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TIMBER EXTRACTION IN THE BRAZILIAN AMAZON: TRENDS IN INTERNATIONAL AND DOMESTIC MARKETS

by

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Timber Extraction in the Brazilian Amazon: Trends in International and Domestic Markets

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Abstract

This paper reviews the major sources of international demand and supply of wood products, Brazil's participation in those markets, and the implications for timber extraction in the Brazilian Amazon. The first section examines global forest inventories, patterns of trade, price trends and elasticities of demand to determine future trends in international timber markets. The second section analyzes Brazil's domestic trade in timber, and documents the expansion of the industry into Amazonnia. The paper closes by reviewing policy measures regulating land use and timber extraction.

1.0 Introduction

This paper reviews the major sources of international demand and supply of wood products, Brazil's participation in those markets, and the implications for timber extraction in the Brazilian Amazon.

In the first section, global forest stocks, patterns of trade, price trends and elasticities of demand are reviewed to determine future trends in international timber markets. Empirical studies linking the timber trade and forest conversion are presented. The section closes by considering efforts to promote certification programs or "green labelling."

The second section analyses Brazil's domestic trade in timber, and documents the expansion of the industry into Amazônia. The paper closes by reviewing policy measures regulating land use and timber extraction.

1.1 International Timber Markets

1.1.1 Estimates of Global Forest Inventories

Brazil contains over one-eighth of the world's total area under forest (see Table 1). Area under forest in Brazil exceeds the combined total of China, India, Indonesia, and Malaysia; Brazil has more area under forest than either the United States or Canada. The only other country, or rather collection of countries, with more forested land than Brazil is the former USSR, which contains 21% of the world's total.

However, much of the timber in Brazil remains inaccessible or of unknown physical and commercial potential. Table 1 reveals that in terms production and exports of wood products, Brazil accounts for a relatively small proportion of the total volume. In terms of roundwood in 1990, volume of production in Brazil was slightly less that of either India or China. Malaysia, which has only 4% of Brazil's forested area, produced net exports worth twice the value of Brazil's. Canada's net exports were over ten times the value of Brazil's in 1990 (see Table 1).

About 60% of Brazil's forested area is comprised of tropical broadleaf forest. A widely cited figure is that Brazil contains one-third of the earth's total area under tropical rainforest.[1] Table 2 shows that while Asia and Africa comprise one-fifth and one-eighth of the total rainforest area, South America contains over one-half. Of that figure, Brazil contains over 67%. Clearly, Brazil is endowed with one of the most extensive and least exploited forest reserves in the world.

1.1.2 Patterns of World Trade in Wood Products

In terms of the overall value, industrialized countries dominate the trade in wood products. With US$ 103 billion in trade in 1992 (current), wood products represent about 20% of

[1] Rainforest is defined by WRI, citing FAO, to consist of wet and very moist evergreen and semi-evergreen forests with annual rainfall exceeding 2,000 mm.

total trade in food, agriculture and raw materials or about 3% of the US$ 3.3 trillion of all goods traded in 1990.[2]

Table 3 presents data on the major exporters of wood products. Without exception, North America and Northern Europe have dominated international wood markets. Over the period 1971-1992, the United States, Canada, Sweden, Finland, and Germany accounted on average for over half the total value of exports annually. Generally, these countries gross between 5 to 15 billion dollars each year in wood exports. Brazil's current wood exports, by comparison, were around US$ 1.9 billion in 1992.

The largest markets for wood imports are the United States, Japan and Germany. Each year, each one of these countries import about US$ 10 billion worth of wood products (see Table 4). Taken together with the United Kingdom, Italy, and France these countries accounted for about half of all wood products imported annually over the period 1971-1992.

1.1.3 Patterns of World Trade in Tropical Wood

Markets for tropical hardwoods are concentrated in Asia. Historically, Japan has imported around 50% of all traded tropical wood, most in the form of logs (Barbier et al., 1992). Korea and Taiwan are also developing significant markets for tropical timber products. In 1990 they imported 11 million cubic meters, just slightly less than the volume

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[2] Figures are from FAO (1994: 295) and WRI (263).

imported by the European Economic Community (see Table 5). Of this figure, well over half the volume was also in the form of logs. Products entering the North American markets by contrast tend to be processed, such as plywood, much of which is re-exported from Korea and Taiwan.

In terms of supply, Indonesia and Malaysia have dominated international markets. Each had exports in excess of US$ 3 billion in 1992, about twice the value of Brazil's total wood exports (see Table 3). Indonesia supplied a significant quantity of non-coniferous sawnwood until 1989, when production shifted to plywood. Malaysia is still exporting sawn hardwood. Since the 1980's, exports from Malaysia have typically accounted for more than one-quarter of total exports of non-coniferous sawnwood.[3] Since 1990, it has exported over 5 million m^3 each year, accounting for over one-third of total hardwood exports (See Table 6).

Brazil, by contrast, averaged only 3% of total volume during this period, exporting on average 500,000 m^3 of sawn hardwood each year. Brazil's exports of sawn hardwoods amounted to $US 152 million (current) in 1992. Relative to forest stocks, current levels of exports are modest. They are similar to the West African country of Cote D'Ivoire, which has about 1% of Brazil's forest area.

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[3] In FAO timber statistics, the closest proxy for tropical timber is "non-coniferous" wood. Barbier et al. (1992) cite figures suggesting that 83% of non-coniferous logs, 62% of non-coniferous sawnwood and 75% of plywood are of tropical origin.

The United States has consistently supplied around 10% - 15% of total market volume in non-coniferous sawnwood. The large volume supplied by hardwood supplied by temperate countries illustrates the problem with using the "non-coniferous" category to measure trade in tropical timber.

1.1.4 Price Trends

Historically, prices and consumption of industrial wood have risen slowly over time. Table 7 shows that globally, rates of growth in consumption slowed somewhat in the 1970's but increased again in the 1980's. Data presented in Sedjo and Lyon (1990) show increases in the real price of industrial wood since the turn of the century in the United States, but at a decreasing rate.

Still, compared to prices for other commodities such as agricultural goods, metals, and minerals, prices for wood products have remained fairly robust over the last twenty years (see Table 8). Figure 1 illustrates the upward trend in timber prices, in contrast to declining price indices for metals, minerals and agricultúral goods. On average, timber prices have increased by 1.5% annually since 1971. The steady increase in wood prices will continue to stimulate timber extraction in the Amazon and extend the frontier of economically accessible

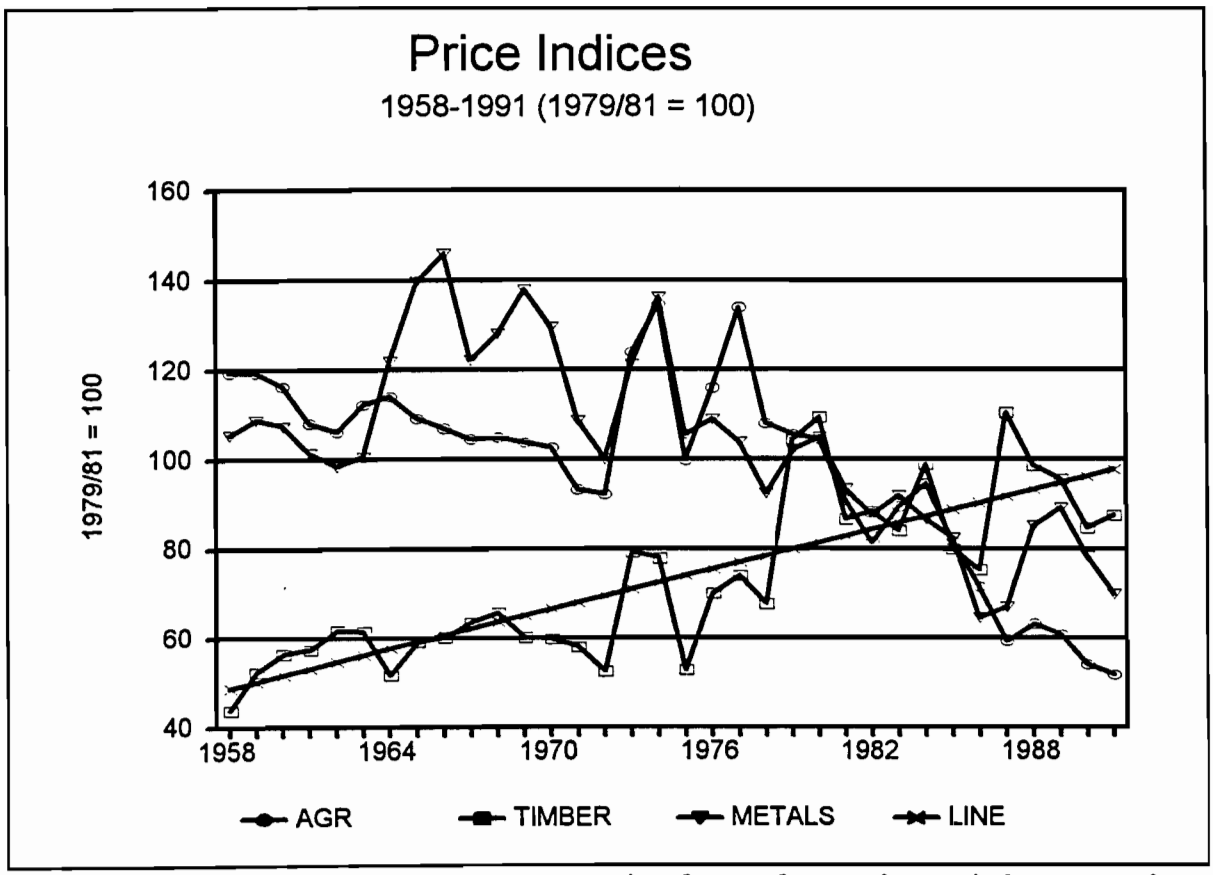

Figure 1: Price Indices for Agricultural Goods, Timber, and Metals (1958-1992)

Source: Table 9.

forests.

Although there is a large diversity of tropical wood, in general prices trend together (see Table 9). Varangis (1990) used time series data on several West-African and South-East Asian tropical timber prices and found that with the exception of Teak, the price data series were cointegrated. He hypothesizes that a high degree of substitutability may explain why the prices move together so closely (see Figure 2). Available estimates of elasticities of substitution by origin for tropical wood support this argument. Constantino (1988) reports that elasticities of substitution by origin are high for tropical wood -- on the order of 2.5 to 4.5 in the short-run.[4]

1.1.5 Price Elasticities of Demand

Price elasticities of demand for timber are generally low. Low elasticities (i.e. less than one in absolute value) imply that demand is not responsive to changes in price; a good with low elasticity of demand is likely to have few close substitutes and occupy a small share of the consumers' total budget. In practical terms, a low elasticity of demand is associated with a steep demand curve: if the price of timber rises, the quantity demanded changes very little. However, if the supply of timber

[4] Elasticities of substitution were defined as the percentage change in the ratio of wood imports from two different countries corresponding to a one percent change in the ratio of import prices between the two countries.

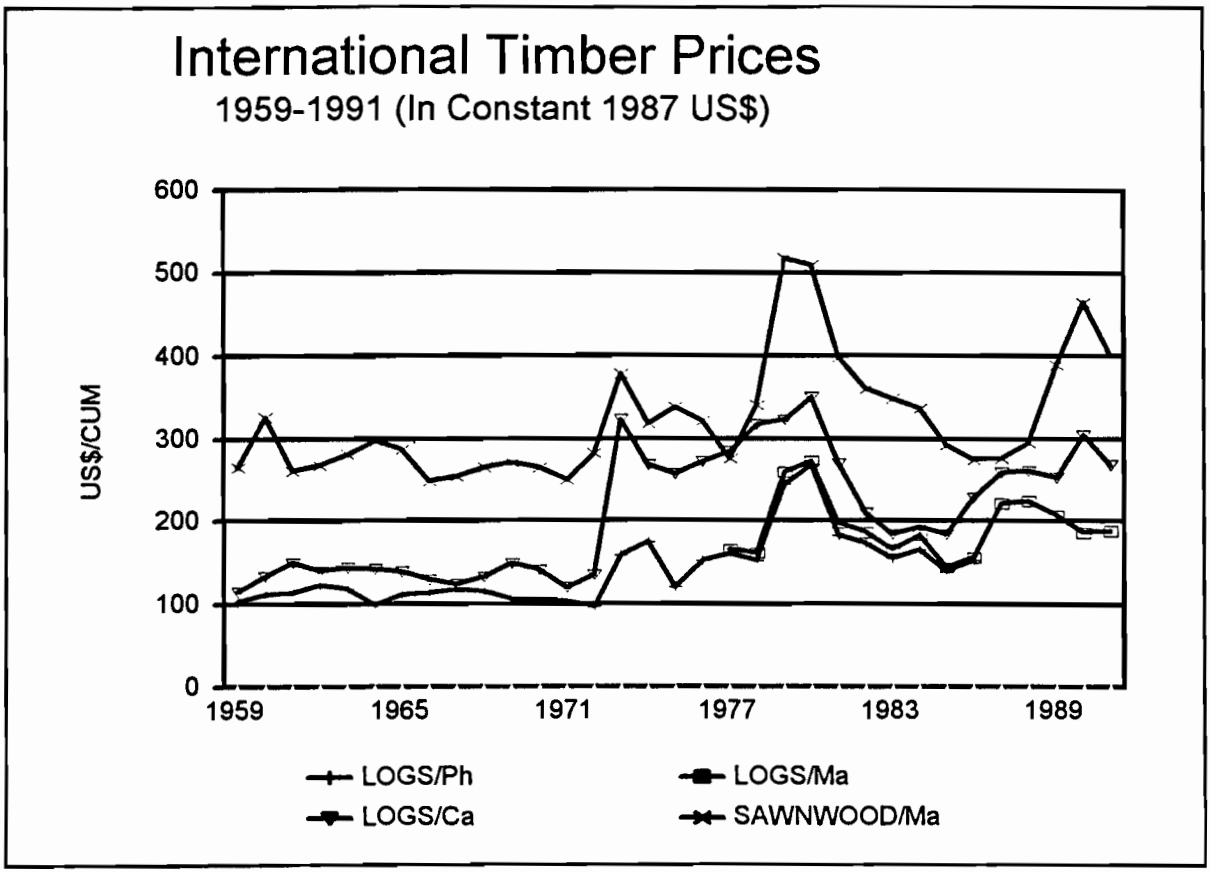

Figure 2: Price Trends in Tropical Log and Sawnwood Products, 1959-1991

Source: Table 8.

increases greatly it will significantly lower prices.

Estimates of price elasticities of demand are presented in Table 10. These estimates vary greatly as a result of different regional emphases and time periods. Price elasticities for hardwood logs varied from a lower bound of -0.16 to -1.50. Demand elasticities for sawn hardwood ranged from -0.34 to -1.30, and for plywood and panels the elasticities varied between-0.18 to -1.80. The sharply lower elasticities for domestic demand of sawn hardwood (as opposed to export demand) reflect strong markets for primary construction materials within producer countries, such as Malaysia, Indonesia and Brazil.

In general, the more processed the wood product, the lower the elasticity. Plywood, panels and veneers had an average elasticity of -0.66, whereas for sawn hardwood the average rose to -0.76 and for hardwood logs the figure was -0.84 (see Table 11). If on average these estimates are accurate, they imply that countries can increase their market power by producing processed wood products.

Cross-price elasticities between tropical and temperate hardwood were not available. However, evidence presented by Constantino (1988) shows that elasticities of substitution between the two wood types are relatively low, suggesting distinct markets for temperate and tropical wood products. Short-run elasticities of substitution were slightly higher for sawnwood (1.30) than for plywood (0.75), a finding which

supports the lower own price elasticity of plywood.

Finally, there are also non-timber substitutes for wood products. Although no cross-price or substitution elasticities are available, the elasticity of substitution is likely to be high, especially in the construction industry where wood products can consume a significant share of total expenditure. The implication for timber producers is to diversify out of rough-hewn timbers and into high-quality, processed wood products where there are no close substitutes.

1.1.6 Demand and Supply Projections

Likely trends in the world timber market have been summarized by Arnold (1991) and Barbier et al. (1992), and can be divided into three main findings. First, they forecast a 15% - 40% increase in demand for industrial wood over the next 15 years. However, with the exception of its plantations, Brazil is not forecasted to become a major supplier of industrial wood (Sedjo and Lyon, 1990). The important regions in terms of supply response, as pointed out by Sedjo and Lyon, and in a separate study, by Nagy et al. (1988), are instead the United States (Northwest and South); Canada (West and Eastern); Nordic Europe; and Asia-Pacific. The former Soviet countries were not considered by the above studies because of the centrally-planned economy, but now their significant timber resources may also be exploited to meet the growth in demand.

Second, they project a real price increase of 60% - 80% over the ten year period 1990 - 2000 for tropical hardwood as a result of the declining stock of tropical forests. Hardwood supplies in temperate countries are stable and will moderate price increases for close substitutes such as construction materials, but for products with no close substitutes prices will rise. The net effect for Brazil will be an increasing share of the tropical timber market. One study projects that by the year 2000, Latin America will overtake the Asia-Pacific region as the largest producer of tropical wood (Jepma and Blom, 1992). There is some evidence that Malaysian and Philippino timber interests are already purchasing concessions in Latin America (Linden, 1994).

Finally, changes in technology and increasing wood prices will shift consumption towards reconstituted wood products and away from traditional solid wood products. This would seem to be a logical move for producers given the elasticity estimates presented in section 1.1.5.

1.1.7 Profile of Brazilian Wood Exports

Despite its large forest endowment, Brazil was a net importer of certain wood products, notably pulp and paper, until the late 1980's. Overall, wood products contributed between 1.7% to 5.3% of total value of exports during the period 1971-1992 (see Figure 3). The data suggest an erratic but increasing proportion of wood in total exports.

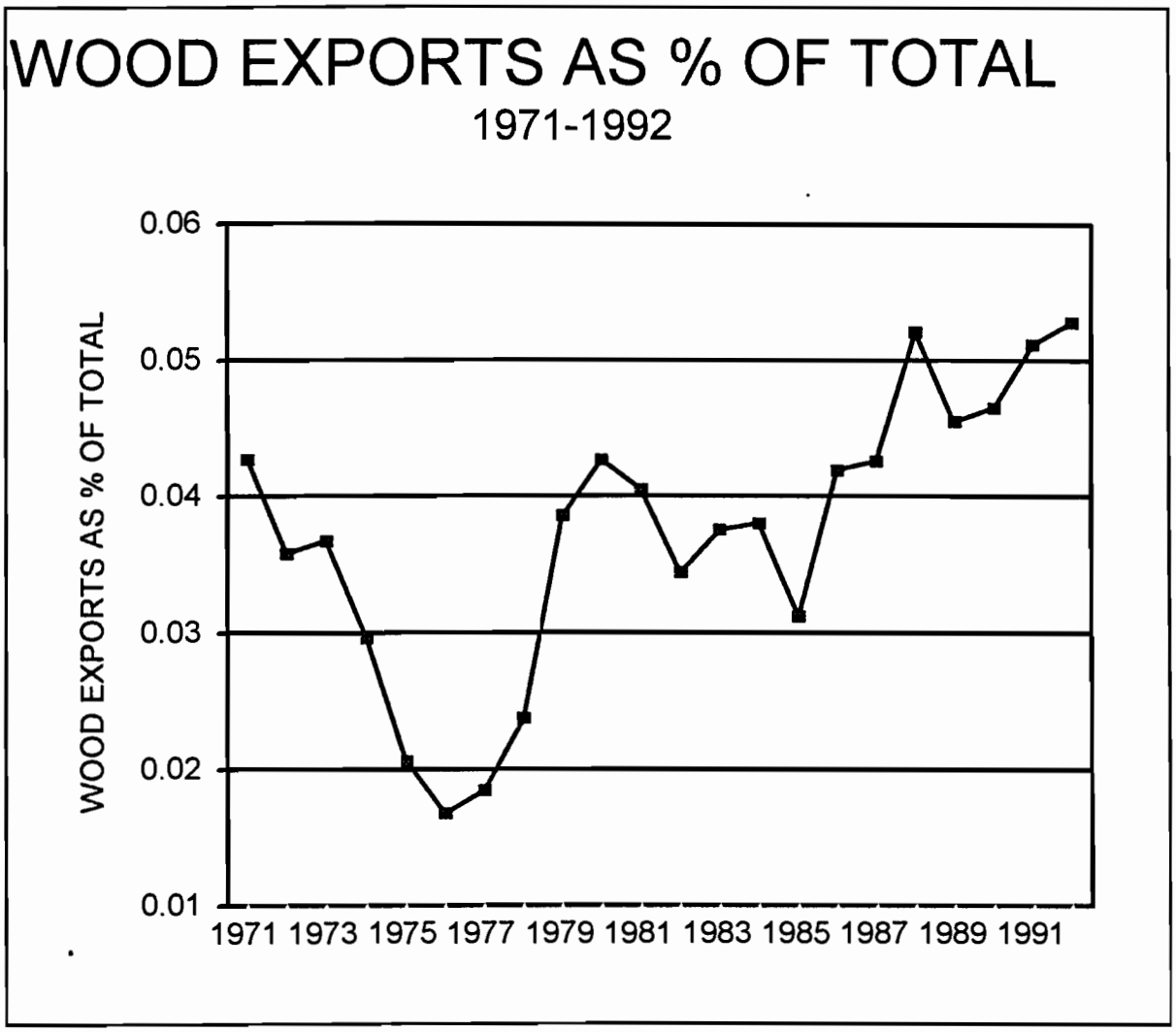

Figure 3: Brazilian Wood Exports as a Percentage of Total, 1971-1992

Source: Table 12.

Pulp and paper dominate Brazil's wood exports. After decades of importing pulp and paper, Brazil now exports over 1 billion US$ worth of these products annually (see Table 13). Figure 4 illustrates the rapid growth in pulp and paper exports from 1971-1992. In addition, panels (which include veneer sheets, plywood and particle board) are becoming another major source of export earnings. Increases in pulp and paper may be related to Brazil's reforestation program during the 1980's which dramatically increased area under plantations (see Section 1.2.1).

Meanwhile, exports of sawnwood and roundwood have stagnated. Export of whole logs (roundwood) was banned in Brazil in 1973, with exceptions for forest clearing for hydroelectric projects. Some sawnwood exports such as mahogany have actually been subsidized (Browder, 1986), and the weak export performance is more difficult to explain. High extraction and transportation costs, lack of markets and problems in quality control have constrained growth in hardwood exports.

Additionally, domestic markets for wood products are strong. As incomes rise in the Northeast and Centerwest regions, the demand for Amazonian timber in increasing. As a result, most sawn hardwood is consumed domestically. Over the period 1950 - 1990, as little as 2 - 10% of total production has been exported (see Table 14). The figures presented in Table 14 illustrate the

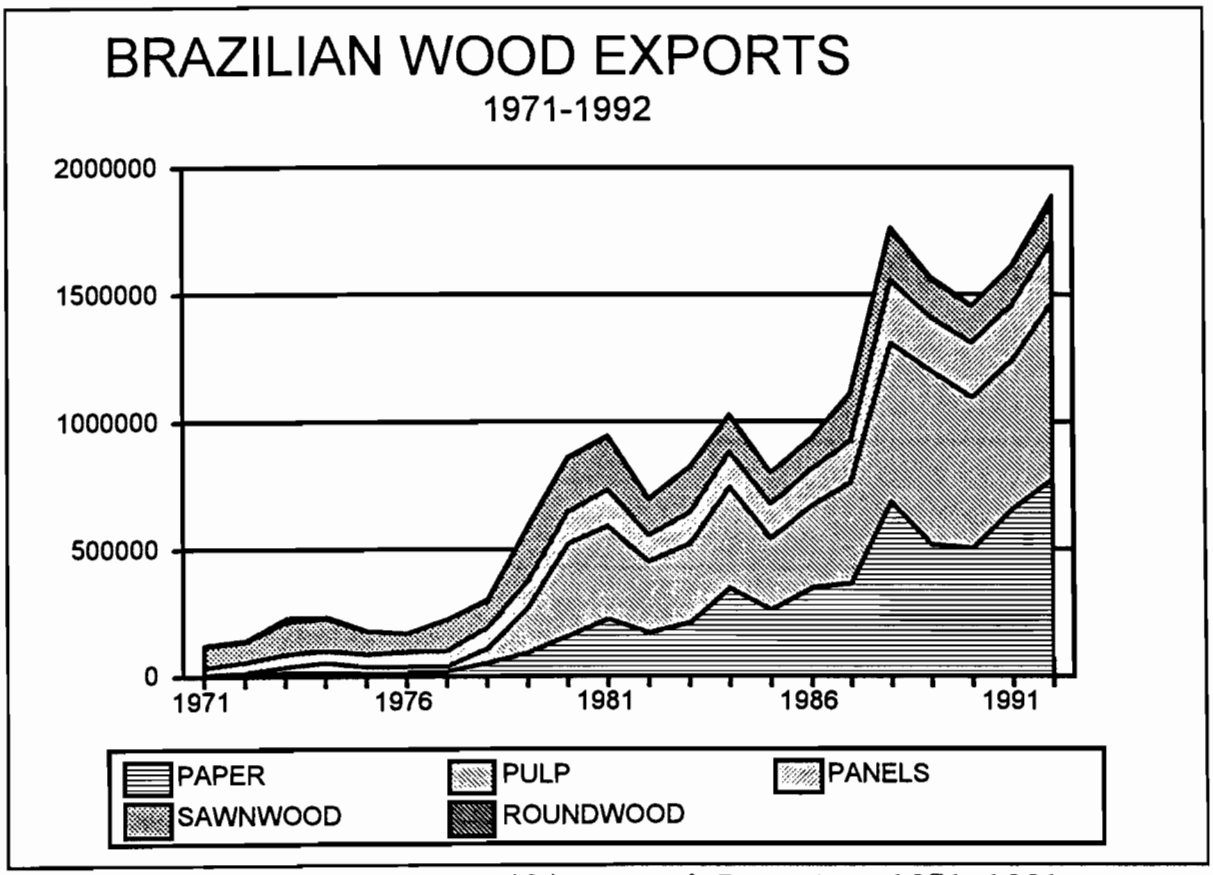

Figure 4: Profile of Brazilian Wood Exports, 1971-1991.

Source: Table 13.

dominance of domestic over international markets for sawnhardwood.

Traditional markets for Brazil's sawn hardwood exports have been the United States and the United Kingdom. For the period 1971-1992, these two countries accounted for almost half of the total volume of exports, with the U.S. importing roughly three times as much as the U.K. (see Table 15). On average, the U.S. and the U.K. imported 140,000 and 50,000 m^3 of sawn hardwood from Brazil, accounting for roughly 30 - 60 million $US (current) in revenues. Other importers of Brazil's sawn hardwood include Canada, Spain, France and Germany, among others.

1.1.8 Efforts to Increase Marketability of Brazilian Hardwoods

A frequently cited reason for Brazil's low volume of tropical hardwood is the great diversity of species and the relative lack of information about their uses (IDBF, 1981). Although roughly 150 - 200 species may be present per hectare, marketable species such as Swietenia Tiesmanii (mahogany), Virola surinamensis (virola), and Manilkara huberi (maçaranduba) are widely scattered and costly to harvest. A list of species and their volummetric density per hectare is provided in Table 16.

There have been several attempts to remedy the problems associated with marketing. Brazil's Ministry of Foreign

Affairs (1949) published a volume detailing the names and physical properties of commonly found timbers. Included in that work are references to wood species with similar qualities found outside of Brazil, for purposes of comparison. In another study the FAO, in collaboration with the IBDF and Ministeirio da Agricultura, conducted surveys at the Tapajós National Forest in Pará to determine the availability of species and their physical properties (IBDF, 1981).

1.1.9 Tropical Timber Trade, Forest Conversion, and Green Labelling

Several studies have explored the relation between trade in tropical wood and rates of forest conversion. Clearly, every log removed decreases the forest area. However, it is unclear whether logging is the main cause of changes in forest area. Burgess (1993) reviewed empirical evidence showing that agricultural expansion and population density were more significant factors than wood production or exports of timber. Also, it is estimated that less than one-quarter of the tropical timber cut in a year is used for industrial purposes, and that even less is traded internationally (Burgess, 1993; Vincent, 1992). The remainder is used for fuel or is simply cleared for agriculture or pasture.

Still, tropical timber does enter international markets, and when it does it usually carries a stigma of destroying rainforests. The response from consumers has come in two

forms: bans and boycotts, and certification programs. Bans and boycotts have been used in Europe and North America. In Germany, Holland and the U.S., for instance, voters in some municipalities have prohibited local government from using tropical timber in public construction projects (Johnson and Cabarle, 1993). In other cases, consumers are urged to simply avoid buying tropical wood products. The problem with bans and boycotts is that they depress the price of tropical timber and hence the economic value of the forest stand. Competing land uses have a higher probability of replacing forest as the main land use in this case.

A more productive approach is the movement to certify timbers on the market coming from responsibly managed forests. Rather than reducing the value of tropical forest land, certification or "green labelling" provides incentives for better management practices. However, there are many unresolved problems with green labelling. First, what defines "sustainable forest management"? According to Johnson and Cabarle (1993), there are at least three competing definitions issued by the International Tropical Timber Organization (IITO), Rainforest Alliance, and the Institute of Sustainable Forestry.

Another question is whether consumers are willing to pay a premium for sustainably harvested wood. Surveys of consumers and marketing firms in the U.K. provided contradictory evidence (Bishop and Bann, 1992). A 1990

telephone survey by the Milland Fine Timber Company found that 63% of the manufacturers in the U.K. sample would be willing to pay a premium for ecologically harvested timber. However, preliminary results from a 1992 mail survey of tropical timber importers found that 71% of the respondents believe their customers would not be willing to pay more for sustainably harvested wood (Bishop and Bann, 1992). Other surveys, conducted in person, found that consumers are concerned about forests in tropical countries and are willing to pay a premium for wood coming from well-managed forests.

Still, even if consumers are willing to pay a premium for such wood, there is no authority to certify claims. Such a vacuum in information created problems in 1992 in the United Kingdom, where the World Wide Fund for Nature discovered widespread use of green labels by retailers of tropical wood products that could not be substantiated (Pearce, 1994).

Finally, the proportion of tropical wood that actually ever enters the retail markets is small. Johnson and Cabarle estimate that the green market in Europe and North America represents about 2% to 3% of all internationally traded wood. In terms of magnitude, green labelling will not have a large effect on forest management. But it offers the prospect of differentiated markets (price discrimination), higher profits, and better managed forests stands in production if information costs can be overcome.

1.2 Domestic timber Markets

The previous section outlined Brazil's role in the international trade in tropical timbers. While wood exports are important for foreign exchange, domestic demand is strong and growing (see Section 1.1.7). The following section reviews the evolution of domestic supply and demand and how it has been shaped by location, policy interventions, and institutional arrangements.

1.2.1 Domestic Supply

Brazil's earliest existence is associated with wood extraction. Early European colonists sought "pau brasil" or brazilwood, a rare and valuable species found in the highland forests and from which Brazil derived its name. Most of the highland forests in the Northeast and Espirito Santo from which pau brasil came are now exhausted.

Once stocks were depleted, the timber industry moved down the coast and into the southern pine forests. Running from 6° to 30°S along the coast of Brazil, the Atlantic forest has been exploited for fuel, sawnwood and railroad sleepers. Less than 3 million hectares remain, much of it in parks.

Throughout the postwar period, Parana pine region of the south of Brazil was harvested intensively to meet domestic demand and for export. Dense and homogeneous, these forests yielded over 250 m^3 of pine per hectare, as compared to volumes of 10-30 m^3 of marketable species in Amazonia (Ros-Tonen,

1993). Parana pine dominated Brazil's wood exports well into the 1970's, when supplies declined and pulp and paper exports became more important (see Table 13).

Plantations became more important as locally available stocks of wood in the Center and South regions were depleted. The first large-scale Eucalyptus plantations were established in 1910 by a railroad company to supply fuelwood, sleepers and posts. In the 1940's and 1950's, eucalyptus plantations emerged in Minas Gerais to supply charcoal for the steel industry. Softwood plantations came later and spread throughout the southern states like Parana; by 1965, there were an estimated 500,000 ha of plantations. Largely a result of a generous incentive scheme, area under plantations in 1980 grew to an estimated 6 million hectares (see Table 17). Over 50% of the approved projects went to the states of Minas Gerais, Parana, and Sao Paulo.

In July 1987, Brazil's economic crisis deepened and the government slowed its program of fiscal incentives for reforestation. No data on rates of growth are available since then, but the forecasts are optimistic. Sedjo and Lyon (1990) estimate that by the year 2000, Latin America (principally Brazil and the Southern Cone) will constitute 50% of the total industrial wood production from plantations (1990: 46).

1.2.2 The Timber Industry in Amazônia

As forests in the South have been depleted, wood

extraction in the Amazon has increased. Roles have been reversed; whereas southern forests dominated the domestic market in the 1970's, by the 1990's most of the industrial wood produced in Brazil originated from the North (Amazonian) region (see Figure 5).[5] This trend is likely to continue and become more pronounced with time.

Early extraction from the Amazon forests was confined to areas accessible by waterway (Rankin, 1985). High value logs were selectively extracted, leaving much of the forest standing. The practice of selective cutting originated in the low density of valuable species and high transportation costs, and has continued to the present. As late as 1980, two-thirds of total timber volume harvested from the Amazon was selectively extracted along waterways (Nascimento, 1985). Only as the government invested in roads has logging on terra firme become profitable.

Table 19 shows the growth in number of registered mills in Legal Amazônia. From a modest base 194 in 1965, the number of registered mills has expanded to over 3,500 in 1988. Of these mills, nearly half are in Pará; taken together with Rondônia, these two states accounted for 84% of total registered mills.

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[5] The North comprises the states of Acre, Amapa, Amazonas, Pará, Rondônia, and Roraima. The Amazon as legally defined in Brazil (Amazônia Legal) also includes portions of the states of Maranhão, Mato Grosso and Toncantins.

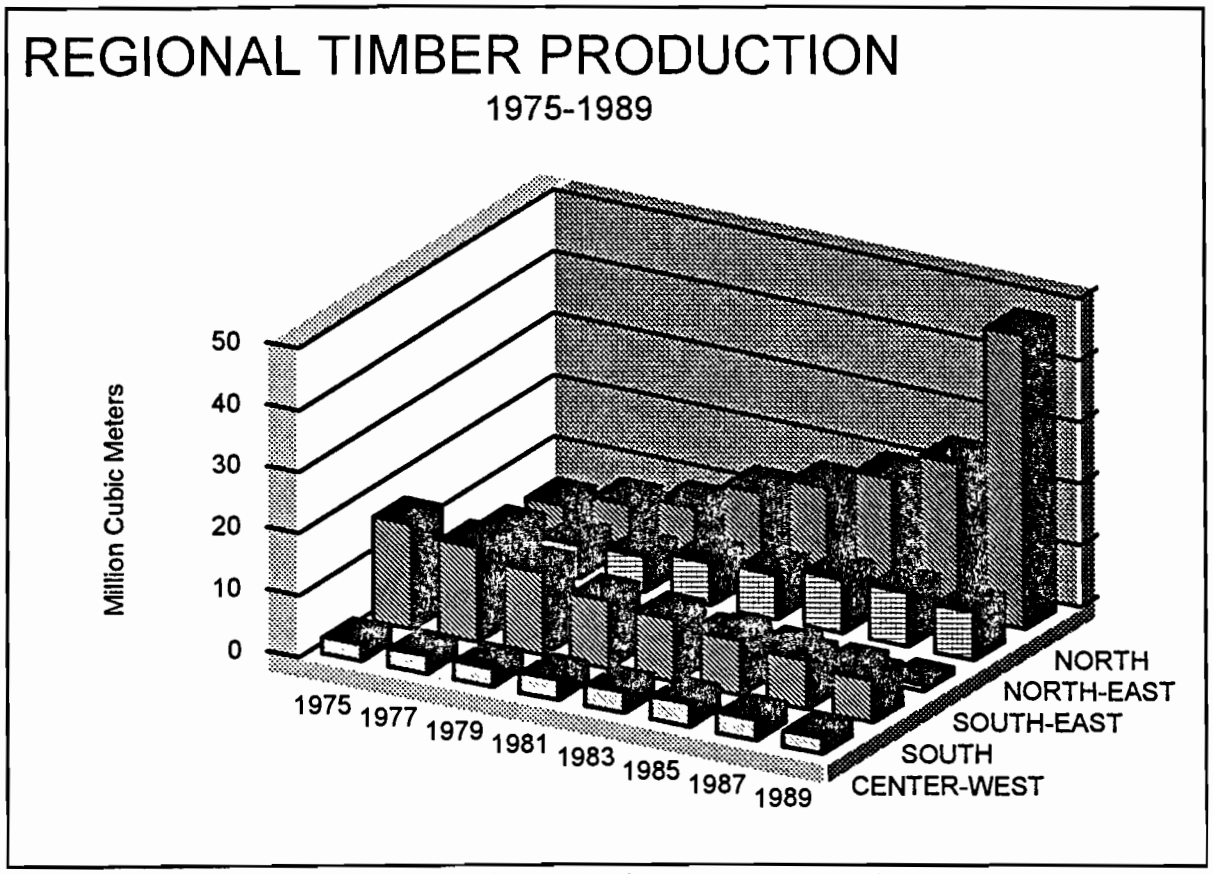


Figure 5: Changes in Regional Timber Production in Brazil, 1975-1989

Source: Table 18.

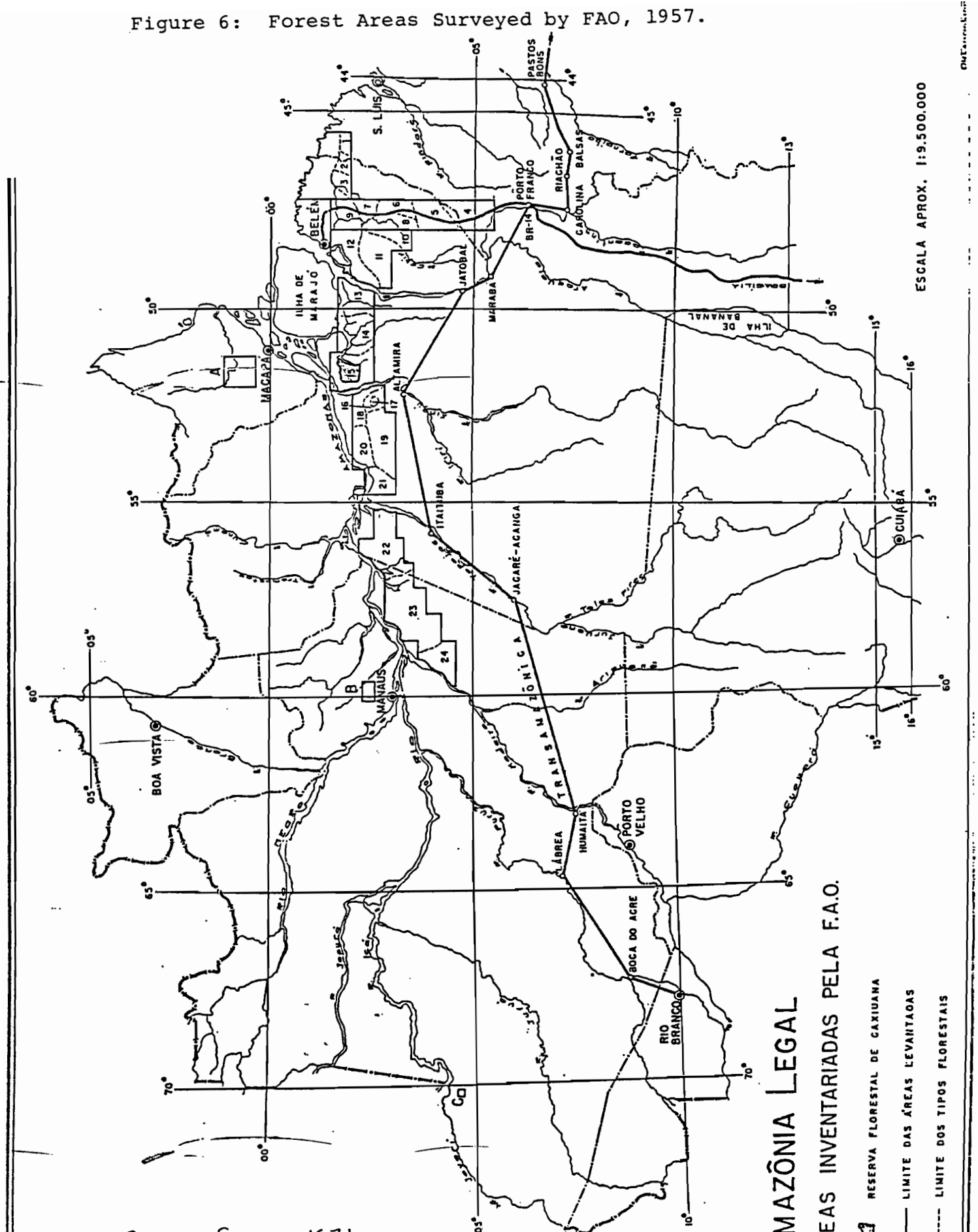
Probably two to three times this number of other mills are operating in these areas without being registered. For example, one study found that in Western Pará, only 40% of the sawmills interviewed were registered with IBDF(Ros-Tonen, 1993: 122). Logging activities are concentrated in these regions because they form the outer periphery of a vast and as yet inaccessible forest.

1.2.3 Forest Inventories in Amazônia

Until the development of accurate and inexpensive remote sensing technology, little definitive knowledge existed about the extent of forest inventories in the Amazon. After World War II the Brazilian Government launched an FAO mission to inventory forest areas along the main waterways (Heinsdijk, 1957). This survey examined a transect of the forest 100 km wide extending 1,700 km from the Atlantic coast to the inland state of Amazonas (see Figure 6). It identified 24 different forest types and estimated the volume of different tree species per hectare within each forest type (see Table 16). According to Ros-Tonen (1993), results of the study were not widely circulated until some years later; a summary is presented in Soares (1971).

The real breakthrough in developing an inventory of the Amazonian forest came in the 1970's when Brazil launched Projeto RADAM. Projeto RADAM used side-looking radar to penetrate cloud cover and map different forest types, as well

Figure 6: Forest Areas Surveyed by FAO, 1957.



Source: Soares, 1971.

as to distinguish geological, mineral and soil profiles (Ministerio das Minas e Energia, 1973). Results of the study have been aggregated from 1:1,000,000 to 1:5,000,000 and published with the Instituto Brasiliero de Geografia e Estatistica (IBGE) as soil and vegetation maps.

Other attempts to quantify the extent of forest areas (and to monitor clearing and fires) have been mounted by Brazil's Instituto Nacional de Pesquisa Espacais (INPE). In addition, Skole and Tucker's widely cited 1993 article in Science used Landsat imagery from 1978 and 1988 to quantify changes in forest cover in the Amazon. Their survey indicates that the extent of forest clearing was much less than previously thought -- 6% of total area as opposed to 12 - 15%. Results from the study, presented in Table 20, indicate that in terms of area cleared Pará has twice the cleared than any other state in Amazonia. Yet the resources of Pará are vast: next to the state of Amazonas, it has the largest remaining forest inventory in the Amazon.

1.2.4 Forestry and Land Legislation

Brazil has written more legislation than it can enforce. This section briefly examines the evolution of land and forest policies and their effect on land use patterns in the Amazon. For an exhaustive study of legislative details, see Prado and Filho (1992).

Originating in the 1750 Treaty of Madrid to resolve land

disputes between Spaniards and Portuguese, *derieto de posse*, or the right to claim land through appropriation, formed an important part of the 1964 Land Statute.[6] Under the 1964 Law, a *posseiro* or squatter who cultivates the land (*culturea efetiva e morada habitual*) for more than one year may obtain a permit to remain on the land, and, after ten years of occupation, has right to a land title. This law has led to many competing land claims (Hetch and Cockburn, 1989) and encourages forest clearing to establish ownership (Binswanger, 1991).

In September 1965 a Forest Code was signed into law.[7] This law limited private property rights on forested land. It established permanent preservation areas adjacent to bodies of water, with slopes of more than 45 degrees, and on indian lands. The 1965 Forest Code also enabled authorities to set aside land to preserve flora and fauna.

Although well-intentioned, the Forestry Code contains many aspects which are difficult to monitor or enforce. For example, the law requires individuals and firms exploiting the forest for commercial gain to register with the public forestry service.

Article 15 of the law prohibits the "wasteful exploitation of native forest areas in the region" (Nascimento, 1985:317).

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[6] The Land Statute (*Estatuto da Terra*), Law No. 4,504, superseded Law No. 601 of 1850.

[7] The Forest Law (*Codigo Florestal*), Law No. 4,771, superseded the 1934 Forest Code.

Article 44 established the 50% rule, meaning that all landowners must set aside 50% of their land and hold it under forest.

In 1967, the Instituto Brasileiro de Desenvolvimento Florestal (IBBF) was brought into creation with Decree No. 289 to oversee and implement the above laws.[8] The IBDF also administered incentives to promote the growth of plantations. If IBDF approved a plantation project, it was subject to tax concessions of up to 50% of income tax due. During the period between 1967-1986, over 6 million hectares of approved afforestation projects were planted (Cottle et al., 1990: 20). However, as Brazil's economic crisis worsened in 1987, the tax concession was reduced to 25%. Eventually, efforts to encourage reforestion shifted to decree. In October of 1987, Portaria No. 449 was issued, obligating firms with consumption of over 12,000 m^3 in logs to maintain a management or reforestation scheme on company land.

In 1989, the IBDF was reorganized, and merged into the Brazilian Institute for the Environment and Renewable Resource (IBAMA), along with the former agencies for rubber (SUDHEVEA) and fisheries (SUPEPE). Like the IBDF, IBAMA has responsibility for overseeing and developing policies for the exploitation and management of forests in Brazil. However, it still suffers from lack of adequate funding and too many

[8]IBDF was created by merging the Department for Renewable Resources and the National Pine Institute and charged with administering the nation's forests.

regulations to enforce.

The amount of legislation has not only created difficulties in enforcement but also insecurity and obstacles to investment in economic activity. For example, the timber industry of Pará has only three legal sources of supply: 1.) legally cleared areas; 2.) areas of managed projects approved by IBAMA; and 3.) forestry plantations. If consumption is above 12,000 m^3/yr., only the second and third options are legally open to firms. To enforce these regulations, IBAMA issues way-bills (ATPF or *autorização de transporte de produtos florestais*) to each firm with managed projects or plantations. Way-bills accompany wood shipments, or else the shipments can be confiscated. As of 1994, 550 projects had been approved, covering an area of 1.1 million hectares (Almeida and Barreto, 1994). Clearly, a vast number of other mills are operating outside of these regulations fostering a climate of insecurity and fraud.

1.2.5 Forestry Taxation

There are several taxes facing entrants to the timber industry in the Amazon.

Income from forestry is treated as agricultural income and is taxed at 6%. Deductions of up to 80% of taxable income are available for land improvements. In addition, normal operating expenses, such as costs of harvest, management, and interest and capital depreciation, are deductible (Hamel and

Robertson, 1988).

Landholders are subject to a property tax, the Imposto Territorial Rural (ITR) which was established as part of the 1964 Land Statute and is levied as a federal tax. Several authors have noted the potential uses of the ITR to encourage better land management (Binswanger, 1991; Almeida and Uhl, 1993). At present it is unclear how well enforced the ITR is in Amazonia, and hence, what role it can play in promoting changes in forest management. For a detailed discussion on the rural land tax, see Almeida and Uhl (1993).

Until 1994, IBAMA collected a forest tax equivalent to $2.00 per m^3 of bole wood extracted (Verissimo et al., 1992: 183). This tax was abolished because it was being used to fund IBAMA's operating expenses rather than to finance reforestation (Almeida and Barreto, 1994). Instead, timber firms are now obligated to plant six saplings for every m^3 of wood removed.

Firms involved in milling extracted timber are subject to two value-added taxes, the state sales tax (ICMS or *Imposto sobre Circulação de Mercadorias e Serviços*) and a federal excise tax on industrial production (IPI or *Imposto sobre Produto Industrializado*). The IPI tax depends on how the wood products are classified. The ICMS tax depends on the destination of the product; within states, the ICM is 17%. Between states, the rate is 12% of gross revenues. For export, the rate is 13%. All ICMS taxes are administered by

the state and represent a major source of their revenue (Hamel and Robertson, 1988). As of 1995, the federal government is proposing to merge the IPI and ICMS into one value-added tax (IVA - *Imposto sobre Valor Agregado*) administered by the central government (O Liberal, 1995). In return for the loss of sale tax revenues, the proposed plan would allow states to levy the ITR land tax.

1.2.6 On State Ownership of Land

Brazil has a policy of "*terras devolutas*" or state ownership of land, similar to such countries as Canada and the United States where the government holds most of the forested land under state control. Yet unlike these countries and other tropical countries, the government has not leased out much forested land for logging. Part of the reason it has not done so is because extraction costs have been prohibitive, and so firms were not interested. However, the idea of large-scale concessions on state land in Brazil has been widely debated.

Two competing plans for managing state forests were proposed in the 1970's. The first, the Pandolfo Plan, proposed a system of income forests (Florestas de Rendimento) to be administered by SUDAM (Pandolfo, 1974). This plan would have established twelve regional forest reserves for commercial logging, with a total area of 39.5 million ha. The idea was to develop a centralized authority to oversee the exploitation of these production forests by private firms.

Never formally accepted, this plan may have sunk under the weight of bureaucratic infighting between SUDAM and IBDF (Ros-Tonen, 1993).

The second plan, the Schmithhusen Plan, proposed forest utilization contracts or "risk contracts" as another means of obtaining income from large forest tracts of state land. Under this plan, developed by a joint IBDF/FAO/UNDP project (Schmithusen, 1978), private corporations would obtain leases for 1-20 years to exploit forest lands. The risk refers to the unknown amount of marketable wood that might be found on the tract. These contracts were criticized by the media who suggested the Amazon would be sold to foreign corporations. Silva (1989) argues that Brazil was not ready to oversee such contracts and that it was just as well that the plan was never implemented.

Rankin (1985) reports the first concession granted in the Amazon was fraught with financial and logistic problems. The 65,000 ha. concession was granted by Eletronorte in 1980, prior to the construction of the Tucurui Dam on the Tocantins River in Pará. Difficulties were encountered in finding a firm willing to accept the risks of the venture with adequate financing to undertake the logging (Rankin, 1985: 378). The contract went to a Southern Brazilian firm specializing in private pension plans, which in the end lost money as the concession yielded only one-tenth of the expected harvestable timber.

1.2.7 Concluding Remarks

Whether in private or public hands, forested land is likely to harvested quickly to gain initial rents. The future productivity of the land depends on how these timber "rents" are extracted and subsequent investments in the land. Private ownership of forest resources can promote stewardship but does not guarantee it. Nor will state ownership, whether through granting concessions or through regulation, guarantee adequate stewardship. The abuse of government land under concession in Southeast Asia is a reminder of the potential for mismanagement of public goods (Repetto, 1988).

Until incomes rise, the demand for conservation is unlikely to be sufficient to force local governments to preserve forested areas (Schneider, 1994). Even in relatively wealthy countries like the U.S., there is serious opposition to conservation measures which threaten vested interests benefitting from the exploitation of public lands (Barber et al., 1994).

In the short-run, Brazil can allow timber markets to develop, and encourage the shift to higher-value wood products to improve local incomes. At the same time, it can at relatively low cost monitor both forest resources via remote sensing and also the development of the regional timber industry.

In the medium to long run, Brazil can increase efficiency of land use by promoting accurate land titling and more

judicious use of environmental legislation. For example, with secure land titles recorded in an geographic information system, it would be possible to trade clearing rights rather than having to arbitrarily preserve 50% of one's land under forest. Such an arrangement would promote forest preservation on lands with the lowest opportunity cost and decrease forest fragmentation.

1.3 Conclusion

Brazil is well-endowed with forest resources. It has a strong comparative advantage in the production of tropical wood products. With an area under forest greater than either that of Canada or the United States, it has one of the largest contiguous forest reserves in the world.

At present, Brazil's share of world timber markets is small. Part of the reason lies with inaccessible forests and low stocking densities of commercial wood, resulting in high extraction costs. However, with international prices of tropical wood projected to increase by 15% - 40% over the next ten years, the area of economically accessible forest in the Amazon will widen.

Domestic markets within Brazil are strong and growing. With rising incomes, the demand for construction materials and other wood products is growing. Although the area under exploitation is small relative to total forest area, increases in domestic and international demand are likely to stimulate

an expansion in the timber industry in Amazônia.

To improve land use efficiency and minimize environmental disturbance, Brazil will need to simplify its land and forestry legislation. However, until incomes in the region rise, it is unlikely that forest conservation will receive any local political support. Thus, Brazil should allow the expansion of the timber industry, but monitor its development, along with the stock of forest resources, closely.

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Table 1: Area Under Forest, Roundwood Production and Wood Exports by Region, 1990
(area in '000 ha; volume in '000 cubic meters; value in '000 1990 US$)

Region	Forest Area	% Total	Roundwood Production Volume	% Total	Total Wood Exports Value	% Total	Net Wood Exports Value
Africa	684,664	17.6%	514,556	14.7%	2,073	2.1%	(2,059)
Europe	157,327	4.0%	393,423	11.2%	43,183	43.7%	(14,540)
Asia	531,722	13.6%	1,073,774	30.6%	11,142	11.3%	(14,783)
China	126,515	3.2%	280,015	8.0%	746	0.8%	(1,824)
India	67,011	1.7%	272,397	7.8%	39	0.0%	(467)
Indonesia	109,800	2.8%	176,428	5.0%	3,777	3.8%	3,412
Malaysia	19,361	0.5%	49,690	1.4%	3,126	3.2%	2,634
Oceania	157,268	4.0%	41,276	1.2%	1,375	1.4%	(319)
Ex-USSR	827,800	21.2%	386,400	11.0%	3,020	3.1%	2,088
North America	646,400	16.6%	694,049	19.8%	30,585	30.9%	13,419
USA	287,400	7.4%	512,800	14.6%	12,598	12.7%	(2,353)
Central America	63,430	1.6%	63,545	1.8%	208	0.2%	(1,161)
South America	829,386	21.3%	343,810	9.8%	2,608	2.6%	1,511
Brazil	493,030	12.6%	259,156	7.4%	1,461	1.5%	1,221
World	3,897,998	100.0%	3,510,832	100.0%	98,900	100.0%	(11,138)

Source: Production and Trade , FAO (1994); Forest Area, WRI (1994).

Table 2: Area Under Forest and Tropical Rainforest, 1990
(in '000 ha)

Region	Total Forest Area	% Total	Tropical Rainforest Area	% Total	% Annual Change Rainforest 1981-1990
Africa	684,664	17.6%	86,411	12.1%	-0.5%
Zaire	174,310	4.5%	60,437	8.5%	-0.6%
Asia	531,722	13.6%	148,027	20.7%	-1.2%
India	67,011	1.7%	8,246	1.2%	-0.6%
Indonesia	109,800	2.8%	93,827	13.1%	-1.0%
Malaysia	19,361	0.5%	16,339	2.3%	-1.8%
Philippines	10,350	0.3%	3,082	0.4%	-3.3%
Thailand	14,113	0.4%	3,728	0.5%	-3.1%
Oceania	157,268	4.0%	29,323	4.1%	-0.3%
Central America	63,430	1.6%	11,154	1.6%	-1.8%
South America	829,386	21.3%	406,162	56.9%	-0.4%
Brazil	493,030	12.6%	291,597	40.9%	-0.3%
World	3,897,998	100.0%	713,790	100.0%	-0.6%

Source: World Resources Institute (1994).

Table 3: Value of Exports of Wood Products
(in million Constant 1987 US$)

Year	USA	Canada	Sweden	Finland	Germany	France	Indonesia	Malaysia	Other	Tot
1971	3,989	7,959	4,311	3,289	1,041	919	451	822	12,476	35,257
1972	4,649	9,070	4,729	3,598	1,168	1,039	598	985	13,866	39,701
1973	6,450	10,540	6,375	4,492	1,959	700	1,402	1,746	20,121	53,785
1974	7,882	12,042	8,488	5,394	2,822	2,194	1,621	1,655	22,753	64,851
1975	7,122	9,921	6,970	4,579	1,949	1,461	961	1,091	18,461	52,516
1976	7,675	11,937	7,029	4,818	2,748	1,629	1,707	1,956	20,419	59,918
1977	6,953	12,825	6,444	5,129	2,658	1,803	1,751	1,893	21,157	60,614
1978	6,718	13,561	6,871	5,454	2,572	1,932	1,728	1,950	22,095	62,881
1979	8,684	14,843	7,918	6,792	2,982	2,099	2,821	3,279	25,782	75,200
1980	9,749	14,676	7,852	7,629	3,220	2,039	2,621	2,771	27,102	77,660
1981	8,383	13,217	6,569	6,322	2,764	1,653	1,231	2,105	22,743	64,986
1982	6,896	11,218	5,486	5,154	2,679	1,427	969	2,495	19,329	55,654
1983	6,565	11,743	5,405	4,772	2,503	1,463	1,303	2,550	18,396	54,701
1984	6,385	12,657	5,659	5,104	2,709	1,588	1,371	1,715	18,251	55,440
1985	5,743	11,887	5,222	4,879	2,839	1,675	1,651	1,803	17,286	52,985
1986	6,588	12,528	5,982	5,671	3,702	1,955	1,805	1,798	19,903	59,932
1987	8,297	15,095	7,288	7,078	4,455	2,570	2,337	2,598	23,737	73,455
1988	10,469	16,948	8,171	7,847	5,066	2,796	2,786	2,485	27,790	84,359
1989	11,368	16,928	8,067	7,831	5,222	3,018	3,484	2,884	28,251	87,054
1990	11,159	15,932	8,585	8,321	5,492	3,223	2,781	2,779	29,329	87,600
1991	10,609	14,401	7,561	7,014	5,516	3,214	3,338	2,667	28,159	82,478
1992	12,343	15,002	7,438	6,737	6,022	3,383	3,283	3,058	28,061	85,327

Source: FAO (1994), Economic Report of the President (1994).

Table 4: Value of Imports of Wood Products
(in million Constant 1987 US$)

Year	USA	Japan	Germany	UK	Italy	France	Netherlands	Other	Total
1971	7,257	4,695	3,830	4,857	1,841	2,346	1,381	13,946	40,151
1972	8,487	5,335	4,235	5,101	2,162	2,665	1,497	14,582	44,064
1973	9,726	9,857	5,646	7,073	3,203	3,293	2,262	19,354	60,414
1974	9,550	10,864	6,002	9,241	4,102	4,697	2,929	26,136	73,521
1975	8,043	7,189	5,311	6,539	2,764	3,390	2,301	23,110	58,646
1976	9,646	8,658	6,901	7,034	3,400	3,979	2,778	23,753	66,149
1977	10,766	8,828	7,032	7,279	3,182	3,733	2,966	25,454	69,242
1978	12,708	9,091	6,905	7,058	3,373	3,668	3,217	25,448	71,469
1979	12,408	13,789	8,253	8,591	4,704	4,340	3,762	28,351	84,198
1980	10,575	13,289	8,868	8,103	5,501	4,905	3,704	31,474	86,418
1981	9,785	7,990	6,759	7,048	3,872	3,817	2,701	29,356	71,328
1982	9,662	7,814	5,721	6,588	3,418	3,187	2,436	26,081	64,907
1983	10,311	6,979	5,579	5,933	2,780	3,214	2,169	23,588	60,554
1984	11,559	6,738	5,599	5,864	3,073	3,070	2,345	23,318	61,566
1985	11,421	6,255	5,197	5,441	2,825	3,021	1,988	22,691	58,839
1986	11,487	6,845	6,627	6,420	3,448	3,779	2,801	25,315	66,722
1987	13,027	9,818	8,112	8,120	4,551	4,515	3,323	29,450	80,916
1988	13,819	10,498	8,887	9,942	5,369	5,092	3,573	32,686	89,866
1989	14,039	12,852	9,423	9,436	5,516	5,115	3,675	35,389	95,446
1990	13,243	11,536	10,519	9,165	5,934	5,525	4,151	37,391	97,465
1991	10,924	10,557	9,227	7,520	5,372	4,898	3,737	37,636	89,871
1992	11,244	10,768	9,536	7,250	5,278	4,880	3,753	35,618	88,329

Source: FAO (1994); Economic Report of the President (1994) for GNP Deflator.

Table 5: Net Imports of Tropical Timber Products in Major Markets, 1990 ('000 Cubic Meters of Roundwood Equivalent)

Product	North America	Japan	Europe (EEC)	Republic of Korea	Taiwan
Logs	3	11,319	3,303	3,731	4,193
Sawn Wood	364	2,468	5,569	1,057	na
Veneer	46	222	435	25	0
Plywood	2,528	6,251	2,369	1,244	996
Total	2,941	20,260	11,676	6,057	5,189

Source: Barbier et al., 1992, p. 26.
Note: Conversion factors are: sawn wood, 1.8; veneer, 1.9; and plywood, 2.3.

Table 6: Major Exporters of Non-Coniferous Sawnwood
(in '000 cubic meters)

Year	Malay.	Indon.	USA	Ex-Yugo.	Philipp.	Brazil	Canada	Cote D'Ivoire	Total
1971	1,308	81	406	547	231	161	380	163	7,238
1972	1,762	107	600	655	231	204	407	163	8,415
1973	2,159	330	670	740	427	367	402	238	10,648
1974	2,008	278	428	530	284	326	277	275	8,928
1975	1,763	394	647	516	254	187	160	212	7,955
1976	3,019	649	547	939	493	261	267	292	11,461
1977	2,910	594	574	838	455	405	273	340	11,240
1978	2,787	756	1,012	1,051	573	391	329	318	12,048
1979	3,418	1,283	726	848	915	593	299	293	13,435
1980	3,141	1,203	885	860	742	622	305	277	12,616
1981	2,756	1,171	1,036	645	547	579	308	266	11,455
1982	3,091	1,222	847	564	591	397	281	308	11,353
1983	3,447	1,793	1,134	580	728	459	274	383	12,856
1984	2,842	2,198	1,168	770	537	446	329	418	13,012
1985	2,782	2,166	940	631	507	421	305	473	12,224
1986	2,991	2,642	1,229	611	495	375	338	475	13,128
1987	3,848	2,208	1,768	734	645	486	454	460	15,262
1988	4,103	2,983	2,908	776	629	533	631	460	17,787
1989	5,135	2,709	2,020	771	438	448	431	455	17,470
1990	5,283	614	2,071	714	77	429	472	570	15,324
1991	4,934	756	2,205	713	87	387	480	470	14,996
1992	5,417	711	2,306	760	56	523	541	559	16,624

Source: FAO (1994).

Table 7: Rates of Growth in Global Wood Consumption and Prices (1900 - 1990)

Period	Consumption	Real Price Growth 1/
1900 - 1950	na	1.37
1950 - 1960	3.54	0.48
1960 - 1970	2.20	-0.35
1970 - 1980	1.10	4.52
1980 - 1990	2.20	0.05
1950 - 1985	2.01	0.34

Source: Sedjo and Lyon (1990); FAO (1994).
Notes: 1/ For U.S. Market only.

Table 8: International Log, Sawnwood and Plywood Prices & Commodity Price Indices
(Wood Prices in Constant 1987 US$; Indices 1980/81=100)

Year	Logs Philipp. 1/	Logs Malay. 2/	Logs Cameroon 3/	Sawn Wood 4/	Ply-wood /5	Agr. Index	Timber Index	Metals & Minerals Index
1958						119.3	43.9	105.4
1959	103.1		115.2	265.6		119.3	52.4	108.7
1960	111.5		133.8	326.5		116.3	56.4	107.3
1961	114.1		149.4	260.8		108	57.4	101.3
1962	122.8		139.9	267.9		106.1	61.7	98.4
1963	118		143.8	281.3	306.3	112.2	61.4	100.5
1964	98.9		142.6	297.8	233.6	114	51.6	121.9
1965	111.6		139.1	286.6	215.1	109	59.1	139.9
1966	113.3		129.3	248.6	250.3	106.8	60.1	146
1967	117.5		123.8	253.8	264	104.4	63.5	122.2
1968	115.1		132.5	265.3	250.5	104.8	65.7	128.2
1969	105.7		148.9	270.9	253.5	103.7	60.1	137.9
1970	106		141.3	264.7	293.7	102.5	59.8	129.6
1971	102.7		120.3	250	221.1	93.2	57.9	108.6
1972	96.9		135.3	282.2	245.9	92.1	52.5	100
1973	158.8		323.5	378	457.1	123.9	79.2	121.1
1974	175.1		268.4	318.7	340.1	134.7	77.9	136.3
1975	120.5		257.3	338.2	247.2	99.8	52.8	105.5
1976	152.2		272.1	321.4	282.6	115.9	70	108.9
1977	160.6	165.7	284.1	275.7	295.3	133.9	74	103.8
1978	152.2	161.5	317.2	340.6	314.3	107.9	67.7	92.4
1979	244.6	259.5	322.9	517.7	400.8	105.5	104.3	102
1980	268.6	272.7	350.8	509.2	381.9	104.3	109.4	104.8
1981	183.3	197.2	269.7	398.1	310.1	90.8	86.7	93.4
1982	173.3	186	209.9	360.4	277.4	81.4	88.3	87.6
1983	155	166.5	184.4	349	263.5	89.4	84.1	91.8
1984	165.9	183.7	193	337.1	249.5	94.5	98.9	86.7
1985	139.8	144.3	184.2	292.7	223.4	81.6	79.9	82.4
1986	153.4	156.1	228.7	274.7	282.5	71.4	75.3	64.5
1987		221.4	258.9	276.1	398.7	59.2	110.4	66.9
1988		224.6	261.1	295.1	345.3	63.1	98.6	85.2
1989		207.3	252.6	389.2	323.2	60.6	95.6	89.2
1990		186.4	304.3	464.3	314.3	53.9	84.7	78.3
1991		188.4	268.5	400.9	316.4	51.6	87.4	69.9
1992		180.8		370.4	275			

Table 2.8: International Log, Sawnwood and Plywood Prices & Commodity Price Indices
(cont.)

Table 9: Price Elasticities of Demand for Timber

Source	Years	Countries	Product	Elasticitiy
ECE/FAO	1964-1981	Germany, France, Netherlands Switzerland and the United Kingdom	Sawn Hardwood	-0.53
			Sawn Softwood	-0.58
			Plywood	-0.24
Wibe	1970-1979	60 Countries w/ GDP Per Capita > US$2,500	NC Sawnwood	-1.19
			C Sawnwood	-0.54
			Panels	-0.18
Kallio et al.	1987	Countries w/ GDP Per Capita > US$ 3000	NC Sawnwood	-1.20
			C Sawnwood	-0.50
			Veneer/Plywood	-0.40
Bourke	1988	Japan: Imports from Developing Countries	Sawn Timber	-1.30
			Plywood/Veneer	-1.80
Netherlands Econ. Inst.	1961-1981	17 European Countries	Tropical Hardwood	-0.34
Buongiorno & Manurung	1992	Not Specified	NC Logs	-0.16
			NC Sawnwood	-0.74
			Plywood	-1.14
Barbier et al. (1992)	1975-1988	Indonesia	Logs - Export	-1.51
			Sawnwood - Domestic	-0.36
			Sawnwood - Export	-0.68
			Plywood - Domestic	-0.91
			Plywood - Export	-0.46
Constantino (1988)	1975-1985	Indonesia	Sawnwood - Export	-0.21
			Plywood - Export	-0.58
Vincent (1992)	1973-1989	Malaysia	Sawnwood - Domestic	-0.55
			Logs - Export	-1.59
Vincent (1989)	1960-1985	Malaysia	Sawnwood - Domestic	-0.27
			Sawnwood - Export	-1.22
			Plywood - Domestic	-0.94
			Plywood - Export	-0.46

Source: Barbier et al. (1992); Tables 4.4, 4.5, and 4.6.

Source: World Bank, Commodity Trade and Price Trends (Various Years).
Economic Report of the President (1992).

Notes: 1/ Luan; average wholesale price in Japan.
2/ Merenti; Sabah Best Quality; Price charged by importers in Japan.
3/ Sapelli; High Quality; f.o.b. Cameroon.
4/ Malaysia: Dark red Merenti, std. density, c.i.f. French Ports
5/ Philippines: Lauan, 3-ply, extra 91cm x 4 mm, wholesale price Tokyo spot.

Table 10: Summary Statistics of Price Elasticities of Demand

Product	Statistic	Elasticitiy
Panels, Plywood & Veneer	Average	-0.66
	Standard Deviation	0.51
Sawn Hardwood	Average	-0.76
	Standard Deviation	0.38
Hardwood Logs	Average	-0.84
	Standard Deviation	0.65
Sawn Softwood	Average	-0.54
	Standard Deviation	0.03

Source: Table 2.9.

Table 11: Contribution of Forest Products to Total Exports
(in million $US current)

Year	Total Exports	Forest Products Exports	Contribution
1971	2,904	124	4.3%
1972	3,991	143	3.6%
1973	6,199	228	3.7%
1974	7,951	236	3.0%
1975	8,670	179	2.1%
1976	10,128	170	1.7%
1977	12,120	224	1.8%
1978	12,659	301	2.4%
1979	15,244	588	3.9%
1980	20,132	859	4.3%
1981	23,293	944	4.1%
1982	20,175	695	3.4%
1983	21,899	822	3.8%
1984	27,005	1,027	3.8%
1985	25,639	801	3.1%
1986	22,349	936	4.2%
1987	26,224	1,116	4.3%
1988	33;789	1,760	5.2%
1989	34,383	1,565	4.6%
1990	31,414	1,461	4.7%
1991	31,620	1,619	5.1%
1992	35,793	1,890	5.3%
1993	38,783		

Source: IMF (1994); FAO (1994).

Table 12: Composition of Brazil's Wood Exports, 1971-1992
(in '000 US $ Current)

Year	Roundwood	Sawnwood	Panels 1/	Pulp	Paper 2/	Total
1971	3,595	83,055	30,459	4,628	757	122,494
1972	4,351	83,055	39,292	13,295	2,617	142,610
1973	13,320	128,120	50,168	23,491	12,726	227,825
1974	6,850	127,034	48,521	36,756	17,125	236,286
1975	1,236	90,225	50,568	30,503	6,022	178,554
1976	1,708	70,546	56,763	26,656	14,403	170,076
1977	1,465	121,268	63,049	19,487	18,981	224,250
1978	2,410	104,440	84,114	57,486	52,153	300,603
1979	3,951	207,987	104,035	181,266	90,786	588,025
1980	3,072	211,471	124,035	364,211	155,543	858,332
1981	2,370	210,405	141,179	365,531	224,833	944,318
1982	1,652	139,856	104,942	278,504	170,431	695,385
1983	1,892	178,815	122,147	310,744	208,434	822,032
1984	2,039	142,981	140,088	396,412	345,560	1,027,080
1985	2,231	121,773	135,981	278,043	262,587	800,615
1986	1,107	119,712	146,016	322,703	346,811	936,349
1987	1,085	189,299	162,997	397,696	364,779	1,115,856
1988	3,824	202,072	244,927	624,963	684,102	1,759,888
1989	6,318	147,721	208,410	686,962	516,253	1,565,664
1990	3,542	141,478	215,150	595,960	501,577	1,457,707
1991	3,097	149,933	217,038	588,100	657,608	1,615,776
1992	24,357	151,587	238,032	698,124	774,749	1,886,849

Source: FAO (1982, 1994)
Notes: 1/ Panels includes veneer sheets, plywood, particle and fiber board
2/ Paper includes paperboard, newsprint, printing and writing paper, and wrapping and packaging paper.

Table 13: Production and Exports of Non-Coniferous Sawnwood (1950-1992) (in '000 cubic meters)

Year	Production	Exports	Domestic Consumption
1950	561	45	92%
1955	3,700	38	99%
1960	2,900	17	99%
1965	2,700	65	98%
1970	3,500	147	96%
1975	4,332	187	96%
1980	7,738	622	92%
1985	9,397	421	96%
1990	9,256	429	95%
1992	10,037	523	95%

Source: Ros-Tonen (1992); FAO (1994).

Table 14: Areas Approved for Plantations by State and Major Species (1967-1986)

State	Area	% of Total	Major Species
Minas Gerais	1,829	29.3%	Eucalyptus
Parana	841	13.5%	Pinus
Sao Paulo	701	11.2%	Eucalyptus
Bahia	535	8.6%	Pinus / Eucalyptus
Mato Grosso	531	8.5%	Eucalyptus
Santa Catarina	366	5.9%	Pinus
Rio Grande do Sul	302	4.8%	Pinus
Espirito Santo	152	2.4%	Eucalyptus
Piaui	149	2.4%	Fruit Trees
Goias	148	2.4%	Eucalyptus
Total 1/	6,252	100.0%	

Source: Cottle et al. (1990).
Note: 1/ Total includes all area under plantations in all states.

Table 15: Non-Coniferous Sawnwood Exports from Brazil
(in '000 cubic meters)

Year	USA	UK	Canada	Spain	France	Germ.	Italy	Neth.	Japan	Other	Total
1971	106	3	4	0	0	5	1	1	1	37	161
1972	142	3	18	0	0	4	3	1	1	44	219
1973	241	16	27	0	4	8	3	3	1	60	367
1974	192	20	43	2	4	8	6	1	1	7	285
1975	3	58	0	0	0	8	0	6	0	111	187
1976	133	27	36	7	2	6	0	2	0	50	263
1977	144	28	35	8	7	10	3	3	0	66	305
1978	47	14	10	4	3	8	3	1	0	63	154
1979	189	78	34	16	19	25	10	7	1	122	502
1980	207	55	52	32	9	38	19	7	6	129	557
1981	177	3	47	12	3	18	7	3	4	293	569
1982	113	1	8	0	4	11	4	4	4	244	394
1983	169	108	26	20	1	17	4	11	4	95	455
1984	169	93	17	22	0	11	11	6	6	59	396
1985	182	89	16	21	9	8	12	6	5	71	421
1986	126	96	23	16	11	4	6	7	5	78	375
1987	214	105	31	17	18	5	12	10	3	70	486
1988	161	97	22	59	24	7	20	12	3	174	583
1989	163	87	5	59	0	0	18	9	8	184	533
1990	0	0	0	0	37	7	24	13	8	444	533
1991	97	51	2	52	53	3	18	18	5	59	387
1992	135	46	11	53	74	5	32	13	6	104	523

Source: FAO (1994).

Table 16: Descriptive Statistics on Volumetric Data, by Species (in cubic meters/hectare)

Name	Species	Average Volume/ Hectare	Standard Deviation	CV %
Macaranduba	*Manilkara huberi*	14.4	10.0	69%
Louro-vermehlo	*Ocotea rubra*	7.5	4.1	54%
Acapu	*Vouacapoua americana*	6.6	9.6	145%
Cuiarana	*Buchenavia spp.*	5.3	3.1	58%
Jarana	*Holopyxidium jarana*	5.1	5.6	109%
Castanheira	*Bertholletia excelsa*	5.1	8.9	175%
Quaruba	*Vochysia spp.*	4.9	4.1	82%
Cupiuba	*Coupia glabra*	3.4	1.9	56%
Muiracatiara	*na*	2.8	3.1	110%
Andiroba	*Carapa guianensis*	2.4	2.9	123%
Piquia	*Caryocar villosum*	2.3	1.6	70%
Pau D'arco	*na*	2.1	2.5	118%
Itauba	*Mezilaurus itauba*	2.1	3.4	160%
Copaiba	*Copaifera spp.*	1.9	1.8	97%
Sucupira	*Bowdichia spp.*	1.6	0.9	54%
Angelin-da-mata	*Hymenolobium petraeum*	1.1	1.1	105%
Marupa	*Simaruba amara*	0.9	0.7	74%
Pau-Amarelo	*Euxylophora paraensis*	0.8	2.0	243%
Acariquara	*Minquartia guianensis*	0.7	0.7	103%
Angelin-rajado	*Pithecolobium racemosum*	0.7	0.6	96%
Morototo	*Didymopanax morototoni*	0.7	0.8	117%
Freijo	*Cordia geobliana*	0.4	0.6	166%
Macacauba	*Platymiscium trinitatis*	0.3	0.5	178%
Cedro	*Cedrela odorata*	0.1	0.4	290%
Total		73.2	36.8	50%

Source: Soares (1971).

Note: Descriptive Statistics are from observations on 24 individual plots (see Heinsdijk, 1957).

Table 17: Area under Plantion Approved by IBDF, By Species (1967-1986)

State	Area	% of Total	Major Species
Minas Gerais	1,829	29.3%	Eucalyptus
Parana	841	13.5%	Pinus
Sao Paulo	701	11.2%	Eucalyptus
Bahia	535	8.6%	Pinus / Eucalyptus
Mato Grosso	531	8.5%	Eucalyptus
Santa Catarina	366	5.9%	Pinus
Rio Grande do Sul	302	4.8%	Pinus
Espirito Santo	152	2.4%	Eucalyptus
Piaui	149	2.4%	Fruit Trees
Goias	148	2.4%	Eucalyptus
Total 1/	6,252	100.0%	

Source: Cottle et al., (1990).
Note: 1/ Total includes all areas under plantation in all states.

Table 18: Log Production by Region, 1975-1990
(in million cubic meters)

Year	North	Northeast	Southeast	South	Center-West	Total
1975	4.5	5.2	2.2	16.9	2.6	31.4
1977	6.7	5.3	2.0	15.3	2.9	32.2
1979	8.4	5.6	1.2	13.4	3.0	31.6
1981	13.1	6.8	1.6	10.9	3.3	35.7
1983	16.1	7.2	1.7	10.2	3.4	38.6
1985	19.8	8.6	1.9	8.9	3.8	43.0
1987	24.6	8.7	1.3	7.9	3.3	45.8
1989	47.5	7.8	1.0	6.9	2.6	65.9
1990	80.8	7.4	0.6	5.0	2.7	97.5

Source: IBGE (various years).

Table 19: Registered Wood Processing Facilities in the Amazon, by State (1965-1988)

State	1965	1973	1978	1980	1986	1988
Acre	9	**	35	61	73	197
Amapa	7	18	*	60	45	72
Amazonas	25	54	89	62	141	228
Para	147	183	510	886	1,244	1,546
Rondonia	3	32	141	250	696	1,419
Roraima	3	**	18	17	32	61
Total	194	287	793	1,336	2,231	3,523

Source: Ros-Tonen (1993); 1986 data from Cottle et al., (1990).
Note: * Included in number for Para.
** Included in number for Amapa.

Table 20: Area under Forest, Cleared of Forest, and Disturbed by Forest Clearing in the Brazilian Amazon, 1988 (in square kilometers)

State	Forest Area	% Total Forest	Total Area	Cleared 1988	% Forest Cleared	Disturbed 1/	% Total Disturbed
Acre	152,394	3.7%	152,787	6,369	4.2%	30,460	5.2%
Amapa	137,444	3.4%	139,610	210	0.2%	900	0.2%
Amazonas	1,531,122	37.4%	1,575,343	11,813	0.8%	48,679	8.3%
Maranhao	145,766	3.6%	261,785	31,952	21.9%	62,222	10.6%
Mato Grosso	527,570	12.9%	900,440	47,568	9.0%	121,238	20.6%
Para	1,183,571	28.9%	1,261,730	95,075	8.0%	218,581	37.2%
Rondonia	212,214	5.2%	238,280	23,998	11.3%	78,751	13.4%
Roraima	172,425	4.2%	225,706	1,908	1.1%	7,145	1.2%
Toncantins	30,325	0.7%	277,244	11,431	37.7%	19,628	3.3%
Total	4,092,831	100.0%	5,032,925	230,324	5.6%	587,604	100.0%

Source: Skole and Tucker (1993).

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