negative in the unit elastic supply model. This negative sign indicates that the average cost of producing logs decreases when logging road increases.

Table 5.2 provides the estimates of elasticities of domestic and export demand for sawnwood. The elasticities with respect to Gross Domestic Product, and domestic price, determine the responsiveness of domestic demand for sawnwood, while the elasticity of domestic price and world price of sawnwood determine the sensitivity of export demand for sawnwood.

Table 5.2. Domestic and export demands for sawnwood.

Variable	Coefficient	t ratio
A. Demand under perfectly elastic supply of logs:		
a.1. Domestic demand:		
- Constant	22.3380	15.528
- Domestic price	1.0860	14.903
- Gross Domestic Product	-2.2620	-14.394
a.2. Export demand:		
- Constant	-0.5989	-0.921
- Domestic price	0.4276	5.555
- World price	0.2972	5.261

Continued

Variable	Coefficient	t ratio
B. Demand under unit elastic supply of logs :		
b.1. Domestic demand:		
- Constant	5.15790	3.428
- Domestic price	0.44901	4.997
- Gross Domestic Product	-0.14657	-0.777
b.2. Export demand:		
- Constant	-1.7288	-2.236
- Domestic price	0.15309	0.973
- World price	0.66343	4.389

Variables domestic price, Gross Domestic Product, and world price are significant at the 99 % confidence level under perfectly elastic supply of logs. Under unit elastic supply of logs, Gross Domestic Product for domestic demand equation and domestic price for export demand equations become insignificant. The negative sign of the Gross Domestic Product is contrary to expectation and probably captures some likely substitution effects, as domestic demand substitutes other products for sawnwood. As mentioned above, an appropriate variable for capturing these effects could not be included due to data limitations. The results are contrary on the predictions of theory for domestic prices under both perfectly and unit elastic supply of logs and for domestic and export demand.

There are three factor inputs in the sawmill industry: (1) aggregate factors (labour, energy and nonwood materials), (2) capital, and (3) logs. The estimates of translog average cost function and the share equations for sawnwood are provided in Table 5.3.

Table 5.3. Average cost function and share equations for sawmilling.

Variable	Coefficient	t ratio
A. Perfectly elastic supply curve :		
A.1. Average cost function :		
- Constant	8.7801	25.7790
- Labour, energy, nonwood materials	0.4289	4.9420
- (Labour, energy, nonwood materials) squared	0.1531	3.6674
- Labour, energy, nonwood materials - Capital	-0.0424	-2.6867
- Labour, energy, nonwood materials - Logs	-0.1107	-2.9953
- Capital	-0.0467	-0.4055
- (Capital) squared	0.0632	3.0768
- Capital-Logs	-0.0210	-0.9007
- Logs	0.6178	4.7445
- (Logs) squared	0.1317	3.0935
A.2. Share of Labour, Energy, Nonwood Materials:		
- Constant	0.4289	4.9422

Continued

Variable	Coefficient	t ratio
- Labour, energy, nonwood materials	0.1531	3.6715
- Capital	-0.0424	-2.6867
- Logs	-0.1107	-2.9975
A.3. Share of Capital:		
- Constant	-0.0467	-0.4056
- Labour, energy, nonwood materials	-0.0424	-2.6867
- Capital	0.0635	3.0775
- Logs	-0.0210	-0.9010
B. Unit elastic supply curve :		
B.1. Average cost function:		
- Constant	8.5462	25.8030
- Labour, energy, nonwood materials	0.2062	2.3148
- (Labour, energy, nonwood materials) squared	0.0241	0.6238
- Labour, energy, nonwood materials - Capital	-0.0011	-0.0743
- Labour, energy, nonwood materials - Logs	-0.0229	-0.6051
- Capital	0.0355	0.3157
- (Capital) squared	0.0486	2.4053
- Capital-Logs	-0.0474	-1.9474
- Logs	0.7582	5.5935
- (Logs) squared	0.0703	1.4735
B.2. Share of Labour, Energy, Nonwood Materials:		
- Constant	0.2062	2.3148
- Labour, energy, nonwood materials	0.0241	0.6238
- Capital	-0.0011	-0.0743
- Logs	-0.0229	-0.6051
B.3. Share of Capital:		
- Constant	0.0355	0.3157
- Labour, energy, nonwood materials	-0.0011	-0.0743
- Capital	0.0486	2.4053
- Logs	-0.0474	-1.9474

The positive sign of the elasticities of aggregate factors in its share under both perfectly and unit elastic supply of logs assumption is contrary to theory. This result is probably due to the effect of aggregation. The sign of capital input in its share is also wrong for both perfectly and unit elastic supply of log models.

The factor elasticity of input demand for the sawmill industry can be derived from the share equations. The elasticity of substitution, the price factor demand elasticity, and the cross price factor demand are important for illustrating how sensitive inputs usage is to price changes for a given level of output. The following tables present the elasiticicities for sawnwood for the period between 1975 and 1987.

Table 5.4. Elasticity of substitution between input for sawmilling.

Input	Labour, Energy & Nonwood Materials	Capital	Logs
A. Under perfectly elastic supply of logs			
1. Labour, Energy, & Nonwood Materials	-0.17991	0.30545	-0.11533
2. Capital	-	-1.59860	0.86018

Continued

Input	Labour, Energy & Nonwood Materials	Capital	Logs
3. Logs	-	-	-0.48314
B. Under unit elastic supply of logs			
1. Labour, Energy, & Nonwood Materials	-3.38196	0.98039	0.76865
2. Capital	-	-1.75929	0.68520
3. Logs	-	-	-0.73417

Note : Elasticities are calculated at the mean value of observations.

All of the own elasticities have the correct sign. For the model assuming a perfectly elastic supply of logs, only the own elasticity of capital is elastic. For the unit elasticity model the own elasticity of the aggregate of labour, energy, and nonwood materials is elastic. For both models, own price elasticities of logs are inelastic.

In the translog cost function, the negative sign of elasticity of substitution and cross price demand elasticity mean that both inputs are complementary, while positive signs means both are substitutes (Binswanger, 1974 p.384). In the model assuming a perfectly elastic supply of logs, only the elasticity of substitution between the aggregate of labour, energy and nonwood materials with logs is negative. The strongest substitution possibilities in the case of the model of a perfectly elastic supply of logs is between the capital and logs, and for the other model the greatest substitution possibility is between the aggregate factor (labour, energy and nonwood materials) and capital.

Table 5.5 shows that all of the own price elasticities are inelastic with the theoretically correct signs. The cross price elasticity between the aggregate factor with logs is negative but low for the model assuming a perfectly elastic supply of logs. The cross price factor demand elasticities are inelastic and indicate that factors are substitutes. The strongest substitution possibility is between capital and logs when a perfectly elastic supply of logs is assumed, and between the aggregate of labour, energy and nonwood materials with logs under the assumption of a unit elastic supply of logs. This substitution between capital and logs could be due to the relative scarcity of capital.

Table 5.5. Price factor demand elasticity for sawmilling.

Input	Labour, Energy & Nonwood Materials	Capital	Logs
A. Under perfectly elastic supply of logs			
1. Labour, Energy, & Nonwood Materials	-0.03611	0.09303	-0.05704
2. Capital	-	-0.48687	0.42543

Continued

Input	Labour, Energy & Nonwood Materials	Capital	Logs
3. Logs	-	-	-0.23895
B. Under unit elastic supply of logs			
1. Labour, Energy, & Nonwood Materials	-0.67887	0.29859	0.38016
2. Capital	-	-0.53581	0.33889
3. Logs	-	-	-0.36310

Note : Elasticities are calculated at the mean value of observations.

The next section contains the estimation results for the plywood model. Sawnwood industries are treated as a residual in wood supply volume.

V.2. ESTIMATION OF PLYWOOD MODEL

The plywood model consists of the same six equations: log supply, cost function, two share equations, and domestic and export demand for final product. The following econometric results are presented in terms of the coefficient parameters, and t ratios. The supply of logs equation resulted in the following coefficient parameters.

Table 5.6. Supply function of logs in plymilling model.

Variable	Coefficient	t ratio
A. Perfectly elastic supply curve :		
- Constant	-32.50800	-46.848
- Annual Allowable Cut	0.89163	17.959
- Logging Road	1.77550	22.261
B. Unit elastic supply curve :		
- Constant	-11.60700	-3.2848
- Quantity of logs	1.00000	0.338E+06
- Annual Allowable Cut	0.27290	0.9911
- Logging Road	-0.58285	-2.8932

All of the coefficient parameters are significant at the 95 % confidence level, except for the Annual Allowable Cut, under the unit elastic supply curve. For both models of log supply, the Annual Allowable Cut and Logging Road variables are inelastic. The Annual Allowable Cut is not significant under a unit elastic supply curve. The sign of logging road coefficient becomes negative in the unit elastic supply model.

The positive sign of the logging road coefficient can be interpreted as increasing costs due to longer transportation distance.

The coefficient parameters on domestic and export demand for plywood are presented on the following table.

Table 5.7. Domestic and export demand for plymilling.

Variable	Coefficient	t ratio
A. Demand under perfectly elastic of logs supply :		
a.1. Domestic demand:		
- Constant	19.1620	5.192
- Domestic price	0.9586	12.388
- Gross Domestic Product	-2.2401	-8.102
a.2. Export demand:		
- Constant	-12.6830	-6.263
- Domestic price	1.8151	51.326
- World price	-0.3597	-2.152
B. Demand under unit elastic supply of logs :		
b.1. Domestic demand:		
- Constant	-53.4760	-8.247
- Domestic price	1.7859	13.927
- Gross Domestic Product	7.1932	13.116
b.2. Export demand:		
- Constant	-27.1460	-9.492
- Domestic price	3.2644	28.027
- World price	-0.5903	-2.900

The variables domestic price and Gross Domestic Product are significant at the 99 % confidence level, and the variable world price is significant at the 95 % confidence level under the assumptions of perfectly elastic and unit elastic supplies of logs. The coefficient of domestic prices has the wrong signs. It is probably due to missing variables in the model and efforts to correct this problem included adding the following variables to the model: consumer price index, population, World Gross Domestic Product have been done. However, these efforts did not help solve the problem. When Gross Domestic Product increases, the domestic demand for plywood decreases. This appears to indicate that when income increases, the consumers turn to substitute materials.

Table 5.8 shows the coefficient parameters of the average cost function and share equations of the plymill industry.

Table 5.8. Average cost function and share equations for plymilling.

Variable	Coefficient	t ratio
A. Perfectly elastic supply curve :		
A.1. Average cost function :		
- Constant	9.5156	19.6040
- Labour, energy, nonwood materials	0.3743	4.9645

Continued

Variable	Coefficient	t ratio
- (Labour, energy, nonwood materials) squared	0.0754	6.2882
- Labour, energy, nonwood materials - Capital	-0.0223	-1.6654
- Labour, energy, nonwood materials Logs	0.0531	-4.3309
- Capital	0.3399	2.4228
- (Capital) squared	-0.0142	-0.5639
- Capital-Logs	0.0365	2.1987
- Logs	0.2856	3.3072
- (Logs) squared	0.0165	0.7027
A.2. Share of Labour, Energy, Nonwood Materials:		
- Constant	0.3743	4.9855
- Labour, energy, nonwood materials	0.0754	6.1492
- Capital	-0.0223	-1.6719
- Logs	-0.0531	-3.9622
A.3. Share of Capital:		
- Constant	0.3399	2.4170
- Labour, energy, nonwood materials	-0.0223	-1.6719
- Capital	-0.0142	-0.5631
- Logs	0.0365	2.2512
B. Unit elastic supply curve :		
B.1. Average cost function:		
- Constant	9.4452	17.6800
- Labour, energy, nonwood materials	0.3303	3.8772
- (Labour, energy, nonwood materials) squared	0.1152	6.9474
- Labour, energy, nonwood materials - Capital	-0.0183	-1.1869
- Labour, energy, nonwood materials - Logs	-0.0968	-6.0272

Continued

Variable	Coefficient	t ratio
- Capital	0.3055	1.7990
- (Capital) squared	-0.0083	-0.2747
- Capital-Logs	0.0267	1.2639
- Logs	0.3640	2.9479
- (Logs) squared	0.0701	2.3067
B.2. Share of Labour, Energy, Nonwood Materials:		
- Constant	0.3303	3.8861
- Labour, energy, nonwood materials	0.1152	6.9713
- Capital	-0.0183	-1.1896
- Logs	-0.0968	-6.1341
B.3. Share of Capital:		
- Constant	0.3055	1.1896
- Labour, energy, nonwood materials	-0.0183	-1.1896
- Capital	-0.0083	-0.2749
- Logs	-0.0267	1.2842

There are three factor inputs in this model: (1) aggregate inputs of labour, energy and nonwood materials, (2) capital, and (3) logs. The positive sign of the aggregate factors elasticities in the share of aggregate factors are unexpected both for perfectly and unit elastic supply of logs. It is probably due to the effect of aggregation. For both models of log supply, the elasticity of capital in the share of capital also has the wrong sign. These results are hard to explain. However, it is possible they arise from missing variables in the model.

The econometric results for the plywood industrial model are shown in Table 5.9.

Table 5.9. Elasticity of substitution between input for plymilling.

Input	Labour, Energy & Nonwood Materials	Capital	Logs
A. Under perfectly elastic supply of logs			
1. Labour, Energy, & Nonwood Materials	-1.60930	0.67631	0.59937
2. Capital	-	-3.29293	1.31325
3. Logs	-	-	-1.03747
B. Under unit elastic supply of logs			
1. Labour, Energy, & Nonwood Materials	-1.10197	0.73376	0.26963
2. Capital	-	-3.19654	1.22918
3. Logs	-	-	-0.79883

Note : Elasticities are calculated at the mean value of observations.

All of the own elasticities have the correct sign and are elastic, except for the own price elasticity of logs under unit elastic supply of logs assumption which is inelastic.

The elasticities of substitution under both perfectly and unit elastic supply of logs assumptions indicate that factors are substitutes. The strongest substitution possibility under both models is between capital and logs.

Table 5.10. Price factor demand elasticity for plymilling.

Input	Labour, Energy & Nonwood Materials	Capital	Logs
A. Under perfectly elastic supply of logs			
1. Labour, Energy, & Nonwood Materials	-0.45054	0.16665	0.28388
2. Capital	-	-0.81137	0.62201
3. Logs	-	-	-0.49138
B. Under unit elastic supply of logs			
1. Labour, Energy, & Nonwood Materials	-0.30850	0.18079	0.12770
2. Capital	-	-0.78761	0.58219
3. Logs	-	-	-0.37835

Note : Elasticities are calculated at the mean value of observations.

The above results show that all of the own price elasticities are inelastic with the correct signs. All of the cross price elasticities indicate that factors are substitutable and inelastic. The cross price factor demand between the capital and logs indicates the strongest substitution possibility for both models.

To the extent that total volume estimates from the plywood model differ little from those of the sawnwood model, no significant gains from the use of a single co-dependent model involving a volume constraint would result.

CHAPTER VI

POLICY SIMULATIONS

The purpose of this chapter is to provide analytical policy simulation results in the form of economic impacts from selected policy changes in tax and royalty rates for the forestry sector in Indonesia. Five different policy changes in taxes and royalties and their impact on the Indonesian sawmill and plymill industries are analyzed. Sawnwood and plywood model simulations are carried out separately.

The five scenarios are implemented through the model using perfectly and unit elastic supply of logs assumptions. The perfectly elastic supply assumption is preserved as an upper bound. The true case for Indonesia's log industry is likely closer to unit elasticity. Summaries of the simulation scenarios selected and the government objectives which underline the simulation selections are listed in Table 6.1 and Table 6.2 respectively.

Table 6.1. Simulation scenarios.

No.	Simulation	Tax and Royalty
1.	Initial condition (1987)	- $ 4 Reforestation Fee - 6 % Product Royalty
2.	Simulation 1	- $ 7 Reforestation Fee - 6 % Product Royalty

Continued

No.	Simulation	Tax and Royalty
3.	Simulation 2	- $ 4 Reforestation Fee - 8 % Product Royalty
4.	Simulation 3	- $ 10 Reforestation Fee - 6 % Product Royalty
5.	Simulation 4	- $ 4 Reforestation Fee - 6 % Product Royalty - $ 250 Export Tax (for sawmilling model) - 6 % Additional Tax on Plywood (for plymilling model)

Table 6.2. Government objectives.

No.	Government objectives
1.	An increase in recovery factor of log used in sawmilling and plymilling.
2.	An increase in employment levels
3.	An increase in government revenues
4.	Stability of domestic prices
5.	Stability in foreign exchange earnings from the plymill industry

The following justifications provide linkages between the simulation scenarios and the government objectives pertaining to recovery factor, employment, domestic price of sawnwood and plywood, government revenues, and foreign exchange earnings.

V.I. JUSTIFICATION FOR SIMULATION SELECTIONS

Three major tax and royalty instruments in Indonesian forestry are simulated in this study: Reforestation Fee, Product Royalty, and Export Tax. The following historical background to these tax and royalty instruments represents supplementary information to the present conditions mentioned earlier in Chapter III. These historical conditions provide a basis for the simulation scenarios selections. The manner in which policy shocks from tax and royalty changes affect the government objectives are below in the section on simulation results.

The objective of the Reforestation Fee is to ensure sustainability. The guidelines to sustainability were introduced in 1969 and were followed by the Indonesian Selective Cutting System in 1972. Reforestation and Forest Regeneration Guarantee Deposit Fund were first implemented in 1980 with a rate of 4 U.S. dollars per cubic meter of logs harvested. In 1989 the rate increased to 7 U.S. dollars and became nonrefundable, and in 1990 it became $ 10. These funds are used to build timber estates and support other silviculture and related activities. In 1989, the Indonesian

Selective Cutting System was replaced by the Indonesian Selective Cutting and Replanting System.

Product Royalty was introduced in 1967 and rates were established in 1968. The rates were between 0.50 and 7 U.S. dollars per cubic meter of logs harvested. In 1979, these rates were changed to 6 percent of domestic log price. In 1989, the Government announced that the Product Royalty would be collected on final products based on the log inputs used rather than directly on the log inputs.

The third tax included in the simulations is the export tax on sawnwood. This tax was introduced in 1989. The rate is between 250 to 2400 U.S. dollars per cubic meter of sawnwood exported. These rates vary according to species.

The economic impacts of tax and royalty changes occur when industry reacts and makes adjustments. An increase in the Reforestation Fee increases the production cost of logs. In general, the price of logs will increase and the harvest volume will decrease. The higher price of log input may increase the recovery factor of logs used by the industry. Indirectly, the Reforestation Fee helps the sustainability of forests. Another way the Reforestation Fee assists sustainability is through spending of tax proceeds. Some of the money collected from the Reforestation Fee is used for reforestation and planting activities which promote sustainability.

Policy change in Product Royalty affects the price of Indonesian products. Some of the tax incidence is borne by firms and is passed on to consumers. Tax on final product increases costs per unit production. It may change firms' behaviour such as utilization of more logs or an increase in the recovery factor of log input. In the long run, with an increase in price of sawnwood and plywood, consumers may turn to substitutes.

Tax on sawnwood export alters the Indonesian export price and reduces the quantity export. With a relatively high export tax, firms are expected to adjust the quantity of produced sawnwood, and the log input would flow to downstream industries. This assessment facilitates additional value to the country.

The base simulation scenario reflects the initial condition in 1987 when a $ 4 Reforestation Fee was levied for one cubic meter of log harvested and a 6 % Product Royalty was levied on final products. Simulation 1 introduces Reforestation Fee shock. The government objective to increase utilization of log input and reduce wastage in the industries may be realized through a change in Reforestation Fee.

Government increased the Reforestation Fee to $ 7 in 1989. The additional rents collected from this fees are used to build new timber estates. This condition underlines the scenario selection of simulation 1 which consists of a $ 7 Reforestation Fee and a 6 % Product Royalty.

Simulation 2 is introduced to examine the impact of an increase in Product Royalty from 6 % to 8 %. With an issue of low price of Indonesian forest products and a government desire to collect desired rents from the forests, this scenario may be applicable to the Indonesian situation.

Another shock from a future change in the Reforestation Fee took place in 1990. As indicated above, Government increased the Reforestation Fee to $ 10 per cubic meter of log harvest. This assessment is included in simulation 3 along with a 6 % Product Royalty.

To increase the value added of forest resources, the government emphasized the downstream industries. Since 1981, more plymill industries were built. Sawmills were expected to supply domestic markets, while log inputs otherwise used for sawnwood exports were to be utilized by the plymill industry. This objective was realized in 1989 when Government announced the sawnwood export tax rated at 250 to 2,400 U.S. dollar per cubic meter. Simulation 4 includes a $ 250 export tax for sawnwood. A $ 2,400 is excluded from the scenarios since this tax is levied on fancy wood only. Simulation 4 applied to the plymill industry is slightly different however. There is no export tax on plywood. An additional 6 % tax on final product is introduced instead. It is assumed that this additional tax on plywood does not directly alter the export market for Indonesia's plywood.

The following calculations are used to attain the performance indicators mentioned above. The first indicator is a percentage change in recovery factor of the industry. The recovery factor shows the percentage of final product obtained from one unit of log input. The effect of tax on the recovery factor is calculated as follows:

$$\%\ change\ R = \left[\left(\frac{QFNL^{t} - QFNL^{wt}}{QFNL^{wt}} \right) - \left(\frac{QLOG^{t} - QLOG^{wt}}{QLOG^{wt}} \right) \right] * 100\% \ ,$$

where R is the recovery factor, $QFNL^{t}$ and $QFNL^{wt}$ are the quantity of final products with and without tax, $QLOG^{t}$ and $QLOG^{wt}$ are the quantity of logs used to produce the final product with and without tax.

The second indicator is the level of employment. This indicator uses the number employed and percentage change in labour for each taxation scenario. It is calculated as follows:

$$EMP^{t} = \frac{QFNL^{t}}{QFNL^{wt}} * EMP^{wt} \quad ,$$

where EMP^{t} is the number employed with tax, $QFNL^{t}$ and $QFNL^{wt}$ are the quantity of final products with and without tax, and EMP^{wt} is the number employed without tax.

The third indicator is government revenue from tax and royalty. It is presented in dollar terms and percentage change and calculated as:

$$REV = (QLOG*RFee) + (\%PRoyalty*PLOG*QFNL*2*1643)$$

$$+ (QFNLEX*EXPTAX) \quad ,$$

where REV is the government revenue, QLOG is the quantity of logs produced, RFee is the rate of the Reforestation Fee, PRoyalty is the rate of the Product Royalty, PLOG is the domestic price of log in Indonesian currency, QFNL is the quantity of final product, 2 is the administratively used conversion factor of the final product to the logs, and 1643 is the exchange rate in 1987.

Another Government goal is to have tax and royalty policies that cause very little fluctuation in the domestic price of final product and to maintain the economic stability of the country. Thus the fourth indicator is the domestic price of final product and its percentage change due to tax and royalty policy. The domestic price of the final product is endogenous in the simulation models. The value of domestic prices from simulation solutions are presented in Table 6.3 and 6.9.

Foreign exchange earnings are the last indicator analyzed in this study. The results are shown in dollar terms and percentage change. The following equation shows the calculation of foreign exchange earnings:

$$FEXER = QEXP*EXPPR \,,$$

where FEXER is the foreign exchange earnings, QEXP is the quantity of exports, and EXPPR is the export price.

The methodology used in simulation is based on the solution to a system of non linear equations using Shazam econometrics software. There are five equations taken from the estimated models. These five equations contain five endogenous variables: price of logs, quantity of logs, domestic price of final products, quantity demand for domestic, and quantity demand for exports. The changes on taxes are implemented on the coefficient parameters of the equations. The five equations are as follows:

1. Supply of logs :

$$\ln PLOG - a_1 \ln QLOG - Constant = 0 \quad ,$$

where PLOG is the price of logs, and QLOG is the quantity of logs. The constant consists of the Annual Allowable Cut, logging road variables, and a constant.

2. Average cost of final product :

$$\ln ACFNL - b_1 \ln PLOG - b_2 (\ln PLOG * \ln PLOG) - CONSTANT = 0,$$

where ACFNL is the price of final products (sawnwood or plywood), PLOG is the price of logs. The variables of aggregate factors, and capital prices enter the constant terms.

3. Share equation :

$$(\ln PLOG * SH * \ln QLOG) / (\ln ACFNL * \ln QFNL)$$

$$- c_1 \ln PLOG - CONSTANT = 0 \quad ,$$

where PLOG is the price of logs, SH is the share of logs for sawnwood or plywood industries, QLOG is the quantity of logs, ACFNL is the price of final products (sawnwood or plywood), and QCFNL is the quantity of final products (sawnwood or plywood). The constant consists of the variables of aggregate factors, capital, and a constant

4. Quantity demand for domestic market :

$$\ln QDOM - d_1 \ln ACFNL - CONSTANT = 0 \quad ,$$

where QDOM is the quantity demand for domestic market, ACFNL is the price of final products (sawnwood or plywood). The variable GDP enters in the constant term.

5. Quantity demand for exports :

$$(\ln QFNL - \ln QDOM) - e_1 \ln ACFNL - CONSTANT = 0 \quad ,$$

where QCFNL is the quantity of final products: sawnwood or plywood, QDOM is the quantity of domestic demand for final product, and ACFNL is the price of final product: sawnwood or plywood. The variable world price enters in the constant term.

Because of the wrong sign of domestic and export demand elasticities for sawnwood and plywood found in this study as presented in Tables 5.4 and 5.9, these elasticities were replaced by the elasticities estimated from previous studies by Constantino (Analysis of the International and Domestic

Demand for Indonesian Wood Products, 1988, and Domestic Demand for Forest Products in Indonesia, 1989). The elasticities from these studies are - 0.2744 and - 0.16 for sawnwood domestic and export demands, and - 0.1107 and - 0.58 for plywood domestic and export demands. The other coefficient parameters used in the equations are obtained from the estimation models in this study. There are no other sources for these parameter estimates.

VI.2. SAWMILL INDUSTRY POLICY SIMULATION RESULTS

Generally taxes, other than lumpsum, change firms' output levels and shift the supply curve. This change alters the equilibrium price and quantity. With the imposition of a tax, firms' willingness to supply is less than before at the same price level. The final impacts of this mechanism are influenced by the elasticities of supply and demand. The more elastic the supply curve, the more the tax borne by consumers. However, in the long run, consumers may find substitutes.

The simulation results are presented in Table 6.3 in terms of the value of endogenous variables. From these numbers the impacts on the recovery factors, employment levels, government revenues, and foreign exchange earnings are calculated.

Table 6.3. Simulation results (endogenous variables) for sawnwood under perfectly and unit elastic log supply.

Variable	Simulation				
	Initial	1	2	3	4
A. Perfectly Elas Supply of Logs:					
1. Price of logs [1]	48309	50509	48314	52538	48314
2. Price of sawn [1]	97489	97836	97650	98158	97506
3. Quantity of logs [2]	36690	36602	37549	36641	39725
4. Quantity of sawn [2]	8767	8756	8761	8747	8735
5. Domestic demand [2]	5105	5098	5102	5092	5103
6. Export demand [2]	3661	3658	3659	3655	3631
B. Unit Elastic Supply of Logs:					
1. Price of logs [1]	48309	49036	48236	49707	48007
2. Price of sawn [1]	97489	97768	97605	98023	97373
3. Quantity of logs [2]	36690	36641	36681	36595	36645
4. Quantity of sawn [2]	8767	8757	8762	8749	8740

Continued

Variable	Simulation				
	Initial	1	2	3	4
5. Domestic demand [2]	5105	5099	5102	5093	5108
6. Export demand [2]	3661	3658	3659	3655	3632

Note: [1]. in Rupiah
[2]. in thousand cubic meters.

Simulations 1 and 3 with an increase in the Reforestation Fee have a higher price and a lower quantity of logs as expected (Table 6.3). This happens for both perfectly and unit elastic log supply assumptions. The additional Reforestation Fee increases the costs of log production and shifts the supply curve. In a perfectly competitive market, firms equate their marginal cost to marginal revenue. This mechanism leads to a higher price or lower quantity of logs. The degree of price and quantity changes depend on the demand elasticity of logs.

An increase in Product Royalty as exercised in simulation 2 brings a higher price and a lower quantity of sawnwood as expected. Product Royalty levied on final product and converted to an input log basis increases the cost per unit production of sawnwood. Since there is free entry to and exit from the industry, the tax excise will lower the equilibrium quantity of sawnwood and raise the equilibrium price.

Simulation 4 results in a higher price of Indonesian sawnwood, since there is a tax on sawnwood export. The export quantity of sawnwood declines under perfectly and unit elastic supply of logs assumptions. The price of Indonesian sawnwood increases under unit elastic supply of logs, but slightly declines under unit elastic supply of logs. This decline is unexpected, but could be due to the second effect after a decline in sawnwood exports.

The following results in the section below are presented and discussed with respect to impacts of tax and royalty changes on recovery of logs used, employment, government revenues, domestic price of sawnwood, and foreign exchange earnings from the sawmilling model.

VI.2.1. LOG RECOVERY RESULTS IN THE SAWMILL INDUSTRY

The efficiency of wood recovery in the sawmill industry represents the level of wastage in the transformation of logs into final products. Increases in recovery factors contribute to the conservation of resources. Table 6.4 shows the percentage change in recovery factors on the sawmilling industry.

Table 6.4. Percentage change on recovery factor in the sawmill industry.

Simulation	% change under perfectly elastic log supply	under unit elastic log supply
1.Simulation 1	0.0310 %	0.0554 %
2.Simulation 2	-0.9840 %	0.0104 %
3.Simulation 3	0.0545 % *	0.1065 % *
4.Simulation 4	-3.4781 %	0.0491 %

Note :
Simulation 1 - US $7 reforestation fee; 6% product royalty.
Simulation 2 - US $4 reforestation fee; 8% product royalty.
Simulation 3 - US $10 reforestation fee; 6% product royalty.
Simulation 4 - US $4 reforestation fee; 6% product royalty; US $250 export tax.
* The maximum increase among 4 simulations.

Simulation 1 and 3 with an increase in the Reforestation Fee and under perfectly elastic supply of logs assumption raise the recovery factors. An increase in the Reforestation Fee leads to a higher price of logs which are a primary sawmilling input. This causes an increase in cost of sawnwood production. Firms make some adjustment such as utilization of more log input and reduction of waste in the sawmill industry.

In this case, an increase in tax on log input ensures an increase in its recovery factor.

Increases on Product Royalty and Export Tax as shown in simulations 2 and 4 under the perfectly elastic supply of logs assumption yield a lower recovery rate. These results were surprising. It is probably due to the effect of the tax on final product rather than on factor input.

VI.2.2. EMPLOYMENT RESULTS IN THE SAWMILL INDUSTRY

One of the government objectives in the forest industrial sector is to increase employment. The policy shock of tax and royalty changes affects the quantity of labour employed by the forest industry, since imposing a tax or royalty decreases the quantity of final product. The following simulation results give indications of the employment level changes for each policy simulation.

Table 6.5. The number and the percentage change of labour employed in the sawmill industry.

Simulation	Number of Labour	% change	Number of Labour	% change
	Under perfectly elastic supply of logs		Under unit elastic supply of logs	
1.Simulation 1	55221	-0.1143 %	55225	-0.1070 %
2.Simulation 2	55252	-0.0572 % *	55257	-0.0486 % *

Continued

Simulation	Number of Labour	% change	Number of Labour	% change
3.Simulation 3	55163	-0.2192 %	55171	-0.2042 %
4.Simulation 4	55084	-0.3621 %	55117	-0.3015 %

Note :
Simulation 1 - US $7 reforestation fee; 6% product royalty.
Simulation 2 - US $4 reforestation fee; 8% product royalty.
Simulation 3 - US $10 reforestation fee; 6% product royalty.
Simulation 4 - US $4 reforestation fee; 6% product royalty; US $250 export tax.
* The highest level of employment.

Table 6.5 shows that all of the tax and royalty scenarios decrease the level of employment between 0.1 to 0.3 percent of the initial level of labour employed in the sawmill industry. Policy simulation 2 with a $ 4 Reforestation Fee and an 8 percent Product Royalty yields the minimum decrease in employment. It seems consumers bear most of the tax burden while firms experience a slight decrease in their labour input. Decreases in quantity of labour employed seem reasonable for all scenarios.

VI.2.3. GOVERNMENT REVENUE RESULTS IN THE SAWMILL INDUSTRY

Direct government revenues created from tax and royalty from forest industry influence the services that the government can provide. These services include the management of forests, such as reforestation activities, and other activities, such as planning and controlling of forest activities. The level of government revenues from tax and royalty on the sawmill industry is presented in terms of U.S. dollars and percentage changes respectively compared to the initial tax and royalty levels.

Table 6.6. The government revenues from tax and royalty in the sawmill industry in million U.S. dollars.

Simulation	Revenue	% change	Revenue	% change
	Under perfectly elastic supply of logs		Under unit elastic supply of logs	
1.Simulation 1	288.943	62.60 %	287.855	61.99 %
2.Simulation 2	191.424	7.72 %	187.886	5.73 %
3.Simulation 3	399.978	125.09 %	397.722	123.82 %
4.Simulation 4	1097.651	517.71 % *	1085.360	510.79 % *

Note :
Simulation 1 - US $7 reforestation fee; 6% product royalty.
Simulation 2 - US $4 reforestation fee; 8% product royalty.
Simulation 3 - US $10 reforestation fee; 6% product royalty.
Simulation 4 - US $4 reforestation fee; 6% product royalty; US $250 export tax.
* The highest level of the government revenue.

The more tax that is imposed, the more revenue government receives. Table 6.6, simulation 2 with a 4 U.S. dollars Reforestation Fee and an 8 percent Product Royalty creates the minimum level of revenue than other scenarios. This implies that an increase in Product Royalty has less impact on government revenue than that Restoration Fee. This happens because the quantity of logs harvested is much greater than the quantity of sawnwood produced. The highest revenue results from an export tax on sawnwood since this tax rate is higher than the other taxes.

VI.2.4. DOMESTIC PRICE RESULTS IN THE SAWMILL INDUSTRY

Price stability is also one of the government's objectives. The domestic prices of sawnwood should not increase too much under the alternative tax and royalty increases chosen. This policy objective is more significant at the present stage because most of the sawnwood production supplies the domestic markets. The simulation results show in the following table.

Table 6.7. The domestic price of sawnwood in thousand Rupiah.

Simulation	Price	% change	Price	% change
	Under perfectly elastic supply of logs		Under unit elastic supply of logs	
1.Simulation 1	97.836	0.356 %	97.768	0.286 %
2.Simulation 2	97.650	0.165 %	97.605	0.118 % **

Continued

Simulation	Price	% change	Price	% change
3.Simulation 3	98.158	0.686 %	98.023	0.547 %
4.Simulation 4	97.506	0.017 % *	97.373	-0.118 % *

Note :
Simulation 1 - US $7 reforestation fee; 6% product royalty.
Simulation 2 - US $4 reforestation fee; 8% product royalty.
Simulation 3 - US $10 reforestation fee; 6% product royalty.
Simulation 4 - US $4 reforestation fee; 6% product royalty; US $ 250 export tax.
* The minimum level of the domestic price.
** The second best of the domestic price level.

If low domestic prices are the objective, then simulation 4 gives the best outcomes for both assumptions of perfectly and unit elastic log supply. However, the minimum domestic price in simulation 4 under unit elastic supply of logs assumption is caused by a decrease in export demand and quantity of sawnwood production. The second best outcome under unit elastic supply of logs is simulation 2 with a 4 U.S. dollars Reforestation Fee and an 8 percent Product Royalty. An increase in Product Royalty does increase the sawnwood price, but it is less than the other scenarios. This situation implies that if the government increases tax on log input, the sawmill firms cannot escape from the tax impact and will set a higher price for final product.

VI.2.5. FOREIGN EXCHANGE EARNINGS RESULTS IN THE SAWMILL INDUSTRY

The last impact of tax and royalty on the sawmill and plymill industries analyzed in this study is the impact on foreign exchange earnings. The Indonesian foreign exchange earnings from forest products are second only to that of the oil industry. Therefore, it is important to know how different policies on tax and royalty affects the national revenue from forest products exports. The foreign exchange earnings are calculated from the quantity exported times the export price. The following table contains the foreign exchange earnings from the sawnwood industrial model simulations.

Table 6.8. The foreign exchange earnings from sawnwood exports in million US dollars.

Simulation	Earnings	% change	Earnings	% change
	Under perfectly elastic supply of logs		Under unit elastic supply of logs	
1.Simulation 1	445.996	-0.09 %	446.004	-0.08 %
2.Simulation 2	446.172	-0.05 % *	446.197	-0.05 % *

Continued

Simulation	Earnings	% change	Earnings	% change
3.Simulation 3	445.642	-0.16 %	445.653	-0.16 %
4.Simulation 4	442.773	-0.81 %	·42.875	-0.79 %

Note :
Simulation 1 - US $7 reforestation fee; 6% product royalty.
Simulation 2 - US $4 reforestation fee; 8% product royalty.
Simulation 3 - US $10 reforestation fee; 6% product royalty.
Simulation 4 - US $4 reforestation fee; 6% product royalty; US $250 export tax.
* The highest level of foreign exchange earnings.

Table 6.8 shows the foreign exchange earnings under alternative tax and royalty shocks. With a $ 250 export tax of sawnwood, foreign exchange earnings decline by about 0.8 percent from the initial rates. It is reasonable to expect that the foreign exchange earnings would decline more with an Export Tax as a direct impact from a fall export volume. However, this small decline is quite surprising. It seems exporters pass on most of export tax to consumers. In the long run, consumers may change to other sawnwood producers. The elasticity of export demand affects the substitution of sawnwood origin. The more elastic is the demand, the greater the ease of substitution.

VI.3. PLYMILL INDUSTRY POLICY SIMULATION RESULTS

The same scenarios for sawnwood, excluding the export tax scenario, are used for the plywood simulations. Simulation 4 is based on an alternative that there is an additional tax on final product. This additional tax could be in the form of a manufacturing tax on production. It differs from the product royalty which is based on log input volume.

Table 6.9 shows the value of endogenous variables under different tax and royalty policies as discribed above.

Table 6.9. Simulation results (endogenous variables) for plywood under perfectly and unit elastic log supply.

	Simulation				
Variable	Initial	1	2	3	4
A. Perfectly Elastic Supply of Logs					
1. Price of logs 1)	48309	50253	48695	52024	48632
2. Price of plywood 1)	609900	612733	612459	617256	613555
3. Quantity of logs 2)	36690	36675	36204	36666	36204
4. Quantity of plywood 2)	6400	6379	6374	6313	6369
5. Domestic demand 2)	752.7	749.9	749.8	740.7	748.7

Continued

Variable	sim0	sim1	sim2	sim3	sim4
6. Export demand [2]	5648	5630	5624	5573	5620
B. Unit Elastic Supply of Logs					
1. Price of logs [1]	48309	49050	48251	49735	48117
2. Price of plywood [1]	609900	611616	610587	613161	611831
3. Quantity of logs [2]	36690	36646	36681	36606	36660
4. Quantity of plywood [2]	6400	6394	6397	6389	6393
5. Domestic demand [2]	752.0	751.5	751.8	751.1	751.4
6. Export demand [2]	5648.0	5642.8	5645.9	5638.1	5642.1

Note: [1]. in Rupiah
[2]. in thousand cubic meters.

Simulation 1 and 3 with changes in the Reforestation Fee from \$ 4 to \$ 7 and to \$ 10 respectively, lower the quantity and increase the equilibrium price of logs in the model. Firms react to an increase in log price, since logs are the primary input for plymilling. Some incidence of the Reforestation Fee is passed to the plymilling industry by log producers. Plymills make adjustments in the forms increased output price and decreased quantity of plywood.

The Product Royalty change simulated in simulation 2 comes up with a high price and low quantity of plywood. The second effect of this exercise is a decline in the quantity of logs used by plymill industry. Simulation 4 with an additional tax on plywood produces the same effects as the Product Royalty increases.

The following recovery, employment, government revenues, and foreign exchange earnings are calculated based on the changes of the endogenous variables as shown in Table 6.9.

VI.3.1. LOG RECOVERY RESULTS IN THE PLYMILL INDUSTRY

The efficiency of log use in the plymill industry refers to the level of wastage from transfering logs into final product. Improvement in recovery factors reduces the forest depletion rate.

Table 6.10. Percentage change in recovery factor in the plymill industry.

Simulation	% change under perfectly elastic logs supply	under unit elastic logs supply
1.Simulation 1	0.0209 %	0.0687 %
2.Simulation 2	0.7640 % *	0.0148 %

Continued

Simulation	% change under perfectly elastic logs supply	% change under unit elastic logs supply
3.Simulation 3	0.0243 %	0.1315 % *
4.Simulation 4	0.7632 %	0.0474 %

Note :
Simulation 1 - US $7 reforestation fee; 6% product royalty.
Simulation 2 - US $4 reforestation fee; 8% product royalty.
Simulation 3 - US $10 reforestation fee; 6% product royalty.
Simulation 4 - US $4 reforestation fee; 6% product royalty; 6 % tax on final product.
* The highest recovery.

The results in Table 6.9 show that all of the tax and royalty scenarios increase the recovery factor in the plymill industry under both perfectly and unit elastic supply of logs assumptions. As explained above, a recovery increase is in the form of a decrease of log input used at a given level of output. The highest recovery under the perfectly elastic supply of logs assumption is reached when government increases Product Royalty. It is reached under unit elastic supply of logs assumption when Reforestation Fee increase.

VI.3.2. EMPLOYMENT RESULTS IN THE PLYMILL INDUSTRY

Employment levels are affected by the tax and royalty changes through production adjustments by plywood firms. An increase in the Reforestation Fee shifts the log supply curve such that there is a higher price for log inputs in the plymill industry. The next effect is in the form of increased costs per unit production of plywood. It shifts the supply curve of plywood and firms operate at a lower level of output with less labour.

Firms' production levels decline under an excise of Product Royalty which also decrease the level of employment in the plymill industry. The same mechanism operates when an additional tax on plywood is levied. Costs per unit of plywood production increase which lowers output and employment.

Table 6.11. The number and the percentage change of labour employed in the plymill industry.

Simulation	Number of Labour	% change	Number of Labour	% change
	Under perfectly elastic supply of logs		Under unit elastic supply of logs	
1.Simulation 1	102398	-0.3176 % *	102635	-0.0871 %
2.Simulation 2	102316	-0.3969 %	102688	-0.0346 % *
3.Simulation 3	101340	-1.3468 %	102551	-0.1686 %

Continued

Simulation	Number of Labour	% change	Number of Labour	% change
4.Simulation 4	102235	-0.4767 %	102621	-0.1005 %

Note :
Simulation 1 - US $7 reforestation fee; 6% product royalty.
Simulation 2 - US $4 reforestation fee; 8% product royalty.
Simulation 3 - US $10 reforestation fee; 6% product royalty.
Simulation 4 - US $4 reforestation fee; 6% product royalty; 6 % other tax on final product.
* The highest level of employment.

At the initial level of tax and royalty, the number of employees in the plymill industry was 102,724 (Constantino, 1989). Simulation 1 with an increase in Reforestation Fee yields the highest employment level in the plymill industry under the perfectly elastic supply of logs assumption. Under the unit elastic supply of logs assumption, the highest quantity of plywood production and associated increase in employment is obtained from simulation 2 with an 8 % Product Royalty.

VI.3.3. GOVERNMENT REVENUE RESULTS IN THE PLYMILL INDUSTRY

Tax and royalty proceeds represent a direct source of government revenues. Although these revenues are in turn, spent in the sector, there is a trade off between the total income from taxes and changes in firms' behaviour which in turn, has an impact on economy of the country through recovery of logs used, employment, domestic price of product, and foreign exchange earnings.

Table 6.12. The government revenues from tax and royalty in the plymill industry in million U.S. dollars.

Simulation	Revenue	% change	Revenue	% change
	Under perfectly elastic supply of logs		Under unit elastic supply of logs	
1.Simulation 1	280.143	65.42 %	279.434	65.00 %
2.Simulation 2	175.047	3.37 %	176.786	4.39 %
3.Simulation 3	390.658	130.68 % *	389.273	129.87 % *
4.Simulation 4	190.068	12.24 %	191.578	13.12 %

Note :
Simulation 1 - US $7 reforestation fee; 6% product royalty.
Simulation 2 - US $4 reforestation fee; 8% product royalty.
Simulation 3 - US $10 reforestation fee; 6% product royalty.
Simulation 4 - US $4 reforestation fee; 6% product royalty; 6 % other tax on final product.
* The maximum level of the government revenue.

A combination of tax and royalty changes in simulation 3 yields the highest government revenue followed by simulation 1. These results are obtained through an increase in the Reforestation Fee. This is consistent with the actual case in when Reforestation Fee was the major source of government revenues in the forestry sector.

VI.3.4. DOMESTIC PRICE RESULTS IN THE PLYMILL INDUSTRY

The domestic plywood price changes as tax and royalty change. The sensitivity of this price with several tax and royalty scenarios are shown in Table 6.13.

Table 6.13. The domestic price of plywood in thousand Rupiah.

Simulation	Price	% change	Price	% change
	Under perfectly elastic supply of logs		Under unit elastic supply of logs	
1.Simulation 1	612.733	0.464 %	611.616	0.281 %
2.Simulation 2	612.459	0.419 % *	610.587	0.112 % *
3.Simulation 3	617.256	1.206 %	613.161	0.534 %
4.Simulation 4	613.555	0.599 %	611.831	0.316 %

Note :
Simulation 1 - US $7 reforestation fee; 6% product royalty.
Simulation 2 - US $4 reforestation fee; 8% product royalty.
Simulation 3 - US $10 reforestation fee; 6% product royalty.
Simulation 4 - US $4 reforestation fee; 6% product royalty; 6 % other tax on the final product.
* The smallest increase of domestic price.

The lowest level of domestic price is reached under simulation 2 under both perfectly and unit elastic supply of logs assumptions. An increase in Product Royalty causes a slight increase in domestic price of plywood. Because most of plywood production supplies foreign markets, this policy simulation should also look at the effects on foreign exchange earnings.

VI.3.5. FOREIGN EXCHANGE EARNINGS RESULTS IN THE PLYMILL INDUSTRY

There is no export tax levied on plywood export. The foreign exchange earnings from the plymill industry are obtained through tax excise mechanism that are different from these for the sawmill industry. Table 6.14 shows the indirect effects of changes in tax and royalty on foreign exchange earnings from plywood exports.

Table 6.14. The foreign exchange earnings from plywood exports in million US dollars.

Simulation	Earnings	% change	Earnings	% change
	Under perfectly elastic supply of logs		Under unit elastic supply of logs	
1.Simulation 1	1263.765	-0.31 % *	1266.551	-0.09 % *
2.Simulation 2	1262.518	-0.41 %	1267.243	-0.03 %
3.Simulation 3	1250.963	-1.32 %	1265.478	-0.17 %
4.Simulation 4	1261.553	-0.48 %	1266.375	-0.10 %

Note :
Simulation 1 - US $7 reforestation fee; 6% product royalty.
Simulation 2 - US $4 reforestation fee; 8% product royalty.
Simulation 3 - US $10 reforestation fee; 6% product royalty.
Simulation 4 - US $4 reforestation fee; 6% product royalty; 6 % other tax on final product.
* The highest level of the foreign exchange earnings.

The results show that foreign exchange earnings from plywood exports are maximum under a $ 7 Reforestation Fee and a 6 % Product Royalty. However, a $ 10 Reforestation Fee and a 6 % Product Royalty yield the lowest foreign exchange earnings. These implies that the Reforestation Fee rate at $ 10 results in a greater decrease in export quantity than from the other tax policies.

VI.4. SUMMARY

In general, the tax and royalty scenarios in the sawmilling and plymilling industries provide reasonable results in the economy under both perfectly and unit elastic supply of logs assumptions, although the maximum levels of impacts vary between the two. The following table shows the desired government goals and the corresponding simulations that best support these goals.

Table 6.15. The desire level of tax and royalty impacts and related supporting simulation scenarios.

Goals	Supporting Simulations	
	Perfectly elastic supply of logs	Unit elastic supply of logs
A. Sawmill Industrial Model:		
1. Recovery of log used	simulation 3	simulation 3
2. Employment	simulation 2	simulation 2

Continued

Goals	Simulation	
3. Government revenues	simulation 4	simulation 4
4. Domestic price	simulation 4	simulation 4
5. Foreign exchange earnings	simulation 2	simulation 2
B. Plymill Industrial Model:		
1. Recovery of log used	simulation 2	simulation 3
2. Employment	simulation 1	simulation 2
3. Government revenues	simulation 3	simulation 3
4. Domestic price	simulation 2	simulation 2
5. Foreign exchange earnings	simulation 1	simulation 1

The above results show that the desire level of impacts vary between sawnwood and plywood simulation models.

CHAPTER VII

CONCLUSIONS

The Indonesian forest industry is important to the country's economic development. To increase value added in this sector and to increase job opportunities, government imposed a log export ban in 1981. Sawmill and plymill industries grew quickly in the period after the ban. Recently, they have become the major forest industries.

Various taxes and royalties have been applied to the forest industries. The objectives of these charges are to govern forest activities and to collect forest economic rents. Several policy alternatives may be appropriate depending on government priorities. The objective of this study was to assess some impacts of forest taxation on the Indonesian economy.

Policy simulations involving five tax and royalty scenarios were carried out. An initial tax of 4 U.S. dollars Reforestation Fee and a 6 percent Product Royalty corresponds to 55,284 persons being employed in the sawmill and 102,724 persons employed in the plymill industries. This initial tax yielded 446.4 million U.S. dollars in government revenue from sawnwood exports and 1,267.7 million U.S. dollars of exchange earnings from plywood exports in 1987.

Simulation results show that the recovery factor in the sawmill industry increases most under a 10 U.S. dollars Reforestation Fee and a 6 percent Product Royalty. For the plymill industry under a perfectly elastic supply of logs assumption, the best recovery factor is achieved under simulation 2 with a $ 4 Reforestation Fee and an 8 percent Product Royalty. With the assumption of unit elastic supply of logs, a $ 10 Reforestation Fee and a 6 percent Product Royalty gives the highest recovery factor.

The lowest decline in the level of employment is realized under a $ 4 Reforestation Fee and an 8 percent Product Royalty for the sawmilling industry. For the plymilling industry it is realized under a $ 7 Reforestation Fee and a 6 % Product Royalty for the perfectly elastic supply of logs, and under a $ 4 Reforestation Fee and an 8 % Product Royalty for the unit elastic supply of logs assumption. These two simulations decrease the employment by 0.04 to 0.05 percent respectively compared to the initial tax case in the sawmill industry. For the plymill industry these two simulations decrease the employment by 0.03 to 0.31 percent respectively.

Government revenue from taxes increases most under simulation 4 in the sawmill model with a $ 4 Reforestation Fee, a 6 percent Product Royalty, and a $ 250 Export Tax. For the plymill industry the maximum increase in government revenue is achieved under simulation 3 with a $ 10 Reforestation Fee and a 6 percent Product Royalty.

Another important indicator of the effects from tax and royalty change are domestic prices of final products. For the sawmill industry the lowest price of sawnwood is reached under simulation 4 with a $ 4 Reforestation Fee, a 6 % Product Royalty, and a $ 250 Export Tax. For the plymill industry, the lowest price of plywood is achieved in simulation 2 with a $ 4 Reforestation Fee and an 8 % Product Royalty.

The lowest decrease in foreign exchange earnings resulted from simulation 2 with a $ 7 Reforestation Fee and a 6 percent Product Royalty levied on the sawmill industry. For the plymill industry the foreign exchange earnings are maximum at a $ 7 Reforestation Fee and 6 % Product Royalty.

A tax on sawnwood exports appears to have different impacts on recovery factors under perfectly and unit elastic supply of logs assumptions. Under the perfectly elastic supply of logs case, the recovery of log used in sawmilling declines, but under unit elastic supply of logs it increases slightly. The tax reduces the domestic price under unit elastic supply of logs assumption, but it increases by very small amount under perfectly elastic supply of logs case. The sawnwood export tax increases the government revenue by 12 to 13 percent over the initial tax. This policy option decreases employment by 0.76 to 0.04 percent from the initial level. The results from this study show at least two indications of policy impacts support the new policy of an export tax on sawnwood.

The most recent government policy increasing the Reforestation Fee from $ 4 to $ 7 and finally to $ 10 gives varying results which depend on the supply elasticity of logs assumption.

In conclusion, the simulations undertaken demonstrate that tax and royalty alternatives on forest industries can be important policy tools for the Indonesian government for resource allocation in the industries.

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APPENDIX 1

DATA VARIABLES AND SOURCES

No. Abbreviation	Variable	Sources
1. TOTCOST	Total Cost	1=Analysis of the International & Domestic Demand for Indonesian Wood Products by Constantino L.F. 1988.
2. VLAB	Value of Labour	1
3. VENER	Value of Energy	1
4. VNWM	Value of Non Wood Materials	1
5. VCAP	Value of Capital	1
6. VLOG	Value of Logs	1
7. PLAB	Price of Labour	1
8. PEN	Price of Energy	1
9. PNWM	Price of Non Wood Materials	1
10. PCAP	Price of Capital	1
11. PLOG	Price of Logs	1
12. QPROD	Production of Sawnwood or Plywood	2=FAO, Year Book of Forest Products; and 3=REPELITA V
13. EXP	Export of Plywood or Sawnwood	2

(Continue)

No. Abbreviation	Variable	Source
14. GDP	Gros Domestic Product	4= International Finacial Statistics, International Monetary Fund
15. EXR	Exchange Rate	4
16. WPRICE	World Price of Sawnwood or Plywood	5=FAO, Forest Products Prices
17. AAC	Annual Allowable Cut	6=Statistical Information Related to the Indonesian Forestry Sector, by Ingram et al, 1989.
18. ROAD	Road	6
19. LOGPRO	Logs production	6
20. SHWOSW	Share of logs for Sawnwood	1
21. SHWOPL	Share of Logs for Plywood	1