

Estimating the Imperfections in Sawtimber Markets: A Case Study for The South Pacific Region, Colombia

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Introduction

Although some benefits derived from forests are being converted to monetary income (Wunder, 2001), in most tropical countries natural forest are directly linked to regional poverty (Gardner-Outlaw and Engelman, 1999; FAO and DFID, 2001; Wunder, 2001; FAO, 2003). Under the statement that, “forest and trees have an important role to play in the struggle

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to reduce poverty” (FAO and DFID, 2001), reducing imperfections in timber markets can be considered a tool to reduce poverty.

Literature about industrial organization indicates that markets contribute to the efficient use of resources. Therefore, they should create conditions to augment economic growth, stabilize national income, and increase rates of employment (Caves, 1967). The role of forestry markets has been the concern of international and national agreements. Recently, at the forum “The Role of Forests and Trees in Poverty Alleviation”,¹ some actions related to forestry markets were defined. Some of these include reduction of barriers to market entry, financing for local forest businesses, and benefits of efficient markets to the poor. In this sense, timber markets have the potential to play an important role in a developing country’s efforts to create economic growth and reduce poverty.

Forests in Colombia cover 67,5 million hectares, 58% of the nation’s land area (FAO, 2000). Colombia is one of the five megadiverse nations in the world (Vergara and Ruíz, 2003). However, most of the population live under conditions of poverty. The Gini coefficient² for Colombia is 0,57, the national poverty rate is 64%, and rural poverty is 79% (Challa, 2003).

In spite of the high proportion of forest cover the forestry sector has not been well developed. The contribution of one forestry sector to the well being of society is less than its potential. The average contribution of the forestry markets to the Gross Domestic Product—GDP—is approximately 0,2% (Minambiente, 1999). A low contribution of forestry activities to the national economy is common in tropical countries (FAO, 2003). The low contribution of forestry markets to GDP is associated with some characteristics of the forestry sector. The principal characteristic is that standing trees do not have value to the producers (Macía and Rojas, 1999); labor-intensive producers extract high-value woods, which are commercialized in an informal market. The low income of landowners constitutes another characteristic. Landowners lack the resources

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- 1 The forum was held by the Food and Agricultural Organization —FAO— and the United Kingdom Department of International Development —DFID—. September 2001.
 - 2 Gini coefficient is a measure of income distribution. If the index for a country is close to zero, the income is distributed equally. If the index is close to one, a highly unequal income distribution exists.

to invest in harvesting equipment so they become employees of sawmills extracting timber from their own land (Macía and Rojas, 1999; Wunder, 2001). The traditional use of a chainsaw to extract and square timber leads to high levels of waste and encourages illegal extraction (Franco and Galindo, 1998). Furthermore, employment does not offer any degree of security since timber is pulled by hand to the nearest creek, channel, river or road; salaries do not compensate labor; loggers do not have incentives to conserve the forest; and the pressure on the natural forest continues.

Laws and regulations do not provide producers with incentives to reduce costs of extraction. In Colombia if the laws and regulations related to harvesting were fully enforced the cost of production would increase. One of the requirements is for producers to maintain 100% inventory of trees in their forest; this prerequisite is inefficient in terms of time required and cost. As a consequence, producers employ fewer people and informal extraction increases. Problems with production are reflected in the economy of the country. Since the mid-1990's demand for sawn products has decreased. This is due to the high cost of production, difficulties in implementing new technology, lack of a banking system, and increasing imports. Firms are not operating at capacity. Nationally small and medium-sized firms use only 49% of their production capacity (Acevedo and Martínez, 2003). The yield per hectare is low and there are quality deficiencies caused by the use of obsolete technology, archaic extraction methods, lack of government regulation, and the scarcity of infrastructure.

Nevertheless, these problems can be overcome. One of the objectives of the National Development Plan of Forestry (Minambiente, 2000) is to allocate forestry products and services in the national and international markets by promoting competitive markets. This objective contemplates the sustainability of the production processes by including the economic, social and political context in which timber production is taking place. Under the concept of industrial organization any attempt to promote competitive markets has to be linked with an understanding of the actual markets and their degree of competitiveness. Markets with imperfect structures and high levels of market power weaken the general contribution to economic welfare.

The purpose of this paper is to estimate the degree and nature of imperfections in the sawntimber markets for the South Pacific Region of

Colombia. This effort will include the description of relationships between the structure and conduct of these markets and the contribution of the forest products sector to the achievement of regional and national economic goals. An econometric analysis is undertaken of selected markets to numerically estimate the degree of the imperfection. This study contributes to a better understanding of the role of timber markets and their relationship rates of poverty.

I. History

The Republic of Colombia is located in northwestern South America. Its total land area is 1'138.918 square kilometers with approximately 50% of the surface covered by forest. Colombia has four major timber-producing regions: Amazonian, Magdalena-Medio, Caldas-Valle and Pacific. Currently the production of timber is approximately one million cubic meters per year.

The tropical moist forest of the Pacific region is known as Chocó Biogeography. It covers approximately 100.000 square kilometers (Sierra, Tirado and Palacios, 2003). The area extends from the Panama-Colombia border south along the Pacific coasts of Colombia and Ecuador. The Colombian departments, the largest political division of the country, covering the Pacific region are Chocó (North), Valle del Cauca (Central), Cauca and Nariño (South). This paper focuses on the South Pacific Region. The principal economic activities for the South Pacific Region are forestry, fishing, mining, and some farming (Minambiente 1999). The South Pacific has been an important producer of timber for more than 30 years; it produces 60% of the total timber from natural forest in Colombia. The 1970's were a good decade for timber production. Technology was current and sawmills produced at close to capacity. Therefore, labor was required and the statistics indicate high levels of employment. In the early 1970's, timber was extracted under concessions. Fifty-four percent of the concessions for forest harvesting were issued to the 179 sawmills established at the South Pacific Region. Production was around one million cubic meters, 71% of the total production of the country (Minambiente, 1999). Despite the contribution of timber production in the 1970's, the national financial system did not help the industry. Forty-eight sawmills closed at the end of 1976. According to Minambiente (1999), the biggest firms closed and only small and medium-sized firms remained.

In the mid 1980's, 168 sawmills were registered in the South Pacific Region —56% of the national capacity—. However, 30 of these sawmills did not produce at full capacity. Because of civil conflict, the number of sawmills started to decline. Small mills and independent loggers supplied the demand for timber. Within this decade, harvesting concentrated on the most valuable species, which were well accepted in local and regional markets (Minambiente, 1999).

According to Minambiente (1999) in 1993, 144 sawmills were located in the Pacific Region (48% of the Colombia's sawmills). The production capacity of these sawmills was estimated to be 2,3 million cubic meters. However, the real production was 1,2 million cubic meters —60%— for the same year. Sawmill employment dropped 44% compared with 1970's. In 1996, the South Pacific Region produced 50% of the total timber: around 500 thousand cubic meters. Then, in 1997, the demand for forest products decreased as new technical requirements for forestry inventories reduced the demand for harvesting permits —Table 1—.

Table 1. *Supply and demand of timber in Colombia*

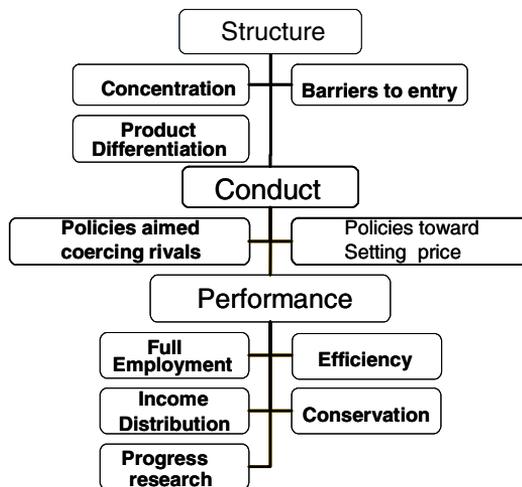
Year	Supply* (Cubic meters)	Demand* (Cubic meters)
1990	602.857	466.408
1991	987.432	419.522
1992	713.350	192.641
1993	952.137	294.379
1994	403.383	196.440
1995	1'169.663	1'368.927
1996	1'311.230	1'221.702
1997	380.038	1'092.447

* Supply is the volume of stumpage and demand is the quantity of timber that is transported or delivered, from the forest the final consumers.

Source: SIEF, 1998a, 1998b and 1999 and Minambiente 1999.

II. Description of Timber Markets

One purpose of the study of industrial organization is to describe and quantify market power. To achieve this goal industrial organization can be described under the paradigm of the structure, conduct and performance of the markets within the industry (Caves, 1967; Bain, 1968). Defining the relationship among observable measures of the structure, conduct, and performance of the industry allows an estimation of the degree of collusion between firms in a particular market (Huergo, 1997). Figure 1 describes the elements of the structure/conduct/performance paradigm.



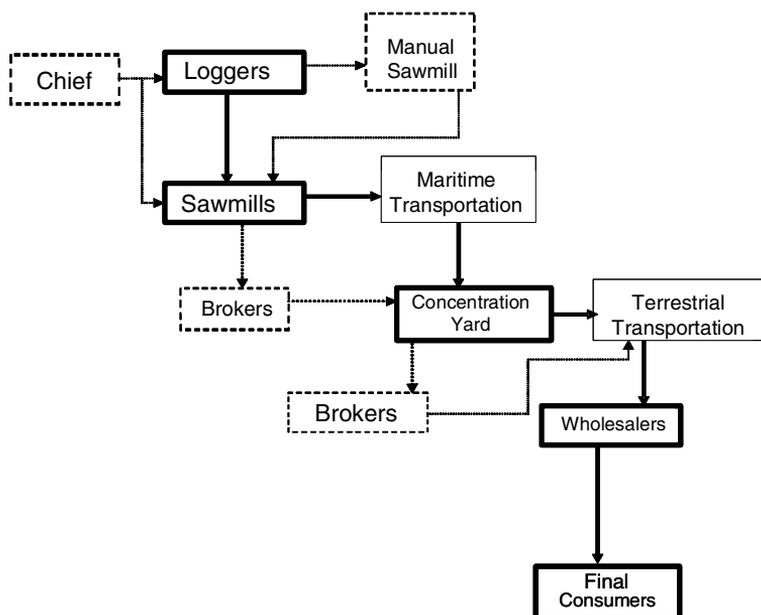
Source: Caves 1967; Bain, 1968 and Vernon 1972

Figure 1. *Elements of market structure/conduct/performance*

Market structure refers to the characteristics of buyers and sellers that exercise influence on the competition and pricing within the market (Bain 1968). Concentration, product differentiation and barriers to entry are the main elements that describe market structure (Caves, 1967). Market conduct refers to the behavior of firms as they adjust to the markets in which they sell or buy. The behaviors include policies to set prices and policies to coerce new entrants (Bain, 1968). Different forms of market conduct have the capacity to produce, either

directly or as side effects, gradual changes in the structure of industries (Harriss, 1979; Scherer, 1980). The goals of markets, efficiency, employment, progress and equity contribute to the well-being of citizens and that is reflected in the market's performance. Market performance is defined as “the appraisal of how much the economic results of an industry's market behavior deviate from the best possible contribution it could make to achieving these goals” (Caves, 1967, p. 97).

The timber industry in the South Pacific Region has five classes of market participants (Franco and Galindo, 1998; Minambiente, 1999). The first class corresponds to final consumers, the construction and furniture industries in Bogotá. The second class consists of wholesalers located in Bogotá. The third class corresponds to the concentration yards, which are located in Buenaventura —Valle—. The fourth class includes producers in Nariño and Cauca. The fifth class consists of loggers from Nariño and Cauca. The sawtimber industry is divided into four markets, which describe the commercial exchange of these participants along the chain of commercialization —Figure 2—.



Source: Franco and Galindo, 1998 and Minambiente, 1999

Figure 2. *Sawtimber chain of commercialization for South Pacific Region*

A. Market Between Wholesalers and Final Consumers

This market is the interaction of wholesalers acting as sellers and final consumers as buyers. This market is characterized by high levels of seller concentration. Six of the 49 selling firms control 60% of the production. Concentration facilitates collusion, and high levels of profitability follow (Caves, 1967; Bain, 1968; Huergo, 1997). Any output adjustment of any of the six largest wholesalers will influence market price and quantity. Markets are oligopolistic when levels of concentration are between 100 and 10 percent (Bain, 1968).

Concentration rests on and reflects other elements of market structure such as product differentiation and barriers to entry (Caves, 1967). Besides sawtimber from the South Pacific Region, wholesalers also sell small quantities of sawtimber from other regions³ and other products including veneer, plywood and roundwood. Buyer preference may also be influenced by advertising or promotions (Caves, 1967; Bain, 1968; Scherer, 1980). Final consumers of timber prefer to buy all their products from a single wholesaler that offers lower prices and provides additional services such as delivery and payment options. Therefore, product differentiation becomes significant between large and small wholesalers. Product differentiation in an industry influences price, market share and market conduct (Caves, 1967; Bain, 1968; Shepherd, 1972; Vernon, 1972; Orr, 1974).

Barriers to entry are also present in this market. These barriers are defined as the disadvantages of potential entrant firms to established firms (Bain, 1968). Knowledge constitutes a barrier to entry; the great number of species creates an opportunity to sell one species for another. New firms who want to get into the market must know the suppliers, most of the commercial timber species, transporters and legislation surrounding the timber industry.

High capital requirements are another barrier to entry. Firms with high levels of capital usually sell lumber with credit and do not charge interest; small carpenters —final consumers— are the principal beneficiaries of this service. As a result, wholesalers with high levels of available capital are able to support buyers to some extent. This support represents an absolute cost barrier to entry into the market for new firms. Established large wholesalers may also set their prices at the minimum level above marginal cost. New wholesalers must adopt these prices to compete, but the prices prevent new

3 Amazonas, Magdalena Medio and Caldas-Valle.

firms from making good profits. Ultimately, the business is not attractive for new firms. Furthermore, largest wholesalers are vertically integrated in some cases; vertical integration is a consequence of the availability of capital. The largest firms are able to use their own trucks to transport timber, transportation services also provides extra profit for large wholesalers by allowing them to transport timber for small firms at higher prices.

Conduct in oligopolistic markets depends on the actions of the sellers (Caves, 1967). This market exhibits mutual interdependence of sellers (wholesalers), a typical characteristic of oligopolistic markets, where sellers set and coordinate prices by looking at actual and potential rivals. Interdependence exists when market shares will be affected by the actions of the firm's competitors (Gollop and Roberts 1979). High levels of concentration and the presence of barriers to entry reveal the sawtimber market conduct to be coercive. In an oligopolistic market leading firms set prices and fringe firms must follow suit or set even lower prices (Caves, 1967). If the largest firms that have strong financial systems reduce prices to the minimum level above the average costs, small firms will be unable to compete. Due to the high barriers to entry, new wholesalers should enter the market on a large scale or by enjoying very low profits in the short run. Setting lower prices translates to lower levels of profitability for small firms (Franco and Galindo 1998).

Even if a new firm decides to operate on a large scale, there is a certain level of risk involved, such as loss of money by selling on credit without interest.⁴ Other risks include the availability of materials to newcomers and the uncertainty of future forestry legislation. Coercive conduct arises also from squeezing operations;⁵ concentrated firms are vertically integrated, and fringe firms do not hold the same market share.

4 Most of the small firms pay after the deadline, in other cases they do not pay and sellers are losing money (See Franco and Galindo 1998).

5 When firms are vertically integrated, they perform more than one production process. Integrated firms may compete at each stage with non-vertically-integrated firms that only produced finished goods and buy and sell in the open market. Non-integrated firms sell their finished goods at prices set by integrated firms and buy raw materials from integrated firms. Thus, integrated firms can set the price of raw materials according to finished goods prices, which squeeze non-integrated competitors and forces them to operate with minimal profits or losses.

Market performance is a good indicator of how well the activity of the firms in the market has contributed to the development of economic welfare. Market performance is a key variable in constructing rational policy toward business (Vernon, 1972). Market structure and conduct patterns are significant only if they are associated with market performance (Bain, 1968). Failure of this market to support economic goals related to employment, price stability, income distribution, economic progress and conservation are the result of the structure and behavior of participants.

National statistics report increases in the rate of unemployment for the forestry sector, decreases in timber production, and consequently, negative values of investment. According to Caves (1967) the size of business reveals unequal distribution: "Ours would be a better society if all businesses were small, if the maximum number of citizens were independent proprietors rather than employees serving the economic interest of an employer" (Caves, 1967, p. 99). Following Cave's statement the distribution of business size is unequal for this market; there are 49 wholesalers, of which six are the largest. There are also 122 wholesalers in a population of 11 million people.

Recall that Colombia's Gini coefficient is 0,57, where 3,6% of the country's income goes to the poorest and 54,4% goes to the richest. This index indicates a very high level of income inequality. A comparison of the contribution of the timber market to the gross domestic product, with the unequal income distribution, concludes that the market is performing poorly in terms of distributing the benefit of output.

If a few large firms of similar size dominate an economy and many small firms enter, the small firms will enjoy little success, so, even in aggregate, their market share is very low. Concentration has not been significantly affected, but the degree of inequality has greatly increased (Encaoua and Jacquemin, 1980). Many small wholesalers report low profits that sometimes do not cover the costs of production. This situation puts small competitors at a disadvantage (Franco and Galindo, 1998).

The value of the gross margin in 1997 was estimated at 61,5% (Franco and Galindo, 1998). This value indicates that the market seems to be efficient; however this value has to be carefully analyzed. A marketing margin is used to compare the same product in different regions of a country (Harriss, 1979). A marketing margin is a means of assuring efficiency; it refers to the

difference in price paid and received by any agency. High levels of concentration and vertical integration among large wholesalers demonstrate efficiency, but there is no evidence of efficiency in small firms; in fact, some of them went out of business while the concentrated wholesalers remained. Concentrated firms are technically efficient, but this does not mean that allocative efficiency is practiced. Finally, if there are high levels of concentration with barriers to entry and vertical integration by the oligopolistic firms, the degree of the imperfection is also high. Firms in the open market do not have the power to set prices; in fact concentrated firms are those which set prices. Vertically-integrated firms, which in turn are also concentrated, restrict output. There is a low probability that small firms will be able to become vertically integrated and join the concentrated firms.

As a result, the low total contribution of the sawtimber market to the GDP leads to the conclusion that the market is not competitive enough to gain a good position within the national economy or in the international exchange. The evidence relies on statistics that show decreases in total consumption of sawtimber products during the 1999-2000 period. Imports declined from 6.300 cubic meters to 2,000 cubic meters; exports also decreased from 8.700 cubic meters to 4.500 cubic meters (FAO, 2002). Despite the high potential of resources, the market is not well positioned in the economy of the country. This low contribution affects government decisions toward the timber market. As a consequence, timber products used for manufacturing are also affected. The furniture industry reported for the earliest 1990's the lowest levels of contribution within the manufacturing industry (DANE, 2000); consequently, timber markets do not perform positively to the economy of the country.

B. Market Between Concentration Yard and Wholesalers

The concentration yard is a place where timber is stored and then distributed to the principal cities. Large quantities of timber are stored and rotate every five days. Within that time frame gatherers obtain permission to transport timber from the *Corporación Autónoma Regional del Valle* —CVC—, a local government entity. The description of the market between the concentration yard and wholesalers indicates a high level of seller concentration. Three of the 68 sellers control 56% of the transactions. There is no product differentiation, but there are barriers to entry

because of the requirements for capital and knowledge. Established gatherers —concentration yard— who know their buyers —wholesalers— and offer them credit options have a certain degree of control over buyers. The structure of the market influences market conduct, which indicates that concentrated firms set prices and output. Dominant firms function as financial facilitators; create barriers to new entrants and control their rivals in the open market. Firms, in the concentration yard, with high levels of capital and good financial services attract wholesalers. More buyers indicates higher output and lower prices. High levels of output are concentrated in three firms, which in turn offer lower prices.

Vertical integration plays an important role between firms and their rivals. Some gatherers possess trucks, ships and sawmills. A vertically-integrated firm does not hold the same output share as its rivals. One of the concentrated firms is completely vertically integrated, owning sawmills, trucks and five of the ten ships that transport raw material. This firm dominates the market because of its transportation advantages. Absolute cost barriers arise from the concentrated firms that also control harvesting licenses and transportation permits. High barriers to entry permit a price near that which maximizes short-run profits without attracting new competitors.

Due to the financial power of the concentrated firms, high levels of concentration and high barriers to entry, predatory price-cutting can be concluded as a coercive technique for this oligopolistic market (Caves, 1967). In this market the largest firm sets prices; therefore price leadership is how this oligopolistic market coordinates prices. Franco and Galindo (1998) observed that the largest firm reported the lowest prices. Concentrated and vertically-integrated firms can easily squeeze their small rivals by charging more for transportation. In the South Pacific Region, one firm owns five of the ten ships; therefore, this firm is able to influence price and output. However, it does not squeeze its rivals completely because it enjoys high profits from selling the transportation service and selling timber at a higher price than the competitive market.

Firms in this market perform inadequately in their contribution to employment, investment and income distribution. The concentration yard is not a very good source of employment due to the low number of workers needed. In 1999, the department of Valle reported a decrease in the numbers of firms related to forestry activities (DANE, 2002). Decreases in employment began in 1999

with 317 employees. It is possible to infer that employment decreases at the same rate nationally. From 1996 to 2000, five firms went out of business. The demand for sawtimber products also decreased. Large firms remained in the business for several reasons: i.) the largest firms have fixed buyers, ii.) the largest firms can produce less without suffering drastic decreases in rates of return and iii.) vertical integration helps firms maintain levels of profitability.

Technical efficiency does not apply at this stage because there is no manufacturing, only transportation and storage. Regarding income distribution, in an economy dominated by a few large firms and many small firms, small firms do not enjoy high levels of profitability; therefore, the income inequality is high (Encaoua and Jacquemin, 1980). According to Franco and Galindo (1998) owners of small firms stated that buyers prefer firms that can deliver timber without any problems, including sending trucks frequently and keeping transportation permits current. Therefore, small firms struggle to survive. This statement, combined with the Gini coefficient, indicates that small firms receive a small portion of the income generated by timber production. There is also an unequal distribution in the size of the firms. There are only three large firms and 65 medium and small ones.

Small firms face other challenges as well. The banking system does not support small firms. High levels of interest were reported for 1997 (Banco de la Republica, 1988, 2004). In addition, small buyers, who buy from small sellers, do not pay for timber on time. Another arrangement between firms in the concentration yard is for larger firms to let their buyers make payments between 30 and 90 days with no interest. Small firms must follow this pattern if they want to sell their products; otherwise, small buyers will buy directly from large sellers even for a higher price.

C. Market Between Sawmills and Concentration Yards

In this market sawmills act as sellers and concentration yards are buyers. Sawmills are scattered along the rivers of Cauca and Satinga in the departments of Cauca and Nariño respectively. Franco and Galindo (1998) recognize sawmills as the first stage in the chain of commercialization. Squaring of logs is considered the first level of manufacturing. Gatherers in the concentration yard decide how much timber is needed because they possess harvesting licenses and know the amount of timber available. Before timber is harvested it is already sold in

Buenaventura, gatherers pay 30% of the value of timber to sawmills. The remaining 70% is paid when timber arrives at the concentration yard. Once timber is unloaded restrictions are imposed on sellers. Ultimately the preharvest price contract is no longer valid. This results in a high degree of price uncertainty.

Forty six percent of the output is concentrated in four of the 54 sawmills indicating a seller-concentrated market structure; all of the largest firms are located in Nariño (Franco and Galindo, 1998). The description of the market between concentration yard and wholesalers showed that most of the largest gatherers own sawmills. Therefore, it is possible to infer buyer concentration. On the other hand, large gatherers in the concentration yard contract with several small sawmills to obtain the amount of timber they need.

Product differentiation arises from location. In addition to timber, ships also transport people, fuel, food and some household goods. Population is more concentrated in Nariño than in Cauca, there is one shipment daily to Nariño meanwhile to Cauca it is one shipment per week (Franco and Galindo, 1998). Consequently, more timber is produced in Nariño because the low cost of transportation. Therefore gatherers prefer timber from Nariño sawmills not only because it is the lowest price but also because of the availability of raw material between shipments. Cauca sellers are disadvantaged; they may not sell enough output to save them from the higher cost of production. Barriers to entry arise from vertical integration, high levels of available capital, and knowledge. The conduct of the market indicates that buyers control the output and the price. Price is not stable in this market because of the nature of payments and the financial system.

The performance of this market is poor; there are high levels of unemployment, unequal income distribution, and high levels of poverty. From 1996 to 1999 total employment decreased by 20%. Salaries also decreased; salaries in Nariño and Cauca's rural areas are lower than the average minimum salaries in Bogotá. There are six municipalities in the South Pacific Region. Around 75% of the population of those municipalities lives in rural areas (DANE, 1985). On average, sawmills employ 20 people (Franco and Galindo, 1998), so 54 sawmills employ 1.080 people of a population of 79.184 habitants. Employment in the South Pacific Region is very low compared with the rate of employment in Bogotá.

The value of production⁶ also decreased for the same period, except for 1997, when it increased from the year before. However, the value of the production in Nariño and Cauca was 43 times less than the value of the production in Bogotá. The South Pacific Region has the lowest indexes of quality of life for the whole country. Eighty percent of the population does not have its basic needs met—food, housing and clothing—, and 60% of the population lives in absolute poverty. Only 30% of the population has access to health services. Seventy-nine percent of the salaries are below the minimum wage (Orozco, 1997; DANE, 2000).

In 1970, the sawtimber industry experienced a high level of production. New technology was purchased in order to export forest products. Today the same technology is still being used. The sawing process produces an average of 45% waste (Orozco, 1997; Franco and Galindo, 1998; Macía and Rojas, 1999). In recent years even higher levels of waste are suspected because chainsaws are used to square timber in the forest.

Low levels of profitability were experienced due to the high cost of production and price uncertainty (Franco and Galindo, 1998). High cost of production also indicates low technical efficiency. There is also illegal trade because of the price uncertainty, high levels of unemployment, high cost of production, and absence of government intervention (Franco and Galindo, 1998). Small sawmills do not have access to the credit required to improve technology and support research. Producers extract any amount of timber to secure any level of income that helps them cover at least their basic needs.

There is no private research in the forest region, although several studies have been made by public institutions (Minambiente, Universidad Nacional Medellín, Corponariño⁷ and CRC⁸) Research is directed toward conservation, management and productivity of the forest, and policies toward social issues, while timber marketing has been poorly studied.

6 The value of production is given in terms of Forestry activities —Manufacture Survey 2001—.

7 Corporación Autónoma Regional de Nariño —Nariño Autonomous Regional Corporate Authority—.

8 Corporación Autónoma Regional del Cauca —Cauca Autonomous Regional Corporate Authority—.

D. Market Between Loggers and Sawmills

In this market loggers are the sellers and sawmills become buyers. The local communities of Nariño and Cauca provide the loggers, which are usually a group of four people or family members who obtain logs from the forest (Orozco, 1997; Franco and Galindo, 1998; Del Valle, 2001). The market at this point is very informal and the available information is poor. Buyers contract with loggers to obtain raw material. The structure of the market indicates buyer concentration. There are 54 sawmills on the South Pacific Region and the number of loggers is not easy to identify. Four of the 54 sawmills produce 46% of the output; there is no product differentiation and there is no evidence of barriers to entry for loggers.

Buyers —sawmills— dominate the market by deciding how much to pay for the logs and how much timber to buy. Sawmills provide loggers with tools, such as chainsaws, food and medicine, or home supplies. Once the logs are at the sawmills, producers decide what the logs are worth. If the amount exceeds what the producers already paid in food and other supplies, loggers will receive cash or more food. However, there are many cases when the amount is not enough to cover producer's expenditures; therefore, loggers must go into the forest and extract more logs (Franco and Galindo, 1998).

The performance of the market results in high levels of poverty, unemployment, unequal income distribution, inefficiencies, and illegal timber trade. The market also exhibits informal employment, where loggers obtain logs to sell to different sawmills. From 1996 to 1999 total employment decreased by 20%. Salaries also decreased salaries in Nariño and Cauca's rural areas are lower than the average minimum salaries in the country. Seventy-nine percent of the salaries are below the minimum wage (Orozco, 1997).

Income distribution is unequal; producers have high levels of profit, which ultimately goes to concentration yards due to vertical integration. The local community not only lives in extreme poverty, but also carries the consequences of forest depletion. Franco and Galindo (1998) estimate that 15% of the gross margin for sawmill producers goes to loggers. This is 3,2% of the total gross margin for the industry. This amount is not a net benefit since the gross margin was calculated based on selling price. The net benefit falls below the gross margin

due to high labor requirements, especially when loggers have to build channels of extraction.

III. Econometric Model

The paradigm of market structure, conduct and performance defined the relationship between observable elements of the structure and performance of the industry. These observations provide insight into the possible collusion of firms. However, the evolution of markets and the availability of data motivated researchers in the 1980s to find an empirical way to describe the organization of the industry. Bresnahan (1989) labeled this technique as the New Empirical Industrial Organization (NEIO).

NEIO designs procedures to estimate the parameters of market conduct. Huergo (1997) concluded that Gollop and Roberts (1979) and Appelbaum (1982) used game theory to estimate the conduct of the markets. These two works have been the basis for much research regarding oligopolistic markets. Appelbaum (1982) based his model on the Lerner index (Lerner, 1933), which not only measures the degree of imperfection but also considers the social welfare implications, which in turn are measures of market performance. Appelbaum's model has been used for several studies of imperfect agricultural and timber markets (Schroeter, 1988; Schroeter and Azzam, 1990; Durham and Sexton, 1992; Murray, 1995; Bhuyan and Lopez, 1997; Azzam, 1997; De Mello and Brandao, 1999; Muth and Wohlgenant, 1999; Arnade and Pick, 1999, 2000; Lopez, Azzam and Liron-España, 2002).

A. Basic Model

The market between concentration yard and wholesalers is analyzed using the model developed by Appelbaum (1982). The specifications developed by De Mello and Brandao (1999) are used to define conjectural elasticity. The methodology is derived from the profit maximization first order condition. The model is specified so that aggregated, price and quantity data are sufficient to analyze the structure of the industry and to define a degree of oligopoly index for the whole industry. A non-linear simultaneous equation system with a market demand function, three factor demand equations and an equilibrium condition are defined.

The degree of the imperfection is expressed by the Lerner index (L)

$$L = \theta E \quad (1)$$

Where θ is the conjectural elasticity — CE — and E is the inverse of demand elasticity.

Conjectural elasticity is applied to oligopolistic industries, and indicates how the firm's market share will be affected by the actions of its competitors (Gollop and Roberts, 1979). Conjectural elasticity depends upon the market share and the conjectural variations. Conjectural variation refers to a firm's expectations about the effects that changes in its production have on the output level of its rivals (Iwata, 1974). If the model is considered in the aggregate, CE will depend on price-cost margin and on the demand elasticity. Therefore, CE depends on market conditions, which are divided in upstream market conditions —factor prices— and downstream market conditions —product price, market share, and demand elasticity— (De Mello and Brandao, 1999). These conditions are associated with other elements including degree of concentration, barriers to entry, institutional framework surrounding the industry, the implicit or explicit agreements, diversification and substitutability of the products and the demand expansion (De Mello and Brandao, 1999).

The conditions mentioned above are present in the sawtimber industry as was mentioned in the description of the markets. Furthermore, the institutional framework has changed in the last 10 years,⁹ leading to unexpected changes for the firms in the industry. Diversification and substitutability also play important roles in the timber industry because of the increase in softwood products.

A Cobb-Douglas function, demand is represented in the equation:

$$\ln Q = \alpha - \varepsilon \ln(p) + \alpha_1 \ln(GDP) + \alpha_2 \ln(PS) \quad (2)$$

Where: p is the price of sawtimber; GDP is the Gross Domestic Product. PS is the price of substitutes —softwood-Pino—. The value of ε is the demand elasticity.

9 The Ministry of Environment was created —Law 99/1993— to coordinate all the activities of the natural resources, including forest. With this new Minister new legislation has been adopted and some others have been changed.

In the factor demand equations, the main industry inputs are raw material (R), capital (C), and labor (L). Assuming a Generalized Leontief Cost Function, cost equation can be written as:

$$C(Q, w) = b_c w_c + b_{w_L} w_L + b_{w_R} w_R + [b_{cc} w_c + b_{LL} w_L + b_{RR} w_R + 2b_{cL} (w_c w_L)^{1/2} + 2b_{cR} (w_c w_R)^{1/2} + 2b_{LR} (w_L w_R)^{1/2}] Q \quad (3)$$

Where: w_L is price of labor, w_R is price of raw material and w_c is price of capital.

Quantity of capital data is not available. Therefore, the capital variable was eliminated from the model. A Similar assumption was used by Schroeter (1988) who estimated the degree of market power in the beef packing industry.

Two factor demands are:

$$\text{Demand for labor: } \frac{\partial C(Q, W)}{\partial w_L} = \frac{f_L}{Q} = b_{LL} + \frac{b_L}{Q} + b_{LR} \left(\frac{w_R}{w_L} \right)^{1/2} \quad (4)$$

$$\text{Demand for raw material: } \frac{\partial C(Q, W)}{\partial w_R} = \frac{f_R}{Q} = b_{RR} + \frac{b_R}{Q} + b_{RL} \left(\frac{w_L}{w_R} \right)^{1/2} \quad (5)$$

Where f_R is the quantity of raw material —timber in cubic meters— and f_L is the number of employees in the sawtimber industry. In the equilibrium condition, positive margin in the model could be found since the market is oligopolistic. The equilibrium condition used by De Mello and Brandao (1999) is:

$$p = (\alpha_R + b_{LL}) w_L + (\alpha_R + b_{RR}) w_R + 2b_{RL} (w_R w_L)^{1/2} \quad (6)$$

Variables Q , p , f_L , f_R are endogenous all others are exogenous.

The parameter of equations 4, 5 and 6 are estimated by using a linear 2 stage system least square method. Knowing b_{LL} , b_{RR} , and b_{LR} the value of Marginal Cost (MC) can be estimated by the assumption that Marginal Cost (MC) equals the price. Having MC and, the conjectural elasticity is estimated:

$$\theta = \frac{p - MC(w)}{p} \varepsilon \quad (7)$$

The elasticity of demand is estimated from equation (2) by using ordinary least squares. The degree of the imperfection, L , can also be found.

Both conjectural elasticity and the degree of oligopoly provide information on the degree of competitiveness in the industry. “They both provide information on the deviation from the perfectly competitive and pure monopolistic cases” (Appelbaum, 1982, p. 293).

The degree of oligopoly is expressed as the *CE* multiplied by the inverse demand elasticity. If the industry is perfectly competitive, then $L=0$; if the industry is pure monopoly, then $L=E$.

B. Data

Data on timber prices and quantities, price of substitutes and price of raw material are available for the years 1990-1997, the sources of information is SIEF, Inderena, and Franco and Galindo (1998). Gross Domestic Product, price of labor and consumer price index are taken from the regional survey of the National Statistic Department (DANE). Prices were deflated by the consumer price index base 1994. Due to the small number of observations, data from related markets was used to illustrate the effectiveness of the model. Prices of sawtimber from Amazonian, Magdalena Medio and Chocó regions were used. However, data of the Amazonian region in 1990, Magdalena Medio 1991, 1992 and 1993 were not available; therefore the model contains 28 observations. A linear system of equations was used in the Statistical Analysis System —SAS—.

C. Results

The elasticity of the demand is $-0,0835$, which is consistent with the economic theory; however, the result has to be carefully analyzed because the t-statistic stated that the estimate is not significant at a 5% level. However, it is significant at a 10% level. Autocorrelation was tested in the demand equation. To test for autocorrelation the null hypothesis is: $H_0: \rho=0$, which indicates that error terms are not autocorrelated. The alternative hypothesis $H_a: \rho>0$ indicates that error terms are autocorrelated. The most common used statistic to test for autocorrelation is Durbin-Watson (Maddala, 2001). The DW statistic was 2,7781, which indicates that the null hypothesis of positive first order autocorrelation is not rejected. To test for negative first order autocorrelation, 4-DW is compared with dU and dL. Since $4-DW=1,22>dL$, this test is inconclusive.

For the system of equations, Table 2 shows the estimates and standard errors. With those estimates, marginal cost, *CE*, and the degree of oligopoly were

estimated. Table 3 shows positive values for CE and for the degree of oligopoly, this indicates a market with imperfectly competitive market structure and the presence of market power. The estimates have to be significantly different from zero. To test the hypotheses for the presence of perfect competition and the absence of market power, sample mean estimates and standards deviation of θ and L are used. Table 4 shows those estimates.

The hypotheses for perfect competition are:

$$H_a : \theta = 0 \quad \text{and} \quad H_a : \theta \neq 0$$

If $\theta = 0$ the market is perfect. The t-statistic test is used for 27 degrees of freedom and a 5% level of confidence.

$t = 2,97$ H_0 is rejected, therefore the market is imperfect.

The absence of market power hypothesis; $H_0 : L = 0$ and $H_a : L \neq 0$

If $L = 0$ there is not market power. The hypothesis is rejected with the t-statistic sample value of 2,97 for 27 degrees of freedom at five percent level of confidence. Therefore, there is market power.

Finally, due to the low value of the demand elasticity a test of sensitivity is used to observe what happen if the elasticity of the demand changes. Therefore elasticities of Pulpwood (-0,31) for US is used (Murray, 1995), and demand value of -0,5 and 1, It was observed that changes in elasticity of demand change conjectural elasticity but keep constant the degree of oligopoly. If the demand elasticity increases, the CE increases too. The greater the elasticity of demand the higher the level of market imperfection.

Table 2. *Estimates and standard errors for parameter for equations (4), (5) and (6)*

Parameter	Estimates	Standard Error
b_{LL}	0,225667*	0,0320
b_{LR}	-1,60623*	0,2168
b_{RR}	13,80943*	1,9481
α_L	-0,02204	0,0132
α_R	-0,24146	1,2444

* significant at a 5% level

Source: SAS output for nonlinear 2SLS.

Table 3. *Estimate values of the conjectural elasticity and degree of oligopoly*

Year	θ	L
1990	0,024	0,285
1991	0,03	0,363
1992	0,023	0,273
1993	0,019	0,225
1994	0,026	0,312
1995	0,049	0,588
1996	0,025	0,296
1997	0,037	0,448

Table 4. *Sample mean estimates*

	$\hat{\theta}$	
Estimate	0,0291156	0,3486902
Estimates standard deviation	0,0098023	0,1173933

IV. Discussion and Conclusions

Market structure and conduct of the market from wholesalers to final consumers determines the performance of the market at a national level. Trade balance, gross domestic product, and public policy explain the relationship of the structure of the market and performance as measures of social goals. Market structure and conduct of the remaining markets determines the performance of the market at the regional level—in this case, Nariño, Cauca and Valle departments.

The study of domestic timber market is a tool for policy makers; timber markets make a low contribution to the economic growth of the country, and the available capital in the forest is being used without any pattern that guarantees its sustainability. Large quantities of waste, the pressure on some species and the method of extraction are depleting the resources. Furthermore, there are no incentives to improve technology, education and infrastructure. As a consequence the communities who live in and from the forest are likely to remain poor (Wunder, 2001). The problem with poverty associated with timber extraction is due to a lack of regulation. Oligopolistic markets that behave almost as monopolies are taking advantage of the lack of government regulations toward the forest and the markets for its products. There is also a lack of incentives that would benefit the community.

The studies devoted to timber markets (Orozco, 1997; Franco and Galindo, 1998; Macía and Rojas, 1999; Minambiente, 1999; Acevedo and Martínez, 2003), associate market imperfection with a large number of participants in the chain of commercialization. This statement is partially true. There are more factors associated to the imperfections in Colombian timber markets. First, in the real world, there are not a perfect markets for any commodities; therefore, all the markets are imperfect. There are imperfect markets where their contribution to social goals is consistent to the role of the markets. Those markets are less imperfect because information is available, barriers to entry are low and output concentration is low. The contribution of these markets to achieve goals of employment, efficiency, and equal income distribution is at their capacity.

On the contrary, markets with strong barriers to entry and concentration associated with high levels of vertical integration and high levels of capital are

more imperfect and their contribution to social goals is limited. This is the case of timber markets in the South Pacific region of Colombia. This market deserves more attention, particularly the markets associated with the concentration yard, which are behaving as oligopolistic/oligopsonistic markets. The econometric model shows fairly high levels of market imperfection (oligopoly) for the concentration yard firms. The degree of power of the three firms in the concentration yard is associated to transportation, knowledge and capital; consequently, concentration yard enjoy the benefits of vertical integration, higher profits, control over prices and control over smaller firms. The fact that large firms in concentration yard provided financial services for the small ones increases the gap between people under the line of poverty and those over the line. Furthermore, Wunder (2001) mentions that the role of loggers in the clearing is instrumental; they are not decision makers. “Opportunities tend to drive tropical frontier deforestation more than poverty—this holds true in most of Latin America and probably in much of Asia...” (Wunder, 2001, p. 1823).

In the struggle to reduce poverty, Colombia’s government should dedicate more time to create incentives for small businesses, associated to education and training. One way to reduce barriers to entry is by having more information available. Therefore, the statistical information system has to be fortified. Local people should be training to obtain manufacturing products; technology has to be updated to reduce waste. At this point is important to indicate that indigenous people —local community— have conserved the forest over the years. Local people are actually conscious of the importance of keeping their environment; in fact it is part of their culture and traditions (Leyva, 1996).

The problem with the South Pacific forest is basically the intensive extraction of timber. However, this forest —*guanadal*—¹⁰ has a good level of resilience due to soil conditions, fire is not use to clearing and there is not soil transformation for agricultural uses (Del Valle, 2001). Their careful use will contribute to solve some of the problems of poverty, mainly because 90% of the population depends heavily on timber commercialization. Government intervention and agreements

10 Ecosystem along the Pacific coast, which follow succession pattern with mangroves ecosystem.

with entrepreneurs have to focus in research, statistic, economic incentives and technical assistance to reach the goal of sustainable production of timber.

Conversely, the Country already did an important step in the arena of land tenure. Law 70 of 1993 was issued to entitle forest land to indigenous and black communities. Therefore, this advantage has to be used to establish agreements between communities, producers and government.

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