ESTIMATION OF IMPERFECTION IN THE MARKET FOR TIMBER PRODUCTS FROM SOUTH PACIFIC COAST OF COLOMBIA

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PREFACE

This study, sponsored by Department of Forestry at the Oklahoma State University, Oklahoma Agricultural Experiment Station, and the International Tropical Timber Organization, was conducted to estimate the degree of imperfection for the sawtimber markets in the South Pacific region of Colombia.

Forest resources in Colombia are extensive. Forests cover 57 percent of the territory of the country. Four important forest areas—Amazonian, Magdalena-Medio, Caldas-Valle and Pacific—produce timber for domestic consumption. Currently the production of timber is around one million of cubic meters. Sixty percent of the production takes place in the South Pacific region, a moist tropical forest. Methods of sustainable use of natural resources are being studied. The National Plan for Forestry considers timber markets as a priority for policy decisions. A study of the timber markets will contribute to the national plan. Timber markets have not been widely studied.

This study estimates the degree of the imperfection in a series of markets. The chain of commercialization includes a sawtimber market between wholesalers and final consumers (furniture and construction industries) in the capital city

(Bogotá). There is also a market between concentration yards and wholesalers. This market is characterized by the geographic distance between them. Concentration yards are located in the southern part of the country west of the Pacific littoral. The market between wholesalers and final consumers is another market identified in the chain; both markets are in the South Pacific, but in different states. Finally, there is a market between loggers and sawmills. A detailed description of the elements of market structure, market conduct and market performance are made for each of the markets. An econometric model is used to estimate the degree of the imperfection for market between the concentration yard and wholesalers.

The description of the markets indicates that there are oligopolistic/oligopsonistic market conditions in all of the markets. Observable elements of performance show that the degree of imperfection is high. Local communities live in absolute poverty, the forest is being depleted, and there are no government incentives to encourage sustainable management practices for the forest. As a result, sawtimber production in the South Pacific region is not sustainable. Therefore, the country is losing its advantage of having large extensions of forest cover that may be potentially the solution of some problems. In the international arena, sawtimber exchange is not comparable to other tropical countries that export large quantities of sawtimber products. If the domestic production continues being unsustainable, fewer possibilities of international exchange surround the country.

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This research is dedicated to all the children of the tropical forest. Our actions in the present determine their future.

ABBREVIATIONS

The list of abbreviations provides the Spanish name of the institution for reference in the bibliography and within the document.

ANALMA : Asociacion Nacional de Madereros (Nacional Association of Timber Producers)

CVC : Corporación Autónoma Regional del Valle (The Valle Regional Corporate Authority)

CORPONARIÑO: Corporación Autónoma Regional de Nariño (Nariño Regional Corporate Authority)

CRC : Corporación Autónoma Regional del Cauca (Cauca Regional Corporate Authority)

DANE: Departamento Administrativo Nacional de Estadística (Administrative Department of National Statistics)

DIAN: Departamento de Impuestos y Aduanas Nacionales

FAO: Food and Agricultural Organization of the United Nations

INDERENA: Instituto de Recursos Naturales (Institute of Natural Resources)

ITTO: International Tropical Timber Organization

Minambiente: Ministerio del Medio Ambiente (Ministry of Environment)

SIEF: Sistema de Información Estadístico Forestal (Forestry Statistical Information System)

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CHAPTER I

INTRODUCTION

1.1 Description of Colombia

The Republic of Colombia, located in the northwestern part of South America, is bounded on the north by Panama and the Caribbean Sea, on the east by Venezuela and Brazil, on the south by Peru and Ecuador, and on the west by the Pacific Ocean. Its total land area is 1,138,918 square kilometers.

The Andes Mountains cover a third of Colombia; they consist of three parallel ranges, which stretch northeast across western Colombia. Coastal lowlands lie along the Caribbean Sea and the Pacific Ocean. The lands along the Caribbean are primarily agricultural. The Pacific lowlands consist mostly of swamps and dense forests.

The population of the country is around 44.7 million people, distributed in three different ethnic groups: indigenous, black and mestizos, a mix of Spanish and natives Colombians. Mestizos are predominantly located in the Andean region; most of the black population is located on the Pacific coast as well as the Caribbean coast. Indigenous people are located in all the regions, but particularly in the Amazon basin and on the Pacific coast. Traditionally, three economic sectors contribute to the Gross Domestic Product of the country. Those are

1. agriculture: products including fishing, mining, silvicultural activities and cattle, but not coffee
2. industry: products related to manufacturing
3. services: activities such as construction, banking, health, education and social services

The economy of the country in 2003 showed a positive performance. During the first quarter of 2003 the economy grew 3.82 percent, the highest growth since the first quarter of 1998. The economic activity was driven by construction (15.8 percent), manufacturing (8.3 percent), and financial sectors (5.8 percent). Annual inflation was 7.2 percent, exceeding by one percentage point the rate registered the previous year (2002). Annual consumer prices also increased between five percent and six percent, exceeding the target set by Colombia's Central Bank by 1.2 percentage points (Banco de la Republica 2003).

1.2 Description of Colombian Forest

According to the Food and Agricultural Organization (FAO 2000), total forest cover is 67.5 million hectares, 58 percent of the nation's land area. The Amazon forest is the most important natural forest, covering 30 percent of the total land. The Pacific tropical moist forest follows; it covers around 11 percent of the country's area. The rest of the forest area is distributed among Andean, Páramos, Savannah, Mangroves, wetlands and riparian vegetation. Cultivated trees cover 0.2 percent of the country. These areas are known as

plantations. Plantations are mainly established along the Andean mountains and the representative genus is Pinus.

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 goes from the Panama-Colombia border southward along the Pacific coasts of Colombia and Ecuador to the equator. It contains the most extensive area of tropical rainfall and wet forest in the neotropics, and it has one of the highest levels of the diversity and endemism in the world (Conservation International 1992). The Colombian states that are represented in the Chocó Biogeography are Chocó (northern), Valle del Cauca (Central), Cauca and Nariño (Southern).

The map in Figure I-1 (page 4) shows the boundaries of the country, the distribution of the Andean mountains and the research area over the Pacific region. Buenaventura and Tumaco are the most important urban areas in the South Pacific region. Their principal economic activities are forestry, fishing, mining, and some farming. The rural economy in the South Pacific is mainly related to forestry activities and fishing.

Commercial paper-pulp operations have clear-cut extensive areas, and considerable land has been deforested in the Tumaco area in the State of Nariño. The lack of forest management is due to the difficult access and lack of research in timber marketing.

Figure I-1 Map of Colombia

Note: Research area refers the part of the South Pacific coast region where timber is obtained

1.3 Forestry Trade

According to FAO (2000) timber production has decreased since 1997. Table I-1 shows total production of timber from 1990 through 2001. Production is based in sawnwood products, which are products obtained from squaring logs.

Table I-1 Estimation of the sawnwood consumption in Colombia (cubic meters)

Year	Production	Imports	Exports	Apparently consumption
1990	813,000	3,800	9,600	807,200
1991	813,000	3,800	18,700	798,100
1992	758,000	6,475	22,632	741,843
1993	694,000	31,548	1,578	723,970
1994	644,000	10,627	1,685	652,942
1995	644,000	15,000	9,700	649,300
1996	1,134,000	4,600	3,000	1,135,600
1997	1,085,000	15,500	5,900	1,094,600
1998	910,000	6,400	2,500	913,900
1999	730,000	6,400	8,700	727,700
2000	587,000	2,100	4,500	584,600
2001	539,000	500	3,800	912,600
Growth %	-1.50%	-12.50%	-8.70%	0.60%

Source: Acevedo and Martínez (2003)

The South Pacific area is one of the biggest producers of sawnwood in the country. In 1996, approximately 60 percent of the total sawnwood was produced there. The sawnwood is primarily used in the construction and furniture industries.

According to Acevedo and Martínez (2003), wood production of Colombia is only 0.4 percent of the world production and 0.02 percent of the world exports. The silviculture and timber production sub sector represents 0.2 percent of the gross national product, and 1.1 percent of the total agricultural contribution to the gross national product. The forestry sub sector generates 37,761 jobs, which equals one percent of the jobs generated by the agricultural sector (Acevedo and Martínez 2003).

Round wood production is low. Most of the wood produced in the country is sawnwood (71 percent), and pulpwood is 16 percent of the total production. Figure I-2 (page 7) shows the distribution of products produced in Colombia. Sawnwood is mainly extracted from natural forest; pulpwood and particle board are obtained from softwoods, which are species introduced to the country and cultivated in plantations.

In 1999 a total of 285 sawmills were reported in Colombia. Forty eight percent of them were located in the Pacific region, which in turn produced at half of their total capacity. Minambiente 2000 estimated the rate of annual demand for sawtimber as 3.5 percent from 1990-1995 and 3.5 percent for 2000. Total employment generated by the sawtimber industry is 6,100 employees, an average of 20 employees per mill. One thousand retailers that commercialized sawtimber were registered in 1999. They are concentrated in principal cities such as Bogotá, Medellín and Cali.

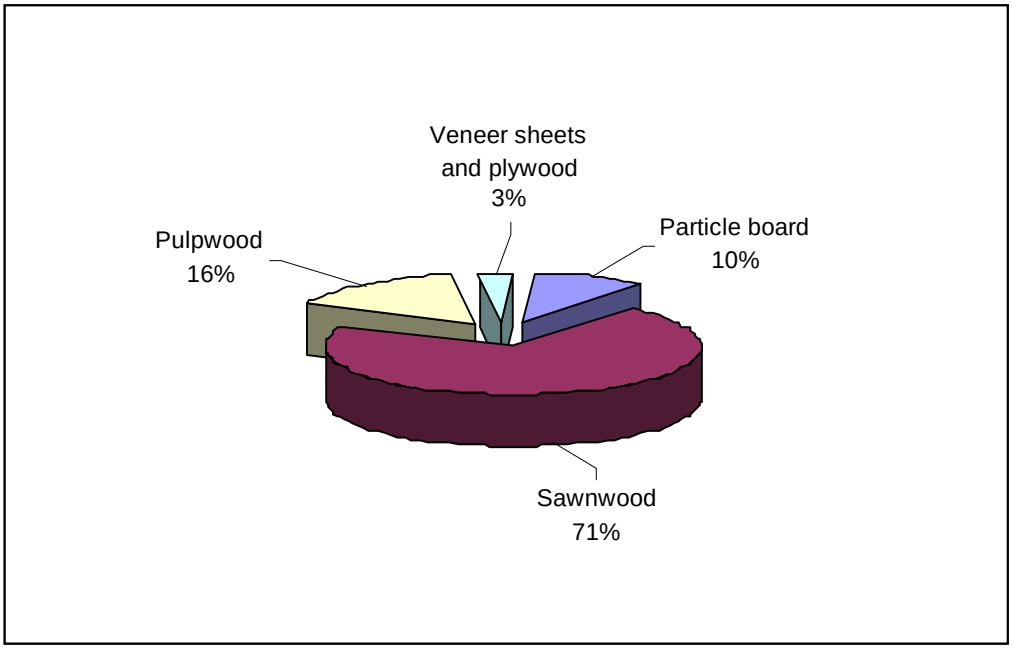

Figure I-2 Distribution by products of the production of timber

Source: Acevedo and Martínez 2003

Table I-2 Distribution of sawmills by potential production capacity and real used capacity in 1999

Type	Quantity	Potential Capacity (Cubic meters)	Used Capacity (Cubic meters)
Small sawmills	145	305,354	-
Median sawmills	140	589,456	-
Subtotal	**285**	**894,810**	**361,388**
Chainsaws*	400	160,000	128,000
Manual sawmills**	1,500	99,000	79,200
Total		**1,153,710**	**568,588**

Source: Minambiente 2000,

* Refers to local loggers that act independently.

** Refers to sawmills where chainsaws are used to square logs.

1.4 Land Tenure System

Until 1993, the South Pacific forest was considered public property. The government issued concessions and permits to harvest the forest. Local communities did not own the forest land. All the activities and legal documentation related to forestry industry was between the local government authorities and the company that wanted to harvest. In 1993, The National Congress issued Law 70 (Ley 70 del 27 de Agosto de 1993). This law gave black communities who have occupied land along the rivers of the Pacific basin the right to own the land as a collective property.

This law has been implemented since 1993; however, the old system of land tenure overlaps with the Law of 1993. Some of the permits expired after 1993, and therefore the old system remained until 1996 and 1997. In 1997, some companies still had permits to harvest forest even though the owners of land were the black communities at that time.

After 1997 all the land of the Pacific basin had to be titled to the local communities. Local communities have to use the forest according to the traditional way of production and by following other specifications of the above-mentioned law. Therefore any plan implemented in the Pacific basin has to include the local communities and their culture and traditions.

1.5 Some Problems Related to the Forestry Sector

There are some problems in the forestry sector of Colombia. Those problems start with the forest itself as a source of raw material. According to Macía and Rojas (1999), standing trees do not have value to the producers, so producers are not concerned about sustaining the forest. Therefore, labor–intensive producers extract high–value roundwoods and high–value sawnwoods, which are commercialized in an informal market. Roundwood is used to manufacture veneer panels, while high–value sawnwood is used for flooring, furniture and house structures. Low–value roundwoods and sawnwoods are used for cheap wood products (for example, wooden boxes to transporting fruit, and mining structures). Local households also extract non–commercial timber for traditional uses such as boat construction, regional sports tools, and musical instruments (Leyva 1996; Sierra, Tirado and Palacios 2003).

Another problem with timber production in Colombia is related to the financial situation of landowners. Landowners cannot afford harvesting licenses so they must become employees of sawmills before they can extract timber from their own land (Macía and Rojas 1999). This form of commercialization of timber not only changes the status of the landowner but also is source of social and biological problems. First, timber is extracted periodically from a community's forests by logging crews (know as cuadrillas) of four to ten people who use no more than two chainsaws. The use of chainsaws represents high rates of waste. Additionally, loggers have developed an informal commercialization process by extracting logs without a license. Cuadrillas receive chainsaws as payment

then cut trees without licenses and sell to other sawmills. The amount of raw material available ultimately decreases because the harvest is not controlled. This method of timber extraction is also linked with other problems: 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 any incentive to conserve the forest; and the pressure over the natural forest continues.

Forest legislation represents another problem. Legislation does not provide producers with incentives to reduce costs of extraction. If forestry legislation were applied and upheld, it would increase production costs. For example, Decreto 1791/96 requires producers to maintain one hundred percent inventory of trees in their forest. A one hundred percent inventory is very expensive; therefore, costs of production increase and the available supply decreases. As a consequence, fewer people are employed and informal extraction increases.

Problems with production are reflected in the economy of the country. The sawtimber industry has been losing importance. Since the mid-1990s, the construction and furniture sectors have been in recession and the demand for sawn products has decreased. This is due to high production costs, high raw material costs, difficulties in implementing new technology, lack of a banking system, and decreasing imports. Firms are not operating at capacity. Small firms and medium–sized firms use only 49 percent of the national production capacity (Acevedo and Martínez 2003).

The forestry sector is not well developed in spite of the high potential of forest cover. Sawnwood production does not have well-developed technology, so the yield per hectare is low and there are quality deficiencies. This problem occurs because of the use of obsolete technology, archaic extraction methods, lack of government regulation, and scarcity of infrastructure. Some of those deficiencies haven been attributed to the difficulties of access to the forest.

1.6 Research Problem

The description of the country showed that Colombia is widely covered by forest; however, the description of the forestry trade showed that the forest's potential has not been well utilized; in fact, the commercialization process for timber causes social and biological problems. However, these problems can be overcome gradually. The national government has considered various solutions to the problems. The National Development Plan of Forestry (Minambiente 2000) states that the economic activities that surround the forest resources cannot be considered apart from the tendency and dynamic of the regional and international markets and the economies. In this sense the sustainability of the production processes has to be analyzed by considering the economic, social and political context in which timber production is taking place.

Including the forestry sector in the national government plan has been an important contribution from the national government to the natural resources. The inclusion of forestry forces forestry and economic researchers to identify the most important problems

and solutions. One of the objectives of the National Development Plan for Forestry of 2000 is to allocate forestry products and services in the national and international markets by promoting competitive markets chains (Minambiente 2000). To achieve the objective the nation has to take these actions:

1. Promote forestry industry by creating forestry industry groups
2. Develop the technology of the forestry industry and
3. Develop the commercial capacity of the forestry products and services

Clearly, timber marketing is one of the priorities of the National Development Plan for Forestry. However, any attempt to promote competitive markets has to be linked with an understanding of the market. The timber market has not been widely studied, either in the context of marketing system or from a microeconomic point of view. Therefore, it is important to describe the market in terms of its structure, conduct, and performance. Microeconomic theory concludes that industries with a monopoly or monopsony and oligopoly or oligopsony structure weaken the general contribution to economic welfare. Since the National Development Plan for Forestry also aims to analyze the economic, social and political context of the timber market, a view of the structure of the market and its connection with performance is a contribution to the process of sustainability.

This research paper focuses on the South Pacific region, which produces 50 to 60 percent of the sawtimber of the country from natural forest. Describing the markets of this region is a good contribution for to process of achieving national economic goals.

1.7 Purpose of the Thesis

The central purpose of this thesis is to estimate the degree and nature of imperfections in the markets for forest products from the South Pacific region of Colombia. This effort will include the establishment of relationships between the performance of these markets and the contribution of the forest products sector to the achievement of national economic goals.

1.8 Objective of the Thesis

The objective of the research is to describe the structure, conduct and performance of domestic markets for sawtimber from the South Pacific region of Colombia, and to estimate the degree and nature of the imperfections in these markets.

1.9 Outline of the Thesis

This thesis is organized in five parts. Chapter I includes a brief description of the country and its forestry activities. Chapter I also states the research problem and the objective of the thesis. Chapter II provides a review of previous work with timber market products in Colombia and descriptive studies of market structure, conduct, behavior and performance. It also includes econometric studies for the estimation of the degree of

imperfection in forestry and agricultural markets. Chapter III presents an introduction to timber marketing in Colombia for the South Pacific region. A description of the structure, conduct, behavior and performance for each market is also included in this chapter. Chapter IV describes the econometric analysis for the market between the concentration yard and wholesalers**.** Finally, Chapter V is a summary of the findings.

1.10 Limitations of the Thesis

Most studies related to the forestry sector aim to observe the biological and ecological importance of forest. Forestry marketing has only become important recently; therefore, few studies have been developed. In addition to the limited knowledge of forestry markets there is a substantial lack of data. One of the attempts to collect data regarding the forestry sector was the Forestry Statistical Information System (SIEF), which collected data during the transition of the National Institute of Natural Resources (INDERENA) to the Ministry of Environment. The data collected covers seven years: 1990–1994 (collected from the INDERENA files); 1995–1997; and part of 1998 (collected by the system itself). In 1999 the Institute of Hydrology, Meteorology and Environmental Studies adopted SIEF to include it as a module of the National Environmental Information System. However, the process has taken years and today the statistics related forestry are not available.

CHAPTER II

LITERATURE REVIEW

This chapter is divided into two parts. The first part contains a brief historical review of the sawtimber market with especial reference to markets from the South Pacific region. The historical review is important because it explains the context in which the market has evolved. The first section also explains the chain of commercialization for the sawtimber market in the South Pacific region, because the chain is important for describing the market and is the primary focus of the research. The second part of the chapter contains a review of previous research related to industrial organization and the market's structure/conduct/performance paradigm. This review is the foundation for Chapters III and IV as well as the support for some conclusions.

2.1 Markets for Colombia's Forest Products

Timber markets in Colombia have not been widely studied. However, all the policies regarding forestry activities acknowledge the importance of timber markets (Minambiente 1999a, 1999b, 2000; Orozco 1996, 1997). Due to the lack of source materials, the review of literature is based on the two studies that refer directly to timber market products. The first is Minambiente (2000), which focuses on the supply and demand of forestry products. The second is Franco and Galindo (1998), which determines

the chain of commercialization and gross margins for the timber market in the South Pacific region.

2.1.1 Historical Review

The South Pacific region has been an important producer of timber for more than 30 years. Satinga, a region in the State of Nariño, has been the most important timber producer of the Pacific area. This historical review will trace the developments of the timber market from the 1970s to the 1990s.

The 1970s was a good decade for timber production; technology was current and sawmills produced at total capacity; therefore, the statistics showed good levels of employment. The construction of a channel with the Patia and Sanquianga rivers was an advantage for all sawmills in the region. Most sawmills are scattered along that channel. In 1963, the South Pacific region registered 92 sawmills; half of them were located in Nariño (Minambiente 1999). In the early 1970s, timber was extracted under concessions. Fifty-four percent of the concessions for forestry harvesting were issued to sawmills of the South Pacific. One hundred seventy-nine sawmills were reported. Labor for harvesting consisted of 7,566 workers. Sawmills employed 5,500 workers, and 800 workers were employed in administrative functions. Production also was important. The Pacific region produced 1,061,274 cubic meters, which is 71 percent of the total production of the country.

Despite success for timber production in the 1970s, the national financial system did not help the industry. In the late 1970s, 131 sawmills were registered in the Pacific region. Forty-eight sawmills closed at the end of 1976. According to Minambiente (1999a), the biggest firms closed and only small and medium-sized firms remained.

In the mid-1980s, 300 sawmills produced timber in the country. Fifty-six percent of them were registered in the Pacific region; however, around 30 firms did not produce at full capacity. Because of civil conflict, mechanical sawmills started to diminish. Small mills and independent loggers supplied the demand for timber in the late 1980s. Within this decade, harvesting was selective toward the most valuable species, which were well accepted in local and regional markets (Minambiente 1999a).

INDERENA, in 1993, reported 300 mechanical sawmills in the country. One hundred forty-four of them were in the Pacific region (Minambiente 1999a). Production capacity was estimated to be 2.3 million cubic meters, but the real production was 1.2 million cubic meters. Sawmills employed 6,100 workers including harvesters. In 1996, total production equaled 1,311,230 cubic meters. Fifty percent of the production took place in the South Pacific region. Then, in 1997, the demand for forest products decreased as new technical requirements for forestry inventories lowered the demand for harvesting permissions. Table II-1 (page 18) shows the demand and supply of timber in Colombia for the period of 1990–1997. Supply is the total quantity of timber under harvesting permission. In other words, supply equals the stumpage volume from natural forest.

Demand is the quantity of timber that was transported, or produced, from the forest to the final consumers.

Table II-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

Source: Minambiente (1996, 1997 and 1998) -SIEF-

Summarizing, the production of sawtimber decreased from 1990–1994, then increased from 1995–1997. According to Minambiente (1999), the annual rate of increase for timber demand from 1990–1995 was estimated at 3.5 percent. The rate for 2000 was three percent. The decrease in demand for 1997 is one of the consequences of the drastic requirements of the Decreto 1791/96 (Minambiente 1999a). However, production remained high during that time.

According to Minambiente (1999a), the Pacific forest produced 60 percent of the sawtimber in 1997; cultivated forest, 15 percent; and the other 25 percent of the

production took place in Amazonian, Caribbean and Medium Magdalena forests. In 1998, the chain of commercialization was defined for each of the forests mentioned. Gross marketing margins for each of the stages of the chain were also estimated. This has been one of the first attempts of the country to include domestic timber marketing as an important tool for the forestry sector's goal of sustainability. Chapter III will describe the chain of commercialization for the South Pacific region.

2.2 Industrial Organization

This section provides a theory for understanding and describing markets based on elements of structure, conduct and performance. First, the industrial organization concept and its relationship with market power is provided.

Industrial organization is a term that embodies the coordination and operation of the enterprise in an economy. Industrial organization can be explained by observing the interaction of buyers and sellers of goods (Bain 1968, Schmalensee and Willing 1989). One of the challenges of industrial organization is to describe and quantify market power. To achieve this goal, industrial organization can be described under the paradigm of structure, conduct and performance of the markets within the industry (Bain 1968). Defining the relationship between observable measures of the structure, conduct, and performance of the industry permits an estimation of collusion within firms in a particular market (Huergo 1997). Market structure refers to the characteristics of buyers and sellers

that exercise influence on the competition and pricing within the market (Bain 1968). Those characteristics are the degree of buyer and seller concentration, product differentiation and conditions to new firms entering the market. 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). Market performance represents the economic results of structure and conduct. Caves (1967) cited four goals that contribute to the well-being of citizens and that reflect in the market's performance. Those goals are

1. efficiency—how factors of production are used
2. employment—how many jobs are generated
3. progress—quality of goods, technology and research
4. equity—distribution of the real output among members of the society

Knowing these goals, 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, 97). Performance in particular industries or markets depends on the conduct of sellers and buyers. Conduct depends on the structure of the relevant market (Bain 1968, Caves 1967, Scherer 1980). Industrial organization helps identify what makes for good or bad performance. It also assists with public policy formation by indicating ways to make the economy perform better.

According to Scherer (1980) there are three different measures that any economy must use to decide how much to produce and how allocate its resources. Tradition is one of

these ways. Another one is planning, and the third is the market system, “under which consumers and producers act in response to price signals generated by the interplay of supply and demand forces in more or less freely operating markets, each participant seeking to make the best of the market conditions he or she faces” (Scherer 1980, 1). Industrial organization is concerned with the market system approach. It is one of the ways to see the contribution of any industry to the economy as well to political decisions. Scherer (1980) considers the fundamental assumption of what society wants from producers of goods and services as reflected in performance, which is observable in social goals. Scherer (1980) states that it is not easy to measure the degree to which goals have been satisfied, but operational approximations can be achieved by using data on price-cost margins, the relationship of actual costs, rates of change in price and output per man-hour, variability of employment over the business cycle, and so forth. In 1930, Edward S. Mason of Harvard University created the broad descriptive model of these relationships that is used in most industrial organization studies (Scherer 1980). The model is illustrated in Figure II-1 (page 22).

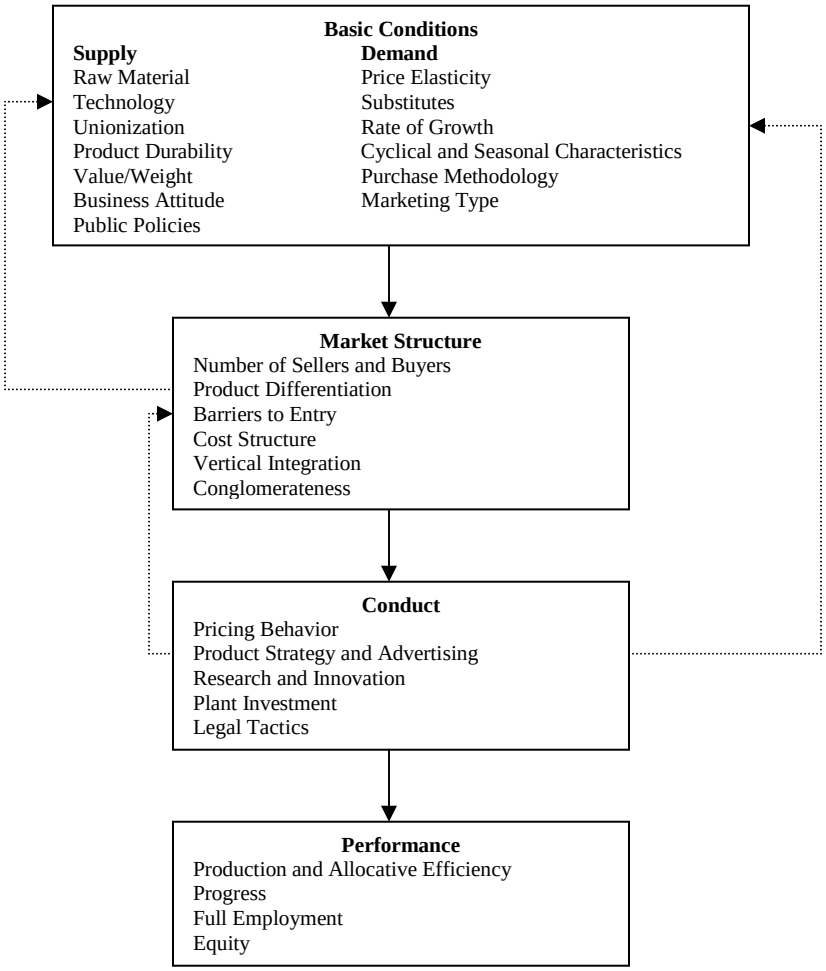

Figure II-1 Model of industrial organization analysis

Source: Industrial Market Structure and Economic Performance. F.M. (Scherer 1980)

The figure suggests that the primary relationship between supply and demand explains market structure, which in turn explains conduct and then performance. This approach has been considered by several researchers (Bain 1968, Caves1967, Shepherd 1972). In fact, it has been used as a foundation for vast empirical studies of the relationship between various measures of market structure, or firm characteristics, and economic performance. However, according to Scherer (1980) and Harriss (1979), there is not such

a rigid flow. Some theories predict performance based on observations of structure, basic conditions and conduct as well the interrelation between conduct and market structure, market structure and basic conditions, and conduct and basic conditions. The light arrows in Figure II-1 illustrate these interrelationships. A description of the elements of market structure, conduct and performance will explain industrial organization and market power of the industry.

2.2.1 Elements of Market Structure

As Caves (1967) indicated, there are some elements in the structure, conduct and performance of the market that need to be considered in order to understand an industry. The main elements of market structure are

1. Concentration
2. Product differentiation
3. Barriers to entry of new firm

These elements can be measured and observed, even if they tend to change over time. “If we can uncover reliable links between elements of structure and elements of performance, we can with relative ease and confidence predict the performance of any industry in which we are interested” (Caves 1967, 17). The following section will define and discuss the elements of market structure in detail.

Concentration

Concentration is defined as “control of a large proportion of some aggregate of economic resources or activity by a small proportion of the units which control the aggregate” (Bain 1968, 78). Concentration ratio is a measure that considers the number and size of firms in a market. The concentration ratio for a monopoly would be 100 percent, while in a competitive industry the ratio of the larger firms would have to be very small, four or ten percent. The ratio for an oligopoly would lie between monopoly and competitive (Bain 1968).

There are different ways to calculate concentration; the most popular indexes of concentration consider the percentage of value added, assets, sales or employees accounted for by the *x* largest firms in an industry. Value added is accepted as the best measure of economic size; however, it is not always available (Vernon 1972). Because the price level of assets varies over time, its use is not accurate unless a rule for the valuation is applied. The most available measure of size is the sale or value of shipments.

An index of concentration overcomes the problem of both inequality of firm size and unknown actual number of sellers. Concentration index can be defined as a measure of the degree of ease with which collusion might be effected (Caves 1967, Bain 1968, Huergo 1997). That is, successful collusion among firms should yield profits approaching the monopoly level, and the ability to collude increases with the degree of concentration. Collusion is not present in unconcentrated industries; therefore, competitive results are expected (Bain 1968).

Economic theory concludes that monopolies, industries with high seller concentration, are more likely to earn higher profits than competitive industries with low concentration. While concentration is an indicator of market imperfection, it is not the only aspect that determines performance. Concentration rests on and reflects other elements of market structure such as product differentiation and barriers to entry.

Product differentiation

In some industries the difference in products does not exist, so consumers have no basis for forming a preference between two products. Indeed, consumers cannot even tell one output from the other, and they would not pay more for one seller or the other. Few markets have undifferentiated products (Mead 1966, Caves 1967, Bain 1968). In an undifferentiated market, if a firm raises the price above the market level, the firm will not sell any units of the product.

Product differentiation arises from various sources. A difference in quality or design among outputs is one of the sources that may influence buyers to prefer one output over the other. Ignorance of buyers regarding the characteristics and qualities of goods is another source of product differentiation. Buyer preference may also be influenced by advertising or promotions (Caves 1967, Bain 1968, Scherer 1980). This particular activity tends to build a product differentiation based on knowledge of the relative designs, qualities and prices of competing outputs. Finally, product differentiation may also result from differences in the locations of sellers of the same good. This source of product differentiation is particularly special. In fact, according to Bain (1968) two conditions

need to be filled: “One is that there are, from the standpoint of the buyer, significant differences among sellers in the cost of either having the good delivered or picking it up, different costs in terms of money, inconvenience or time. The other is that buyers pay or suffer these delivery or pickup costs in such a way that they pay different full prices (prices at seller’s locations plus monetary or other costs of delivery or pickup) to sellers located at different distances from them” (Bain 1967, 228).

Product differentiation in an industry influences price, market share and market conduct (Caves 1967, Bain 1968, Shepherd 1972, Vernon 1972, Orr 1974). The impact of product differentiation in market conduct relies on the degree or intensity of product differentiation and on whether differentiation occurs in conjunction with seller concentration. Bain (1967) states that some industries in agriculture, forestry, fishing and mining do not have significant product differentiation. The goods produced in these sectors are likely to be more or less standardized or uniform.

Barriers to entry

Barriers to entry are defined as the disadvantages of potential entrant firms to established firms (Bain 1967). In the long run, established firms can increase their selling prices above the minimal average cost of production and distribution without inducing potential entrants to enter the industry. Established sellers can set the selling price very slightly above the level of minimal average cost. Potential entrants cannot make enough profit at that price (Caves 1968) to survive.

Orr (1974), confirmed the hypothesis that industries with high barriers to entry are significant more profitable than industries with average barriers to entry, but low barrier industries are not significantly less profitable than average barriers: "Low barriers to entry will permit a price not much above P_c if rivals are not to be tempted into the industry" (Caves 1967, 23). P_c is defined by Caves as competitive price.

There are some sources of barriers to entry for firms that are already in the market. Barriers arise when firms do not achieve the lowest possible production costs until they have grown to occupy a large portion of the market (Caves 1967). Another source of barriers to entry is the absolute cost, which arises from many sources (patents, well-known production techniques, secret ingredients, limited supplies of some special inputs, and capital requirements). Absolute cost barriers, particularly high capital requirements, also explain some of the cases of moderate to high barriers. Finally, barriers to entry are also related to product differentiation. An established firm that has good standards and services enjoys a good reputation; a new firm has to start by offering better quality and services to convince buyers to buy from it.

Analyzing barriers to entry illustrates how elements of market structure influence each other. "Product differentiation is the major source of high entry barriers. Likewise, high barriers to entry and low concentration would come as a surprise. High barriers tend to shut off the flow of the new firms into an industry. Since firms disappear from time to time, due to natural causes, the number of sellers remaining is sure to fall. If the barriers remain high, concentration is likely to rise" (Caves 1967, 33-34).

2.2.2 Elements of Market Conduct

Market conduct consists of changes in prices, output, product characteristics, selling expenses, and research expenditure. Conduct links the structure of the industry to the quality of its performance. “Market conduct consists of a firm’s policies toward its product market and toward the moves made by its rivals in that market” (Caves 1967). The principal elements of market conduct are

1. policies toward setting prices
2. policies aimed at coercing rivals

According to Caves (1967), market conduct depends on whether the industry is monopolistic, purely competitive or oligopolistic. If an industry faces pure competition it exhibits low concentration, low barriers to entry and no product differentiation. Therefore, firms have no choice to make about their products and the market will set the price of the product. Pure competition does not allow a firm to decide how efficient it needs to be.

Conduct under an oligopoly has more implications to consider. An oligopoly is composed of a small number of firms that can recognize the impact of their actions on rivals. “In an oligopoly they react to one another in a direct and personal fashion. This inevitable interaction of sellers in an oligopolistic market we call mutual interdependence” (Caves 1967, 39). Interdependence exists when market shares will be affected by the actions of the firm’s competitors (Gollop and Roberts 1979).

Policies toward setting prices under oligopoly

According to Caves (1967), some economists have declared that large corporations do not seek to maximize their profits. Therefore, "They may set a certain normal rate of return on their investment as a target, or use a standard mark-up added onto their cost to determine the price" (Caves 1967, 40). These two strategies will not consider profit maximization every time. However, a normal mark-up may be the profit a firm thinks it can earn without attracting entrants.

Another thing oligopolists consider when setting the price is how well they can anticipate the responses from their rivals. Consider the following example: an oligopolistic corporation raises its price. The prevalent price now in the market is too low to maximize the industry's profits. If all the rivals of the corporation also raise their prices, the corporation's profits will increase. But if one oligopolist lowers its own price without its rivals lowering theirs, the oligopolist has the opportunity to increase its market share, therefore its profits. In an oligopolistic market, there are several ways in which price is coordinated:

1. **Agreements among sellers**: All sellers sign an agreement regarding the price that they will charge. Other agreements include selling practices, quality of the product and even territory of selling. The term cartel is usually applied to extensive and formal agreements that divide up markets.
2. **Price leadership:** Price leadership is a pattern of seller coordination that exists without any formal organization among its members. By this arrangement changes in industry prices are first announced by the leader, usually the largest

firm in the industry. The other firms make the same price change with little or no time lag. Price leadership is most likely found in oligopolies with no product differentiation. In these industries if the leading firm changes price the other sellers will be affected.

3. **Tacit collusion**: In some industries firms seem able to take one another's responses into account without betraying any external signs of clear price leadership. A firm with product differentiation removes the pressure for a uniform price. Information about a rival's production and costs is important here, since price changes according to costs of production and demand conditions. Thus if information is available, "All sellers can independently announce about the same price changes and keep prices at a level yielding some monopoly profits to the industry without any explicit collusion at all" (Caves 1967, 45).

There are not separate definitions for oligopoly conduct and oligopsony conduct. The oligopsonist, instead of setting up a demand function, attempts to select a definite price to be paid for the materials and services that it buys and a fixed quantity. The combination of price and quantity is optimal from the oligopsonistic point of view. However, the quantity that the oligopsonist buys depends on the prices that its competitors will pay, who in turn, are affected by the price that oligopsonist will pay. Mead (1966) mentioned some important differences between an oligopoly and an oligopsony. In an oligopsony, price tends to be a significant variable, and buyers tend to be professional and have good knowledge of the quality and the price of the product. Therefore, price competition in an

oligopsony deserves more attention. Another difference stated by Mead is that oligopsonistic markets may be geographically narrow.

Murray (1995) indicates that natural resource products are often characterized by many atomistic sellers and few concentrated buyers. It occurs because of transportation and storage factors. Therefore, those markets tend to be oligopsonistic or monopsonistic. As a consequence the price of the affected input is depressed. This price distortion has adverse welfare implications. “The presence of monopsony/oligopsony may have particular policy significance for private investment in forest management, given domestic and global concerns over the rate of deforestation” Murray (1995, 486).

Policies aimed at coercing rivals

“The patterns of conduct involved in setting prices and quality of products are influenced by market structure but do not influence it in return” Caves (1967, 49). Sometimes firms behave in a way that drives out their rivals. For example, firms increase concentration by driving rivals out of business or by behaving in a way that keeps potential rivals out. These conduct patterns are called coercive because they worsen the structural position of their rivals. Coercive conduct can take the form of eliminating existing rivals or of increasing barriers to entry. Coercive conduct is more likely to happen where high concentration is present, and it only makes sense in oligopolistic situations. There are three different kinds of coercive conduct

1. **Predatory price cutting**: Firms with strong financial systems can eliminate their market rivals. If a rival wants a large market share, a predatory firm can

decrease the market price to unprofitable levels for the weak rival. On the other hand, when there are any barriers to entry that arise from economies the scale, the new entrant has two choices: 1) to start inefficiently on a small scale, or 2) to start on a large scale and experience high levels of risk, because of competitive reactions of the existing firms. Sometimes predatory price cutting occurs only in segments of the market.

2. **Squeeze operations**: When firms are vertically integrated, they perform more than one production process (produce raw materials and finished goods). 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. Integrated firms do not hold the same market share at each processing stage. 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 squeezes non-integrated competitors and forces them to operate with minimal profits or loss. Integrated firms, which produce their own raw materials at costs below what non-integrated firms must pay, can remain successful.
3. **Barriers to entry by vertical integration**: "Vertical integration itself creates coercion even if no squeeze is applied" (Caves 1967, 52). Coercion, in this case, is applied to potential entrants rather than actual rivals. Vertically-integrated firms may buy all the raw material to supply their own needs. Therefore, increases in barriers to entry come in the form of absolute cost barriers.

Considering all of these elements of market conduct, it is possible to conclude that market conduct is a predictable consequence of market structure as well as market performance. Caves (1967) explained that coercive conduct, which in turn increases concentration or barriers to entry, may affect the allocation of resources. Oligopolies with rigid and coordinated prices say little about the quality of performance; however, patterns of conduct reflect the structure of the market, which in turn directly relates to performance.

The New Empirical Industry Organization (NIEO) recognized that there is a theoretical link between structure and conduct (Lopez 1984). This link can be empirically determined by estimating conjectural elasticity. Conjectural elasticity indicates how rivals of a firm will respond to changes in its purchases of material input (Iwata 1974; Appelbaum 1982; Kolstad and Wolak 1986). The NIEO technique, defined by Bresnahan (1989), began as a way to observe the organization of the industry, given the availability of data and the evolution of markets.

2.2.3 Elements of Market Performance

"Market performance encompasses the strategic end result of the market conduct of sellers and buyers" (Bain 1967, 372). 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).

Four economic goals or performance traits are important in meeting social goals. Efficiency, full employment, progress and equity are the goals that any economy must achieve for the well being of the citizens. Caves (1967) defined market performance 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 achieve these goals" (Caves 1967, 97). The following sections will discuss each of the four economic goals.

Full employment and price stability

One of the goals of market performance is full employment. As aggregate money demand changes in the economy, there is less variation in industrial prices; therefore, there is more variation in employment. Price rigidity and pricing policies in concentrated industries may cause some problems for maintaining price stability (Caves 1967). Consider, for example, two industries, one purely competitive and the other highly concentrated. If both industries work at capacity, their market prices tend to rise in proportion to the cost of production. If the government imposes a policy to reduce price inflation, demand for the two industries decreases. Then the competitive industry will have an excess capacity that will slow increases in price, but the oligopolistic industry will continue raising prices in proportion to the costs, despite its excess capacity. So public policy does not affect price increases in concentrate industries, but it does affect employment and full utilization of capacity without raising prices.

Income distribution

High levels of concentration can be a good indicator of high income for people. However, this situation not always is true; it depends on whether citizens prefer having more even or less even distribution of income than now exists; the situation may favor a wider or narrower range of concentration levels. Concentration and income distribution are not closely related. High profit means a high rate of return on the capital employed in an industry, but a high return per unit of capital does not mean a large income except for people who have a large share in the company (Caves 1967).

Encaoua and Jacquemin (1980) state that there are some similarities between degree of concentration and an index of income inequality, but they do not reflect the same features or the same goals. 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.

Besides income distribution, equitable distribution of the economy can be observed under different point of view—the distribution of business sizes. Caves (1967) states that if all business were small the society would be better because the maximum number of citizens would be independent proprietors rather than employees. Therefore, the best possible market performance will be reached.

Progress, research and innovation

Progress, research and innovation are related to degree of concentration. Caves (1967) lists three indicators that large, concentrated firms are promoting research and innovation. The indicators are patents, important innovations and productivity growth. Caves' conclusions indicate that "highly competitive industries with atomistic firms and little concentration rarely seem to support extensive research and development and frequently show little technical progress" (Caves 1967, 102). Strong oligopolistic industries would not include progress as an element of performance; this suggests that large firms do not do proportionally more research than small ones. Excessive concentration may slow technical change. New technology spreads quicker through less concentrated industries (Caves 1967).

On the other hand, high barriers to entry may also affect progress and low barriers may accelerate the pace of technical change. According to Caves (1967), some degree of concentration is needed to promote research and innovation, but whether existing structures provide too much or too little remains debatable. Some form of oligopoly is probably preferable to either monopoly or very low concentration, but it is difficult to say what the optimal degree of concentration is.

Mead (1966), found significant evidence of economic progress in the form of a high annual increase in productivity (output per man-hour). New technology causes an increase in productivity. Therefore it is expected to find low product prices and increased wages. However, Mead states that timber industry cannot easily reach this conclusion

because lumber manufacturing deals with heterogonous raw material; it has not been easily adaptable to modern handling techniques.

Efficiency

The principal concern of efficiency is how resources are allocated among the various types of goods and services produced in the economy (Caves 1967; Bain 1968). Allocative efficiency concerns the size of the industry output as judged by the relationship of its long-run selling prices to its long-run marginal cost of production (Bain 1968). Profit is an indicator of efficiency under conditions of perfect competition; however, information about profit is not always available. The price-cost relationship (reflected in the profit rates) is feasibly measured by the ratio of the selling price to the long-range average cost or by the ratio of long-range average industry profits to the value of owners' investments in the firms. The price-cost relationship can be used as an indicator of efficiency.

One dimension of the economic efficiency goal concerns profits; Caves (1967) defines normal rate of profit as the opportunity cost of equity capital, the minimum normal rate of profit, based on what it could earn in other uses. Risk influences profit; however, the positive or negative implications of risk depend on the willingness of the investor to take the risk. Whether high risk represents high profits, or vice-versa, cannot be directly determined. Concentration and barriers to entry have a relationship to profit. Industries with high concentration and high barriers to entry produce high profits, although increases in concentration cannot be associated with steady increases in profit.

Allocation of resources within industries is another aspect of efficiency to consider. Industries with large numbers of inefficient, small-capacity plants seem to be those in which product differentiation does not exist. Some producers are able to make profits in a small and inefficient plant if they maintain a faithful clientele and are able to charge a higher price (Caves 1967).

The marketing margin, the share of the consumer's price obtained by the producers and traders at each stage of the marketing process, provides insight into the industry's allocative efficiency. A marketing margin is used to compare the same product in different regions of a country or at different points in time (Harrisss 1979). A marketing margin is a means of assuring efficiency; it refers to the difference in price paid and received by any agency. The total margin is the difference between the price paid to the producer and the price paid by the consumer. It is also known as producer's share in the consumer's price.

Economic theory yields a number of predictions about the relationship between market structure and price-cost margins. Margins will be greater in industries with relatively high growth of demand. For any given level of seller concentration, the greater the concentration on the buyer's side of the market, the lower the industry margin will be. (McFetridge 1973). Margins should also be greater in industries in which product differentiation is important.

Efficiency is one of the elements of market performance; it is not easy to determine whether or not a market is efficient. However, some estimations of the allocative efficiency can be determined by looking at profit (Caves 1967; Bain 1968). Price-cost relationship is another way to determine efficiency (McFetridge 1973; Cowling and Waterson 1976; Harriss 1979). The structure of the markets affects the efficiency. Industries with high concentration and high barriers gain more profits. Therefore, it is expected that those industries will use their resource wisely to obtain good profits.

Conservation performance

For industries whose operations involve extraction of natural resources, a significant dimension of the market performance involves how well they conserve resources (Bain 1968). Good conservation requires that extraction techniques, production patterns, investments, and other costs combine over time to yield optimal net social benefits (for now and for the future) relative to costs. Mead (1966) states a similar concept regarding timber resource management.

Bain (1967) lists three different things that may contribute to deviations from good conservation performance:

1. Antagonistic exploitation of resources by competing interests, in which a competitive race to capture the resource or its outputs before others results in a disregard for long-term yield considerations
2. An inherent shortsightedness of firms that are using resources—firms that value immediate profits more than future production

3. Competitive conditions which bring about such low returns to firms in some extractive industries that they cannot afford to invest in the long-term maintenance of resource yields

2.2.4 Relationship of Market Structure, Conduct and Performance

The theoretical concept of industrial organization explained by Bain in 1967 has been widely used in theoretical and empirical studies related to industries. Caves in 1967 described the American industry under the concepts of structure, conduct and performance. Economists have used the structure-conduct-performance pattern since. Some economists state that the relationship can also run from conduct to structure to performance (Harrisss 1979; Scherer 1980). Thus, different forms of market conduct have the capacity to produce, either directly or as side effects, gradual changes in the structure of industries. Other economists simply observe the relationship between structure and performance, ignoring conduct or including it as an inherent part of the structure (Orr 1974; Cowling and Waterson 1976; Peltzman 1977; Gisser 1982; Bothwell, Cooley and Hall 1984).

The interrelation between elements of market structure has been also studied; Shepherd (1972) developed and tested models of market structure, based on profitability of firms. He concluded that in static models, market share emerges as the main element of market structure, independent of the leading-firm group and entry barriers. His research suggests that leading firms play a small role in market structure. One can aggregate the individual shares and behavior of leading firms in an oligopoly for descriptive purposes, but one

cannot safely regard the oligopoly group as a main determinant of its members' profitability. Shepherd (1972) also concludes that barriers to entry appeared to have a relatively small role in market structure; however, their descriptive and theoretical use is important. Market share and concentration appear to be independent of barriers to entry.

Shepherd (1972) also made public policy recommendations in the study. The case of persistent high profitability at market shares above 50 percent are unusual, suggested an antitrust evaluation of competitive and technological trade-offs. Finally, his study suggests that the yields from altering market shares are greater than those from changing concentrations, barriers or advertising patterns.

Demsetz (1973) discusses the relationship between concentration, collusion and efficiency. Bain (1968) indicates that concentration and efficiency are related, and that efficiency in sizes of the firms justifies concentration. Demsetz (1973) hypothesized that deconcentration will promote inefficiency: "If concentrated industries exhibit higher rates of return, it is difficult to determine whether it is efficiency or monopoly power that is at work. Similarly, large firms would tend to gain high profit rates in concentrated industries either because they are efficient or they are colluding" (Demsetz 1973, 5). The study demonstrated that there is not close relationship between concentration and collusion; therefore, attempts to reduce concentration do not have positive effects on efficiency. It also showed that the rates of return earned by small firms do not increase with concentration. Large portions of industry output are produced by large firms in concentrated industries. These industries may exhibit higher rates of return than other

industries; however, the study suggests that because small firms receive a large share (by total assets), industry rates of return are reduced even for concentrated industries in which large firms continue to perform well. The study also revealed that there is a significant relationship between concentration and differences in rate of return, especially when comparing the largest and smallest firms in an industry. This view of industry structure suggests that rapid changes in concentration are from changing cost conditions and not from alterations in the height of entry barriers.

Peltzman (1977), on the other hand, suggested that decreases in concentration reduce cost and increases in concentration also reduce cost. But only increases in concentration significantly increase productivity. Put differently, changes in concentration reduce cost but they are more pronounced when concentration increases. The primary conclusion of Peltzman's study was that changes in market structure are accompanied by increased efficiency. Any attempt to correct concentration may reduce the efficiency associated with concentration. (Demsetz 1973; Peltzman 1977; Bothwell, Cooley and Hall 1984). If government wants to promote anti-concentration it may interfere with improvements in resources allocation (Peltzman 1977). Gisser examined the relationship between concentration and market performance; he stated that a reduction in concentration might deprive society of the apparent benefits of concentration.

In markets where research is necessary and costly, price levels of more concentrated markets will be lower (Salop and Stiglitz 1977). In 1979 Stiglitz observed the equilibrium in product markets with imperfect information under the assumption that the only barrier

to entry is the fixed cost of establishing a new firm. He indicated that “attempts to promote competition by increasing the number of firms or by removing barriers to entry may actually reduce effective competition, increase prices and lead to lower efficiency” (Stiglitz 1979, 344).

Gisser (1982) observed the relationship between concentration and productivity. Increased concentration is associated with increased total input productivity. His empirical study revealed that increases in total productivity, which were linked to a concentration change, were roughly sufficient to offset the entire loss of consumers. He suggested that any attempt to restructure the oligopolistic industry might deprive society of the apparent benefits of concentration. The link between the increase in productivity and output growth shows that economies of scale might be present.

Seller concentration alone is not an adequate indicator of monopoly power. Barriers to entry are a crucial element of market structure. A study by Orr (1974) highly supported the role of barriers to entry in the market structure/performance relationship. The study supported Bain’s statement that high–barrier industries are significantly more profitable than medium– and low–barrier industries. Therefore entry barriers influence profitability independent of concentration. However, the impact of entry barriers on profitability as additive to, rather than interactive with, concentration cannot be supported by empirical studies. Cowling and Waterson (1976) conclude that changes to concentration ratios have significant effects on changes to price-cost margins because of price elasticity.

Stigler (1963) implicitly observed the relation of market structure/performance in his study of capital and rates of return. He showed that risk differentials explain profitability. High rates of return reflect neither a monopoly nor superior efficiency, but high rates of return reflect the premium payment to risk-averse investors. Thus high levels of profitability can be explained because of the risk involved.

Market conduct plays an important role in oligopolistic markets. Caves and Porter (1978) find that differences between more and less concentrated markets, as well as conduct variables in general, provide a broad test to support the theory of oligopolistic bargains. An oligopolistic bargain is more fragile in medium–concentrated industries and the range of disturbances that can lead to its breakdown is widest there. Market share instability represents the second attribute of market conduct, very much like price discrimination. Market share instability holds two divergent implications for market performance. It indicates aggressive conditions for the effective recognition of mutual dependence among oligopolists, and it favors an allocation of resources more nearly matching the competitive norm. Furthermore, Caves and Porter's study indicates that market structure influences oligopolistic behavior because stability of shares reflects the stability and completeness of the oligopolistic bargain, as well as the size and nature of exogenous disturbances to that bargain.

Bothwell, Cooley and Hall (1984) suggested a new view of the market structure/performance relationship. Uncertainty is the main element in their study. Uncertainty is a consequence of the unreliable data used in most of the economic studies.

The authors argued that the theory that high concentration leads to high profits, which is tested by Bain and his successors, cannot be supported if the model includes incomplete specifications and uncertainty as variables. The researchers found a positive correlation among advertising, profits and market in the model as well as between market shares and profits. Stronger theoretical restrictions on the data than are typically offered in market structure/performance studies would make it easier to interpret the conditional correlations that emerge. At the very least, the substantial role of specification uncertainty warrants caution when using the empirical results to support policy changes.

2.3 Empirical Estimates of the Degree of Market Imperfection

The paradigm of market structure, conduct and performance (Bain 1968) defined the study of 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 observe the organization of the industry. Bresnahan (1989) labeled this technique as the New Empirical Industrial Organization (NEIO). NEIO designs procedures that estimate the parameters of market conduct. Huergo (1997) classifies those studies in three different ways: 1) studies that use the comparative static of the industry structure or the market equilibrium; 2) studies that use the estimate of marginal cost with data of cost functions or factor demand functions; and 3) studies that review game theory. Gollop and Roberts (1979) and Appelbaum (1982) used the second classification of Huergo in their research. Gollop and Roberts (1979) estimated the

interdependent behavior among firms in an oligopolistic industry. Appelbaum (1982) estimated the degree of oligopoly. 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 is a measure of market performance.

Appelbaum's model has been used for several studies in oligopolistic agricultural markets (Schroeter and Azzam 1990; Bhuyan and Lopez 1997; De Mello and Brandao 1999; Arnade and Pick 1999, 2000; Lopez, Azzam and Liron-España 2002) Chapter IV of this study uses Appelbaum's research to create an econometric analysis for oligopolistic markets. Appelbaum's model is also applied to monopolistic markets (Schroeter 1988) and oligopsonistic markets (Durham and Sexton 1992; Azzam 1997; Muth and Wohlgenant 1999). Appelbaum's model has also been applied to forest markets. Murray (1995) measured the oligopoly's power with shadow prices for sawlog and pulpwood markets. Each of these studies have extended the base model to adjust for data requeriments, to test multi-product oligopolies, to measure the effects of concentration, to used shadow prices, to test seasonal oligopolies, and so forth.

Due to large data requirements and the difficulty of obtaining the conjectural elasticity in Appelbaum's model, this study will extend the study by De Mello and Brandao (1999). Conjectural elasticity is estimated using similarities to De Mello and Brandao's study on

the sawtimber market in the South Pacific region. A more detailed explanation is found in Chapter IV.

2.4 Contestable Markets

The theory of contestable markets is a generalization of the theory of perfectly competitive markets (Martin 1993). “In the limiting case of perfect contestability, oligopolistic structure and behavior are freed entirely from their previous dependence on the conjectural variations of incumbents and, instead, these are generally determined uniquely and, in a manner that is tractable analytically, by the pressures of potential competition….”(Baumol 1982, 2).

Perfectly contestable markets are defined as those that are accessible to potential entrants and follow two properties: 1) potential entrants can, without restriction, serve the same market demand and use the same productive techniques as those available to established firms, and 2) potential entrants evaluate the profitability of entry at the established firms’ pre-entry prices (Baumol 1982).

Another characteristic of contestable markets is that entry is absolutely free and exit is absolutely costless. The entrants do not suffer disadvantage in terms of techniques or quality, compared with established firms. Entrants can evaluate the profitability from prices of incumbents. Thus potential entrants make their decisions taking the market price as given.

Contestable markets theory implies that policy intervention in markets is unnecessary if entry and exit is free and easy. Potential competition and actual competition will influence market performance. However, Martin (1993) argued that, “the theory of contestable markets applies where efficient firms can be so small that they make decisions taking price as given” (Martin 1993, 301). Therefore, he argues that contestability theory does not improve as the theory of perfect competition. Baumol (1982), however, argues that if firms are free to exit and able to recover their costs of entry, the firms need not be small for contestability to hold. Friedman (1982) stated that the entry or exit of one firm in an oligopoly depends on changes in policies (prices, and so forth) by the firms that are active before and after the change. Therefore, price–taking behavior is a reasonable assumption to make about oligopolies.

Even if market structure suggests that a market is not efficient, to the extent that the market is contestable, it may be efficient. Under contestability theory, though, the less free firms are to enter and exit, the less contestable the market. Therefore, a key part of this research examines barriers to entry.

2.5 Summary

Colombia has four major timber–producing regions. The most important is the South Pacific region, which produces 60 percent of the total production of sawtimber. The South Pacific region also has the best–known chain of commercialization of the regions. Therefore, this study will analyze the structure, conduct, and performance of the region to

gain a better understanding of the national sawtimber market. Researchers commonly use the structure/conduct/performance paradigm to study agricultural and manufacturing markets. With a good understanding of the observable elements of market structure, conduct and performance, it is possible to identify the elements of market structure that determine conduct and which in turn determine market performance, a measure of social goals.

Studies of the relationship between market structure and market performance that are based on Bain's work conclude that the more concentrated the industry is, the easier it is for firms to coordinate their policies. Firms operating in more concentrated industries can collude, either explicitly or implicitly, easier than firms in less concentrated industries. Successful collusion should lead to some degree of market power for firms that collude. Another conclusion of the studies is that measurable elements of market structure are exogenous to measures of profitability.

The structure/conduct/performance paradigm helps identify imperfections in the market. However, because of data limitations the degree of this imperfection can only be inferred from observation. NEIO studies use econometric techniques to estimate numerically the degree of imperfection.

This review has also summarized the range of applications of Appelbaum's model. Those studies were reviewed to find the best model that could be applied to the market in South Pacific region with the available data.

Finally, there is a theory that relates elements of market structure, such as barriers to entry, with performance criteria such as efficiency. This theory gives a different view of the perfectly competitive market and the relation of structure, conduct and performance study by Bain (1967) and his successor. However, this new theory can be only applied under certain circumstances. The theory of contestable markets predicts only that market structure will be efficient; it does not explain determinants of market structure. Briefly, the theory could be applied if only efficient would considered as and element of market performance.

CHAPTER III

SAWTIMBER MARKET DESCRIPTION

This chapter describes the South Pacific timber market through the structure/conduct/performance paradigm. The chapter is divided into two parts: the first part shows the commercialization chain for the sawtimber market in the South Pacific region and its participants; the second part describes each stage or market of the chain. The description contains introductions to the activities of and information about the participants in each market. This is followed by a broad description of the elements of structure (concentration, barriers to entry and product differentiation); conduct (policies to coerce rivals and policies to set prices); and performance (full employment and price stability, income distribution, progress in research and innovation, efficiency and conservation performance), based on the review of literature in Chapter II.

3.1 Timber Marketing Channel for the South Pacific Region

This section delineates the chain of commercialization for the sawtimber market, beginning with the forest where raw material is obtained and continuing through to final consumers, who manufacture wood products. The Environmental Ministry describes the marketing channels for the four timber-producing regions in the country: Caqueta-Putumayo (Amazonian), Pacifico Sur (South Pacific), Magdalena medio and Caldas-Valle. The chain of commercialization for the South Pacific region has both direct and

indirect agents of commercialization. Direct agent refers to agents who have direct contact with timber and assume the ownership of it (Franco and Galindo 1998; Minambiente 1999a). Direct Agents include

1. loggers: agents who work in groups of four to ten people and provide raw material
2. producers: owners of mechanical sawmills
3. manual sawmills: agents who own chainsaws, square timber themselves, and work in groups of family members
4. gatherers: agents in the concentration yard who buy sawtimber
5. wholesalers: agents who distribute sawtimber to the principal cities
6. final consumer: agents, including construction and furniture industries, retailers, and individuals, who purchase the products

Indirect agents participate in the process of commercialization but do not own the timber. Indirect agents include

1. chiefs: sawmill employees who organize groups of loggers
2. boat transporters: agents in charge of transporting timber from sawmills to the concentration yard
3. brokers: agents located in the concentration yard who make contact between gatherers and wholesalers and between producers and gatherers, and who also organize transportation
4. truck transporters: agents who move timber from the concentration yard to final distributors

The gross margin for each chain of timber commercialization between actors of the marketing channel in each region was estimated in 1997 (Franco and Galindo 1998). In

the South Pacific Coast channel, the gross margin for loggers was 15 percent of the final price. Producers obtained 23.7 percent; gatherers, eight percent; brokers, 34.5 percent; and final distributors, 18.9 percent.

The timber industry in the South Pacific region has five market levels (Franco and Galindo 1998; Minambiente 1999a). The first level corresponds to final consumers, the construction and furniture industries in Bogotá. The second level is made of wholesalers located in Bogotá. The third level corresponds to the concentration yard, which is located in Buenaventura. The fourth level contains producers in Nariño and Cauca. The fifth level is made of loggers from Nariño and Cauca.

For the purpose of this study, the description of the markets is based on the commercial exchange between market levels. For example, the trade between wholesalers as sellers and final consumers as buyers is considered one market.

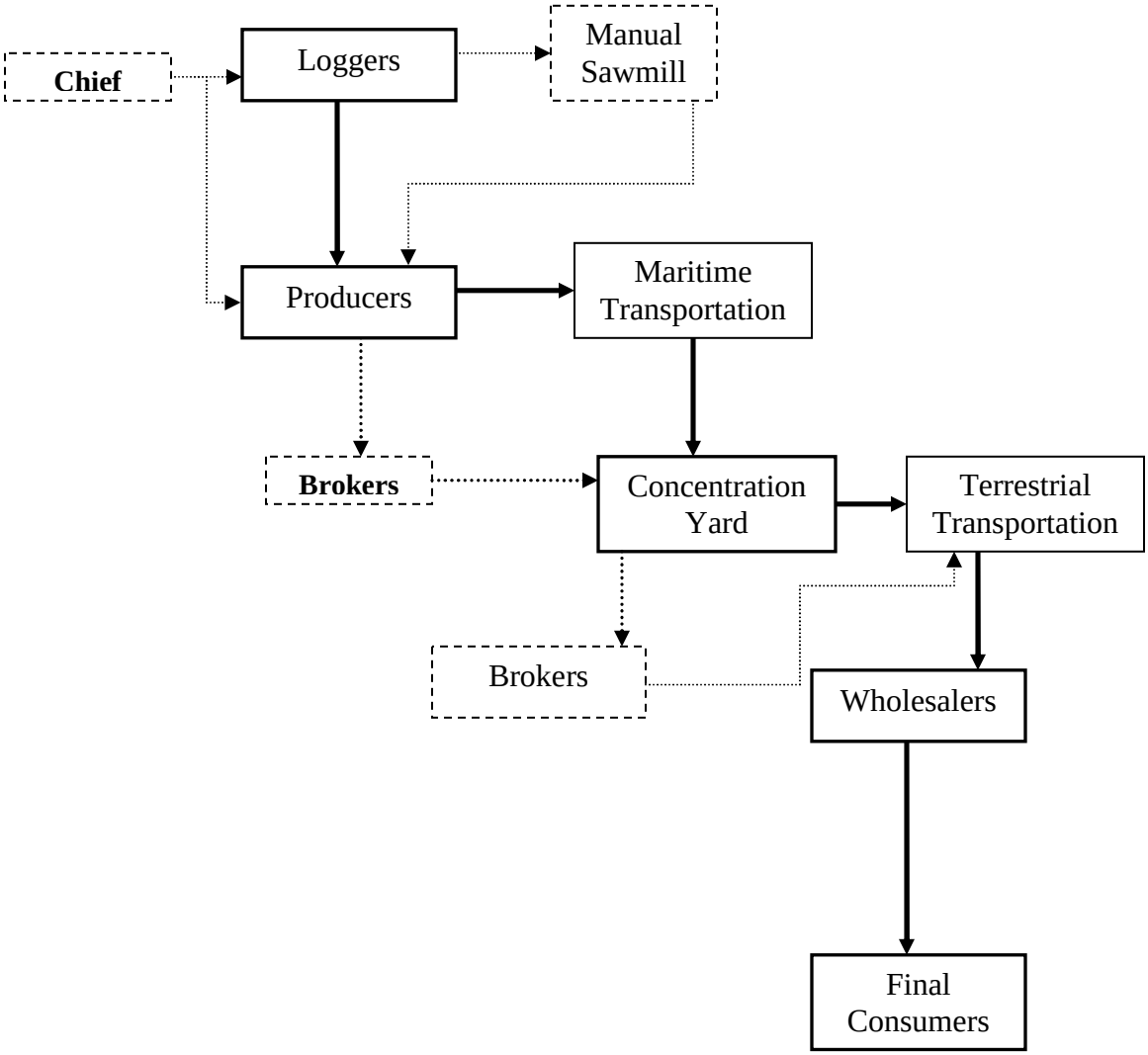

Figure III-1 Chain of commercialization for sawtimber in the South Pacific region of Colombia
Source: Minambiente (1999a); Franco and Galindo (1998)

3.2 Market from Wholesalers to Final Consumers

In this market wholesalers are sellers with final consumers acting as buyers. The sawtimber industry attends to internal demand. Final consumers of sawtimber products

include furniture and construction industries. Wholesalers gather sawtimber from different regions of the country and sell it primarily in Bogotá, the center of sawtimber commercialization. Sixty percent of the timber sold in Bogotá comes from the Pacific Region. Table III-1 presents the three primary sawtimber products with their respective dimensions.

Table III-1 Principal sawtimber products commercialized from the South Pacific region

Product	Dimensions (m^3)		
	Width	Thickness	Length
Bloque	0.1	0.25	2.8
Tabla	0.025	0.15	2.8
Tablon	0.05	0.2	2.8

Source: Franco and Galindo (1998) and Minambiente (1999a).

According to Minambiente (1999a), there are a few large firms that not only sell sawtimber, but also plywood and veneer. These firms have fixed suppliers of raw material and fixed buyers of sawtimber. There are also medium and small firms that sell small quantities of plywood and veneer to small consumers.

Three different types of sellers are reported by Franco and Galindo (1998) and Minambiente (1999a): 1) Independent Intermediate, 2) Intermediate Distributor, and 3) Final Distributor and Processor. Franco and Galindo defined the first type as people who contract with gatherers and transporters in El Piñal-Buenaventura to sell timber in Bogotá. Because they do not assume ownership of the timber, they will be called brokers.

The purpose of Franco and Galindo's research was to estimate the marketing margins, which were calculated for final and intermediate distributors. The latter is the sum of

independent–intermediate and intermediate distributors. For the purpose of this study marketing margins of independent–intermediate, intermediate distributors and final distributors will be added to give a total marketing margin for wholesalers in Bogotá.

3.2.1 Market Structure from Wholesalers to Final Consumers

Market structure refers to the characteristics of the market and how the relationships between sellers and buyers are affected by the characteristics. Market structure means how characteristics of the market exercise influence on the competition and price within the market (Bain 1968). There are some elements of market structure that are observable, such as concentration, barriers to entry and product differentiation (Caves 1967). The next sections will describe the elements and explain the structure of the market.

Concentration

According to Franco and Galindo (1998), there are approximately 124 firms comprising the industries of construction and furniture in Bogotá. Forty-nine wholesalers sell sawtimber products. Sixty percent of the monthly production is concentrated in the largest six firms. These firms on average produce the same quantity of output; the rest of the production is unevenly distributed in the remaining 41 firms.

Product differentiation

Product differentiation at this stage of the marketing chain is evident. Besides sawtimber from the Pacific coast, wholesalers also sell small quantities of sawtimber from other regions (Amazon, Magdalena Medio and Caldas-Valle) and other products such a veneer,

plywood and roundwood. Buyers prefer to buy all their products from a single source that offers them lower prices and provides additional services such delivery and payment options. Product differentiation becomes significant between large and small firms.

Barriers to entry

A high capital level is one barrier to entry. Firms with high levels of capital usually sell lumber with credit as the way of payment; small buyers are the principal beneficiaries of this service. They need credit because of high production costs that arise from the price of land and machinery, the time spent finding suppliers of raw material and willingness of those suppliers to sell the raw material.

Another barrier to entry involves the large number of tree species available. People tend to misclassify timber products as well as their mechanical properties. Input sellers may confuse one timber for the other easily. Once timber is in Bogotá, bringing it back to Buenaventura is a cost that wholesalers do not want to incur. Therefore, if a new firm wants to be in business it should know most of the species very well.

3.2.2 Conduct of the Market between Wholesalers to Final Consumers

Conduct is defined as features of buyers and sellers in the market. Price policies and policies toward rivals are observable elements of conduct that are determined by the structure of the market. This section describes elements of market conduct in the market where the concentration yard is acting as sellers and wholesalers are acting as buyers.

Policies toward setting prices

The structure of the market determines how sellers set prices and the consequences of the prices they set. There is a wholesaler's national organization, National Association of Timber Sellers (ANALMA); however, the association cannot provide evidence of price-setting agreements. Lack of information about production costs for rivals is to be expected because of the scarcity of national statistics regarding cost of production, prices, employment and other information about firms.

Concentrated firms set prices. Fringe firms must adopt these prices to remain in the market. Large firms have lower prices than small firms; however, the price difference is not dramatically large. For example, in 1997 selling price of a bloque was $7,300 pesos for a large firm and $7,500 for a small firm (Franco and Galindo 1998).

Policies aimed at coercing rivals

Price changes by leading firms will affect small firms. Leading firms set their prices to the minimum level above the marginal cost. If large firms reduce prices to very close to their marginal costs or to unprofitable levels, small firms will be unable to compete accordingly. If one firm in the concentration group increases its prices, a close rival can adjust its prices accordingly. Prices are stable because of rival firms, not because of small firms.

Few firms in the market are vertically integrated. To be vertically integrated at this stage, firms must have trucks and capital to bring lumber from the concentration yard. Many small firms cannot afford trucks and cost of transportation; therefore, they pay large firms for this service. Large firms set prices that let them enjoy high levels of profits both by bringing timber to small firms and by selling their own timber.

3.2.3 Market Performance for Market between Wholesalers and Final Consumers

According to Bain (1968) market performance refers to the success of firms in pursuing their purposes. Since one of the purposes of the market is to contribute to the economic well being of the society (Caves 1967; Bain 1968; Scherer 1980), elements of performance within social context will be analyzed.

Full employment and price stability

According to a survey of the manufacturing industry (DANE 1998), the number of firms for the sawtimber industry in Bogotá decreased in 1999-2000 by thirty percent compared to 1996-1998. Central Bank of Colombia (Banco de la Republica) stated that small firms are greatly affected in periods of economic recession, which applies to the sawtimber industries in the survey. Therefore, employment for the same years decreased by fifty percent. Total value of production also decreased, except in 1998 when production rose to 66 million pesos, compared with an average of 33 million pesos for the other years. Another DANE survey (2002) found that the net investment for the sawtimber industry in Bogotá presented negative values for 1996, 1998 and 2000. These findings are consistent

with the increased value of total production in 1998, since there were no investments. However, the industry maintained good levels of product value.

Income distribution

Firms with high concentration levels tend to have more profit and be more secure (Caves 1967; Bain 1968; Demsetz 1973). Wholesalers with high concentration are vertically integrated, and they influence prices. 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).

Progress, research and innovation

Product innovation is evident in this market. Large firms sell plywood, veneer, edge–glued boards and a wide variety of chips. This variety attracts large buyers, but not small ones who still buy sawtimber to be used in informal construction of houses and for housing repair. Increases in products besides sawtimber attract more buyers; therefore, the price of sawtimber decreases, which further benefits large firms.

Efficiency of the market

Franco and Galindo (1998) calculated the gross marketing margin at this stage of the commercialization chain. Their research revealed that for each $100 pesos paid by final consumers, the net utility for wholesalers is 61.5 percent. The same study concluded that high margins would be considered high levels of profitability. Since efficiency is linked

with profitability, the market for wholesalers can be considered efficient. However, the contribution of the market to the national economy is low, representing only 0.2 percent of the gross domestic product, which is a small quantity compared with other industries of the country.

Colombia's timber trade in 2000 showed that 88 percent of total imports of solid timber were for sawtimber. Colombia is importing large quantities of sawtimber from Peru. The neighboring country provided 75 percent of the total sawtimber imports (DIAN 2000). The industry is not competitive enough to supply the internal demand and to export.

Tables (III-2 and III-3) show total production and trade balances for sawtimber. Table III-2 (page 62) contains information for natural forest from 1990-2002. The tables reflect that total production has been decreasing from 1996 through 2002. However, the trade balance for the same period was positive ($2,000,000 pesos). Table III-3 (page 63) contains total production and trade balance for natural forest timber (non-coniferous) and cultivated forest timber. Comparing Table III-2 and Table III-3, it is evident that sawnwood production is mainly for non-coniferous species. Sawtimber of the natural forest is imported in greater quantities than non-coniferous (softwood) sawtimber. Curiously, it is also exported in larger quantities than softwood. Table I-1 (page 5) reveals that total consumption and total production are close. In 1992, about 50 percent of the non-coniferous sawnwood produced was exported. Then, in 1993, imports of sawnwood increased; however, exports decreased, and total consumption of timber

increased for that year. For the rest of the years imports and exports are evenly distributed. The trade balance for the same period of time is positive ($813,000 dollars).

Table III-2 Production and balance trade of non-coniferous sawnwood

Year	Production (Cum)*	Imports		Exports	
		Quantity (Cum)*	Value (1000$)**	Quantity (Cum)*	Value (1000$)**
1990	569000	2000	538	9,600	2,157
1991	569,000	2,000	538	9,600	2,157
1992	514,000	3,229	1,273	21,441	4,015
1993	450,000	29,674	3,554	1,051	444
1994	400,000	6,500	1,489	1,065	539
1995	400,000	11,000	1,407	7,900	1,671
1996	1,034,000	600	362	2,200	429
1997	946,000	13,000	2,267	5,700	918
1998	872,000	5,500	1,279	2,100	364
1999	699,000	6,300	1,506	8,700	2,004
2000	567,000	2,000	139	4,500	1,365
2001	521,000	400	70	3,800	1,112
2002	509,000	0	0	2,800	800

Source: FAOSTAT 2002
* = Cubic meters
** = Thousand of dollars
Note: Non-coniferous sawnwood is referred to tree species from natural forest

Table III-3 Production and balance trade for total sawnwood***

Year	Production (Cum)*	Imports		Exports	
		Quantity (Cum)*	Value (1000$)**	Quantity (Cum)*	Value (1000$)**
1990	813,000	3,800	936	9,600	2,157
1991	813,000	3,800	936	18,700	3,365
1992	758,000	6,475	2,019	22,632	4,288
1993	694,000	31,548	3,818	1,578	563
1994	644,000	10,627	2,310	1,685	684
1995	644,000	15,000	2,349	9,700	2,105
1996	1,134,000	4,600	1,473	3,000	950
1997	1,085,000	15,500	3,995	5,900	1,037
1998	910,000	6,400	1,693	2,500	569
1999	730,000	6,400	1,530	8,700	2,004
2000	587,000	2,100	195	4,500	1,365
2001	539,000	500	126	3,800	1,112
2002	527,000	18100	4,547	16,300	6,541

Source: FAOSTAT 2002
* = Cubic meters
** = Thousand of dollars
*** = Included Coniferous and Non-coniferous.

Minambiente (1999b) reported a negative sawtimber trade balance for period of 1987-1997 ($-13,277,056 dollars). The decrease of construction is closely related to the decrease of sawnwood production and affected international trade.

Conservation

Most of the research about timber in Colombia has been done either to show the biological importance of the forest or to show the high levels of deforestation and its implications. However, production of timber continues and there is very little research regarding timber commercialization. The Ministry of the Environment did the most recent studies. One study described timber market channels for four timber-producing regions (Minambiente-SIEF 1998), and the other one evaluated the demand and supply of timber products and the possibility of an international timber trade (Minambiente 1999a).

3.3 Market from the Concentration Yard to Wholesalers

The concentration yard is a place where timber is stored and then distributed to the principal cities. The most important concentration yard in the South Pacific is El Piñal, which is located in the Port of Buenaventura. Three types of products are commercialized there: bloques, tables and tablones, with the same dimensions that Table III-1 shows. The concentration yard sells approximately 122.6 cubic meters of sawtimber per month to wholesalers in Bogotá (Franco and Galindo 1998). Large quantities of timber are stored and rotate every five days. Within that timeframe gatherers obtain permission from the local government entity (CVC) to transport timber.

Gatherers play an important role in the chain of commercialization for sawtimber products because of their strategic placement. Some gatherers use brokers to sell timber to wholesalers; others prefer to do it themselves. Vertically-integrated firms generally do not use brokers for their transactions with wholesalers (Franco and Galindo 1998) because they have fixed buyers.

3.3.1 Market Structure from the Concentration Yard to Wholesalers

This section describes elements the market structure from the concentration yard to wholesalers. Elements of market structure help determine market conduct and performance in this market.

Concentration

Concentration is expressed in the quantity of output sold by gatherers. Franco and Galindo (1998) report 68 firms or gatherers in the port of Buenaventura. There are three important large gatherers—Maderas Del Patia, Maderas Marco Aurelio Zuluaga and Maderas Almontes—that concentrate 56 percent of the total production. Competitive industries have concentration levels of 4-10 percent (Bain 1968), so this market is obviously highly concentrated.

Gatherers have full information about their customers, which is reflected in their method of payment. When timber is delivered to customers, 35 percent of the total amount is paid; then customers have 30 to 60 days to pay the remaining 65 percent. Therefore, gatherers know how much capital their wholesalers have to buy timber.

Transportation is another source of concentration. According to Franco and Galindo's (1998) survey, vehicles are under possession of gatherers. The largest firms have at least 50 percent of the total number of trucks. A firm that supplies small quantities delivers its products in only one shipment; therefore, the cost of transportation is higher for this kind of firm. Transportation service becomes risky because payment depends on the quantity delivered. Sometimes 35 percent of that quantity paid in advance does not cover the cost of transportation. A firm that delivers large quantities uses more shipments; therefore cost of transportation is low. Transporters prefer to work with big firms rather than small firms because their payments are more secure.

Product differentiation

There is no product differentiation in this stage; all firms in the market sell the same products. However, it is important to point out that high product rotation forces gatherers to sell green timber, timber with high levels of water. If timber is not properly stored in trucks and storage places in Bogotá, the natural water loss results in the deformation of the product. Consequently, products will lose value and wholesalers will have to sell them at a lower price.

Barriers to entry

The barriers to entry at this stage involve costs and profit. Because the largest producers own ships and sawmills, the costs of getting input material is low for them (for this market the input and the output is the same—sawtimber). Gatherers not only have this advantage, but they also posses harvesting licenses to acquire input material and

transportation permits to send timber to wholesalers. New firms in the market must make high initial investments.

Another barrier to entry involves extending credit to buyers. Established gatherers who know their buyers and offer them credit options have a certain degree of control over buyers. New firms cannot offer credit options because they would not enjoy short-term profitability. Therefore, new firms are not attracted to the business.

3.3.2 Market Conduct from Concentration Yard to Wholesalers

This section describes elements of market conduct that are the consequence of the structure of the market. Those elements reflect how sellers set prices and how sellers behave to avoid more rivals.

Policies toward setting prices

There are two relatively new gatherer organizations in the concentration yard: Amadelpa and Ecomaderas de Buenaventura (Minambiente 1999). Their purpose is to improve the efficiency of timber commercialization for domestic and international markets. But there is still no evidence of price agreements among the gatherers.

Franco and Galindo (1998) surveyed 13 gathering firms in the concentration yard, including the three largest ones. On average, prices for the largest gatherers are the same for each product mentioned in Table III-1 on page 55. For example, one bloque in 1997 was sold for $6,100 pesos. But the price of the same product was $6,300 pesos for the

rest of the firms. Firms in the concentration yard have good knowledge of their rivals because all the firms work in Buenaventura and information is available through brokers.

Two of the three concentrated firms are vertically integrated (own sawmills), and their prices were lower than the other firm's prices. Concentrated firms rely on actions of their rivals. Vertically-integrated gatherers are self-producers of raw material, although sometimes they are unable to produce enough products to meet the demands of output. Therefore concentrated gatherers also purchase raw material from other sawmills. Concentrated gatherers will estimate how much raw material they need to buy from their rivals or fringe firms and how much they will be able to sell in Bogotá.

Firms that are not vertically integrated are also well positioned by their buyers because of the financial systems that they offer; those firms sell fewer units of output, but at higher prices. However, there is a certain degree of risk involved. Timber is sold by credit and most of the buyers are small, so not all of the buyers are able to pay at the stipulated time.

Policies aimed coercing rivals

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, neither within the concentration yard nor with fringe firms. In fact, Franco and Galindo's survey showed that non-vertically-integrated firms generate higher quantities of output within the concentrated group. However, the same research found that Maderas Marco A. Zuluaga, a vertically-integrated firm, owns five of

the ten ships that deliver timber in Buenaventura. If this firm reduces its price to the minimum level above marginal cost, fringe firms will be unable to compete unless the other concentrated firms make some promotions to reduce the price.

3.3.3 Market Performance from Concentration Yard to Wholesalers

Performance is said to depend on the conduct of buyers and sellers and on the structure of the market (Scherer 1980). There are observable elements of market performance (which are measured in social goals) such as income distribution, efficiency, employment and conservation.

Full employment and price stability

The concentration yard is not a very good source of employment due to the low number of workers needed. No employment statistics exist for El Piñal-Buenaventura. However, beginning in 1999, the State 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:

1. The largest firms have fixed buyers
2. The largest firms can produce less without suffering drastic decreases in rates of return
3. Vertical integration helps firms maintain some levels of profitability

The value of total production decreased from 1996 through 1999. In 2000 the value of production went up 20 percent. Net investment was negative for 1996, 1997 and 1999.

Income distribution

Recalling Encaoua and Jacquemin (1980) from Chapter II, 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. This statement is supported by Franco and Galindo (1998), where the 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.

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.

Progress, research and innovation

Research and innovation do not occur at this stage. The concentration yard is a place where timber is stored for five days, so firms do not invest in research, even when the

timber comes from a different state. Since the timber does not undergo manufacturing, and products remain the same, there is also no innovation in products.

Efficiency of the markets

The gross margin for this stage was 17 percent (Franco and Galindo 1998). The margin is the net benefit obtained by gatherers during sawtimber commercialization. For every $100 pesos that wholesalers pay, $17 pesos goes to the firm in the concentration yard. The gross margin of the final price for concentration yard is 9.5 percent; thus, for every $100 pesos that the final consumer pays, $9.50 pesos goes to the seller in the concentration yard. Franco and Galindo (1998) explain that the gross margin was obtained from the selling price; it does not reflect the net benefit. However, even if gatherers do not have high margins, their production costs remain low due to low numbers of employees and the absence of timber manufacturing.

Conservation performance

Again, at this stage of the chain of timber commercialization any attempt to promote the conservation of the forest in terms of its management has done by public entities. Firms are not involved in research, though they know the implications of over-exploitation of the forest.

In order to have some control over the forest, government entities require gatherers to report how much timber they receive each month from Nariño and Cauca. According to Franco and Galindo (1998), gatherers reported 518.8 cubic meters of timber per firm

monthly. If that amount of timber is multiplied by the number of firms, the total amount is 50,840 cubic meters, which is incompatible with the total amount reported by Nariño and Cauca (42,010 cubic meters). Therefore, 8,830 cubic meters are being commercialized monthly without being registered with the appropriate government entities. There is no proof of which firms are obtaining illegal quantities of timber.

In 2000, a new organization was created to promote the sustainable use of the forest, Ecomaderas Del Pacifico. The organization promotes sustainable use of the forest. It also attempts to promote the green label, a certification of the products. Due to the recent establishment of this organization this study did not find reports of the activities of the organization.

3.4 Market from the Sawmill to the Concentration Yard

This section describes the market between sawmills that sell raw material and the concentration yard that purchase the material. Sawmills are scattered along the rivers of Cauca and Satinga in the states of Cauca and Nariño respectively. Satinga is the most important region that produced sawtimber. Twenty-seven sawmills supply 87 percent of the total demand in Buenaventura. 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. Thus, gatherers pay 30 percent of the value of timber in advance to the sawmill. They pay the remaining 70 percent when timber arrives at the concentration yard. Sawmills use advance payments to cover some production costs. The production process in sawmills includes labor to obtain logs, labor to square timber, transportation fees, transportation costs, loading and unloading, administrative costs, machinery and equipment. Small ships with capacities of 70 to 120 cubic meters deliver the timber. There are also large ships with capacities of 140 to 210 cubic meters.

3.4.1 Market Structure between Sawmills and the Concentration Yard

This section describes three important elements of market structure: concentration, product differentiation and barriers to entry. The section on concentration includes a specific part for buyer concentration, which is important in this market.

Concentration

Concentration is measured as the quantity of output sold by sawmills. There are 54 producers (sawmills) in the South Pacific region. Nine of them are located in Cauca and 45 are located in Nariño. The four largest sawmills produce 46 percent of the total output, and the six largest produce 63 percent of the total output. All of the largest firms are located in Nariño (Franco and Galindo 1998). The market between wholesalers and the concentration yard showed that most of the largest gatherers own sawmills. Therefore, it

is possible to find buyer concentration. Additionally, Franco and Galindo (1998) reported that the Marco Antonio Zuluaga firm is the owner of the four most–recognized ships of the region for transporting people, food, and timber products between Buenaventura and Pacific littoral of Nariño.

On the other hand, large gatherers in the concentration yard contract with sawmills to obtain the amount of timber that they need. Gatherers pay 30 percent of the price before timber is harvested, and gatherers decide how much more they will pay for the products after the products are unloaded in Buenaventura.

Product differentiation

There is no physical product differentiation at this stage; bloques, tablas and tablones are the products that sawmills distribute. However, there is an extrinsic product differentiation due to location (Bain 1968). In addition to timber, ships also transport people, fuel, food and some housing goods. Population is more concentrated in Nariño than in Cauca, so more shipments go back and forth from Buenaventura to Nariño. According to Franco and Galindo (1998) there is one shipment daily to Nariño. Consequently, more timber is produced in Nariño because the transportation cost in Cauca is higher. Gatherers prefer timber from sawmills located in Nariño over those located in Cauca, even though products are the same in both locations. Some of the buyers are vertically integrated and others finance sawmills. Nariño sellers can sell at lower prices because the large amounts of timber they produce and because the cost of production is lower for them than for Cauca sawmills. Cauca sellers are disadvantaged; they may not sell enough output to save them from the higher cost of production.

Another source of product differentiation gives buyers (gatherers) some power over prices. Buyers pay 30 percent for the output in advance; at that point they agree to a price for a product that they have not yet seen. Once the timber is delivered to Buenaventura, buyers may claim that the timber quality is not as good as they expected. Buyers may reduce the amount they are willing to pay. Producers have no choice but to accept the reduction and receive less profit. Franco and Galindo (1998) observed that this situation is very common in small sawmills. Producers claim that sometimes the cost of production cannot be covered because producers are not able to predict what buyers will say about the products.

Barriers to entry

The barriers to entry at this stage arise from high costs of production, lack of knowledge and vertical integration. In order to obtain a harvesting license, local government entities (CRC and CORPONARIÑO) require producers to hold a forest management plan with its respective tree inventory. If a new producer wants to get into the market it should at least know what the requirements are and be able to find a specialist who can do the inventory. The requirements appear simple, but the geographical and climatic conditions of the area complicate the management plans and increase the expense. Additionally, the species inventory has to be 100 percent and that complicates the situation.

Knowledge is an important barrier to entry. Established firms have the experience to identify what part of the forest has not been harvested yet or is ready to be harvested again. Conditions in the region do not allow for mistakes. If a new firm decides to go into the business with insufficient knowledge of the region two things can happen: the

management plan may be rejected because of low technical specifications, or the firm may believe that the forest is productive when it is actually in the regeneration stage.

Another barrier involves the extraction of timber. The extraction of logs from the forest to sawmill requires knowledge of where the river channels are. Some of those channels are built privately, and new companies cannot use them. Therefore, new firms face channel construction, high costs of production, and high prices. Higher prices cannot compete with established prices that are usually just above the minimum level of the marginal cost.

Finally, vertical integration constitutes another barrier to entry. Firms in the concentration yard own the largest sawmills, and most of the small sawmills are financed by firms in the concentration yard. Additionally, one of the largest firms in concentration yard controls 50 percent of the ships that transports timber. If a new firm wants to joint the market it should be aware of this and try to enter on a large scale.

3.4.2 Market Conduct between Sawmills and the Concentration Yard

Elements of market structure provide information about how producers (sawmills) and buyers (gatherers) behave in setting prices and how they act in response to their rivals.

Policies toward setting prices

Established firms make decisions about their prices by looking at the reactions of their rivals. Franco and Galindo (1998) reported three different producers. The first category is

producers who are directly financed by their buyers in the concentration yard. The second category is producers who sell the service of squaring timber. There is no commercialized trade between these producers and the concentration yard. The third category is composed of those who are not financed by the concentration yard but sell timber in advance. This is the most common group in the South Pacific region. Franco and Galindo's survey in 1998 shows that firms that produce larger quantities of timber belong to the first group and have large differences in price compared with firms in the other two groups. Therefore, in 1997 large firms sold bloques for an average of $5,000 pesos, while small firms sold the same product for an average of $5,400 pesos. In the latter case, the price is relative, because when timber is unloaded in the concentration yard, buyers reclassify it and give it a different price. In most cases the new price is lower than the original. There are no significant differences in price between Nariño and Cauca, no matter what the differences were in transportation costs.

Within the concentrated sawmills information about rivals is complete, since the production process is the same for all of them. However, producers cannot act independently, because buyers (gatherers) demand more quantity than even the largest firms can supply. The largest sawmills cannot set high prices because small firms would produce more output. The largest sawmills also cannot set very low prices because there are some sawmills that contract services from them. If large sawmills set low prices, small sawmills could not afford to contract services from them, and large sawmills would not enjoy profits for those services.

Policies aimed at coercing rivals

High levels of concentration, as well as vertical integration, enable the largest firms to eliminate their rivals. In 1997, four sawmills went bankrupt because their capital levels were too low to sustain them (Franco and Galindo 1998). If a large sawmill sets its price at the minimum level above the marginal cost, a small sawmill will have to go out of business, especially a small one that contracts services from the large sawmill (sawing and transportation).

3.4.3 Market Performance between Sawmills and Concentration Yard

Market performance is described under observable elements such employment, progress, research and innovation, income distribution, efficiency and conservation. Those elements of market performance can be measured in social goals.

Full employment and price stability

Prices in this market are unstable. Buyers pay 30 percent in advance for products that they have not seen. Payment is based on a certain price, and once lumber is in the concentration yard, buyers (gatherers) decide how much they will pay according to the quality of the products. In 90 percent of the cases buyers pay less than the agreed price (Franco and Galindo 1998). Therefore, there is a high level of price uncertainty.

Employment in the South Pacific region is very poor compared with the rate of employment in Bogotá; therefore, salaries are lower in the South Pacific and violence has

increased in the region (Franco and Galindo 1998). There are 6 municipalities in the South Pacific region. Three correspond to Nariño and three correspond to Cauca. Around 75 percent of the populations of those municipalities live in rural areas (DANE 1985). The main sources of employment in the South Pacific region are forestry, mining and fishing. From 1996 to 1999 total employment decreased by 20 percent. Salaries also decreased; salaries in Nariño and Cauca's rural areas are lower than the average minimum salaries in Bogotá. The value of production 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. On average, sawmills employ twenty people (Franco and Galindo 1998), so 54 sawmills employ 1,080 people of a population of 79,184 habitants.

Income distribution

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 percent of the population lives in absolute poverty. Only 30 percent of the population has access to health services. Seventy-nine percent of the salaries are below the minimum wage (Orozco 1999; DANE 2000).

Progress, research and innovation

Production techniques in any industry of the economy are continually improving or progressing, which results lower production costs. The timber industry, as a part of the economy of Colombia, should not be the exception.

In 1970, the sawtimber industry experienced good 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 percent waste (Franco and Galindo 1998; Orozco 1999; Macía and Rojas 1999). In recent years even higher levels of waste are suspected because chainsaws are used to square timber in the forest.

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

Efficiency

There are two ways of measure efficiency: allocative efficiency and technical efficiency. Allocative efficiency is related to price-cost margin and profit rates. The gross margin for producers is of 21.5 percent (Franco and Galindo 1998). Again this margin does not reflect profitability. Low levels of profitability were inferred due to the high cost of production and price uncertainty (Franco and Galindo 1998). Technical efficiency indicates how close the firms in the industry are to the lowest costs of production. For this market there is no evidence that indicates which is the lowest cost of production.

Conservation performance

Illegal trade occurs at this stage of the chain. Companies have exploited the forest without following management patterns or even management restrictions. Franco and Galindo (1998) reports illegal trade due to price uncertainty, high levels of unemployment, high cost of production, and absence of government intervention. One example of illegal trade involves a sawmill that was installed along a river on the border of Cauca and Valle. The local authority of Cauca (CRC) should control sawmills; however, when CRC inspectors went to check the sawmill, it moved across the river and out of the CRC's jurisdiction. There is no way to control this sawmill, and additional inspectors cannot frequently inspect the area due to high transportation costs. (Franco and Galindo 1998).

There is also another geographical problem. Harvesting permits are issued for a specific region, but there is evidence that timber is extracted from different locations that were not reported in the management plan. Local authorities are developing methods to overcome the problem; one of the solutions is to use a geographical satellite positioned according to the regulations of Decreto 1791(Minambiente 1999a).

Del Valle (2001) concluded that the production of timber of the Pacific South region (with major emphasis in Satinga, Nariño) will be sustainable but will depend on the evolution of the price of timber in the future (2001). His research found that the actual harvesting rate is reducing productive trees, and ultimately timber production will decrease. However, because of soil properties, the actual agricultural system (fire is not

used), and the null existence of cattle in wide-land extensions, the forest will remain resilient.

3.5 Market from Loggers to Sawmills

Although this stage is not considered part of the sawtimber market (Franco and Galindo 1998), it is important to understand how this stage affects the performance of the sawtimber industry. The local black community for Nariño and Cauca comprises the loggers, which are usually a group of four people or family members who obtain logs from the forest (Orozco 1997; Franco and Galindo 1999; Del Valle 2001). The market at this stage of commercialization is informal. Buyers contract with loggers to obtain raw material. There is a chief who organizes the groups. Inside the forest, logs of three meters long and not less than 0.3 meters in diameter are cut. Then the logs are carried by shoulder to the channels or pathways, where they float downstream until they reach the river. In the river logs are tied to let them flow downstream to the sawmills. The process takes at least 5 days. However, it can be longer if loggers have to construct the river channels.

3.5.1 Market Structure from Loggers to Sawmills

This section describes the market in terms of elements of concentration and product differentiation. The market at this point is very informal and the available information is poor.

Concentration

The number of landowners is not easy to identify. Most of the landowners are peasants that become loggers. There are 54 sawmills on the South Pacific coast. The four biggest firms produce 46 percent of the total output, which indicates that they buy large quantities of raw materials.

Product differentiation

There is no differentiation at this point. Loggers struggle to find the best trees in order to obtain better logs and gain a premium for them. To understand this, it is important to understand the methods of payment, too. Producers give loggers tools, such as chainsaws, to use for harvesting timber. Producers also give them food and medicine or home supplies. Once the logs are on sawmills, producers decide what the logs are worth. If the amount exceeds what the producers already paid in food and other supplies, the 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 get into the forest and find more logs (Franco and Galindo 1998).

3.5.2 Market Conduct from Loggers to Sawmills

Sawmills decide what price to pay for logs. They argue that price depends on the quality of the log. At this point, there are no barriers to entry and no vertical integration, and sellers have no influence on price or on their rivals.

3.5.3 Market Performance from Loggers to Sawmills

The performance of the market is observable in social goals. Because of the scarcity of information few things can be described; however, enough can be described to understand the socio-economic impact of the timber trade.

Full employment and price stability

Price is unstable. Loggers do not exactly know what their wages will be because the wages depend on the willingness of sawmills to pay for labor. DANE (2000) registered high levels of unemployment. There is also informal employment, where loggers obtain logs to sell to different sawmills. From 1996 to 1999 total employment decreased by 20 percent. 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 1999).

Income distribution

There is no real income for loggers. They do not receive payments that let them enjoy their own expenditures and savings. Income distribution is unequal; producers have high levels of profit, which ultimately goes to Buenaventura due to vertical integration. The local community not only lives in extreme poverty, but also carries the consequences of forest depletion. Income distribution is equal for all loggers, but that income is not enough to cover the community's basic necessities.

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 percent of the population lives in absolute poverty. Only 30 percent of the population has access to health services (Orozco 1999; DANE 2000).

Efficiency

Franco and Galindo (1998) estimate that 15 percent of the gross margin for sawmill producers goes to loggers. This is 3.2 percent 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.

Conservation performance

The forest has been exploited without following management patterns or even management restrictions. Franco and Galindo (1998) reported illegal trade due to price uncertainty, high levels of unemployment, high costs of production, and absence of government intervention. However, it is important to remember that producers pay with tools and food. Once loggers pay for their chainsaws, they can sell timber to other producers (Franco and Galindo 1998). Loggers are aware of the low payments that they will receive for timber, so they find different producers to sell to. Consequently, the forest is being harvested without government permission. There is no evidence of how much timber is harvested in this manner, but legal authorities have detected the

harvesting. One of the results of this harvesting is high level of waste because timber is squared inside the forest with chainsaws. Another result of the illegal trade is that the most valuable wood is extracted in this way—because it has more value, and because the wood cannot be extracted legally. Because there is no control over the illegal extraction, the government is unaware of exactly what kind of timber is being harvested. Franco and Galindo (1998) also mentioned that firms in the concentration yard pay for this labor, taking advantage of holding the harvesting licenses and transportation permits.

3.6 Summary

The sawtimber market of the South Pacific region was described under the paradigm of structure, conduct, and performance. Elements of market structure help to describe elements of conduct. Elements of performance were described based on the abilities of the markets to attain social goals.

The sawtimber industry is divided into four markets, which describe the commercial exchange of the participants along the chain of commercialization. The market between wholesalers and final consumers describe the interaction of wholesalers acting as sellers and final consumers as buyers. The structure of this market indicates that six of the 49 wholesalers concentrate 60 percent of the output. Product differentiation is present in this market; wholesalers also commercialize plywood, veneer, roundwood and sawnwood from other regions. There are also barriers to entry that arise from high levels of available capital. Market conduct indicates that concentrated firms that are vertically integrated set

price and output levels. The market performance contributes to decreases in employment in the forestry sector, decreases in the value of production, negative values of net investment for the sawtimber industry and low levels of profit for small firms. The industry contribution to the economy of the country is below its potential. This is reflected in the low contribution to the gross domestic product. Large quantities of sawtimber are being imported from neighboring countries.

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 percent of the transactions. There is no product differentiation, but there are barriers to entry because of the requirements for capital and knowledge. The structure of the market influences market conduct, which indicates that concentrated firms set prices and output. Dominant firms function as financial facilitators and create barriers to new entrants and control their rivals in the open market. Firms in these markets perform poorly in their contribution to investment, employment, and income distribution. Research and innovation are not evident in this industry. There is evidence of illegal trade in timber products.

The market between sawmills and concentration yards indicates that sawmills act as sellers and concentration yards are buyers. The market structure indicates seller concentration, 46 percent of the output is concentrated in four of the 54 sellers. Product differentiation arises from location and 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. The concentrated buyers finance small sawmills to produce timber. Price is not stable in this market because of the nature of payments and the financial system. The performance of this market is poor because of high levels of unemployment, unequal income distribution, and high levels of poverty. 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.

The market structure between loggers and sawmills; loggers are the sellers and sawmills become buyers, indicates buyer concentration. Four of the 54 sawmills concentrate 46 percent of the output; there is no product differentiation and there is no evidence of barriers to entry for loggers. Buyers decide how much pay for the logs and decide also how much timber to buy. The performance of the market results in high levels of poverty, unemployment, unequal income distribution, inefficiencies and illegal trade in timber.

Market structure and conduct of the market from wholesalers to final consumers determines the performance of the market at national level. Therefore, trade balance, gross domestic product and public policy were considered. 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 states.

CHAPTER IV

ECONOMETRIC MODEL

This chapter describes an econometric model to measure the degree of imperfection. The model can be used to measure the degree of oligopoly of the sawtimber market. This research presents the model as a demonstration to be then applied in the different timber markets when reasonable data will be available. This chapter will delineate data requirements and model specification.

4. 1 Description of the Model

The model will follow De Mello and Brandao (1999) specifications, which are based in the model by Appelbaum (1982), which uses the New Empirical Industrial Organization approach to test oligopoly power. 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 define a degree of oligopoly index for the whole industry.

Appelbaum (1982) defined a non-linear simultaneous equation system with a market demand function, three factor demand equations and an equilibrium condition. Consider an industry with *n* firms producing homogenous output.

The cost function of the *jth* firm is:

(1) $$C^j = (q^j, w)$$

Where:

C^j= cost of output

q^j = quantity demanded

w = vector of input prices

Market demand function

(2) $$Q = D(p, v)$$

Where:

p = Output price

v = Vector of exogenous variables

Profit maximization function is:

(3) $$\max\left\lfloor pq^j - C^j(q^j, w)\right\rfloor \text{ subject to market demand}$$

The first order condition requires *jth* firm's marginal revenue equal to its marginal cost, then.

(4) $$p(1-\theta_j E) = MC_j$$

Where:

θ_j = conjectural elasticity for the *jth* firm

$\theta_j = \frac{\partial Q}{\partial Q^j} * \frac{Q^j}{Q}$, where $\frac{Q^j}{Q}$ is market share of the *jth* firm

E = inverse 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).

The equilibrium condition for the *jth* firm can be written as:

(5) $$\frac{p - MC_j}{p} = \theta_j E$$

The Appelbaum equilibrium conditions for the whole industry can be written as:

(6) $$p(1 - \theta E) = MC(w)$$

Where:

p = Product price

E = Inverse demand elasticity

MC = Marginal Cost

w = Factor Price vector and

θ = Conjectural Elasticity

Since conjectural elasticity cannot be constant, Appelbaum defined it as:

(7) $$\theta_t = A_0 + A_K WK_t + A_L WL_t + A_R WR_t$$

Where:

WK = Price of capital

WL = Price of Labor

WR = Price of Material

Substituting (7) into (6) permits parameters A_0, A_K, A_L and A_R to be estimated. These parameters provide basis to estimate annual conjectural variation. However, the linear dependence in equation (7) appears to be restrictive (De Mello and Brandao 1999) since conjectural elasticity depends upon the market share and the conjectural variations. Conjectural variation refers a firm's expectation about the effects than changes in its production have on the output level of its rivals (Iwata 1974).

If the model is considered in the aggregate conjectural elasticity will depend on price-cost margin and on the demand elasticity. So conjectural elasticity 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 related with some other aspects such 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, amongst others (De Mello and Brandao 1999).

Equation (7) is not appropriated for the timber industry because the conditions mentioned above are present in the industry, chapter three described these conditions. Furthermore, institutional framework has been changed since the last 10 years, leading to unexpected changes of the firms facing the industry. Diversification and substitutability also play important role in timber industry because of the increase in softwood products.

De Mello and Brandao (1999) present a modification of Appelbaum's approach to overcome the problem. Assume an industry with *n* firms producing a homogenous output using *m* production factors. Taking firm *j* and maximizing, the equilibrium equation can be representing the same as Appelbaum's model:

(8) $$p(1-\theta_j E) = MC_j$$

Where:

p= market price

θ_j = firm j's conjectural elasticity

E= inverse demand elasticity

MC_j = firm j's marginal cost

The degree of the industry's market power is defined as:

(9) $$L = \sum_j \frac{p - MC_j}{p} * s_j = \sum_j \theta_j E s_j$$

Where;

s_j = firm j's market share

L = degree of oligopoly

Since firm level data is not available. The model is applied to the aggregate industry. Assuming that marginal cost is the same for all firms, thus, $\theta_j = \theta$ equations (8) and (9) can be written as:

(10) $$p(1 - \theta E) = MC$$

(11) $$L = \theta E$$

Therefore the degree of oligopoly is expresses as the conjectural elasticity multiplied by the inverse demand elasticity. If the industry is perfect competitive $L = 0$, if the industry is pure monopoly $L = E$.

From equation (10) the conjectural elasticity is:

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

Where:

ε = demand elasticity

w = vector of factor prices

Demand elasticity and industrial marginal cost in equation (12) need to be estimated. A simultaneous equations model with a demand equation, an equilibrium condition and three factor demand functions is constructed.

Demand is a function of price and a vector of exogenous variables that affect demand.

(13) $$Q = D(p, v)$$

Where:

Q= total output quantity (timber in cubic meters)

p = market price (pesos per cubic meter)

v = Vector of exogenous variables

Using a Cobb-Douglas function, demand is represented in equation (14).

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

Where:

p = price of sawtimber in actual pesos

GDP = Gross Domestic Product in current pesos.

PS = Price of substitutes (softwood-Pino) in actual pesos.

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

(15)

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

Quantity capital data is not possible to obtain. Therefore, capital variable will be eliminated from the model. A Similar assumption was used by Schroeter (1988) who estimated the degree of market power in beef packing industry based on Appelbaum's procedure.

Two factor demands are:

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

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

In the equilibrium condition, positive margin in the model could be found since the market is oligopolistic (De Mello and Brandao 1999).

Assuming the equilibrium equation as:

(18) $$p(1-m') = \frac{\partial C(Q,w)}{\partial Q}$$

Where $m' = g(p,w)$ is alternative form for the mark up, being between 0 and 1. The markup is considered to be some quantity above the unitary cost that is usually expressed by the equation $p = (1+m)MC$, if costs are positive. If MC = p, then m = 0. If MC tends to 0, then m tends toward infinite. To define mark up instead of use cost, price will used. De Mello and Brandao (1999) call this procedure, markdown, they used of the fact that the unitary cost is, generally, a fraction of the price. Consequently, m' goes from 0 to 1 since, if MC > 0 $\Rightarrow p(1-m') > 0 \Rightarrow (1-m') > 0 \Rightarrow m' < 1$ and if

$p > MC \Rightarrow p \geq p(1-m') \Rightarrow 1 \geq 1-m' \Rightarrow m' \geq 0$

Therefore

(19) $$m' = \alpha_R \frac{w_R}{p} + \alpha_L \frac{w_L}{p}$$

(20) $$\frac{\partial C(Q,w)}{\partial Q} = b_{RR} w_R + b_{LL} w_L + 2b_{RL} (w_R w_L)^{1/2}$$

Substituting (19) into (20)

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

Variables Q, p, $f_{L,} f_R$ are endogenous all others are exogenous. The complete system is:

(22) $$\ln Q = \alpha - \varepsilon \ln(p) + \alpha_1 \ln(GDP) + \alpha_2 \ln(PS) + e_1$$

(23) $$\frac{f_L}{Q} = b_{LL} + \frac{b_L}{Q} + b_{LR} \left(\frac{w_R}{w_L} \right)^{1/2} + e_2$$

(24) $$\frac{f_R}{Q} = b_{RR} + \frac{b_R}{Q} + b_{RL} \left(\frac{w_L}{w_R} \right)^{1/2} + e_3$$

(25) $$p = (\alpha_R + b_{LL}) w_L + (\alpha_R + b_{RR}) w_R + 2b_{RL} (w_R w_L)^{1/2} + e_4$$

Using a linear 2 stage system least square method, parameters will be estimated. Knowing $b_{LL,}$ b_{RR}, and b_{LR} the value of Marginal Cost can be estimated. With MC and ε, the conjectural elasticity is estimated, and finally L, the degree of the imperfection, can also be found.

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

Data of timber prices and quantities, price of substitutes and price of raw material are available for years 1990-1997, the sources of information is Ministry of Environment (SIEF-INDERENA). Gross Domestic Product, price of labor and consumer price index are taken from the regional survey of National Statistic Department (DANE). Prices were deflated by consumer price index base 1994.

Due to the small number of observations, data of markets related was used to illustrate de effectiveness of the model. Prices of sawtimber of Amazonian, Magdalena Medio and Chocó were used. However, data of Amazonian 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). Linear regression estimated the demand equation.

4.2 Econometric Model for Market between Concentration Yard and Wholesalers

The demand equation gives the elasticity of the demand, which is used to calculate the Marginal Cost. Table IV-1 on page 98, shows the estimate values and the standards errors. The elasticity of the demand is -0.0835, which is consistent with the economic theory, however the result has to be carefully analyzed because t-statistic stated that the estimate is not significant at 0.05 level of significance.

For the system of equations Table IV-2 (page 99) shows the estimates and standard errors. With those estimates marginal cost, conjectural elasticities and the degree of oligopoly were estimated. Table IV-3 (page 100) shows MC, conjectural elasticities and L estimates for the seven years.

Table IV-1 Estimate and standard errors of the demand equation

Variable	Estimate	Standard Error
Intercept	14.1713	9.2245
LnP	-0.0835	0.5387
LnGDP	-0.4786	1.5855
LnPS	-0.3684	0.5920

Source: SAS output

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, comparing this value with the table for critical values for Durbin-Watson (DW) with T = number of observations (28) and K = number of variables including the constant term (4).

dU = 1.651 Upper level

dL= 1.162 Lower level

DW is not within these bounds (DW > dU), so 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.

The estimates needed to calculate *MC,* θ and *L* are b_{LL}, b_{LR}, b_{RR}, α_L and α_R.

(23) $$\frac{f_L}{Q} = b_{LL} + \frac{b_L}{Q} + b_{LR}\left(\frac{w_R}{w_L}\right)^{1/2} + e_2$$

(24) $$\frac{f_R}{Q} = b_{RR} + \frac{b_R}{Q} + b_{RL}\left(\frac{w_L}{w_R}\right)^{1/2} + e_3$$

(25) $$p = (\alpha_L + b_{LL})w_L + (\alpha_R + b_{RR})w_R + 2b_{RL}(w_R w_L)^{1/2} + e_4$$

Table IV-2 Estimates and standard errors for parameter of equations 23-25

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

Source: SAS output for Nonlinear 2SLS
* Significant at 0,05 level

These parameter estimates and the demand elasticity are sufficient to estimate marginal cost by using the assumption that P = MC (*w*), indicates that MC is a function of input prices. Then MC is inserted into equation (12) and the conjectural elasticity is estimated, then with conjectural elasticity and the inverse demand elasticity the degree of oligopoly is estimated. Table IV-3 (page 100) shows positive values for conjectural elasticity and

for the degree of oligopoly, this indicates a market with imperfectly competitive market structure and the present of market power.

The estimates have to be significantly different from zero. To test the hypotheses for the present of perfect competition and the absence of market power, sample mean estimates and standards deviation of θ and L are used. Table IV-4 (page 101) shows those estimates.

Table IV-3 Estimated values marginal cost, conjectural elasticity and degree of oligopoly

Year	P*	MC*	$\hat{\theta}$	$\hat{L}$
1990	734.87	525.28	0.024	0.285
1991	595.35	379.53	0.030	0.363
1992	436.28	317.25	0.023	0.273
1993	305.45	236.66	0.019	0.225
1994	194.50	133.82	0.026	0.312
1995	252.62	104.09	0.049	0.588
1996	188.91	133.02	0.025	0.296
1997	241.32	133.21	0.037	0.448

* Dollars per cubic meter

Table IV-4 Sample mean estimates

	$\hat{\theta}$	$\hat{L}$
Estimate	0.0291156	0.3486902
Estimates standard deviation	0.0098023	0.1173933

To hypotheses for perfect competition is:

$H_0 : \theta = 0$
$H_a : \theta \neq 0$

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

t = 2.97 H_0 is reject, therefore market is imperfect.

The absence of market power hypothesis;

$H_0 : L = 0$
$H_a : L \neq 0$

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.

Due to the low value of the demand elasticity a test of sensibility is used to observe what happen if the elasticity of the demand changes. Pulpwood elasticity of the demand value (-0.31) for U.S is used (Murray 1995), and demand value of -0.5 and 1. Table IV-5 (page 102) shows the values of conjectural elasticity (θ) and degree of oligopoly (L).

Table IV-5 Degree of oligopoly for different demand elasticities

Year	$\hat{\theta}$	$\hat{L}$	$\hat{\theta}$	$\hat{L}$	$\hat{\theta}$	$\hat{L}$
	(-0.31)		(-0.5)		(-1)	
1990	0.088	0.285	0.142	0.285	0.285	0.285
1991	0.112	0.362	0.181	0.362	0.362	0.362
1992	0.084	0.272	0.136	0.273	0.273	0.273
1993	0.070	0.225	0.113	0.225	0.225	0.225
1994	0.097	0.312	0.154	0.312	0.312	0.312
1995	0.182	0.588	0.294	0.588	0.588	0.588
1996	0.092	0.296	0.148	0.296	0.296	0.296
1997	0.138	0.448	0.224	0.448	0.448	0.448

Changes in elasticity of demand change conjectural elasticity but keep constant the degree of oligopoly. If the demand elasticity increases, the conjectural elasticity increases too. The greater the elasticity of demand the higher the level of market imperfection.

CHAPTER V

CONCLUSIONS

Chapter III described the four stages of the sawtimber industry for the South Pacific region. Chapter V will present conclusions about each market based on the structure/conduct/performance paradigm used in Chapter III. Conclusions about the econometric model (Chapter IV) are included in this chapter. This chapter also presents some recommendations about the industry in the national context. These recommendations are intended to assist policy makers.

In general terms, research revealed that observable elements of structure dictate conduct; and structure and conduct influence the performance of the market, which reflects a high degree of market imperfection.

5.1 Market from Wholesaler to Final Consumers

High levels of concentration were found in this market. Six of the 49 firms involved in this market concentrate 60 percent of the production. Concentration facilitates collusion, and high levels of profitability follow. Recall Bain (1968), who explained that the level of concentration for oligopolistic markets is between 100 percent and 10 percent. Therefore, this market has the characteristics of an oligopolistic market: any output adjustment of

any of the six largest firms will influence the market price and quantity. Wholesalers have mutual interdependence over price-output decisions.

It is evident that the largest firms are vertically integrated at this stage in the chain of commercialization. The largest firms have capital that allows them to reduce transportation costs by using their own trucks. Controlling transportation services also provides extra profit for large firms by allowing them to transport timber for small firms. Vertical integration is a consequence of high levels of available capital. At this stage high levels of available capital increase profits.

Firms with high levels of available capital can support buyers to some extent. This support presents an absolute cost barrier to entry into the market for new firms. Established large firms may also set their prices at the minimum level above marginal cost. New firms must adopt these prices to compete, but the prices prevent new firms from making good profits. Ultimately, the business is not attractive to them.

Knowledge constitutes another barrier to entry in sawtimber market. Wholesalers are heavily dependent on the supplier's species expertise. Wholesalers do not meet their suppliers because of distance; nevertheless, wholesalers buy timber from them because suppliers deliver the best products from the right species. 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.

New firms can enter the market, but they face high levels of investment and competition from the largest firms; therefore, absolute cost barriers to entry characterize this market. The statement of Caves (1967) that high levels of concentration imply a high level of barriers to entry is confirmed in this market. In summary, conduct in oligopolistic markets depends on the actions of the sellers (Caves 1967). This market exhibits mutual interdependence of sellers, a typical trait of oligopolistic markets, where sellers set and coordinate prices by looking at actual and potential rivals. In an oligopolistic market such as the one describe above, leading firms set prices and fringe firms must follow suit or set even lower prices. Setting lower prices translates to lower levels of profitability for small firms (Franco and Galindo 1998).

High levels of concentration and the presence of barriers to entry reveal the sawtimber market conduct to be coercive. If the largest firms that have strong financial systems reduce price to the minimum level above the average costs, small firms will be unable to compete. Due to the high barriers to entry, new firms should enter the market on a large scale or by enjoying very low profits in the short run. 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. Other risks include the availability of materials to newcomers and the uncertainty of future forestry legislation. Furthermore, coercive conduct arises from squeezing operations, too; concentrated firms are vertically integrated, and fringe firms do not hold the same market share.

So far, the market behavior is consistent with economic theory and with the theory that elements of structure determine conduct. The analysis of performance indicates that there is a relationship between structure, conduct and performance. One of the elements of performance is employment. National statistics reveal increases in the rate of unemployment, decreases in timber production, and consequently, negative values of investment. The equitable distribution can be viewed under Caves' statement of distribution of the size of business: "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, 99). Therefore, the distribution of the size business is unequal for this market; there are 49 wholesalers, of which six are the largest. There are also 122 wholesaler of a population of 11 million of people.

At this point it will be helpful to include Gini's coefficient as 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. For Colombia the Gini coefficient is 0.57. This means that 3.6 percent of the country's income goes to the poorest people and 54.4 percent 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.

According to the value of the gross margin (61.5 percent) the market seems to be efficient, but this value has to be carefully analyzed. High levels of concentration and vertical integration among large firms demonstrate efficiency, but there is no evidence of efficiency in small firms; in fact, some of them went out the business while the concentrated firms remained. Concentrated firms are technically efficient, but this does not mean that allocative efficiency is demonstrated. Finally, if there are high levels of concentration with high levels of barriers to entry and vertical integration by the oligopolistic firms, the degree of the imperfection must also high. Firms in the open market do not have the power to set prices. Vertically-integrated firms restrict output. There is a low probability that small firms can become vertically integrated and join the concentrated firms.

On the other hand, the low total contribution of the sawtimber market to the gross domestic product leads to the conclusion that the market is not competitive enough to gain good position within the national economy or in international exchange. The total consumption of sawtimber products decreased during the period 1999-2000. 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. 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 timber market. As a consequence, timber products used for manufacturing are also affected. The furniture industry reported the lowest levels of contribution within the manufacturing industry, therefore timber markets do not perform positively to the economy of the country.

Minambiente (1999a) predicted a decrease in sawnwood production for 2000-2004, resulting from a decrease in construction and quality improvements in wood substitutes. Minambiente forecasted that the national production of sawnwood for 2000-2004 would decrease by 10 percent to 15 percent and be supplemented with imports. Looking at the actual statistics available, sawtimber production did decrease from 2000-2003, but the trade balance was positive for that period. The country's exports for 2000 and 2001were composed of non-coniferous sawtimber. During the same period, the amount of imports of sawtimber decreased for both coniferous and non-coniferous (Tables III-2 and III-3). Clearly different sources of information generated conflicting data as well biased estimations.

Conservation performance is also negative. The study observed that final consumers and wholesalers do not promote any research in the South Pacific region or within the industry. Any information about conservation, forest production, reduction of logs extraction, and losses in manufacturing has been provided by government entities such as Minambiente, CORPONARIÑO and Universidad Nacional-Medellín.

Recommendations

Fifty percent of the surface of Colombia is covered by natural forest; 73 percent of the timber produced is from natural forest; and 60 percent of that production is from the forests of the Pacific region. The South Pacific Region, as the primary producer of timber (particularly sawtimber), requires specific attention from the economic, ecological and social points of view. Any attempts to promote sustainable development and

competitiveness must be based on good knowledge of the market. The attempts should emphasize economic, ecological, and social benefits.

Despite the effort of government to study the possibility of exporting timber and be competitive in the international exchange, it is important first to know the domestic markets—how they are structured, how they behave and how much they contribute to the national economy under the concept of sustainable development. Without this knowledge any effort to promote international competition will fail. The current study agrees with Orozco (1997) that Colombia should not yet seek to find ways to export timber from the Pacific region, even after improvements are made in domestic markets.

Colombia cannot compete in the international sawtimber market now for several reasons. The first is lack of knowledge about domestic markets, which is reflected in a lack of data. Second, domestic markets show low contributions to the national economy, measured as contributions to the Gross Domestic Product (GDP). GDP is an indicator for sustainable management of natural tropical forest. Third, domestic consumption can be covered by the actual production, but there is not enough remaining to export.
Ruiz and Castro (2003) studied the possibilities of creating a para-fiscal base for the forestry sector for the chain of timber commercialization. A para-fiscal base would create a group of government and private members to serve as an incentive for producing and commercializing of timber. The base would be in charge of finding financial resources, better rates of interest, and incentives for production as well as technological assistance for each of the stages of the commercialization chain. The Ruiz and Castro study is one

more attempt to include the forestry sector within national accounts. However, the researchers also claim serious data collection problems. In fact, the study does not include statistics from the South Pacific region, which produces 60 percent of the nation's sawtimber.

One problem with these studies is a serious lack of data for researchers to use. Production data and data about consumption and demand of timber products vary among Minambiente (1999a), FAO (2000), Acevedo and Martínez (2003) and Ruiz and Castro (2003). The data reported by Minambiente for 1995, 1996, 1997 and the first quarter of 1998 has a high level of credibility because it was an extensive data collection of the regional offices designed to create a database of SIEF, which was supported by the Ministry of Environment and the International Tropical Timber Organization. Consequently, if we look at the statistics production increased for those years compared with production of years later. However, the decrease in production for years 1998-2000 (Table I-1 on page 5) is biased. There is a high level of probability that the production remains around one million cubic meters for those years. Ruiz and Castro (2003) claim that the statistics of 1998-2001 lack data. CORPONARIÑO, Corpouraba, Corpoamazonia and CDA did not report production data to the central government. Those entities registered most of the 50 percent of the production for years 1995-1997 (Minambiente-SIEF). Consequently total production of 1998-2001 should be interpreted carefully.

Researchers urgently need accurate and complete data. Without reliable data, all attempts to study the forestry sector will be inaccurate. Therefore, the Forestry Statistic

Information System (SIEF) should be fortified in the regional and national context. Governments must consider establishing a survey of timber manufacturing industries as well as producers for all of the timber production regions. Recent studies of timber production and marketing have been evaluated at the national level; but it is very important to study the region where the timber came from, too. Therefore, careful studies of the other three chains of commercialization are necessary.

Knowledge of the structure of the market and its influence on the regional and national socioeconomic results will help policy makers in the future, especially now that the National Government plan considers the trade of forest products as a good strategy to achieve sustainable development.

5.2 Market from Concentration Yard to Wholesalers

High levels of concentration characterize this market. Three of the 68 firms concentrate 56 percent of the total production. Although the numbers of buyers and sellers are similar, because of the high concentration the market is oligopolistic. Due to the small number of concentrated firms, collusion is likely, along with high profit levels.

Product differentiation does not affect price, but high levels of concentration, high levels of capital, and vertical integration affect price. Timber is sold by credit, and approximately 50 percent of the firms own trucks. Those are sufficient conditions to reflect high levels of capital and vertical integration respectively. Firms with high levels

of capital and good financial services attract buyers, but those firms have fixed buyers in Bogotá, where wholesalers congregate. More buyers indicates higher output and lower prices. Franco and Galindo's survey (1998) confirms this statement. High levels of output are concentrated in three firms, which in turn offer lower prices.

Absolute cost barriers and economies of scale are included in this market. One of the concentrated firms is completely vertically integrated, owing sawmills, trucks and five of the ten ships that transport raw material. The concentrated firms 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.

Mutual interaction between sellers is common in oligopolistic markets. This market is no exception, and any change in output in one of the firms will affect the others. Market conduct indicates how firms set prices and coerce their rivals. In this market the largest firm sets prices; therefore price leadership is the way that this oligopolistic market coordinates prices. In 1997, Franco and Galindo's survey observed that the largest firm reported the lowest prices. The largest firms are also vertically integrated.

Due to the strong financial system of the concentrated firms, high levels of concentration and high levels of barriers to entry, predatory price-cutting can be concluded as a coercive technique for oligopolistic firms. These firms can set the price at the minimum level above marginal cost, or even to unprofitable short-term levels, to weaken their rivals or block the entrance of new firms. If concentrated firms set their prices to

minimum levels, fringe firms will be unable to compete and will ultimately leave the business. Fringe firms set their prices at points that allow small profits; however, these prices are higher than the prices of concentrated firms. Therefore concentrated firms sell more output and enjoy better profits than small firms, who barely remain in business with small profit levels.

Concentrated and vertically-integrated firms can easily squeeze their small rivals by charging more for input transportation. In the South Pacific coast, one firm owns five of the ten ships. This firm heavily affects 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.

Some firms do not want to be vertically integrated, even with their high levels of capital. They may prefer risky, potentially high–profit investments. These firms sell sawtimber on credit and guarantee future sales by pleasing their customers. According to Franco and Galindo (1998), sellers act like banks for small buyers, but with different financial systems. Thus, concentrated firms supply not only large buyers but also finance small buyers at higher price, which represents more output sold.

Market performance is analyzed under efficiency, employment, and income distribution and conservation performance elements. Technical efficiency does not apply at this stage because there is not manufacturing, only storage. Furthermore, this market is characterized as having low opportunities for employment. Regarding income

distribution, according to Franco and Galindo's (1998) survey, small firms claim simply to be surviving. This statement, combined with Gini's 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.

Conservation performance indicates that there is illegal trade. The forest is being harvested without legal permits. The complexity arises in one part because of the geographical distribution of the forest and the concentration yard. The productive forest is in Nariño and Cauca where local government corporations (CORPONARIÑO and CRC) issue transportation licenses (*permiso de movilización*). The license indicates, in cubic meters, how much timber is allowed to travel to the concentration yard. In the concentration yard, the local corporation (CVC) issues a license to transport timber (*permiso de re-movilización*) to Bogotá. The quantities of timber registered with CORPONARIÑO and CRC should be equal to the quantities registered with the CVC. However, this is not true. Franco and Galindo (1998) observed that in 1997, the CVC reported more than CORPONARIÑO and CRC. The excess timber is illegal. Due to the geographical distances, low budgets of the entities, low accessibility to the forest area, and low number of employees, the three entities are not well coordinated. Furthermore, there are informal loggers that pay no attention to the government entities. They cannot hold a transportation license because they do not have harvesting licenses, which are required for the transportation license. However, informal loggers obtain logs from the forest and sell them to sawmills. That timber is not being registered in the government

corporations. Franco and Galindo (1998) suspect that this is the excess quantity reported by the CVC.

5.3 Market from Sawmill to Concentration Yard

This market exhibits high levels of concentration. Six of the 54 firms in the market concentrated 63 percent of the output. In terms of the number of buyers and sellers, the market can be considered competitive, but the high concentration levels determine the market to be oligopolistic.

A high level of buyer concentration is also present in this market. The largest firms in the concentration yard are vertically integrated—they either own sawmills or finance small sawmills. The market is oligopsonistic because buyers (gathers in concentration yard) control the price and the output. Additionally, the fact that buyers control price represents a high degree of price uncertainty. Buyers pay in advance for products that have not yet been extracted from the forest. They agree on a price with the sawmills. Then, when the products are in concentration yard, buyers reduce the price claiming that products are poor in quality. Consequently, the profitability of small firms is greatly reduced.

There are some sources of barriers to entry in this market; new firms must face established large firms that are controlled by buyers. To enter into the market a new firm should also think to be gathered in concentration yard too, which implies high levels of capital and investment. If the new firm is strong enough to gather in the concentration

yard, it must compete with large firms. New firms should also own ships and be ready to pay high fuel costs. Recalling that ships also transport people and some other goods, these new firms should know those markets, too. New firms also should have good knowledge of legislation and will need to invest in the harvesting licenses. Additionally, there is a risk of investment. That is, there are some requirements to obtain the license. A management plan is one of those and is also the most expensive. However, the plan is not always approved, so that the forest cannot be harvested. For all those reasons new firms are not attracted to this market.

Due to the oligopolistic/oligopsonistic market, the largest firms weaken the smallest ones. For 1997, Franco and Galindo (1998) reported 96 sawmills, but only 54 of them were active. This indicates that 42 sawmills left the business. Consistent with the Central Bank (Banco de la Republica) report, small firms are highly hit during periods of business recession. Curiously, there is no report of any firm that closed in the concentration yard. Therefore, vertically-integrated firms remain in business.

There is no research or innovation at this stage. Firms are using old, obsolete technology that lowers efficiency. Only 38 percent of the raw material is used. Forests are being depleted. Again looking at Franco and Galindo (1998), producers claim that distance makes getting into the forest very difficult.

High levels of buyer concentration and seller concentration indicate high levels of inefficiency. Therefore, the market is performing poorly. There are low levels of employment and low wages. Unemployment and low wages affect the security of the

region (Franco and Galindo 1998). The degree of imperfection at this stage is high because of the influence that concentrated firms have over price and output. Contrary to what economic theory expects — high concentration, high profitability and high levels of efficiency — this market shows high concentration, high levels of profit, and low levels of efficiency.

The market at this stage is also highly imperfect. It is an oligopoly/oligopsony market that performs very poorly. Chapter II and III indicated the main income of the local population is from forestry activities, but the region has a high poverty index, which indicates unemployment and unequal income distribution.

Conservation performance is poor. Not only is the rate of waste high, but there is also illegal trade. Standing trees have no value, which indicates that the forest itself is not valued. Sustainable development in the region is discussed but not practiced.

Recommendations

To achieve sustainability, timber market organization needs to be a high priority of the country. Sustainable developments imply economically–efficient, socially– acceptable and ecologically–sustainable programs. This study concludes that none of those three conditions is met. There are a few firms with high levels of profit; however, their contribution to national goals in terms of allocative efficiency and income distribution is poor.

A good system of credit to facilitate timber trade will minimize the impact of poor performance. More firms will want to be in the business, small firms will improve technology and the domestic market will want to be in the business and the domestic market will gain standards of competition. Consequently, better standards of life will be achieved.

5.4 Market from Loggers to Sawmills

High levels of buyer concentration indicate an oligopsonistic market. Buyers set prices. Market performance is poor and follows the same pattern as the previous market. High levels of poverty are reported for the Pacific region; therefore, income distribution is unequal. Wages are also below the national average. Forests are exploited without following patterns of production. Additionally, there is lack of information regarding the regional timber market.

Recommendations

The production of sawtimber in Colombia will continue. It will have raw material available as Del Valle (2001) indicates, due to the high levels of regeneration. However, because timber market is not contributing to the economic development of the region, domestic markets have to be the priority of the country. Orozco (1997) indicates that government should implement some policies to correct market imperfections. Those policies require that local communities remain well organized. Keeping those two conditions will improve the level of life for the population of the Pacific region.

Manufacturing of timber in Nariño and Cauca should be promoted. The increased of value added to timber in the harvesting place will increase employment. However, this promotion has be accompanied by good sources of credit and policy incentives that guarantee a better use of the resources. Orozco (1997) proponed that largest firms should include local communities that develop plans to harvest and use forest resources. This study agrees with the that statement. Those plans may include agreements between firms and communities because firms have economic resources and communities have the raw material.

5.5 Econometric Model

After the econometric analysis, the estimate of the elasticity of demand is consistent with the economic theory. Demand elasticity has to be negative. The elasticity of demand for the market between the concentration yard and wholesalers is -0.035, this means that the quantity demanded is relatively unresponsive to changes in price. The scope of this research is not to evaluate the behavior of the demand; the elasticity is used to calculate the degree of imperfection.

Looking at Table IV-3 (page 100) the values of L are positive and less than 1. Based on the Appelbaum (1982) conclusions, an index between 0 and 1 indicates oligopolistic behavior. There is sufficient evidence to state that the market is not competitive. Sensitivity analysis shows that the value of conjectural elasticity increases as the value of

the demand elasticity increases. Therefore, as the demand becomes more elastic the expectations of the oligopolists for changes in their outputs increase, too.

In all the markets, data at the firm level is very difficult to obtain. Therefore the econometric models used aggregate data. This market was not an exception. In fact, the scarcity of data, specifically prices, forced the model to use cross-section data. Prices of sawtimber products of related markets were used, for a total of 28 observations.

Despite data problems, the econometric model indicates fairly high estimates of the degree of market imperfection and market power. The estimates are statistically significant, which lead to the conclusion that the market is oligopolistic (imperfect) with fairly high levels of market power. The highest level of market power was found in 1995 (L=0.588).

Recommendations

The recommendation at this point is again to emphasize and strengthen the National Forestry Statistical Information System (SIEF) as a source of national and regional data. The model can be applied for the other stages of the chain of commercialization of the South Pacific region, as well as in the other three markets (Amazonian, Magdalena Medio and Caribbean), which present similar chains of commercialization.

5.6 Summary

The description of the markets identified four markets that characterized the industry of sawtimber in the South Pacific region:

1. Market from the wholesalers to the final consumers
2. Market from the concentration yard to the wholesalers
3. Market from the sawmill to the concentration yard
4. Market from loggers to the sawmill

Markets one, two and three show high levels of seller concentration. Markets one and two behave as oligopolies, while markets three and four behave as oligopsonies. Neither oligopolistic nor oligopsonistic markets contribute to the economic and social goals of the country. Policy and decision makers should pay special attention to the concentration yard, which is behaving as oligopoly/oligopsony and has several implications in the economic for the economy. One is the low contribution of the sawtimber industry in the Gross Domestic Product of the country, and a second is the high Gini coefficient as an indicator of income inequality. Furthermore, the country is importing sawtimber (non-coniferous) from Venezuela, Ecuador and Perú, which are tropical and have commercialized the same tree species that Colombia has.

Results of the econometric model indicate the degree of market imperfection (θ) and the degree of market power (L) for market from the concentration yard to the wholesalers. Results are fairly realistic considering that the estimates are significantly different from zero at the five percent level of significance. Chapter IV stated that the model is

presented as a demonstration because of the absence of reasonable data and the small number of observations. However, comparing the prices of the other regions (Amazonian, Magdalena Medio and Chocó) with the prices of South Pacific does not show a large difference in price per year. Therefore, the estimates are reasonable.

One of the most important recommendations of this study is aimed at policy and decision-makers. It is important to consider that the role of the markets is to achieve a desirable rate of economic growth, to use efficiently the resources and to help stabilize income and employment. Forestry markets are not an exception; therefore, the role of government as facilitator of market system (for example by setting standards, enforcing regulations and helping develop human capital) is necessary. Orozco (1997, 174) stated that one of the problems of the development of the forestry industry is government failures related with lack of policies to commercialize timber, lack of technical and economic assistance and the lack of control. Therefore, Orozco (1997) developed the high priority of examining the economic viability of the harvesting and commercialization of timber in the Pacific Region. This study contributes to the understanding of sawtimber commercialization and the causes and consequences of the industry's imperfection.

To correct the market imperfections and their low contribution to the economic and social goals, more research needs to be done. It is a process that should include local communities, private companies and government. The objective of this research is to demonstrate that there is a timber market imperfection which has negative impacts in the

economy of the country. One of the principal goals should be to reduce the barriers to entry. Orozco (1997) proposes that timber should be manufactured in the region, in order to reduce unemployment. To achieve this goal it is important to improve coordination between communities who now are the landowners and the companies who have technology and infrastructure. This coordination should include government assistance, which will improve the sustainability of the forest.

Finally, the nation should promote new sources of data collection and fortify the existent ones such as the Forestry Statistic Information System. The econometric model as well as the description of the markets can be applied in the other sawtimber markets and other industries such plywood and pulpwood. The implementation of the model will help to find a better understanding of the forestry industry of the country.

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VITA

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Timber markets play an important role in the communication of society's preference regarding the sustainable utilization of forest and the equitable distribution of benefits. However, the preferences of societies may be distorted because of imperfections in markets.

The objective of this research is to estimate the degree and nature of imperfections in the markets for forest products from the South Pacific region of Colombia. This objective is achieved through a description of the structure of timber market, and an examination of behavior of the participants in the market. This effort will include the establishment of relationships between the performance of these markets and the contribution of the forest products sector to the achievement of National economic goals. An econometric analysis was undertaken of selected market to numerically estimate the degree of the imperfection.

The description of the markets indicates high levels of seller concentration. There are high barriers to entry in the markets associated with knowledge requirements, high levels of available capital, vertical integration, lack of institutions and deficient banking system. As a consequence markets are imperfect. Imperfect markets deviates the best possible contribution to the economic well being of the citizens, particularly for the communities living in the forest. High levels of unequal income distribution, unemployment and poverty characterized the South Pacific region. The low contribution of the timber industry to achieve economic and social goals has negative impact in the conservation of the forest. The econometric model for market wholesalers-concentration yard indicates a fairly high estimate of oligopoly power which is consistent with the description of the markets.

Advisor Approval Dr. David K. Lewis