FACTORS INFLUENCING THE PRODUCTION OF INDONESIAN SAWNWOOD AND PLYWOOD

By

Hezlisyah Siregar

Degree paper submitted to the Faculty of the
Virginia Polytechnic Institute and State University
in partial fulfillment of the requirements for the degree of

MASTER OF FORESTRY
IN
WOOD SCIENCE AND FOREST PRODUCTS

APPROVED:

A.L. Hammett, Chairman

Robert J. Bush **John Muench** **Philip A. Araman**

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(ABSTRACT)

The forest products industry of Indonesia grew rapidly after the establishment of the log export ban policy in May 1980. As a result, within about five years, Indonesia was transformed from the biggest exporter of tropical logs into a major exporter of processed wood products. To better understand this transition, this study presents multiple regression models of Indonesian sawnwood and plywood production and consumption based on time series data from 1970 to 1994.

This study had three main objectives: 1) to create models that can be used for projecting future production of Indonesian sawnwood and plywood, 2) to identify the relationship and establish the degree of association between production and factors that influence their trends, and 3) to analyze Indonesian forestry policies of log export ban and sawnwood export tax as they affect production of sawnwood and plywood.

Domestic sawnwood consumption was modeled as a function of population, log export policy (no log export ban vs. log export ban), and sawnwood tax policy (tax vs. no

tax). Domestic plywood consumption was modeled as a function of population, consumer price index (CPI), and log export policy (ban vs. no ban). Export plywood consumption was modeled as function of exchange rate, log export policy, and sawnwood tax policy. The consumption and production of sawnwood and plywood were analyzed by multiple regression techniques. All parameters in the sawnwood and plywood equation were found to be significant. However, price did not influence the consumption or production of sawnwood and plywood significantly. All parameters in this study were found to be elastic.

It is found that, during the period under investigation (using 1970 as the base year), the production and consumption of Indonesian sawnwood and plywood increased considerably. The projection of sawnwood and plywood productions for 5 years (1995-1999) also shows an increasing trend.

ACKNOWLEDGMENTS

I would like to express my deep gratitude to Dr. John Muench for serving as my major adviser during the first year of my program and later for serving as a member of my committee, and to Dr. A.L. Hammett for serving as the major adviser during the last year of my graduate studies, for their continuous encouragement and guidance provided throughout my work on this paper.

Appreciation is extended to Dr. Robert J. Bush and Mr. Philip A. Araman, as members of the committee, for their advice and suggestions.

I am grateful the Perum Perhutani for providing a scholarship. Thanks are also due to all my colleagues at Perum Perhutani headquarters for their support.

Finally, a very special expression of appreciation is extended to my beloved father H. Bahri Effendi Siregar, mother Hanifah Hanum, sisters Linda and Nina, and brothers Ucok, Ricky, Dody, and Romy. Their understanding and encouragement made this effort successful.

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INTRODUCTION

Problem Statement and Justification

Indonesia has twice as much of its land surface in forest cover (60 percent) as the United States (32 percent). Furthermore, it has a tropical rain forest area of about 143.5 million hectares, the second largest in the world after Brazil (Nusantara Jaya Foundation 1991). The greater part of forest is scattered within five main islands: Sumatera, Java Kalimantan, Sulawesi, and Irian Jaya.

Wood products are considered as one of the most important export commodities of Indonesia, and as a group are second after oil and gas as a source of foreign exchange revenues for the country. The exports of these products have increased dramatically during the past decade, in part as a result of the log export ban which was made effective in 1985. Indonesia has changed from an insignificant supplier in world markets for wood products, to that of a dominant exporter (Constantino, 1988).

There is the great importance of Indonesia's forest resources in the social and economic development of the country, particularly as an important source of foreign exchange earnings. It is important to study the trends of Indonesia's wood products, especially sawnwood and plywood production and consumption since they make up the bulk of all wood products produced in Indonesia. The study will provide information for decision making in the wise and optimal use of forest resources. This should help

Indonesian public policy makers, industries, and traders to make better decisions in their operations.

Objectives

The goal of this study is to develop simple regression models of Indonesian sawnwood and plywood production and consumption from which empirical estimates of production, consumption and their elasticity can be obtained

The objectives of this research are:

- to create models that can be used for projecting future production and consumption of Indonesian sawnwood and plywood;
- to identify the relationship and establish the degree of association between production and consumption and factors that influence their trends; and
- to analyze Indonesian forestry policies of log export ban and sawnwood export tax as they affect production of sawnwood and plywood.

Chapter II

LITERATURE REVIEW

Indonesian Economy

The Republic of Indonesia comprises the world's largest archipelago, nestled between two continents, Australia and Asia, and two oceans, the Indian and the Pacific. As a maritime country, it consists of about 17,500 islands spanning 5,120 kilometers (3,200 miles) from east to west along the Equator, roughly equivalent to the expanse of the United States from coast to coast; and 1,760 kilometers (1,100 miles) from north to south. Five major islands, whose area accounts for most of the land, are: Sumatera, Java, Kalimantan, Sulawesi and Irian Jaya. Indonesian land area and sea territory total about 2 million km^2 (772,000 sq. miles) and 3 million km^2 (1,158,000 sq. miles), respectively (Perum Perhutani, 1994 and Nusantara Jaya Foundation, 1991).

Indonesia is categorized as a developing country. It experienced high economic growth in the past decade through the rapid development of non-oil based industries. Indonesia has emerged as an important exporter of manufactured-products and simultaneously provides a large market for international goods and services. Some measures indicate the important position of Indonesia plays in the world market today. Indonesia is one of the fifty billion US dollars economy countries (US$ 133.0 billion), top fifty traders (US$ 54 billion) (Czinkota and Ronkainen, 1995) and 28 countries with GDP

over US$ 80 billion (US$ 107 billion). The numbers in parentheses denote Indonesia's position (Terpstra and Sarathy, 1994).

There are several economic indicators usually used to measure the economy and market size of a country, such as GDP/GNP, national income, private consumption expenditure, and population. Indonesia has shown modest growth of real GDP/GNP, compared to other countries within Asia Pacific area. Its annual change of real GDP/GNP was 6.6 % in 1992, which is as much as Malaysia's and even larger than Taiwan's. Moreover, this rate actually exceeded GDP/GNP growth for the group of seven (Canada, USA, Japan, Germany, France, UK, Italy), and Oceania, Latin America and Eastern Europe (Widman Management Consultants, 1992).

Indonesia is the largest oil exporter in Southeast Asia and a member of the Organization of Petroleum Exporting Countries (OPEC). Even though this country has been relatively successful in diversifying its export products, the oil industry still plays an important role in providing foreign exchange revenue for the government (Czinkota and Ronkainen, 1995). Furthermore, endowed with abundant natural gas sources, Indonesia is the largest exporter of liquefied natural gas in the world.

While oil and gas continue to play a significant role, the Indonesian economy is increasingly diversified. For instance, its other natural resources such as tin, rubber and palm oil are gaining an important position in the world market, where Indonesia ranks as the second largest exporter for those products.

Endowed with a large tropical rain forest area, forestry is another important sector contributing a significant share to the country's development. The value of aggregate

forest products ranked second among the main export commodities in 1982, just after crude petroleum and LNG, in the amount of US$ 966 million (Schreuder and Vlosky, 1985). Forest products exports reached US$ 6.5 billion in 1993 and they were the second largest non-oil contributor to aggregate national exports, after textiles and textile products (USDA/FAS, 1995).

With 190 million people, Indonesia is the fourth most populous nation in the world after China, India and USA (Terpstra and Sarathy, 1994). Its population is expected to grow to 255 million by the year 2025 (Czinkota and Ronkainen, 1995). Private consumption expenditure reached US$ 64.2 billion in 1991, with a 5.6 % average annual increase from 1987 to 1991. Thus, Indonesia represents a large market of many potential consumers and with high disposable incomes, needing an array of products, including several forest products.

Moreover, its high economic growth leads to a significant growth in consumer-spending power. Logically, this also means that the demand for wood products – such as plywood for housing, paper for education, and furniture for households – will also increase.

Forest Resources of Indonesia

According to information provided by its Department of Forestry, Indonesia still has 143.5 million hectares of forest, of which 113 million hectares have been designated as permanent forests. Various floras have grown in those areas, such as mahogany, teak,

bamboo, rattan, and spice trees; however *Dipterocarpaceae* spp. (meranti-merantian) are dominant. While the remaining forests (about 30 million hectares) have non-forestry uses – such as tree plantation, settlement, and transmigration – the permanent forests are classified into four major use groups: (1) protected forests for wild flora protection (allotment of 30 million hectares), (2) nature conservation forests for national parks (19 million hectares), (3) production forests for commercial harvesting (64 million hectares), and (4) convertible forests for transmigration, agriculture, farms and other uses (300,000 hectares) (Nusantara Jaya Foundation, 1991).

The following table gives the forest areas and allocations on the principal islands, which average 74 percent forest cover.

Table 1. Land Area and Forest Resources in Indonesia (in thousands of hectares)

No.	Region	Land area	Permanent forest land	Non-permanent forest land	Total forest land	Percent
I.	Java	13,219	3,013	-	3,013	23
II.	Other islands					
	- Sumatera	46,949	25,251	5,049	30,300	64
	- Kalimantan	54,825	36,674	8,293	44,967	82
	- Sulawesi	19,661	11,277	1,602	12,879	65
	- Nusa Teng.	8,778	3,365	3,007	6,372	73
	- Maluku	8,573	5,097	436	5,533	65
	- Irian Jaya	41,066	28,816	11,775	40,591	99
Total other islands		179,853	110,481	30,164	140,645	78
Indonesia (I + II)		193,072	113,404	30,164	143,568	74

Source : Muelenhoff (1986)

Some common Indonesian species which are widely used and traded within domestic and overseas markets are as follows: kapur (*Dryobalanops aromatica*), meranti (*Shorea* spp.), keruing (*Dipterocarpus* spp.), kempas (*Koompassia* spp.), merawan (*Hopea* spp.), and mangir (*Callophylum* spp.). These species are naturally found within lowland tropical rain forests, the main site of commercial timber species (Muelenhoff, 1986).

Principally, the Indonesian government holds full-rights on all forest area. The Department of Forestry authorizes private or state companies, contracts or concessions to utilize the forest under tight government supervision.

To improve forest conditions and conduct sustainable forest management, the government developed a reforestation plan to operate from 1985 up to the year 2000. It is hoped that by the year 2000, 6,200,000 hectares of forests will be replanted, and that after this period reforestation will be continued at an average of 363,000 hectares per year. Reforestation activities will be associated with a timber estates program, carried out by private and state companies (Mangundikoro, 1986). Reforestation activities are also crucial for promoting tropical rain forest products to those concerned about environmental issues.

Great attention is focused on the activities of Perum Perhutani (the author's employer), a state forest company authorized to manage forests on Java and Madura Islands since 1961, as a result of the reorganization of the forest service (Peluso, 1992). This company manages its 3 million hectares of forest land, including one million hectares of well-managed teak (*Tectona grandis*) plantations, using a professional management

system to ensure sustainable yield (Perhutani, 1994). The government's Department of forestry tends to implement Perum Perhutani's forest management systems on timber estates program outside Java island.

The government has been striving to improve forest conditions to ensure the survival of tropical rain forests. That would also mean that the supply of forest products could last forever.

Forest Industries

Until the late 1960s, the teak plantations of Java dominated the forestry production in Indonesia. During the last 20 years, production activities have shifted to the outer islands, mainly in terms of logging in natural mixed hardwood forest for saw logs. Log production, for instance, has increased dramatically from 4 million m^3 in 1963 to 10 million m^3 in 1970 and 28 million m^3 in 1994.

This significant increase of capital investment in the sector developed as a result of the open investment policy launched by the government in 1967 to reconstruct the national economy. In addition, the main strength of the industry during this high growth time is attributed to the abundant supply of high quality raw materials and the availability of relatively cheap labor. This expansion situation was further strengthened by a highly active export market for logs and processed forest goods.

Though from 1983 to 1989 the forestry sector accounted for only one percent of Indonesia's total Gross Domestic Product (Ahmad, 1995), this gross figure misrepresents

the importance of forestry and related industries in rural areas. The Indonesian forestry sector employed around two hundred thousand workers (Ahmad, 1995). While direct employment is a mere 0.3 percent of the labor force, the forestry industry makes a substantial indirect employment contribution by supplying input and related goods and services to other sectors of the economy (Directorate General of Forest Utilization and FAO, 1990). A study by Van der Heide (1989) pointed out that for each job created in forestry (logging), there will be 1.8 jobs elsewhere in the economy (multiplier effect). The employment multiplier for sawmilling and *plymilling* is 1.5, whereas the employment multiplier for pulp and paper, including printing, is 2.1.

Furthermore, the forestry sector plays a significant role in the Indonesian economy as a foreign exchange contributor. In 1989, processed forest products trade generated about US$ 4 billion of the country's export revenue and it increased to US$ 6.5 billion in 1993. As such, the forest sector was the second largest foreign exchange earner for the country, surpassed only by oil and natural gas (Kompas, 1994). Also, forest exports had increased almost twenty-one times from US$ 314 million in 1980.

The Indonesian forestry sector has experienced both rapid growth and structural change over the past two decades. This has, for the most part, been the result of government policies rather than market forces. The policy which had the biggest impact in wood-based industry was the log export ban, first announced in May 1980 by the government of Indonesia through a Joint Decree of the Ministers of Agriculture, Industry and Trade. It prescribed a total ban on log exports by 1985, to be phased in gradually over five years. This policy was designed to force forest concession holders to develop

domestic wood processing industries. According to Indonesian policy-makers, this policy would: 1) increase total export revenues by significantly raising export earnings from processed wood products, 2) expand job opportunities in the forest products industry, 3) increase value-added production, and 4) stimulate regional economic development (SKBTM, 1980).

Because of the log export ban (and the attendant facilitation of wood processing industries), Indonesia was transformed from an exporter of logs into an exporter of manufactured wood products. In 1979, Indonesia's share of the world's log exports was 41 percent (FAO, 1995). At that time, the main importers of Indonesian logs were Japan, China and South Korea, with Japan accounting for 57 percent (FAO, 1995). By 1980, Indonesia was the biggest exporter of tropical logs in the world and exported a greater volume of tropical hardwood logs than all of Africa and Latin America combined. In 1981, Indonesia's share of the world's log exports had fallen to 20 percent, one half the market share of the largest exporter of raw logs.

Since the log export ban policy enactment, the wood-based industry in Indonesia has grown rapidly. Government policies have had an important and continuing influence on the development of domestic wood processing industries, especially on the development of the plywood industry. The expansion of this industry has become a long-standing government objective (Arnold, 1990). Table 2 and Figure 1 (see the Appendix) show the development of the plywood and sawnwood industries in Indonesia. Total production of plywood grew rapidly from 19,000 m^3 in 1973 to 10 million m^3 in 1994. Meanwhile, the production of sawnwood grew from 1.7 million m^3 in 1977 to 10 million

m^3 in 1987, and then decreased to 4 million m^3 in 1994. Conversely, production of logs fell from 25 million m^3 in 1973 to 16 million m^3 in 1984 with the enforcement of ban policy. Then as the capacity of the domestic wood-based industry grew, log production quickly exceeded pre-1990 levels, reaching 27.5 million m^3 by 1987.

Page 60 and 62 illustrate the path of export volume and indicates the steep decline in log exports after 1980 (the first year of partial log export ban). Plywood exports increased rapidly from 1.2 million m^3 in 1982 to 8.8 million m^3 in 1994. Meanwhile, sawnwood exports increased from 1 million m^3 in 1979 to 2.7 million m^3 in 1989. These exports then decreased drastically to an insignificant number after a new sawnwood export tax was imposed in November 1989. Export of Indonesian plywood by primary destination country can be found in Table 4 page 63.

Sawnwood and Plywood: Productions and Revenues

- Roundwood

Indonesia possesses standing inventories of commercial species about 50 to 150 m^3 per hectare which is similar to production of average 61 million m^3 per year (Schreuder and Vlosky, 1985). As stated earlier, logs had been the principal forest products export item until the 1980 log export ban. Some documents show that within the 1966-1967 period, Indonesia produced 4 million m^3 of logs, of which 400,000 m^3 (10%) were exported overseas. By 1979, log production increased almost 6-fold to 25 million m^3, of which 72 % (18 million m^3) was exported. Converted to US dollars, logs and timber

exports in 1978 earned almost one billion dollars. The top seven species extensively harvested in 1973 were meranti (*Shorea* spp. and *Parashorea* spp.), ramin (*Gonystylus bancanus*), keruing (*Dipterocarpos* spp.), teak (*Tectona grandis*), agathis (*Agathis* spp.), pelai (*Alstonia* spp.), and kapur (*Dryobalanops* spp.) (FAO, 1981).

Due to the log export ban, the volume of log exports dropped drastically from 19 million m^3 in 1977 to only 1.5 million m^3 in 1982. This shocked some countries which had depended upon Indonesia for raw materials, such as Japan, Korea and Taiwan, who immediately sought new suppliers, such as Malaysia and New Guinea. Domestically, the regulation stimulated forestry companies to establish various wood-based industries, mostly producing sawnwood and plywood. Soon production of plywood tremendously increased in order to fulfill the market left by Japanese, Taiwanese and Korean plywood manufacturers (Schreuder and Vlosky, 1985).

- Sawnwood

Indonesian sawnwood industries obviously benefited from the log export ban. With total annual production at less than 2 million m^3 in 1970s, production greatly increased to 4 million m^3 in 1984, of which 2 million m^3 was exported overseas. Sawnwood production has been growing consistently over the years, though more slowly than plywood. The present situation of the sawnwood industries resembles former roundwood one. In order to add value on wood products, the government regulates sawntimber exports with heavily through export taxes (USDA/FAS, 1995). The purpose of such a restriction is to stimulate the development of wood downstream industries, such as the furniture industry.

In 1985, Indonesia was the second leading exporter of hardwood sawnwood, surpassed only by Malaysia, supplying 27 percent of world hardwood exports; in 1977 its share was only 8 percent. In 1990, the Indonesian sawnwood exports share declined again after a November 1989 export tax of US$ 250 to US$ 1000 per m^3, in favor of downstream domestic wood processing industry. Even though Indonesia still exports sawnwood, the volume is insignificant.

Between 1989 and 1992, developed countries imported 52 to 59 percent of the world's hardwood sawnwood exports from developing countries. The EEC (European Economic Community) took 28 to 30 percent of the world's imports in the same period. The USA has not imported more than 7 percent of world hardwood sawnwood during the last 15 years. In developed countries, most of the increased demand for sawnwood can be attributed to the expansion in construction, furniture production, and manufacturing.

Japanese imports of tropical sawnwood in 1992 accounted for 12 percent of the world's tropical sawnwood exports. The Japanese government restricts imports of tropical wood in manufactured form by imposing import duties. For instance, the Japanese have had a 5 percent import tariff rate on sawn hardwood from developing countries, whereas rates on imports from other developed countries are generally nil (FAO, 1988).

Since 1992 Thailand became the top tropical sawnwood importer in the world purchasing 18 percent of total hardwood sawnwood exports from tropical countries (74 percent of Thailand's imports came from Malaysia). Thailand's logging ban, together with its growing economy and large furniture and secondary processing industry, are responsible for the growing sawnwood imports (FAO, 1995).

- Plywood

The Indonesian government has given private companies the opportunity to establish wood manufacturing industries. Previously mentioned regulations on logs and sawntimber exports were created to stimulate domestic forestry processing companies. The plywood industry was the pioneer on wood-manufacturing development in Indonesia. The regulation caused the shut-down of most of the plywood industries in Japan, Korea and Taiwan because of the shortage of raw materials. The result for Indonesia's plywood industry was incredible. With only 19,000 m^3 production in 1973, plywood industries reached a phenomenal production of 1 million m^3 in 1980 with the beginning of the ban. And when the ban was fully implemented in 1985, total production reached 5.3 million m^3, 278 times higher than 1973's production (Schreuder and Vlosky, 1985).

In the international plywood trade, statistics do not distinguish hardwood from softwood, or tropical plywood from temperate plywood. For instance, like the hardwood sawnwood trade, the production statistics of plywood in Japan (and other developed countries) do not show how many cubic meters were made from temperate hardwood logs.

By 1982 Indonesia ranked third in plywood production, behind only the USA and Japan. Its exports of hardwood plywood had only been 8,000 m^3 in 1976. However, this figure increased phenomenally to 3.8 million m^3 in 1985. The US was the primary destination, accounting for 20-25 percent of total Indonesian exports. Other markets such as Hong Kong, the Middle East and Singapore followed the US as important markets (Schreuder and Vlosky, 1985). As time has gone, overwhelming progress has been taken

by Indonesian plywood exporters. By 1987, Indonesia superseded Japan, with 93.5 percent of market share replacing Canada, a producer of softwood plywood, which had 39 percent of total plywood market share in 1983. Likewise, Indonesia held 56 percent of the hardwood plywood exports to the US (Hyam, 1989).

The major exporters of hardwood plywood in the early 90s were Indonesia, and Malaysia. In 1992, Indonesia's share in the world market was 54 percent, and Malaysia's share was 10 percent. Previously, South Korea had been the leading Asian exporter of plywood in the 1970s, with 27 percent of the world exports in 1977, followed by Taiwan with 15 percent. By 1985, the shares of these countries dropped to only 2 and 6 percent, respectively, largely due to the shortage of log supplies. Their share then dropped to almost nothing in 1992. The other leading supplier of plywood had been Singapore, accounting for around 7 percent of world exports from 1977 to 1985, but only 4 percent in 1992. The remaining plywood exports currently come from industrialized countries, predominantly the EEC, and the USA. There are no major exporters of plywood in Africa and Latin America.

Indonesia's share of the world plywood exports market has increased dramatically from essentially zero in 1977 to 46 percent in 1985 and 54 percent in 1992. In fact, since 1982, Indonesia has been the largest plywood exporting country in the world, accounting for 18 percent of world plywood exports (FAO, 1994).

The developed countries are the major importers of plywood, with the EEC and USA together consuming about 60 percent of all imports in 1977 and 38 percent in 1985 through 1992. In 1985, about 25 percent of Indonesian plywood was exported to the

USA, and another 26 percent to Hong Kong, and 13 percent to Singapore. This export level accounted for 67 percent of total USA imports and 12, 89 and 75 percent of imports by the EEC, Hong Kong, Singapore, respectively. The latter two countries re-export the bulk of the imported plywood. During the 1970s the USA market was dominated by the Philippines, South Korea, and Taiwan. But the shares of these countries have become negligible in recent years with Indonesia dominating the market.

In 1992, the major importing countries of Indonesian plywood were Japan and China which accounted for 29 percent and 24 percent, respectively, of total Indonesian exports. Meanwhile, US imports of Indonesian plywood exports declined to 10 percent of Indonesia's total exports.

In summary, Indonesian plywood exports have been growing steadily. Exports volume reached 8.8 millions m^3 or US$ 4,000 million in 1994. (USDA/FAS, 1995). As a result, Indonesia is currently the largest hardwood plywood producing and exporting country in the world, holding 54 percent of the global plywood export trade in 1992. This is noteworthy because in 1977 its share was essentially nil.

In spite of the government efforts to stimulate the emergence of finished-products industries, plywood industry continues as one of the most promising sources for foreign exchange and apparently will remain so in the future.

Trade policy

Following the log export ban, Indonesia was able to expand its exports of tropical hardwood plywood and sawnwood at the expense of other suppliers such as Korea, Taiwan, and the Philippines. Benefiting from abundant raw materials, it was relatively easy for Indonesia to capture a major share of the North-American and European markets for tropical wood products, particularly plywood. Continued expansion may involve competing with the few remaining high-efficiency foreign producers, but more than that, it may involve trying to penetrate the much larger softwood plywood and sawnwood markets. This will be possible if the tropical products are good substitutes for the softwood temperate products. Schreuder and Bender (1986), for example, have argued that this is so.

On the other hand, if tropical wood products are not good substitutes for softwood and other temperate zone products, the size of the market will be smaller and continuous expansion of exports would only put a serious downward pressure on prices. In this case the restriction of exports may in fact be the best policy, because it would increase foreign exchange revenues and reduce the threat of resource depletion. The danger is that other countries may supersede Indonesia in export markets (Constantino, 1988).

As Westoby (1988) has pointed out, if increasing quantities of wood products are unloaded in the export markets, this is likely to put a downward pressure on the international price of tropical wood products, and could ultimately lead to a decline in

total foreign exchange earnings and welfare, if prices fall considerably. By this argument, Indonesia may in fact be better off by restricting, or at least maintaining export levels, rather than increasing them. This tactic is further supported by previous developments in the plywood industries. According to Nasendi (1982), the rapid growth of plywood exports from Indonesia led to marketing problems and to a self-imposed rationing (quota) by the Indonesian wood panel association (APKINDO); APKINDO allocated export markets between plywood producers, in an effort to stabilize the international price of plywood. This was later followed by the imposition of an export quota by the Ministry of Trade. More recent policies provide incentives to plywood and other wood products manufacturers to diversify into exports of higher value-added products (Constantino, 1988)

As Kallio et al. (1987) have pointed out that ignoring trade in forest sector planning can lead to biases in the assessment of the impacts of forest policies. Estimates of potential international demand for various forest products, together with estimates of the domestic requirements for those products, are therefore important for the planning process.

During the late seventies and early eighties, when Indonesia was expanding its exports of wood products at the expense of competing suppliers such as Malaysia, the Philippines, South Korea, and Taiwan, Indonesia could plan to attain a given level of exports, consistent with sectoral development policies, without consideration for international demand. At those early stages of export development it was expected that the world would be willing to absorb an increasing amount of inexpensive Indonesian

products. As this situation does not appear valid currently, an investigation of the potential demand for Indonesian forest products is in order (Constantino, 1988).

The high demand for wood products has begun to cause a shortage in the domestic roundwood supply within Indonesia. A few private wood companies are already importing roundwood from Malaysia and Brunei today, which signifies that consumption and production of local roundwood is entering an unbalanced situation. The future of the Indonesian wood products industry could be in jeopardy, since Malaysia and Brunei might eventually ban their log exports as well. If the government does not become aware of the existing and potential conditions, it is possible that in the near future, Indonesia would emerge as a net importer of roundwood.

Since nearly all forest area in Indonesia is owned by the government, private forest concession companies have been given the right to exploit the forest for up to 20 years under tight government supervision. It is important to understand and predict future production trends of sawnwood and plywood, in order to provide a relevant and reliable basis for government to make forestry related policies governing forest management, the forest products industry, and forest products trade.

Previous Regression Models in Forest Products

Projected production or consumption is defined as the volume of products that will be produced or consumed in the projection years, based on assumptions concerning the changes in population, economic activity, prices, and other determinants of production or

consumption are realized. In this study, the author assumes that production is equal to consumption in long-run (in an equilibrium market). Manurung (1995) used the same assumption in his study. Therefore, the terms of production and consumption will be used interchangeably.

An important aspect of production or consumption relationships is elasticity, which measures how responsive the dependent variable, production or consumption, is to independent variable changes (Byrns and Stone, 1987). Production or consumption is elastic if it responsive to independent variables, and inelastic if it is unresponsive to independent variables.

As with most natural resources, the consumption of many forest products is inelastic, because they are consumed indirectly by the production of other goods (Gregory, 1987). McKillop (1967) recognized three types of forest products primary, secondary, and intermediate. Roundwood (logs) and stumpage are classed as primary products. Sawnwood, plywood, paper board, and paper are classed as intermediate. Consumption for most secondary products is derived from the sale of finished products, such as houses, furniture, boxes, and newsprint. The consumption of stumpage and logs, as primary forest products, is derived from the consumption of secondary wood products.

Robinson (1974) developed a model of Douglas Fir and Southern Pine consumption for the softwood lumber markets in the Pacific Northwest. He modeled softwood production as a function of stumpage price and the interest rate, and separated the softwood lumber production into domestic and import markets. Domestic lumber production was a function of stumpage price, lumber price, and lumber production per

man-year in the sawmill industries. The quantity of softwood lumber imported was a function of lumber price, lumber freight revenues, exchange rate, value of residential construction or dwelling units, and the number of new dwelling units. Robinson found most of the estimated coefficients in his study were significant. He concluded that consumption for Douglas fir and Southern pine were price inelastic.

Brannlund et al. (1985) modeled Swedish pulpwood consumption as a function of lumber price, timber price, and the wage rate in the sawmill industry. Brundlund found all coefficients in the consumption equation were significant.

Daniels and Hyde (1986) modeled consumption of North Carolina softwood and hardwood stumpage as a function of stumpage price and wood product prices. They developed the stumpage price from the weighted average of stumpage prices for softwood and hardwood sawtimber and pulpwood. Final wood price was represented by the relative price index of national lumber and wood products. Daniels and Hyde had multicollinearity problems in their models. However, their model can still be used for predictions. They found that consumption was fairly inelastic with respect to stumpage price changes.

Newman (1987) examined an aggregate regional model of the southern solidwood and pulpwood stumpage markets. He modeled stumpage demand as a function of capital, labor, and raw materials (stumpage input).

Cengel and McKillop (1990) described the aggregate production of South Sea tropical hardwood logs from a producing country as a function of the delivered price in the currency of that country, exchange rate, export prices from the producing country to other countries, and the total economically accessible log volumes in each year. The

quantity of logs demanded by plywood industries was specified as a function of the import price of logs, the export and domestic prices of lumber and plywood, prices of other inputs, and productive capacity.

Cengel and McKillop (1990) showed that price (export or import price) is not a key factor in influencing the South Sea tropical hardwood log suppliers from log-producing countries (Philippines, Malaysia, and Indonesia). Rather, the productive capacity of plywood industries in importing countries (Japan, South Korea, and Taiwan) was found to be a statistically significant factor influencing log consumption.

Chou and Buongiorno (1983) investigated the United States' consumption for hardwood plywood imports from Korea, Taiwan, Japan, the Philippines, and the rest of the world. A model of the aggregate demand for imports was estimated, leading to a price elasticity of -2.2. That means that if the price of plywood imports increases (or decreases) by 1 percent, then the United States consumption for imports will decrease (or increase) by 2.2 percent.

Caballero-Deloya (1981) modeled production of Mexican wood products through regression analysis with the following independent variables: population, gross domestic products (GDP), and roundwood harvest.

A study using regression equations for projecting trends in demand for paper and board has been conducted by the U.S. Forest Service (Hair, 1967). Several independent variables could be used in projecting demands for most of the major grades of paper and board. The various possibilities were as follows: population, households, gross national product (GNP), disposable personal income, and industrial production.

Arifin (1994) studied supply and demand relationships for hardwood logs in Indonesia. He found that log price, as measured by weighted average index price of log and inventory, as represented by the working area of concession holders, was found to significantly influence the supply and demand of hardwood logs in Indonesia. Other variables that significantly influenced log demand were the price of plywood and the Indonesian-Japanese exchange rate. Dummy variables, constructed for investigating the effects of the log export ban, were statistically significant as well.

Manurung (1995), who investigated economic impacts of the log export ban policy created by the Indonesia government, found that the ban was statistically significant in influencing the production of Indonesian wood products.

When regarding all of these studies, one might expect some of the following factors to drive forest products production or consumption: population, GDP/GNP, exchange rate, and price.

This study of consumption and production of Indonesian sawnwood and plywood will use techniques similar to the previous consumption and production studies discussed above. In building the theoretical consumption and production models, domestic and foreign markets have been separated. This study uses some input for independent variables such as population, economic activities, prices, and other determinants of forest product consumption.

Chapter III

METHODOLOGY

Regression Model

Regression analysis is the statistical technique used perhaps most frequently to analyze the relationship between two or more variables in business and economics. This technique deals with the way one variable tends to change as one or more other variables change. Analyzing the relationship between two variables is called a simple regression analysis. The model that extends a simple regression to use with two or more independent variables is called a multiple regression analysis.

There are two kinds of variables, the dependent variable, denoted by Y, and the independent variable, denoted by X. Dependent variable values depend on the values of another variable. The dependent variable may also be known as the response variable. The independent variable, which is also known as the explanatory variable, is used to explain the dependent variable. The value of an explanatory variable normally offers at least a partial explanation of the behavior of the dependent variable.

There are several reasons for using the regression technique. First, it is well suited for use with the detailed time series data available on production and consumption of forest products and on population, gross national product, and other related measures of economic activity. Second, it is generally understood by researchers in government and

industry and can be used for making long-run projections. And finally, its predictive reliability seems to be as good as other alternatives.

The independent variable is a major determinant of the projected values for a dependent variable. Traditionally, three criteria have been used in choosing independent variables for projecting long-run trends in demand for products. These are:

1) the availability of long-run estimates or projections of future values of the independent variables;
2) the closeness of the historical functional relationships between the independent and dependent variables; and
3) The casualty of the relationship between the independent and dependent variables.

Long-run projections of potentially usable independent variables for projecting production and consumption for forest products – such as population, households, gross domestic product, exchange rate, and prices – are prepared and published regularly.

Most of the long-run projections of production and consumption for forest products such as logs, sawnwood, paper and board, have been derived from regression equations. These equations have been used to project the historical relationship between production and consumption of forest products and one or more independent variables, such as population or income, which have been important determinants of demand in the past and for which estimates of future values were available.

As stated earlier, the terms consumption and production are used interchangeably, assuming an equilibrium market in the long-run.

A multiple regression model can be defined as:

$$Y = a + b_1X_1 + b_2X_2 + \ldots + b_iX_i + e$$

where: Y = dependent variable

a = intercept

$b_1 \ldots b_i$ = slope

$X_1 \ldots X_i$ = independent variables

e = error

In this study, the production or consumption of sawnwood (domestic) and plywood (domestic and export) were incorporated into equations as the dependent variables (Y). Factors influencing the level of sawnwood and plywood production or consumption such as population, exchange rate (US$ Dollar vs. Indonesia Rupiah), consumer price index (CPI), and dummy variables were included in the equation as the independent variables.

There were two kinds of dummy variables used in the equation: dummy log ban and dummy export tax. Dummy variables were used to show the impacts of the log export ban in 1985 (dummy log ban) and sawnwood tax regulation in 1989 (dummy sawnwood tax). The number one (1) was used for representing a period before the log export ban or the tax regulation, and zero (0) for after the ban or the tax regulation. The impacts of these regulations were different, as shown by the sign of the dummy's coefficients. If the sign is positive, ceteris paribus (everything being constant), the production or consumption before the log ban or tax regulation is higher than after the regulation, and vice versa.

Using a statistical analysis program (Minitab), those dependent and independent variables were regressed to find the multiple regression estimate, given the historical value of the variables.

Goodness of Fit

Two alternative measures can be used to measure the goodness of fit for a regression. First is the standard error estimate (S_e), which is a measure of the typical deviation of the predictions from the actual values of the dependent variable (Y). Second is the coefficient of determination (R^2), which is used to measure the proportion of total variation in Y that is explained by the intercept and the independent variables.

While the standard error estimate provides one measure of the accuracy of the prediction, it is not particularly easy to interpret. R^2 is more useful for interpreting the accuracy of the prediction. If we take the square root of the coefficient of determination, we will find the correlation coefficient (r). This is used to measure the closeness of the relation between the predicted and actual values of the dependent variable. Hence it is useful to investigate the relationship between the correlation coefficient r and the coefficient of determination R^2.

For each equation, describing the production or consumption of sawnwood (domestic) and plywood (domestic and export), R^2 will determine the ability of the independent variables in explaining variations in the dependent variable.

Tests on Regression Models

After having estimated the regression model, we would like to know whether the dependent variable is related to the independent variables. To find out, we can test whether an individual regression coefficient or a set of regression coefficients is significantly different from zero. For this purpose, we use the t-statistic to test an individual coefficient, and the F-statistic to test a set of regression coefficients.

When we want to test whether the slope (b) is different from zero (t-test), the alternative hypothesis (H_1) is that the slope is different from zero; it does not matter whether the slope is positive or negative. The null hypothesis (H_0) in such cases is that the slope is zero.

$H_0 : b_i = 0$

$H_1 : b_i \neq 0$

The F-test is used to test whether all true population regression (slope) coefficients equal zero. The null hypothesis for this case is:

$H_0 : b_1 = b_2 = b_3 = \ldots = b_i = 0$

H_1 : at least one b is not zero

If the null hypothesis is not true, then each $\mathbf{Y}_i$ (estimated value of dependent variables) will differ from $\mathbf{Y}_i$ (averaged value of dependent variables) substantially. In other words, the R^2 will be relatively large. In conclusion, for t-test failure indicates that, although the variable may be related to the dependent variable, the variable fails to marginally affect the dependent variable (and thus cannot aid predictions) when the effects

of the other independent variables are removed. When the F-test on R^2 is insignificant, it means that the entire regression is essentially worthless.

The F-test was used to test the significance of equations on the production or consumption of sawnwood (domestic) and plywood (domestic and export). For each slope of the equations (slope of constant and independent variables), a t-test was used to determine its significance. Confidence levels of 95 % and 99 % were used for either F-test or t-test.

Problems

Potential problems with time series data include multicollinearity, autocorrelation, and heterocedasticity. Multicollinearity occurs when two or more explanatory variables are highly correlated. Parameter estimates are unbiased but the errors are inflated (Greene, 1993).

Autocorrelation occurs when the errors associated with a given time period are correlated with errors in other time periods. The parameters obtained will be biased and inconsistent (Pindyck and Rubinfeld, 1991).

Heteroscedasticity occurs if the error variance is not constant across observations. It places more weight on the observations with large error variances than on those with small error variances. The parameter estimators will be unbiased and consistent, but inefficient (Maddala, 1992; Pindyck and Rubinfeld, 1991).

Bohrnstedt and Carter (1971) state that violations of the assumptions of homoscedasticity and normality do not generally cause serious distortions in regression estimates. The regression estimates are, however, rather seriously distorted by a biased measurement.

One way to detect collinearity is to construct a variance inflationary factor (VIF) for each explanatory variable. Researchers have used $VIF_i = 10$ as a critical value rule of thumb to determine whether there is too much correlation (Lee, 1993).

Autocorrelation can be detected using the Durbin-Watson statistic (D-W). The range of D-W is from 0 to 4. If, after fitting a forecasting model, the errors are essentially random, then the D-W statistic is around 2 (Makridakis et al., 1983).

Selecting Variables for Prediction

It is often possible and useful to select from a pool of variables a smaller set which will be as efficient, or almost as efficient, as the entire set for the purpose of prediction. When variables are selected from an available pool, the aim is usually the selection of the minimum number of variables necessary to account for almost as much of the variance as is accounted for by the total set.

To select variables so that the best regression equation is obtained, various selection procedures may be used. The best equation is defined as the equation that maximizes the R^2. Selection methods include: all possible regressions, forward selection,

backward elimination, and stepwise selection (Pedhazur, 1982). In this study, the author used the all possible regressions method to find the best regression equation.

For instance, a regression equation consisting of 4 independent variables has a certain level of R^2. Using the all possible regressions method, it can be tested statistically whether the number of independent variables (4) is the best, or the number should be decreased. The increment of R^2 from the equation with 3 independent variables, for instance, relative to the equation with 4 independent variables, can be tested for significance using the F-test in the manner shown below (Pedhazur, 1982):

$$F = \frac{(R_1^2 - R_2^2)/(k_1-k_2)}{(1 - R_1^2)/(N - k_1 - 1)}$$

where:

R_1^2 = coefficient of determination of the first regression equation (4 variables)

R_2^2 = coefficient of determination of the second regression equation (3 variables)

k_1 = number of independent variables of the first equation

k_2 = number of independent variables of the second equation

N = number of samples

If the result of the F-test above is insignificant, then the number of independent variables in the original equation (4) should be reduced.

In this study, the author put all appropriate independent variables available into the production or consumption of sawnwood and plywood equations in the first attempt. Later on, all insignificant independent variables (tested by the t-test) were removed from

the equation, after showing that the increments of their R - squares in the equation were insignificant.

Elasticity

Elasticity is essentially used to measure a percentage change in the estimated coefficient of a dependent variable caused by a change in the estimated coefficient of an independent variable. The elasticity of production or consumption equation can be calculated by using this formula (Tomek and Robinson, 1985):

$$E = \frac{\Delta Y/Y * 100\%}{\Delta X/X * 100\%}$$

$$= \Delta Y/\Delta X * X/Y$$

$$E_i = b_i * X_i/Y$$

where:

E = elasticity

Y = dependent variable

X_i = independent variables

b_i = slopes

value of E: $|E|$: < 1 (inelastic)

$= 1$ (unielastic)

> 1 (elastic)

For example, the price elasticity for plywood consumption is 1.5. This level of elasticity indicates that a one percent plywood price increase brings about approximately a 1.5 percent increase in the quantity of plywood consumed.

To find the elasticity of each independent variable on the production or consumption of sawnwood and plywood equations, the average values of the dependent variable (Y) and independent variables (X_i) were calculated. Then, using the above equation for elasticity, the elasticity was obtained.

Data

Time series data (1970-1994) were used in this study. Data were collected from: (1) Forestry Statistics of Indonesia, Ministry of Forestry; (2) The Statistical Yearbook of Indonesia, Central Bureau of Statistics; (3) The International Financial Statistics, International Monetary Fund; and (4) other sources. The raw data is given in Table 2 and 3, in the Appendix.

The time period studied was limited by several factors. First, the availability of data forces the analysis to stop at 1994. The study utilized the latest data available in the Department of Forestry's yearly statistical book ending in 1994. Second, Indonesia's forestry sector built up in the early 1970s. Some new forest products, such as plywood, were not produced domestically until the early 1970s.

This data is unique because it is considered confidential, or strictly not for public use. Forest utilization involves many influential parties who have their own vested interest. Therefore, data collection for this study was quite difficult. Fortunately, the author has received a great deal of support and help from colleagues who are working in the Department of Forestry, the Indonesia Wood Panel Association (APKINDO), and the Indonesia Sawmill and Wood-working Association (ISA). They provided most of data needed for this study. Without them, this study could not have done properly.

The definition of the forest products trade used in this study follows the United Nations Standard International Trade Classification (SITC). Specifically:

- Roundwood (SITC 246/247)

These commodity aggregates include all industrial wood in the rough (sawlogs and veneer logs, pulpwood and other industrial roundwood) and, in the case of trade, chips and particles and wood residues.

- Sawnwood (SITC 248)

Sawnwood includes sleepers, unplaned, planed, grooved, tongued, etc., sawn lengthwise or produced by a profile-chipping process (e.g. planks, beams, joists, boards, rafters, scantlings, laths, boxboards, lumber, etc.), and planed wood, which may also be finger-jointed, tongued or grooved, chamfered, rabbeted, V-jointed, beaded, etc. With few exceptions, sawnwood exceeds 5 mm in thickness.

- Plywood (SITC 634)

Plywood includes veneer plywood, core plywood, veneered wood, blockboard, laminboard, battenboard, cellular board, and composite plywood.

Consumption of Sawnwood

Consumption of sawnwood was defined as the annual volume of sawnwood produced, measured in million of m^3. As already stated, this assumes an equilibrium market, where production equals consumption in the long-run. The data came from *Forestry Statistics of Indonesia*, published by the Ministry of Forestry and the Indonesia Sawmill and Wood Working Association (ISA). Sawnwood exports were not considered because Indonesia only exported an insignificant amount of sawnwood after the tax regulation in 1989.

Consumption of Plywood

Production or consumption of plywood (export and domestic) was defined as the annual volume of plywood produced, measured in million of m^3. Again as already stated, this assumes an equilibrium market, where production equals consumption in the long-run. The data came from *Forestry Statistics of Indonesia*, published by the Ministry of Forestry and the Indonesia Wood Panel Association (APKINDO).

Some Measures of Economic Activities

- Consumer Price Index (CPI)

CPI measures the number of dollars or Rupiahs that it takes to buy a specified amount of goods and may represent the typical family's purchases. Thus the percentage

increase in the CPI from one year to the next measures the rate of inflation. This index is sometimes called a deflator when it is used to convert (deflate) figures in current prices into constant price terms. The year 1990 was used as the base year, with CPI = 100. Therefore, the 1990 constant prices are used in the estimation.

- Gross Domestic Products (GDP)

GDP is the total of all economic activity in one country, regardless of who owns the productive assets. For example, Indonesia's GDP includes the profits of a foreign firm located in Indonesia even if they are remitted to the firm's parent company in another country. It describes the total level of production, as a yardstick for measuring economic achievement or other indicators.

- Exchange Rate

Exchange rates are the amount of one country's currency needed to purchase one unit of another currency. In this study, the value of the Rupiah in U.S. dollars is used for the calculation of the exchange rate.

To make a projection based on the resulting production equation, projection of future values of independent variables are needed. The author used future projections of some economic activities provided by the Indonesia's Central Bureau of Statistics and the Ministry of Forestry.

Some indicators of Indonesian economic activities used in this study can be seen in Table 5 in the Appendix.

Chapter IV

RESULTS

Sawnwood Production

General model of multiple regression can be written as:

$$Y = a + b_1X_1 + b_2X_2 + \ldots + b_iX_i + e$$

where: Y = dependent variable

a = intercept

$b_1 \ldots b_i$ = slope

$X_1 \ldots X_i$ = independent variables

e = error

The equation for sawnwood production was estimated by multiple regression. Sawnwood production (Y) was used as the dependent variable and 3 independent variables were jointly tested to create the equation that contributed the most to the total sum of squares. The independent variables that provide the best fit are as follows:

X_1 = Dummy log ban

X_2 = Dummy sawnwood tax

X_3 = Population (million)

The best equation was obtained after combining variables X_1 through X_3. The multiple-regression estimate thus obtained is:

$$Y = -10.8 - 0.71X_1 + 2.22X_2 + 0.08X_3$$

The multiple-determination coefficient (R^2), a measure of goodness of fit, was 0.95 at the 0.001 significance level. This high R-square implies that the variation in the independent variables was good in explaining the variation of the dependent variables.

In the equation, the three estimated coefficients were significant. First, the population was statistically significant at the 0.001 level. The estimated coefficient of population was 0.08, indicating that a one million increase in the population, ceteris paribus (everything being constant), results in a 80,000 m^3 increase in sawnwood production. The population elasticity was 4.4, indicating that a one percent increase in population brings about a 4.4 percent increase in sawnwood production.

Other variables that were statistically significant were the dummy log ban and dummy sawnwood tax, with estimated coefficients of -0.71 at the 0.05 significance level and of 2.22 at the 0.001 significance level, respectively. This indicates that the log export ban in 1985 and tax regulation on sawnwood export in 1989 affected the level of sawnwood production. The impact of these regulations were different, as shown by the sign of the dummy's coefficients. The dummy log ban had a negative sign, implying production of sawnwood increased significantly after log export was banned. Conversely, the dummy sawnwood tax had positive sign, implying that the heavy tax regulation on sawnwood export caused a decreasing quantity of sawnwood produced.

The symptoms of multicollinearity among independent variables can be diagnosed from the values of variance inflation factors (VIF). The VIF values of the production

equation (Table 6) indicate no problem with multicollinearity. As a whole, the equation had a Durbin-Watson (D-W) statistic of 1.8, indicating the equation had no problem with autocorrelation.

Using the future projection of independent variables in year 1999 (see Appendix Table 7), the production of sawnwood in 1999 would be of 5.74 million m^3 assumed log supply available and no policy constraints. This would be a 28 % increase from 1994 production. The projection of sawnwood production from 1995 to 1999 with 95% confidence level can be found in Table 8 in the Appendix.

Plywood Production

- Domestic consumption

For the consumption of plywood for the domestic market, the independent variables used were as follows:

X_1 = Dummy log ban

X_2 = Population (million)

X_3 = Consumer price index (CPI)

A multiple-regression model relating these variables is :

$$Y = -6.13 + 0.29X_1 + 0.05X_2 - 0.01X_3$$

The coefficient of multiple determination was 0.97 at the 0.001 significant level. In the production equation, the population was statistically significant at the 0.001 significance level. The estimated coefficient was 0.05, indicating that a one million increase in the population level, ceteris paribus, leads to a 50,000 m^3 increase in plywood production. The population elasticity was 12.4, indicating that a one percent population increase should bring about a 12.4 percent increase in the production of plywood domestically.

Moreover, the estimated coefficient for CPI was statistically significant at the 0.001 significance level. The estimated coefficient was -0.01, indicating that a one index number increase in the CPI, ceteris paribus, leads to a 10,000 m^3 decrease in plywood production. The CPI elasticity was 1.2, which implies CPI was elastic. The CPI elasticity indicates that a one percent increase in the CPI brings about a 1.2 percent decrease in plywood production.

Lastly, the dummy log ban coefficient was statistically significant at the 0.001 significance level. The positive sign of the dummy implies that the production of plywood for domestic market decreased after the log export ban took place in 1985 .

The D-W number for the equation was 1.8, indicating that the equation only had a slight problem with autocorellation, which could be ignored. Moreover, the VIF values of each independent variables (Table 6) indicated no problem of multicollinearity in the equation.

Using the future projection of independent variables in year 1999 (see Appendix Table 7), the domestic consumption of plywood in 1999 would be 1.32 million m^3. This

would be a 34 % increase from 1994 consumption. The projection of domestic plywood consumption from 1995 to 1999 with 95% confidence level can be found in Table 8 in the Appendix.

- Export

The independent variables used in the plywood export equation were as follows:

X_1 = Dummy log ban

X_2 = Dummy sawnwood tax

X_3 = U.S. Dollar - Indonesia Rupiah exchange rate

The equation relating these variables is:

$$Y = 0.51 - 1.19X_1 - 1.16X_2 + 0.01X_3$$

The coefficient of multiple determination was estimated 0.99. It was significant at the 0.001 significance level. The estimated coefficient of exchange rate was also statistically significant at the 0.001 significance level. The exchange rate was expected to be a significant parameter. As Indonesian currency (Rupiah) gets weaker against the U.S. dollar, Indonesian products will be more affordable abroad. The estimated coefficient was 0.01. Results indicate that a one Rupiah increase in the Indonesian - U.S dollar exchange rate (Indonesian Rupiah gets weaker), ceteris paribus, leads to a 10,000 m^3 increase in the quantity of plywood exports overseas.

The exchange rate elasticity was 1.1, which implies the exchange rate variable was elastic. The exchange rate elasticity indicates that a one percent increase in the exchange rate brings about a 1.1 percent increase in the volume of plywood export.

The dummy log ban and sawnwood tax were statistically significant with estimated coefficients of -1.19 at the 0.05 significance level and of -1.16 at the 0.001 significance level, respectively. This indicated that the quantity of plywood export increased after the government imposed the log export ban and the heavy tax regulation on sawnwood.

The equation had a D-W statistic of 1.97, indicating that multicollinearity was not a problem. The VIF values of equation can be found in Table 6 and indicate no problem with multicollinearity.

Using the future projection of independent variables in the year 1999 (see Appendix Table 7), plywood exports in 1999 would be at 13.1 millions m^3. This would be a 47 % increase from 1994 export levels. The projection of plywood exports from 1995 to 1999 with 95% confidence level can be found in Table 8 in the Appendix.

The tables containing the estimated coefficients of the production equations (Table 9) and the elasticiticities of variables affecting the production of Indonesian sawnwood and plywood (Table 10) can be found in the Appendix.

Chapter V

DISCUSSION

Although the statistical tests show that there was a close functional relationship between changes in most of the independent variables and changes in production or consumption of sawnwood and plywood, there is no statistical way to establish that these relationships were causal, i.e., that the changes in the independent variables caused the changes in the dependent variable. Yet this is a matter of great importance in making a model that can be used for projections which extend beyond the range of the base data. The validity of such projections rest in part upon the assumption that the relationships occurring in the base period will continue through the projection period. The chances that this will occur are greater if changes in the dependent variable are caused by, rather than merely associated with, changes in the independent variable.

While it cannot be mathematically established that the historical relationships were causal, it seems logical to conclude that the relationships between changes in independent variables, such as population and exchange rate and changes in the consumption of sawnwood and plywood, were both functional and causal. Admittedly, in many relationships the cause and effect were indirect. The volume of domestic plywood consumption, for example, is directly a function of such factors as volume of housing construction, size of houses, and number of plywood needed for each house. However,

long-run projections of these and more direct determinants are usually not available and thus they are not readily adaptable for use as independent variables

Changes in the direct determinants are, of course, a function of changes in the aggregate variables such as population and gross domestic product. The effects of the direct variables on demand are thus implicitly included in any model using these aggregates as the independent variables. Aggregate variables, such as the gross domestic product (GDP), implicitly include the effects of many factors such as consumer tastes and technological developments which cannot be readily quantified, or explicitly recognized.

Indonesia has a large number of tropical forest resources. These invaluable resources are extremely important both in supporting the environment and fostering the social and economic welfare of the country. The forest products industry of Indonesia has encountered rapidly changing circumstances since the establishment of the log export ban policy in 1985 in favor of the domestic wood processing industry. Log exports were phased out to ensure that the Indonesian people benefited more from the harvesting of their forest, through growth in the processing sector, and generation of employment. Concessionaires were required to establish wood-based industries as part of the agreement through which concessions were granted. Indonesian policy-makers believed that the export of raw materials was wasteful, that export revenues and jobs were forgone whenever natural resources were exported in unprocessed form.

Indonesia has been successful in diversifying its forest product exports. The processed forest products, particularly plywood, play a major role in the country's foreign exchange earnings. The change in the policy to restructure the forest products from logs

to processed products, particularly sawnwood and plywood, has enhanced the growth performance of the Indonesian forest products industry.

The dramatic increase in the share of the Indonesian plywood exports to some Asian markets has, to some extent, created some trade battles. Consequently, faced with a relatively large supply and industrial capacity, Indonesia has been forced to find new alternative markets. The nature of this study, however, does not allow us to cover specifically the consumption of Indonesia's plywood of each importing country.

It is found that, during the period under investigation (using 1970 as the base year), the production or consumption of Indonesian sawnwood and plywood increased considerably.

In the world market, the share of Indonesian plywood exports has been growing dramatically from practically nil in 1977 to 18 percent in 1992. During the same period, the estimated coefficient of plywood price and its elasticity for export, however, show no significance statistically. This suggests that the active pricing policy might not have had much success at increasing plywood export revenues.

Typically, the price of a product has always been considered an important determinant of consumption, with consumption tending to vary inversely to price changes. However, domestic sawnwood and plywood consumption have grown independent of pricing, especially in recent years. This is likely due to the rapid growth of the Indonesian economy, which has led to the fast development of public housing. Indeed, the coefficients of sawnwood and plywood prices were not significant in this study. This result seems to agree with the explanation above regarding the market situation in Indonesia.

For plywood exports, the exchange rate was a significant factor; as the Indonesian Rupiah gets weaker, more plywood can be purchased in the international market. Therefore, the quantity of export plywood should increase accordingly. Conversely, as the Indonesian currency gets stronger, buyers are likely to shift to plywood from competitor countries.

Population was another variable that significantly influenced the production or consumption of sawnwood and plywood domestically in the positive direction. As population increases, the production or consumption of the products domestically increases, which is a logical pattern. As the population grows, more houses and buildings are needed, hence, more sawnwood and plywood is produced and consumed.

CPI influenced the domestic consumption of plywood. As the CPI increases, which represents an increase in inflation, the consumption would decrease. High inflation weakens the purchasing power of the consumers.

The dummy variables, dummy log ban and dummy sawnwood tax, constructed for investigating the effects of the log export ban and tax regulation on sawnwood export, captured the intended purpose. The log export ban regulation did favor the development of the sawnwood industry. By artificially reducing foreign demand, the log export ban depressed the domestic price of logs, which provided the domestic wood processing industry with a cost advantage in cheaper raw materials. As a result, production of sawnwood became profitable, and the processing capacity expanded. Some of the products were exported. This phenomenon agrees with the negative sign of dummy log

coefficient on the sawnwood production equation. The negative sign shows that the production of sawnwood increased after the log export ban.

However, after the government launched a heavy tax regulation on sawnwood export in 1989, at the new tax rate of between US$ 250 and US$ 1,000 per m^3, the quantity of sawnwood exports reduced dramatically to an insignificant numbers. As a result, most forestry companies converted their business to build plywood industries which was very profitable and was encouraged by the Indonesian Government. The positive sign of the dummy sawnwood tax on the sawnwood production equation shows this phenomenon exactly. It implies that the production of sawnwood decreased after the implementation of the tax regulation.

The log export ban and the tax imposition on sawnwood exports were both expected to increase plywood production. The high production of sawnwood (before the period of the tax regulation) and plywood also happened because in the early years after the announcement of the ban, several forest concession rights (or HPH) holders who previously did not develop domestic wood processing industries (although it had been required in the Forest Concession Agreement), were forced by the government of Indonesia to do so during the 1980's. Moreover, HPH owners, who used to make easy profits by exporting logs, were forced to follow another Joint Regulation announced by the government of Indonesia in April 1981 (the beginning of the partial log export ban), known as SKBEDJ. The objective of this regulation was, again, to speed up the development of the wood processing industry, especially plywood mills. Among the terms in this Joint Regulation two were important. The first was that a log export quota was

granted to the HPH owner whose plywood mill was at the first stage of commercial operation, i.e., capable of utilizing at least 10 percent of its installed capacity and marketing the product. HPH owners who fell into this category were allowed to export 20 percent of their log production within one year (in 1981). The second allowed an HPH owner whose plywood mill was under construction a log export quota of two-thirds of his approved log production for two years. This enabled him to be more competitive.

As a result, plywood production increased from 4 million m^3 in 1985 to 10 millions m^3 in 1994. The fact that plywood production increased rapidly suggests that the government of Indonesia's decision to center the development of wood processing industries on plywood mills was successful.

On May 27, 1992, the Government of Indonesia lifted the ban on log exports and imposed a new export tax. The problem with this new policy was that the export tax rate, between US$ 500 to $4,800 per m^3 of logs, depending on the wood species, was very high. At that time, Malaysian export log prices of meranti (*Dipterocarpaceae* spp) to Japan, were at most about US$ 300 per m^3 (Gresham, 1994). So in reality, the new export tax rate imposed by Indonesia was an effective ban on log exports, under another name.

According to Parthama and Vincent (1992), the rapid growth of the Indonesian wood industry, especially plywood, in such a relatively short period is indeed due to the log export ban. With this policy, the industry has been enjoying a much lower price of logs as compared to the world price level. Combined with other subsidies, the ban enables the industry to obtain sizable profits despite their inefficiency and below-capacity

production. This also explains Indonesia's rapid expansion on the world market. Such subsidies, however, will entail unsustainable forest resource exploitation.

An export tax can indeed have the same effect as an export ban. It can generate revenue as well as provide protection to the industry. As the industry matures and is able to compete internationally, then the export tax (for protection purposes) could be reduced. Government subsidies or protection must always be temporary in nature, otherwise they will invariably result in inefficient industries (Kenen, 1989).

It appears that the government of Indonesia's decision to center the development of wood processing industries on plywood mills agree with Takeuchi's view (1974, 1982), which suggested that plywood manufacturing should be the core of the development strategy for the wood processing industry in log producing countries like Indonesia. According to Takeuchi, the development of the plywood industry would automatically promote sawmilling and production of other wood-based panels. These activities complement plywood manufacturing through improving the efficiency of raw material usage. For instance, logs unfit for plywood could be sent to a nearby sawmill and wastes and residues from plymilling and sawmilling can be used for particle board manufacture.

Chapter VI

SUMMARY AND CONCLUSIONS

My study shows that Indonesian sawnwood and plywood consumption are influenced by population growth, inflation rate (CPI), exchange rate, and most importantly, by government regulations. This study, furthermore, indicates that prices are not statistically significance in influencing the production or consumption of sawnwood and plywood.

The models presented show that Indonesian production or consumption of sawnwood and plywood will increase in the future as long as the relationships from the base period continue through the projection period. Predicted growth also assumes that the independent variables (population, GDP/GNP, CPI, exchange rate, etc.) remain as they have been projected.

The regression model in this study provides some insight into the behavior of Indonesian sawnwood and plywood consumption. Some estimated parameters in the consumption equation were consistent with underlying economic theory. In the sawnwood consumption equation, population and the dummy variables, representing the effect of heavy taxes on exported sawnwood and log export ban, were found to significantly influence the domestic consumption of sawnwood. The dummy log ban had a negative sign, implying that the production of sawnwood increased because the log export ban was implemented. Conversely, the dummy sawnwood tax had a positive sign, implying the

production of sawnwood decreased after the tax regulation was implemented. Furthermore, population positively influenced the domestic consumption of plywood in a significant way.

When analyzing the domestic consumption of plywood, three variables significantly influenced plywood consumption: the CPI, population, and a dummy log ban. This result represents the situation in Indonesia, or other countries. As inflation increases, shown by an increase in CPI, the purchasing power of consumers weakens. Therefore, consumption of plywood would decrease accordingly. Another variable that significantly influenced the plywood production domestically was population. As population increases, the production of plywood increases. Finally, the dummy log export ban showed that the production was slightly lower after the log export ban was implemented.

Three variables significantly influenced the production of plywood for export: exchange rate, dummy log ban, and dummy sawnwood tax. Plywood is one principal export commodity of Indonesia. International buyers usually pay for the product using the U.S. Dollar; thus as the Indonesian Rupiah weakens against the U.S Dollar, more plywood can be purchased using the same amount of money (U.S. Dollars). Therefore, the export of plywood should increase accordingly. The negative signs of the dummy log ban and sawnwod tax implied that the plywood export increased after these regulations.

Furthermore, the elasticity of each variable whose influence is statistically significant was calculated. As stated earlier, elasticity shows a percentage change in consumption brought by a certain independent variable.

The need to more completely comprehend the world trade of forest products will be more imperative in the coming years. The growing concern for environmental quality and the continuing trend of tropical deforestation will cause the world markets to experience increasing local and regional scarcity of both tropical and temperate forest products.

Considering the world demand pattern on the one hand, and the relative abundance of forest resources and cheap labor that Indonesia possesses on the other, it might be worthwhile for Indonesia to consider a gradual shift to other forest products which are in high demanded in the world market. Those commodities are printing and writing paper, paperboard and newsprint. Production and consumption of Indonesian paper products could be a focus of new research in the future.

Furthermore, tariff and non-tariff barriers in the importing countries may have a crucial impact on the Indonesian forest products trade flow, particularly for plywood. Therefore, any future study on the important demand model in various markets which can incorporate those trade barriers will certainly help Indonesian policy makers in exercising price strategy.

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APPENDIX

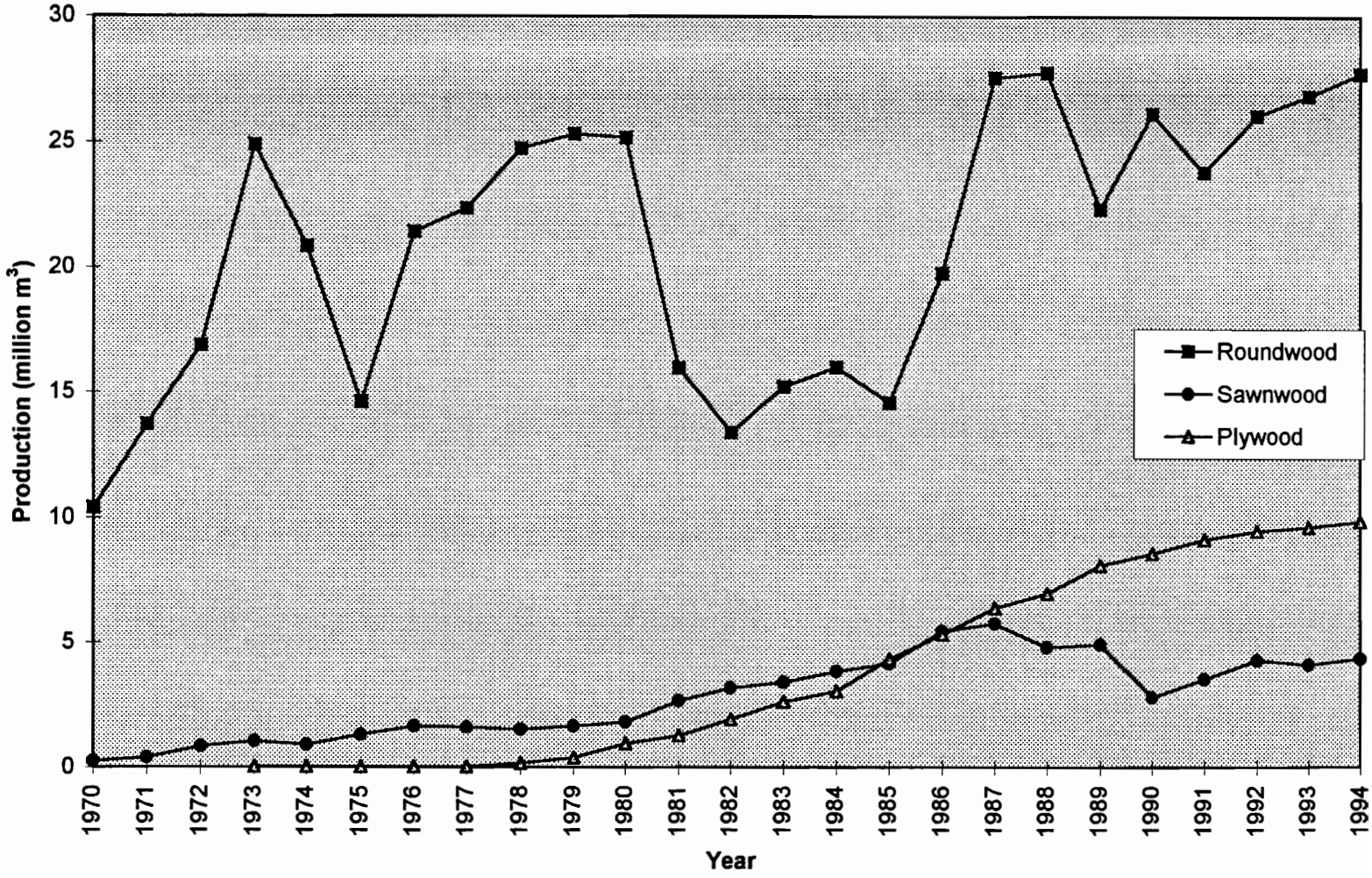

Figure 1. Trends of Indonesian Roundwood, Sawnwood, and Plywood Production 1970 -1994 (million cubic meters)

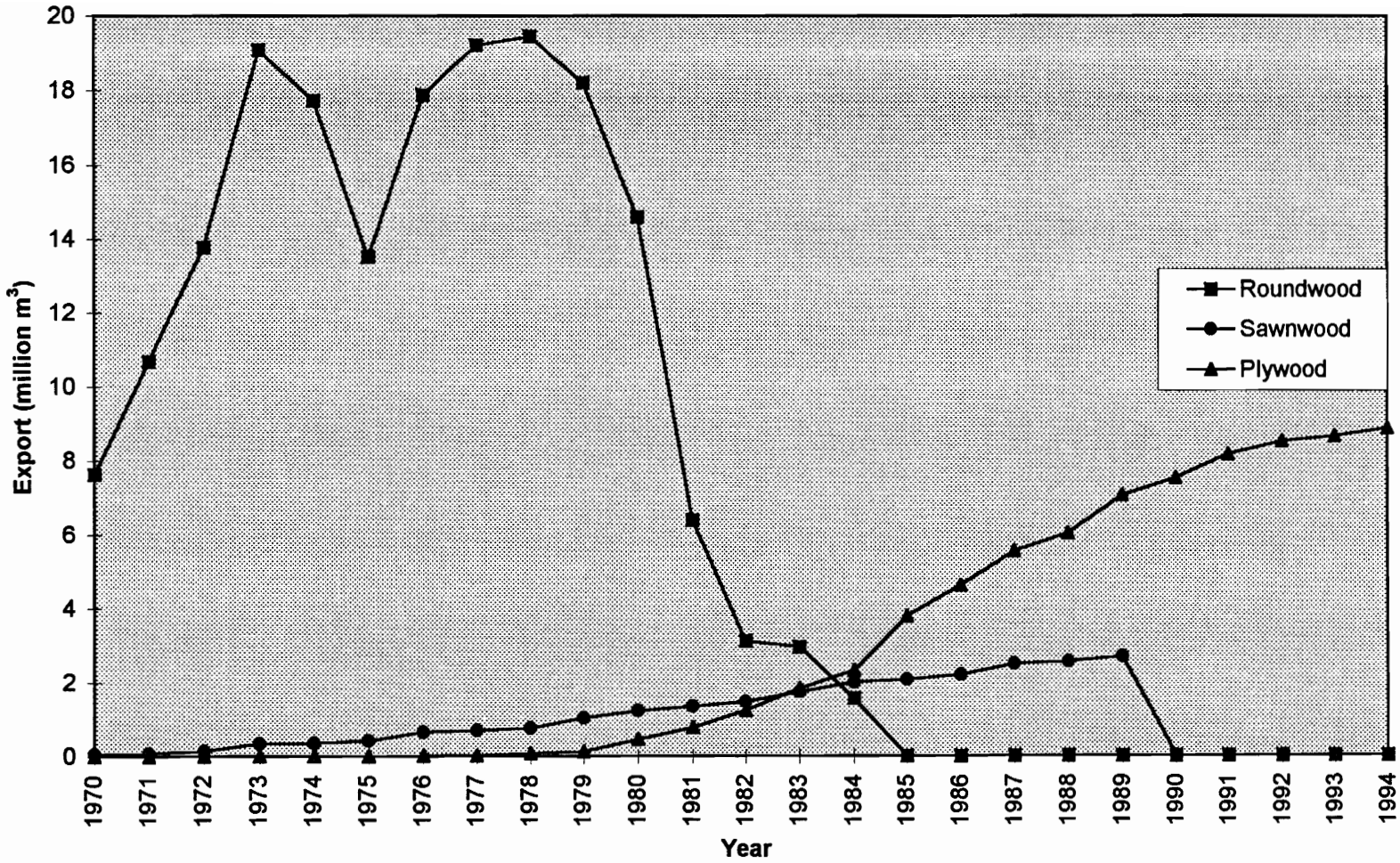

Figure 2. Trends of Roundwood, Sawnwood, and Plywood Exports 1970 -1994 (million cubic meters)

Table 2. Production of Indonesian Roundwood, Sawnwood, and Plywood 1970 -1994 (million cubic meters)

Year	Roundwood Production	Sawnwoood Production	Plywood Production
1970	10.408	0.245	
1971	13.706	0.375	
1972	16.877	0.840	
1973	24.920	1.037	0.019
1974	20.861	0.892	0.024
1975	14.588	1.308	0.017
1976	21.428	1.635	0.025
1977	22.345	1.608	0.026
1978	24.743	1.513	0.168
1979	25.314	1.637	0.386
1980	25.190	1.794	0.946
1981	15.954	2.659	1.253
1982	13.377	3.186	1.909
1983	15.209	3.411	2.605
1984	15.958	3.819	3.042
1985	14.552	4.145	4.322
1986	19.758	5.442	5.313
1987	27.566	5.750	6.385
1988	27.760	4.805	6.951
1989	22.316	4.919	8.079
1990	26.128	2.802	8.568
1991	23.810	3.506	9.123
1992	26.049	4.277	9.449
1993	26.848	4.091	9.624
1994	27.753	4.350	9.836

Source: Forestry Statistics of Indonesia (Ministry of Forestry, 1970 -1995)

Table 3. Export of Roundwood, Sawnwood, and Plywood 1970 -1994
(million cubic meters)

Year	Roundwood Export	Sawnwood Export	Plywood Export
1970	7.632	0.062	
1971	10.680	0.081	
1972	13.759	0.132	
1973	19.095	0.338	
1974	17.728	0.354	
1975	13.511	0.410	
1976	17.877	0.644	0.008
1977	19.212	0.694	0.011
1978	19.443	0.757	0.070
1979	18.205	1.042	0.117
1980	14.583	1.218	0.445
1981	6.391	1.342	0.772
1982	3.103	1.462	1.232
1983	2.959	1.730	1.829
1984	1.567	1.991	2.321
1985		2.075	3.784
1986		2.192	4.618
1987		2.491	5.551
1988		2.552	6.027
1989		2.692	7.047
1990			7.513
1991			8.159
1992			8.497
1993			8.627
1994			8.852

Source: Forestry Statistics of Indonesia (Ministry of Forestry 1970 -1994)

Table 4. Export of Indonesian Plywood by Primary Destination Regions (thousand cubic meters).

Year	USA/Canada	Europe (including UK)	Far East Countries	Middle East (including Singapore)
1980	55	30	114	70
1981	83	86	264	292
1982	230	120	369	485
1983	599	227	364	809
1984	822	237	1,031	880
1985	1,008	314	940	888
1986	1,135	461	1,478	763
1987	1,250	530	3,457	569
1988	1,000	799	4,128	768
1989	1,010	655	5,613	621
1990	1,047	832	5,767	644
1991	875	849	6,251	677
1992	962	1,061	6,193	764
1993	886	680	7,108	732
1994	749	557	6,384	758

Source: APKINDO (1995)

Table 5. Economic Indicators of Indonesia

Year	Population (million)	Exchrate (1US$=Rp)	GDP (1990 billion Rp)	GDP Deflator	GDP (current billion Rp)	Wholesale Price Index	CPI	GDP (Rp per capita)
1970	119.470	378	53.170	6.3	3.340		9.1	445,049
1971	122.530	415	56.895	6.5	3.672	7.5	9.5	464,335
1972	125.640	415	62.257	7.3	4.564	8.4	10.1	495,519
1973	128.800	415	69.298	9.7	6.753	11.4	13.3	538,028
1974	132.000	415	74.588	14.4	10.708	14.7	18.7	565,061
1975	135.670	415	78.301	16.1	12.643	16.3	22.2	577,143
1976	133.530	415	83.693	18.5	15.467	19.2	26.7	626,773
1977	136.630	415	91.026	20.9	19.011	21.9	29.6	666,223
1978	139.800	625	98.163	23.2	22.746	24.1	32.0	702,167
1979	143.040	627	104.304	30.7	32.025	32.2	37.2	729,195
1980	147.490	627	114.609	39.7	45.446	38.2	43.9	777,063
1981	151.310	644	123.694	47.0	58.127	42.0	49.3	817,487
1982	154.660	692	126.473	49.4	62.476	45.5	53.9	817,749
1983	158.080	994	131.776	58.9	77.623	54.5	60.3	833,603
1984	161.580	1074	140.967	63.8	89.885	61.6	66.6	872,429
1985	164.630	1125	144.439	67.2	96.997	64.3	69.8	877,355
1986	168.350	1641	152.925	67.1	102.683	69.7	73.8	908,375
1987	172.010	1650	160.458	77.8	124.817	80.2	80.7	932,841
1988	175.590	1731	169.732	83.7	142.105	88.5	87.2	966,638
1989	179.140	1797	182.389	91.7	167.185	94.5	92.8	1,018,137
1990	179.480	1901	195.597	100.0	195.597	100.0	100.0	1,089,798
1991	181.380	1992	209.192	108.7	227.450	106.0	109.4	1,153,336
1992	184.490	2062	222.705	116.7	259.884	116.1	117.7	1,207,139
1993	187.600	2110	237.172	139.0	329.776	124.5	129.0	1,264,243
1994	190.680	2200	254.574	148.2	379.212	137.4	140.0	1,335,085

Sources:
1. Statistic of Indonesia (Central Bureau of Statistics 1970 - 1995)
2. International Monetary Fund (1995)

Table 6. D-W Statistic and Variance Inflation Factors (VIF) of Indonesian Sawnwood and Plywood Production Equation

Explanatory variable	VIF	D-W statistic
Sawnwood:		1.8
Dummy log	4.4	
Dummy tax	1.9	
Population	4.7	
Plywood:		
- Domestic		1.8
Dummy log	4.6	
Population	9.7	
CPI		
- Export		1.9
Dummy log	6.8	
Dummy tax	2.5	
Exchange rate	10	

Table 7. Trends of Independent Variables Needed for Projecting Sawnwood and Plywood Production

Explanatory Variable	Year					Source
	1995	1996	1997	1998	1999	
Population (million)	195.283	198.342	201.390	204.423	207.440	2
Sawnwood price (in constant 1990 Rp/m^3)	1,400,000	1,500,000	1,700,000	1,800,000	2,000,000	1
Plywood price (in constant 1990 Rp/m^3)	1,100,000	1,200,000	1,250,000	1,300,000	1,400,000	1
Roundwood Production (million m^3)	26.4	27.0	27.6	28.1	28.7	1
Exchange rate (1US$ = Rp.)	2,580	2,760	2,940	3,130	3,300	2
G D P (in current billion Rp.)	371.8	408.3	446.5	486.4	528.1	2
C P I	144	153	162	171	181	2

Sources:
1) Ministry of Forestry (1994)
2) Central Bureau of Statistics (1993)

Table 8. Projection of Indonesian Sawnwood and Plywood Production 1995 -1999
(million cubic meters)

Product	Year				
	1995	1996	1997	1998	1999
Sawnwood	4.78 (4.22 - 5.05)	5.06 (4.44 - 5.32)	5.25 (4.65 - 5.59)	5.53 (4.86 - 5.86)	5.74 (5.07 - 6.13)
Plywood:					
- Domestic	1.01 (1.09 - 1.27)	1.02 (1.11 - 1.32)	1.03 (1.14 - 1.38)	1.04 (1.16 - 1.43)	1.05 (1.16 - 1.48)
- Export	8.9 (9.66 - 11.01)	11.2 (10.19 - 11.85)	11.9 (10.71 - 12.71)	12.6 (11.25 - 13.61)	13.3 (11.73 - 14.43)

The numbers in parantheses denote projection range with 95% confidence interval

Table 9. Estimated Structural Relationship Describing Production for Indonesian Sawnwood and Plywood

Explanatory variable	Estimated coefficient	Standard error	t - Statistic
Sawnwood:			
Intercept	-10.8	1.48	-7.28**
Dummy log	-0.71	0.33	-2.12*
Dummy tax	2.22	0.28	8.03**
Population	0.08	0.01	9.92**
Plywood:			
- Domestic			
Intercept	-6.13	0.63	-9.80**
Dummy log	0.29	0.06	4.68**
Population	0.05	0.01	9.77**
CPI	-0.01	0.002	-4.95**
- Export			
Intercept	0.51	1.01	0.51
Dummy log	-1.19	0.5	-2.38*
Dummy tax	-1.16	0.35	-3.34**
Exchange rate	0.01	0.0005	7.86**

* Significantly different from zero at the 0.05 significance level based on a one tailed t-test
** Significantly different from zero at the 0.001 significance level based on a one tailed t-test

Table 10. The Elasticities of Variables Affecting the Production Indonesian Sawnwood and Plywood

Explanatory variable	Elasticity
Sawnwood:	
Population	4.4
Plywood:	
- Domestic	
Population	12.4
CPI	1.2
- Export	
Exchange rate	1.1