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Department of Forest Resources Management
The University of British Columbia
Vancouver, Canada
Date October 13, 1999
SPATIAL PRICING PATTERNS AND MARKET POWER: THEORY
AND EVIDENCE FROM THE BC INTERIOR PULP FIBRE
MARKET

by

HARRY NELSON

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE
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THE FACULTY OF GRADUATE STUDIES

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Department of Forest Resources Management

We accept this thesis as conforming

To the required standard

THE UNIVERSITY OF BRITISH COLUMBIA

July 1999

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ABSTRACT

The large scale and transportation costs of most wood producing industries, especially in the pulp and paper sector, typically leads to high levels of concentration in regional markets for wood fibre. This in turn has meant that the possible exercise of market power in forest product input and output markets has been long recognized. A recurring issue in British Columbia has been the prices paid by local pulp mills for wood chips used to produce pulp. The provincial government has directly and indirectly regulated the pulp fibre market in the Interior of the province both during its inception and throughout much of the past forty years. Government intervention led to a non-competitive outcome marked by low prices for wood chips that were characterized by the fact that prices paid to suppliers were invariant with respect to distance. A model shows how this particular equilibrium was inherently unstable, as evidenced by prices increasing four-fold after a change in firm behaviour.

Because the province owns of most of the forest land in the province it has developed a set of goals concerning the provincial forest industry that include providing employment, maintaining community stability, and collecting revenues from the harvest of timber on behalf of the public. The provincial government faces a series of policy questions regarding the forest industry in terms of harvest levels, regulation, trade policy, and stumpage design. If past trends continue, pulp and paper mills are likely to become the largest users of the forest resource within the next five years, while provincial forest policy remains focused on the production of solid wood products. At the same time, increased fibre costs due to a combination of government initiatives and decreasing fibre availability are affecting the entire forest industry in BC. For pulp and paper mills their fibre costs can determine their competitiveness in world markets. How the government responds to these issues will affect both fibre flows within the sector as well as the future structure of the forest sector.

Key Words: price discrimination, pulp, wood chips, market power, British Columbia
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Finally, I would like to dedicate this thesis to Bannock.
Introduction

This thesis examines the development and structure of the residual wood chip market in the Interior of British Columbia (BC) over the period 1961 to 1996. Since the inception of the pulp and paper industry in the Interior, wood chip prices within the region have been a recurring issue that has received government attention. A number of authors have noted that chip prices received by sawmills in this region are thought to be "too low" or "uncompetitively low" and have attributed these low prices to imperfectly competitive markets.\(^1\) This issue warrants investigation for several reasons.

First, despite its low profile, the market is quite substantial in size. Measured by the value of shipments in 1996, the Interior wood chip market exceeded the GDP of agriculture, fishing and trapping, petroleum and natural gas, and coal in BC (BC Stats 1998). Despite the importance of this market, it is poorly understood by those people who are not directly involved in the industry, in part due to a dearth of public information. The market is the largest wood fibre market within the province (as well as the largest regional market for pulp fibre in Canada). Virtually nonexistent forty years ago, the market today provides the bulk of the fibre for the fourteen pulp and paper mills within the region as well as significant amounts to both the Coastal industry as well as the export market. It also serves as an important market for one of the main co-products of the sawmill industry in BC.

Second, the wood chip market provides an opportunity to examine how government intervention can frustrate normal market processes and lead to non-competitive outcomes. The wood chip market has faced at various times direct controls on prices, restrictions on exports, and constraints on where domestic volumes could be sold. These policies have

\(^1\) See Mahood(1990:195) and Bernsohn (1981:98), which make reference to low chip prices. An Interior newspaper refers to chip prices less than half of those paid in the BC Coast market (Citizen 1974). In addition, Woodbridge (1984) and Nilsson (1985) note that residual chips sell for substantially less than roundwood chips on the BC Coast and predict that residual chip prices will move up to roundwood prices. At the time, Interior prices for residual chips were below Coastal prices.
also appeared to various degrees in other parts of the forest sector, most noticeably constraints on log exports. How these policies have influenced the development of the wood chip market illustrates some of the potential shortcomings of government intervention. In addition, the issues involved in the pricing of pulp fibre have long been a concern of forest policy makers throughout Canada and other parts of the world.

Finally, it has long been debated whether delivered pricing systems (formulas that explicitly calculate prices based on the geographic location of the producer or customer) facilitate or hinder competition. In this case, a detailed data set on individual firm prices and a relatively static industry structure can shed light on the issues involved in such systems and show that, based on the evidence from this market, delivered pricing systems do facilitate collusive outcomes through permitting firms to coordinate prices.

This thesis has the following objectives:

- To explore the development of the Interior wood chip market;
- To develop a model to examine the pricing policies employed in the wood chip market; and
- To investigate the policy consequences of both market power and government intervention in the Interior wood chip market.

In terms of methodology, the thesis will:

- review the development of the wood chip market in the BC Interior, including specific policies geared towards the wood chip market;
- review the economic literature regarding pulp fibre markets and market power, concentrating on price discrimination;
- develop a model of the Interior wood chip market and test it for evidence of market power; and
• discuss the results and the implications for future public policy.

The thesis relies on a large data set on wood chip prices collected by the Ministry of Forests which surveys wood chip prices in the BC Interior as part of the stumpage appraisal process. It was supplemented by additional information collected in a series of interviews with company executives after access to the provincial data base was terminated. The primary data set is limited to transactions between independent sawmills and plywood mills and pulp mills. Information on the identity of purchasers was discontinued in early 1995 due to a change in government policy. This required the collection of information on prices from company executives directly, and as a result, the data collected covers a smaller set of purchasers through the first two months of 1996 (which covers the market peak). The data set on prices is also supplemented by additional data from other sources on prices in other markets as well as relevant production statistics.

The thesis provides an extensive description of market power in the form of price discrimination, which occurs when different customers (suppliers) pay (receive) different prices for the same good, after all adjustments for any differences in the good, such as quality or transportation costs, have been taken into account. The thesis focuses on a particular type of price discrimination that falls in the general category of delivered pricing systems. These pricing systems are characterized by prices that are determined by some geographic formula; for example, a customer's price may be determined as the price of a good delivered from a specified point under basing point pricing (e.g. "Pittsburgh plus"), even if the good does not come from that location. Economists have long debated, with inconclusive results, whether such systems reflect competitive or collusive behaviour.

The thesis shows that in this case, the particular delivered pricing system employed in the BC Interior wood chip market cannot be explained by models of competitive behaviour. Rather, the pricing system reflects a non-competitive outcome that was sustained through
tacitly collusive behaviour until very recently. In general, it appears that delivered pricing systems can hinder competition through reducing uncertainty about firm-specific prices through the use of common price-setting formulae by all rivals and enabling firms to coordinate prices.

The thesis concludes with an examination of the consequences of government regulation and intervention in the development of the wood chip market. It also discusses some of the issues that arise in the pulp fibre market that need to be taken into consideration in developing future forest policy in BC.
1. The Development of the Wood Chip Market in the British Columbia Interior

What is a Wood Chip?
Wood chips are produced by the breakdown of slabs and other pieces of solid wood that are produced during the manufacture of lumber. These pieces are fed into a chipper that turns the irregularly sized pieces into smaller, more uniform pieces of wood approximately the size of a matchbook called wood chips. Depending on the nature of the sawmill, these chips can be directly conveyed to waiting trucks, rail cars, barges, or put into storage bins or stockpiles outside, where they can be reloaded onto the appropriate vehicle for delivery to customers (pulp and paper mills). Because of variations in species and moisture content, wood chips are usually expressed in terms of a standardized measurement based on weight. In the Interior of British Columbia, the most common unit is the Bone-Dry Unit (BDU), which is the volume of wood chips that will weigh 2400 pounds (1089 kilograms) after it has been oven-dried to a constant weight (Biermann 1996). Wood chips can also be produced by chipping whole logs, using specialized equipment, or through the use of small mobile chipping machines on the logging site. Whole log chips are commonly referred to as “roundwood” chips, referring to the manufacturing process, compared to the chips produced as a co-product during the manufacture of solid wood products which are commonly called “residual” chips.

Development of Wood Chips as a Fibre Source
The use of wood chips by the pulp and paper industry was first pioneered in the Pacific Northwest in Port Angeles. Pulp and paper mills within the region had originally relied on large old growth western hemlock (Tsuga heterophylla (Raf.) Sarg.) to provide their raw material. This bright wood was particularly well suited to the prevailing sulfite pulping process in existence at that time.

---

2 For a typical cubic metre of solid wood input, an Interior sawmill will produce approximately 250 board feet of lumber or 50% of the log; .15 BDUs of chips or 30% of the log, with the remaining 20% sawdust and hog fuel (Kuan 1997).
Sawmills were only interested in the higher value old growth Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco var. *menziesii*), and pulp and paper mills could acquire abundant quantities of hemlock for little more than the cost of hauling logs out of the bush. As the valuable old growth stands on the West Coast were logged, sawmillers shifted into less accessible parts of the region and started utilizing different species, including western hemlock.

Increasing competition for hemlock logs led pulp and paper mills to search for alternative fibre supplies. This resulted in the use of residual wood waste (mainly wood chips) from the sawmills within the Pacific Northwest (Washington, Oregon, and the BC Coast) as a source of furnish starting in the 1930s. This was encouraged by the development of the Kraft pulping process, which provided a technology that could easily accommodate the wide varieties of species within the region, and the Pacific Northwest saw sulfite and groundwood mills gradually replaced by Kraft mills. Abundant sawmill residue provided a cheap source of fibre for the pulp and paper mills and supplied a growing proportion of their furnish for mills in the US Pacific Northwest, increasingly displacing the use of pulp logs (Carrothers 1938). In the 1940s two new pulp mills opened on Vancouver Island (the Bloedel mill at Port Alberni and the Harmac mill in Nanaimo, both still operating today). They were the first to utilize wood chips within BC (Wellburn 1996). By the 1950s, then, wood chips had been proven as a technologically feasible source of fibre.

The development of engineered wood products, such as Oriented Strand Board (OSB) and Medium Density Fibreboard (MDF) in recent years, has increased the demand for wood chips and marginal wood fibre, leading pulp and paper mills to again search for less costly alternative supplies of fibre. For example, some Interior pulp producers now use sawdust to manufacture short-fibred pulp, while others have either built plants or adapted some of their processing capacity to use such hardwood species as cottonwood (*Populus balsamifera* ssp. *Trichocarpa* (Torr. & Gray ex Hook) Brayshaw) and aspen (*Populus tremuloides* Michx).
In 1996, residual fibre from sawmills made up slightly less than 70% of all fibre consumed by pulp mills in Canada (excluding recycled pulp), up from slightly more than 40% at the beginning of 1980 (CPPA 1996). Within the United States, residual furnish makes up 41% of all fibre consumed; within the Pacific Northwest, the proportion is higher at 65% (APA various years). Within the BC Interior, residual chips make up 84% of the fibre needs of pulp and paper mills (Nelson et al. 1997). Such a heavy reliance on sawmill residual chips has tightly bound the two industries together more so than anywhere else in North America.

Before embarking on a description of the wood chip market, it is helpful to understand the resource base that underlies the sawmilling and pulp and paper sector within the province of BC.

**The Forest Industry in British Columbia**

**The Resource**
The Province of British Columbia (BC) covers 95.2 million hectares, of which 60.3 million hectares are covered by trees and 46 million hectares are considered productive forest land (BC MOF 1994). There are two broad forest types in British Columbia, with the dividing line between the Coast and the Interior running down the middle of the Cascade range roughly parallel to the BC Coast, with Vancouver Island and the Queen Charlottes considered part of the Coastal forest region. While both forest regions are dominated by softwoods, there are considerable differences in the composition of species. Table 1 shows the relative composition in terms of species for standing timber volumes for the different regions.

**Table 1. British Columbia Mature Standing Timber Volumes as of 1996**

(millions of cubic metres)

<table>
<thead>
<tr>
<th>Species</th>
<th>Coast</th>
<th>Interior</th>
<th>Total Province</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spruce**</td>
<td>116</td>
<td>1,474</td>
<td>1,590</td>
</tr>
<tr>
<td>Hemlock**</td>
<td>1,175</td>
<td>341</td>
<td>1,516</td>
</tr>
<tr>
<td>Balsam**</td>
<td>411</td>
<td>859</td>
<td>1,270</td>
</tr>
<tr>
<td>Lodgepole Pine</td>
<td>26</td>
<td>1,481</td>
<td>1,507</td>
</tr>
<tr>
<td>Douglas Fir</td>
<td>134</td>
<td>284</td>
<td>418</td>
</tr>
<tr>
<td>Western Red Cedar</td>
<td>296</td>
<td>98</td>
<td>394</td>
</tr>
<tr>
<td>Yellow Cedar</td>
<td>112</td>
<td>*</td>
<td>112</td>
</tr>
<tr>
<td>Red/Yellow Cedar***</td>
<td>261</td>
<td>15</td>
<td>276</td>
</tr>
<tr>
<td>Larch</td>
<td>-</td>
<td>29</td>
<td>29</td>
</tr>
<tr>
<td>Ponderosa Pine</td>
<td>-</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>White Pine</td>
<td>1</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

* less than .5 million cubic metres

** includes various species which differ between regions

***Species are the same as above but reflect different reporting requirements for different tenures

(source: Council of Forest Industries 1997)
The topography is also varied. The Coast is rugged, with little or no public road access, while much of the Interior has substantial areas of rolling forest accessible by road. Again, there are differences within the Interior; the southern and eastern Interior are more rugged than the northern and central Interior, and the transportation infrastructure is not as well developed.

Relative Importance of the Forest Industry

The forest sector in British Columbia can be broken into four parts following the Standard Industrial Classification (SIC) used by Statistics Canada. The first two parts, Logging Industry (SIC 04) and Forestry Services (SIC 05), are concerned with timber harvesting and management. The remaining two parts concern the users of the logs generated: Wood Industries, which consists of what are called solid wood producers who manufacture such goods as lumber, plywood, shakes and shingles, poles and posts, and remanufactured products (SIC 25); and the Paper and Allied Industries, producing mainly market pulp, newsprint, groundwood papers and other paper and paperboard products (SIC 27). In terms of the value of shipments, the forest sector accounted for 57.4% of all manufacturing shipments in BC in 1995, exports of lumber were $7.5 billion, and exports of all pulp and paper products were $8.2 billion (COFI 1996).

Pulp and paper mills in the province receive most of their fibre needs indirectly from the solid wood sector in the form of residual wood chips produced during manufacturing; when these are taken into account fibre consumption between the two major industries, wood and pulp and paper, was nearly equal in volume. In value-added terms, newsprint and pulp accounted for, on average, 28% of the value-added in the forestry sector for the period 1983 to 1993, while lumber and plywood accounted for 37% (Schwindt and Heaps 1996).

There is some significant variation in the pulp and paper industry between the two regions, reflecting differences in the resource base and the development of markets. For example,
the availability of western hemlock and its suitability for newsprint, coupled with the tidewater location of Coastal pulp and paper mills has led to the development of more newsprint and other groundwood paper capacity relative to the Interior. In addition, the specialized lumber production of different species (such as cedar and Douglas fir) on the Coast has permitted the development of specialty pulps to a larger degree than in the Interior, where most lumber production is SPF (Spruce-Pine-Fir) with the resulting chips a blend of different species.

Interior pulp and paper mills have also been nearly completely reliant on residual chips produced in the Interior, while Coastal mills have had to rely increasingly on a variety of sources including imported chips, chips from the Interior, and chips produced from roundwood. Government policy, including how stumpage charges are calculated, also differs between the two regions, in terms of what types of pulp fibre are included in the appraisal system and what type of harvested material is required to be brought in.

In the past, nearly all of the wood chips produced and consumed in the Interior have been residual chips produced by sawmills, although there has been an increasing use of roundwood chips in recent years.

The alternative for Interior sawmills to shipping wood chips to pulp and paper mills in the Interior is either to burn them or to put them into landfills, both common practices in the past. In most cases, chips were burnt along with other residue in “beehive burners”. Environmental considerations have caused a rapid escalation in the costs associated with landfilling, and the provincial government is in the process of prohibiting the burning of wood waste throughout the region.
Patterns of Resource Use in BC

Before investigating the development of the wood chip market, it is instructive to look at the patterns of production and use of wood fibre in British Columbia. Figure 1 shows timber production in BC on the Coast and in the Interior for selected years since 1950. It can be seen that while the harvest steadily increased in both areas, peaking on the Coast in 1987 and in the Interior in 1989, the overall increase in harvest levels has come mainly from the Interior. While harvest levels roughly doubled on the Coast, they increased tenfold in the Interior from 1950 to 1995.

Figure 1. Harvest by Region in BC for Selected Years

(Source: Ministry of Forests, various years)

This increase in timber production was accompanied by an increase in pulp and paper production. Table 2 shows the production of pulp (which may be further converted into paper or sold as pulp) and lumber in the province over the past twenty five years. The production of both has steadily grown, with pulp production peaking in 1994, seven years after the peak in lumber production.
Table 2. Lumber and Pulp Production in BC

<table>
<thead>
<tr>
<th>Year</th>
<th>Lumber (in MMbf)</th>
<th>Pulp (in thousands of tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960</td>
<td>5,305</td>
<td>1,754</td>
</tr>
<tr>
<td>1970</td>
<td>7,657</td>
<td>3,731</td>
</tr>
<tr>
<td>1975</td>
<td>7,445</td>
<td>3,808</td>
</tr>
<tr>
<td>1980</td>
<td>11,351</td>
<td>5,456</td>
</tr>
<tr>
<td>1987</td>
<td>15,886</td>
<td>6,990</td>
</tr>
<tr>
<td>1990</td>
<td>14,198</td>
<td>6,604</td>
</tr>
<tr>
<td>1991</td>
<td>13,308</td>
<td>6,702</td>
</tr>
<tr>
<td>1992</td>
<td>14,141</td>
<td>6,646</td>
</tr>
<tr>
<td>1993</td>
<td>14,308</td>
<td>7,048</td>
</tr>
<tr>
<td>1994</td>
<td>14,269</td>
<td>7,617</td>
</tr>
<tr>
<td>1995</td>
<td>13,819</td>
<td>7,608</td>
</tr>
<tr>
<td>1996</td>
<td>13,845</td>
<td>7,287</td>
</tr>
<tr>
<td>1997</td>
<td>13,375</td>
<td>7,099</td>
</tr>
<tr>
<td>1998</td>
<td>12,814</td>
<td>7,073</td>
</tr>
</tbody>
</table>


Table 3 shows the production of residual wood chips by region for the past ten years. Due to the nature of the production process, residual chip production shows the same pattern as lumber production, peaking in 1987. While overall residual chip production levels have subsequently fallen, it can be seen that is mainly due to a decrease in residual chip production on the Coast, while Interior residual chip production has remained relatively steady.

Table 4 shows the export of wood chips from the province, identified by their region of origin, over the study period. Exports from the Interior have ranged around 10% of total production for the past decade, and include exports by Fibreco Export (an export agency for sawmills in the Interior), individual sawmills, and pulp companies within the region. While exports from the Interior have fallen in recent years, an increasing proportion of shipments to Fibreco Export have been purchased by pulp mills on the BC Coast.
Table 3. Residual Chip Production in BC, by Region
(in 000's of BDUs)

<table>
<thead>
<tr>
<th>Year</th>
<th>Coast</th>
<th>Interior</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985</td>
<td>2,964</td>
<td>5,706</td>
</tr>
<tr>
<td>1986</td>
<td>2,796</td>
<td>5,667</td>
</tr>
<tr>
<td>1987</td>
<td>3,475</td>
<td>6,685</td>
</tr>
<tr>
<td>1988</td>
<td>3,741</td>
<td>6,700</td>
</tr>
<tr>
<td>1989</td>
<td>3,250</td>
<td>6,770</td>
</tr>
<tr>
<td>1990</td>
<td>2,770</td>
<td>5,832</td>
</tr>
<tr>
<td>1991</td>
<td>2,681</td>
<td>6,290</td>
</tr>
<tr>
<td>1992</td>
<td>2,582</td>
<td>6,479</td>
</tr>
<tr>
<td>1993</td>
<td>2,494</td>
<td>6,341</td>
</tr>
<tr>
<td>1994</td>
<td>2,594</td>
<td>6,221</td>
</tr>
<tr>
<td>1995</td>
<td>2,340</td>
<td>6,336</td>
</tr>
<tr>
<td>1996</td>
<td>2,262</td>
<td>5,979</td>
</tr>
<tr>
<td>1997</td>
<td>2,078</td>
<td>5,907</td>
</tr>
<tr>
<td>1998</td>
<td>1,835</td>
<td>5,576</td>
</tr>
</tbody>
</table>

(Source: Statistics Canada 35-001, various years)

Table 4. Exports of Wood Chips from BC by Region for Selected Years
(BDUs)

<table>
<thead>
<tr>
<th>Year</th>
<th>Coast</th>
<th>Interior</th>
</tr>
</thead>
<tbody>
<tr>
<td>1987</td>
<td>310,301</td>
<td>577,420</td>
</tr>
<tr>
<td>1991</td>
<td>487,598</td>
<td>914,944</td>
</tr>
<tr>
<td>1992</td>
<td>385,751</td>
<td>943,476</td>
</tr>
<tr>
<td>1993</td>
<td>233,855</td>
<td>842,437</td>
</tr>
<tr>
<td>1994</td>
<td>154,509</td>
<td>483,009</td>
</tr>
<tr>
<td>1995</td>
<td>107,611</td>
<td>353,251</td>
</tr>
</tbody>
</table>

(Source: unpublished data, Ministry of Forests)

Increased pulping capacity throughout BC has led to the growing use of roundwood chips, with most of production and consumption taking place on the Coast. Although production statistics do not separate roundwood from residual chip production, there are summary statistics available that provide some indication of the amount of roundwood chips being
produced. Table 5 shows estimates of the fibre passing through pulp mill wood rooms and chipping mills over the past five years versus that going to other primary producers (who may also produce roundwood chips). It can be seen that while the amount of lumber processed at sawmills fell slightly, the largest increase was in the amount of roundwood passing through chipping mills. This has reflected both a move into poorer quality stands, yielding a greater proportion of wood suitable for chipping, and the need to supplement declining quantities of residual wood chips.

Table 5. Estimates of the Primary Breakdown of Harvest in BC from 1990 to 1996

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sawmill</td>
<td>64,129</td>
<td>58,128</td>
<td>60,849</td>
<td>61,472</td>
<td>60,098</td>
<td>59,576</td>
<td>58,841</td>
<td>-8%</td>
</tr>
<tr>
<td>Chip Mill</td>
<td>1,647</td>
<td>2,237</td>
<td>2,468</td>
<td>3,098</td>
<td>4,155</td>
<td>4,237</td>
<td>3,454</td>
<td>110%</td>
</tr>
<tr>
<td>Pulp Mill</td>
<td>3,605</td>
<td>7,600</td>
<td>3,349</td>
<td>3,851</td>
<td>2,841</td>
<td>3,815</td>
<td>3,769</td>
<td>5%</td>
</tr>
<tr>
<td>Veneer/Panel</td>
<td>4,406</td>
<td>4,450</td>
<td>4,713</td>
<td>4,642</td>
<td>5,413</td>
<td>5,435</td>
<td>5,103</td>
<td>16%</td>
</tr>
<tr>
<td>Shake/Shingle</td>
<td>1,711</td>
<td>1,539</td>
<td>1,321</td>
<td>1,223</td>
<td>1,173</td>
<td>1,291</td>
<td>1,437</td>
<td>-16%</td>
</tr>
<tr>
<td>Pole/Post/Log</td>
<td>372</td>
<td>521</td>
<td>530</td>
<td>476</td>
<td>479</td>
<td>582</td>
<td>528</td>
<td>42%</td>
</tr>
<tr>
<td>Export</td>
<td>804</td>
<td>768</td>
<td>1,139</td>
<td>1,170</td>
<td>735</td>
<td>612</td>
<td>312</td>
<td>-61%</td>
</tr>
<tr>
<td>Reject</td>
<td>197</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>76,477</td>
<td>75,297</td>
<td>74,369</td>
<td>75,932</td>
<td>74,894</td>
<td>74,952</td>
<td>73,891</td>
<td></td>
</tr>
<tr>
<td>Actual Harvest</td>
<td>78,316</td>
<td>73,676</td>
<td>74,004</td>
<td>75,392</td>
<td>75,650</td>
<td>76,741</td>
<td>75,213</td>
<td></td>
</tr>
</tbody>
</table>

(Source: Economics and Trade, Ministry of Forests, unpublished data derived from Major Primary Timber Processors)

Harvest levels from provincial lands peaked in the late 1980s (see Figure 1) and a series of government initiatives could mean that harvest levels might fall 17% in the future, with some areas facing even greater reductions (Price Waterhouse 1995). Consequently, both lumber and wood chip production levels are expected to drop in the near future. Sawmills within the Interior have increasingly turned to importing wood fibre from Alberta and other provinces and increased purchases of wood from private lands within the province to meet their fibre needs during periods of high demand.
Simons and Cortex (1993) examined the historical prices of lumber and chips in British Columbia. They reported that chip prices on the Coast showed a downward trend of 2% per year in real terms from 1970 to 1993, while interior chip prices had not changed significantly in real terms for the same time period, expressed as a percentage of the pulp price. Figure 2 shows prices for both lumber, pulp, and interior wood chips in real terms for the period 1970-96. As can be seen, pulp and lumber prices have shown strong cyclical behavior over this period, while the price of interior chips has closely tracked pulp prices until 1995 when both pulp and chip prices reached record levels, only to fall in 1996. The prices reported are for NBSK pulp (Needle Bleached Softwood Kraft pulp, SPF studs (2x4 lumber in 8 foot lengths) and SPF lumber (2x4 lumber in random
lengths), along with the price for Interior wood chips, and have all been deflated using the GDP deflator.

**Structure of the BC Interior Wood Chip Market**

In 1996 there were 136 sawmills in the Interior with an annual capacity in excess of 2 million board feet.\(^3\) Of these, 94 had an annual capacity of over 24 million board feet per year. Those 94 accounted for 97% of the total Interior lumber capacity of 11 billion board feet (as of 1996). Approximately 51% of this capacity is owned by independent sawmills (that is, unaffiliated with a company producing pulp and paper).\(^4\)\(^5\) Although regional rights to timber differ, integrated companies control slightly more than half of the assigned cutting rights to Crown timber. **Table 6** shows the top twenty Crown timber license holders in the province, with companies possessing pulp and paper processing capacity shown in bold type.

There are currently 25 pulp mills in the province.\(^6\) Fourteen of the pulp mills are located in the Interior, with two, Skeena Kraft and Eurocan, on the North Coast and nine on the BC Coast.\(^7\) With the exception of two, Celgar and Harmac Pacific, these pulp mills are owned by companies that have either received cutting rights through sawmills owned or affiliated with the company or have received cutting rights directly.\(^8\)

---

\(^3\) There are no reliable numbers on sawmills smaller than this. As a measure of comparison, there are 88 sawmills on the BC Coast with an aggregate capacity of 4.3 billion board feet.

\(^4\) Slocan accounts for 10% of this capacity and is included as an independent, although they own nearly all of the pulp mill at Taylor. They had acquired half ownership of one of the pulp mills and sawmills at Mackenzie which they have subsequently sold to the other partner. Their sawmilling operations are widely distributed throughout the province and the bulk of their sales are made to non-affiliated pulp mills.

\(^5\) These figures were derived from *Major Primary Timber Processing Facilities in British Columbia 1995* issued by the BC Ministry of Forests.

\(^6\) The pulp mill at Gold River was closed in 1998 and efforts to re-open it have so far failed.

\(^7\) Both Skeena and Eurocan rely for a substantial portion of their pulp fibre needs on residual wood chips from the Interior and consequently are considered part of the Interior market.

\(^8\) Celgar filed for bankruptcy in July, 1998, while Harmac was acquired by Pope & Talbot, a company with sawmills in the Southern Interior, in December 1997. In addition, MacMillan Bloedel spun off its two remaining pulp mills on the BC Coast in June, 1998, but retains obligations to supply fibre to those mills.
Table 6. Annual Public Cutting Rights in BC in 1997 by Company (in cubic metres)*

<table>
<thead>
<tr>
<th>Company</th>
<th>License Volumes</th>
<th>% of AAC</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slocan Forest Products</td>
<td>6,797,383</td>
<td>9.6</td>
<td>9.6</td>
</tr>
<tr>
<td>MacMillan Bloedel</td>
<td>5,917,561</td>
<td>8.4</td>
<td>17.9</td>
</tr>
<tr>
<td>Canadian Forest Products</td>
<td>4,810,040</td>
<td>6.8</td>
<td>24.7</td>
</tr>
<tr>
<td>West Fraser Mills</td>
<td>4,204,134</td>
<td>5.9</td>
<td>30.7</td>
</tr>
<tr>
<td>International Forest Products</td>
<td>3,514,152</td>
<td>5.0</td>
<td>35.6</td>
</tr>
<tr>
<td>Noranda Forest Inc.</td>
<td>3,441,398</td>
<td>4.9</td>
<td>40.5</td>
</tr>
<tr>
<td>Domany Industries</td>
<td>2,427,140</td>
<td>3.4</td>
<td>43.9</td>
</tr>
<tr>
<td>Skena Cellulose</td>
<td>2,337,549</td>
<td>3.3</td>
<td>47.2</td>
</tr>
<tr>
<td>Riverside Forest Products</td>
<td>2,306,776</td>
<td>3.3</td>
<td>50.5</td>
</tr>
<tr>
<td>Weldwood</td>
<td>2,099,109</td>
<td>3.0</td>
<td>53.4</td>
</tr>
<tr>
<td>Weyerhaeuser</td>
<td>1,762,813</td>
<td>2.4</td>
<td>55.8</td>
</tr>
<tr>
<td>Avenor</td>
<td>1,658,558</td>
<td>2.3</td>
<td>58.1</td>
</tr>
<tr>
<td>Tolko</td>
<td>1,547,914</td>
<td>2.2</td>
<td>60.3</td>
</tr>
<tr>
<td>Timberwest Forest</td>
<td>1,445,280</td>
<td>2.0</td>
<td>62.3</td>
</tr>
<tr>
<td>Anderson/Stewart Group</td>
<td>1,387,740</td>
<td>2.0</td>
<td>64.3</td>
</tr>
<tr>
<td>Ainsworth Lumber</td>
<td>1,349,034</td>
<td>1.9</td>
<td>66.2</td>
</tr>
<tr>
<td>Crestbrook Forest</td>
<td>1,220,095</td>
<td>1.7</td>
<td>67.9</td>
</tr>
<tr>
<td>Industries</td>
<td>1,175,137</td>
<td>1.7</td>
<td>69.6</td>
</tr>
<tr>
<td>Louisiana-Pacific Canada</td>
<td>904,000</td>
<td>1.3</td>
<td>70.9</td>
</tr>
<tr>
<td>Evans Forest Products</td>
<td>630,898</td>
<td>0.9</td>
<td>71.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Allowable Annual Cut (AAC)</th>
<th>AAC Held by Companies with</th>
<th>Pulp and Paper Interest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>70,864,250</td>
<td>38,935,060</td>
<td>54.9% of AAC</td>
</tr>
</tbody>
</table>

*These volumes are as of July 22, 1997, and do not include any private timberlands which provide significant volumes to several companies.

b The company has spun off of all of its pulp and paper mills but still retains fibre obligations to them.

c Canadian Forest Products holds 1/3 interest in the Anderson/Stewart group that is not included in this volume.

d These firms have evergreen contracts dedicating significant portions of their pulp fibre production to pulp companies (see Gaston et al 1995 for more information). The cutting rights are not included in the calculation of the AAC held by pulp and paper companies.

• When the parent company (Fletcher Challenge Canada) de-integrated it retained the right to all pulp fibre produced by Timberwest and hence these volumes are included in the pulp and paper AAC.


All of these pulp mills, with the exception of the Louisiana Pacific pulp mill in Chetwynd, the Scott Paper mill in New Westminster, and the Newstech mill in Port Coquitlam, use coniferous chips as either the main portion of their furnish or as their complete source. In 1995, independent sawmills in the Interior provided 42% of the residual wood chips consumed by Interior pulp mills (although there was substantial regional variation).9

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9 This figure is based on background data from Nelson (1997).
Concentration within regional fibre markets is quite high (these regional markets correspond to the six forest regions the province uses in managing provincial forests). Throughout much of the Southern Interior (the Kamloops and Nelson Forest Regions), one pulp mill will purchase the majority of the fibre produced within the region. While small volumes of chips may be exported, shipments are capped and require government approval every few years. Within the Kamloops area, the proximity of the Coast and higher production levels relative to the capacity of the Weyerhaeuser pulp mill mean that significant volumes of chips are shipped into the Coastal market (Gaston et al. 1995). In the Northern Interior (100 Mile House and the area to the north), the closer proximity of pulp mills to one another usually means two or more purchasers within local markets. Despite this proximity, sawmills in the past tended to sell to only one purchaser. Most exports from the Interior were made through a cooperative owned by sawmills throughout the Interior called Fibreco Export. The cooperative placed various constraints on the price members could receive and the volumes that could be shipped (Fibreco Export is discussed later in this chapter). Fibreco export volumes are also subject to overall restrictions and the need to obtain government approval for exports every few years.

Pulping Processes
Broadly speaking, there are two main ways to produce pulp from wood fibre. One is through strictly mechanical means to separate the wood fibres (sometimes termed refiner pulp) and the other is through chemical processes such as sulfite pulping or sulfate pulping (referring to the predominant chemical present during pulping). In addition, recent years have seen the development of some hybrid processes such as chemi-thermomechanical pulp (CTMP) that use both mechanical and chemical processes. The fibre requirements differ for the varying processes. Mechanical pulps require naturally bright woods, western hemlock and spruce being the preferred species. While kraft pulping can accommodate a greater variety of species than mechanical pulping, bright woods are also desirable as they reduce the need for chemical bleaching. The major difference between the two processes,
however, is that mechanical processes require roughly half the fibre per unit of output compared to the kraft process although the energy requirements are substantially higher.

Most of the pulp mills in the Interior use the bleached kraft process while the mills built since 1980 at Quesnel, Taylor, and Chetwynd rely on either the thermo-mechanical (TMP) or the chemi-thermomechanical pulp (CTMP) process. The most recent mill built, Louisiana Pacific in Chetwynd, uses aspen, while the Taylor mill has the capacity to use aspen.

Some sawdust pulp capacity exists at both the Kamloops and Kitimat mills, while Fletcher Challenge has recently installed a sawdust digester at its Mackenzie mill. The bulk of the capacity is in chemical pulp using residual softwood chips. Figure 3 shows the location of pulp and paper mills in the Interior and the extent of what is commonly called the Interior market. Table 7 shows the development of pulping capacity in the Interior over the period 1988-1998 as well as the type of capacity. Capacity has remained relatively unchanged over this time frame, with the exception of the expansion of the Celgar mill in the southeast corner of the province.

The pulp and paper industry in BC produces mainly pulp and newsprint, with some specialty groundwood papers. In the Interior, with the exception of the Finlay mill, which produces newsprint exclusively, and Prince George Pulp & Paper which along with Eurocan produces sack kraft and linerboard, the main product for the remaining pulp and
Figure 3. Location of Pulp Mills in the BC Interior

Note: Locations are approximate and the map does not show any of the pulp mills in the Vancouver Forest Region.
paper mills is market pulp (Lockwood Post directory, 1995). Market pulp is
defined as pulp sold in arms' length transactions between non-affiliated companies (as
opposed to pulp consumed by a paper mill affiliated with the pulp mill). While BC has 27%
of the Canadian pulp and paper capacity, slightly behind Quebec with 31%, BC is the
largest producer of market pulp in Canada with 49.4% of the Canadian market pulp
capacity. Canada itself is the largest producer of market pulp in the world and has 27% of
world capacity (Anonymous, 1994).

Table 7. Interior Pulp Capacity by Mill and Location, Selected Years
(in thousands of air-dried metric tonnes)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Weyerhaeuser</td>
<td>Kamloops</td>
<td>426</td>
<td>431</td>
<td>440</td>
<td>431</td>
<td>447</td>
</tr>
<tr>
<td>Celgar</td>
<td>Castlegar</td>
<td>193</td>
<td>183</td>
<td>414</td>
<td>396</td>
<td>414</td>
</tr>
<tr>
<td>Crestbrook</td>
<td>Skookumchuck</td>
<td>185</td>
<td>181</td>
<td>181</td>
<td>219</td>
<td>224</td>
</tr>
<tr>
<td><strong>Total Southern Interior Capacity</strong></td>
<td></td>
<td>804</td>
<td>795</td>
<td>1,035</td>
<td>1,046</td>
<td>1,085</td>
</tr>
<tr>
<td>Quesnel River Pulp</td>
<td>Quesnel</td>
<td>300</td>
<td>311</td>
<td>328</td>
<td>302</td>
<td>314</td>
</tr>
<tr>
<td>Cariboo</td>
<td>Quesnel</td>
<td>276</td>
<td>276</td>
<td>328</td>
<td>311</td>
<td>323</td>
</tr>
<tr>
<td>Intercontinental</td>
<td>Prince George</td>
<td>235</td>
<td>236</td>
<td>236</td>
<td>258</td>
<td>(c)</td>
</tr>
<tr>
<td>PG Pulp &amp; Paper</td>
<td>Prince George</td>
<td>270</td>
<td>274</td>
<td>276</td>
<td>273</td>
<td>528</td>
</tr>
<tr>
<td>Northwood</td>
<td>Prince George</td>
<td>502</td>
<td>569</td>
<td>500</td>
<td>518</td>
<td>518</td>
</tr>
<tr>
<td>Fletcher</td>
<td>Mackenzie</td>
<td>207</td>
<td>207</td>
<td>207</td>
<td>207</td>
<td>207</td>
</tr>
<tr>
<td>Finlay</td>
<td>Mackenzie</td>
<td>138</td>
<td>138</td>
<td>138</td>
<td>180</td>
<td>190</td>
</tr>
<tr>
<td>Fibreco</td>
<td>Taylor</td>
<td>207</td>
<td>180</td>
<td>177</td>
<td>212</td>
<td>231</td>
</tr>
<tr>
<td>Louisiana Pacific</td>
<td>Chetwynd</td>
<td>-</td>
<td>-</td>
<td>155</td>
<td>155</td>
<td>173</td>
</tr>
<tr>
<td>Skeena Cellulose</td>
<td>Prince Rupert</td>
<td>431</td>
<td>483</td>
<td>466</td>
<td>449</td>
<td>449</td>
</tr>
<tr>
<td>Eurocan</td>
<td>Kitimat</td>
<td>374</td>
<td>409</td>
<td>355</td>
<td>452</td>
<td>455</td>
</tr>
<tr>
<td><strong>Total Northern Interior Capacity</strong></td>
<td></td>
<td>2,940</td>
<td>3,083</td>
<td>2,930</td>
<td>3,057</td>
<td>3,388</td>
</tr>
<tr>
<td><strong>Total Interior Capacity</strong></td>
<td></td>
<td>3,744</td>
<td>3,878</td>
<td>3,965</td>
<td>4,103</td>
<td>4,473</td>
</tr>
</tbody>
</table>

*CTMP/TMP process
*b mill using 100% hardwood
*a mill capacity included in PG Pulp & Paper capacity
(Source: Economics and Trade, Ministry of Forests, Victoria unpublished data)

In summary, the Interior wood chip market has been fairly stable in terms of production
levels and regional demand (as measured by capacity). Concentration tends to be high
because markets for chips are geographically constrained and there is only a small number
of purchasers (often only one) within most local markets. In order to sell into the export

19 According to the CPPA (1996), total industry capacity in BC for market pulp, paper, and
paperboard was 8.3 million tonnes, of which 5.2 million tonnes were in market pulp, or 63% of the
total.
market, provincial government approval is required and volumes tend to be small and of limited duration. The similarity of end products and prevalence of the same species means that most of the wood chips produced within the Interior are potentially interchangeable, and firms in the region do engage in chip swaps (trading fibre from different suppliers to either meet species requirements or to reduce transportation costs). However, in the past, most sawmills supplied only one pulp mill, and these supply patterns had remained relatively unchanged since the development of the Interior market in the 1950s (Nelson et al. 1994). This pattern changed in 1994, and to understand why, it is necessary to examine the development of the Interior market.

**Historical Development of the Interior Pulp Industry**

The development of the pulp and paper industry in the BC Interior reflects the provincial government's traditional approach to forest policy based on the allocation of tenure and fibre to encourage industrial development outside the lower mainland area. However, as part of this strategy, the Province has also had to address concerns over market power and fibre supply. This section will show how both the market and government policy have evolved in some unexpected ways.

Initially, the market for Interior wood chips was limited to small shipments to pulp mills outside the region. Sawmills in the Interior after World War II tended to be small, and most of the wood fibre produced was in the form of slabs and lily pads (lily pads were the disks of wood sliced off the ends of logs). Any residual chips produced were either burned or put into landfills along with other waste wood, although there were some shipments of chips from those sawmills in the southern Interior nearest to Coastal pulp mills. Due to concerns about the amount of waste left behind (some estimates suggested that 75% of the tree was left behind in the woods) (Garner 1991), the government commissioned a study in the early 1960s to examine the feasibility of a pulp mill in the Prince George area to utilize the marginal wood left behind. The findings of the report
led Ray Williston, then Minister of Forests, to develop a set of policies to encourage companies to establish pulp and paper mills in the Interior (Garner 1991).

**The Development of Pulpwood Harvesting Agreements**

Given the concerns over the size of the capital investment required to construct a world-competitive pulp mill (approximately $50 million in the early 1960s), Williston offered the guarantee that mills built would have an assured fibre supply through a new type of forest tenure called Pulpwood Harvesting Agreements (PHA). These were introduced under amendments to the Forest Act in 1961 (British Columbia 1961), and were originally restricted to the Interior.  

Although this provision was later dropped for several years, there were never any PHAs issued for the Coast. The PHAs were for 21 years and required the successful applicant to build and operate a pulp mill of a specified capacity. The agreements specified a certain area and a maximum volume that could be harvested, and required the pulp mills to purchase pulpwood and wood residues from timber cut within the pulpwood area by existing tenure (quota) holders before they could utilize the agreement.  

Those purchases were conditional on the prices for the residue not exceeding the costs of harvesting pulp wood for the pulp mill. If the pulpmill was unable to purchase enough fibre at that price, the agreement conveyed the right to cut pulpwood directly to make up any deficiency. The first pulpwood agreement was awarded to Prince George Pulp & Paper in 1963, followed by one to Kamloops Pulp and Paper in 1963, then Northwood Pulp & Paper in 1964, Cariboo Pulp and Paper in 1965, and another one to Prince George Pulp & Paper in 1965.  

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12 Clause number seven appears to have been related to the issue of the potential conflict between sawmills and pulp mills for cutting rights. Pearse, a chairman of a Royal Commission, queries Prince George Pulp on this: [Pearse]: “Now, my understanding is that originally, in 1962, the pulp company was prohibited from competing for saw timber sales in the P.H.A. area without the consent of the Minister.” [Gunther]: “Yes, that was a condition in clause 7, I believe, of the original P.H.A. agreement.” (Pearse 1976a: 701)

In P.H.A. no. 2, clause 7b required the pulp mill to purchase pulpwood generated in the course of harvesting a stand if offered to the company before they could utilize the agreement. However, these clauses as they relate to pulpwood appear to have been modified or dropped entirely subsequently [this clause as it related to P.H.A. 1 was dropped in 1972 when the commitment to purchase residual chips was incorporated]](Pearse 1976a: 701)
However, not all the pulp mills built in the Interior received PHAs. The first mill established in the Interior was Columbia Cellulose (now Celgar) at Castlegar in the Southern Interior in 1961, which received its cutting rights through an adjacent sawmill in the form of a Tree Farm License (TFL). The two pulp and paper mills on the North Coast (considered part of the Interior market) also received cutting rights through TFLs. Skeena Cellulose opened a second Kraft pulp mill in 1967 in Prince Rupert. The original owner, Columbia Cellulose, had opened a sulfite pulp mill there in 1951 which was later converted to Kraft in 1980. Eurocan opened a pulp mill in 1970 at Kitimat (a joint partnership between West Fraser and a Finnish company, Enso-Gutheizt).\textsuperscript{14} Crestbrook Forest Industries also built a pulpmill in 1969 at Skookumchuck, in the Southeast corner of the province, but did not receive a PHA. Crestbrook received an assured supply of fibre through their mill license which directed sawmills in the area to send them their residual chips (this is discussed more fully in the section entitled \textit{Introduction of Chip Direction Policy}).\textsuperscript{15} The other exceptions have been the two integrated sawmill and pulpmill operations at Mackenzie, each of which received harvesting rights for the sawmills and were envisaged as stand alone operations.

Many of the companies that built pulpmills in the Interior such as Northwood, Weldwood, and West Fraser had pre-existing sawmills in the area. Others were joint ventures between local sawmills and outside interests, such as Kamloops Pulp and Paper (subsequently acquired by Weyerhaeuser) and Crestbrook, while Canadian Forest Products built a sawmill at Prince George after receiving its PHA. This ensured that a portion of their supply was met by wood chips from their own facilities.

At the same time the BC government had been studying the feasibility of establishing pulp mills in the Interior, a new type of sawmill called the Chip N’Saw had been developed (Keays, 1979).

\textsuperscript{13} Several other PHAs were awarded but the pulp mills were never built and the agreements lapsed.

\textsuperscript{14} Celgar received TFL 23, which was the only Interior TFL issued appurtenant to a pulp mill. On the North Coast, Eurocan received TFL 41 in 1966, while the two pulp mills in Prince Rupert had two TFLs (nos. 1 and 40), each dating from the establishment of a pulp line. TFL 1 contains an appurtenancy clause requiring the licensee to operate a pulp mill (Haley in litt. 1995).

\textsuperscript{15} Mill licenses were required in the past by companies planning to build or expand timber-processing capacity.
Prevailing designs at the time broke down logs by sawing off the sides, leaving behind slabs and various other pieces of irregularly sized solid wood which could then be fed into a chipper to be converted into wood chips. The Chip N’Saw, however, chipped off the log faces while holding the log more firmly. This permitted smaller logs to be processed more quickly. Smaller logs had presented a problem with the older design as they tended to wander when being sawed and slowed down production. Because more of the standing timber could now be utilized, it now paid to sort logs and to run batches of similar sizes through the Chip N’Saw. This also reduced the need to change the sawing setup to accommodate variations in log size required with the older designs. As a consequence, the throughput of logs could be increased significantly, thereby raising lumber and chip production.  

The Move to Close Utilization Standards  
The BC government also undertook some specific policies affecting the supply of timber within the Interior. This involved a change from an intermediate utilization standard to a “close utilization” standard in the mid-1960s. This standard required companies to harvest smaller trees than in the past (as well as taking more of the tree). Operators could receive additional timber rights (or quota) by demonstrating that they had the equipment to process smaller timber and could produce chips to sell to a pulp mill. Because the increase in harvest levels by adapting close utilization standards could not be fully absorbed by all the sawmills at the time, the additional unallocated wood was known as “third band wood”. Applicants did not have to bid for the additional quota.
but rather received it through a Timber Sale Harvesting License (TSHL). By the 1970s, the BC government was mandating the use of close utilization standards for all cutting areas. To make this smaller wood even more attractive, the government fixed the rate at 55 cents per 100 cubic feet. This was below the sawlog stumpage rate at the time.

The allocation of this additional volume had several effects on the Interior sawmill industry. The first was the increased capital requirements for equipment such as debarkers and equipment that could process smaller timber, as well as the need to obtain a chip contract with a nearby pulp mill. Smaller sawmill operators started selling out as they were unable to afford the required equipment and the overall result was a significant decline in the number of Interior sawmills while average capacity steadily increased. In addition, chip revenues had now started to become part of the sawmill’s revenue, and those without buyers for residual chips or the ability to produce chips found themselves at a growing disadvantage.

The lumber industry responded quickly as the BC government offered the possibility of increasing the amount of timber a quota holder could cut if they moved to close utilization standards. Growth was aided in part by booming housing markets in the US. The production of wood chips was

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19 The forest service started issuing TSHLs in 1967 although there was no specific legislation or amendments that spelled out this new type of tenure. They permitted firms that held cutting rights in the PSYU who could process such timber. The remaining third of the rectangle, or the “third band”, was then the difference between that now held by the quota holders in the PSYU and the increased harvest levels for the entire PSYU coming from close utilization. (Bernsohn 1981: 83-85).

20 These rates were set administratively and were subsequently dropped in 1972 when the NDP government came into power (Garner 1991).

21 Rees (1966) reports that as security for a Barker (a minimum of $100,000) sawmills often had to show a chip contract with a pulp mill. Bernsohn (1981) reports that barkers and chippers cost about $215,000 at the time.

22 “Obviously, at least a portion of the sawmill industry is working toward close utilization standards much sooner than Victoria, and even pulp mill management, expected it would.” (BCL 1966)
so great that many of the pulp mills built in the 1960s shut down their wood rooms (these were facilities in the pulp mill that chipped pulplogs), while some of the later ones did not even construct wood rooms. At the same time, increasing pulp and paper capacity on the Coast also sent more mills into the Interior looking for additional fibre, but high transportation costs limited the potential supply from the Interior.

Adam Zimmerman, then president of Northwood Pulp at the time, described the evolution of chip prices in the Northern Interior when testifying before the Pearse commission in 1975:

...$3.85 was the cost [in 1966] including our capital and interest charges of producing chips...[i]f one attributed no value to the wood going into the product. The original price was started off at around $6 or $7.00, as I recall, and quickly escalated to about nine dollars and a half, and in my judgment, there was real open competition between the pulp mill chip buyers...That was in the initial stage, and I think that was relatively stable for perhaps a four or five year period, at which point it began to escalate, and as you point out, there were more buyers, the competition became I guess more active, although I would say equally the volumes of chips that you were dealing with, the numbers all became a lot bigger. The end result of that was that in what would be about an eight year period, or really less than that, the chip price went from something around $7.00 to about triple that amount...

Pearse: ...I’m sure that you would agree that in certain places in British Columbia, there are monopsonistic [sic] or monopolistic circumstances which would preclude truly competitive prices from emerging?

Zimmerman: ...I think it was a truly competitive price in the circumstances, the circumstances being that there were initially two buyers who were unrelated and in competition. The market was isolated to some extent, although the fringes — on the fringes it was competitive. The Williams Lake area could flow south, and I don’t remember the dollar limit but that put a limit on it. There was the alternative source [presumably referring to roundwood chips], and then there was the question of what really has become a flood of chips...the supply exceeded our expectations..

(Pearse 1976: 964, 966-7)

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23 Chipped roundwood fell from 341,000 BDUs (29% of total fibre consumed) in 1966 to 201,000 BDUs (6.5% of total fibre consumed) in 1973 as residual chips used increased from 800,000 BDUs to 2.9 million BDUs over the same period (this excludes the North Coast)(Interior Pulp Group, 1975).

24 Coastal companies reporting that from one-third to three-quarters of the cost of an Interior chip was transportation and they would not pay more than price at which they could obtain Coastal chips. Reported prices in the Interior were reported in the winter of 1966 to range from $5 to $12 per BDU at the sawmill (Rees 1966).
The Introduction of Chip Direction Policy

The Interior pulp companies, while enjoying the increased production of residual chips, became concerned over the increasing harvest coming from the move to a close utilization standard by the sawmills, as sawmills were now processing wood that only a few years earlier had been considered pulp wood. In response to this concern Ray Williston, the Minister of Forests, created the chip direction policy in the mid 1960s. It required any operator utilizing third band wood to offer its chips to the nearby pulp mill, with the quantities based on the amount of fibre received through the move from intermediate to close utilization as well as the area under which it had received rights. For the most part, chip direction meant that chips went to the same pulp mill that held the PHA in which a sawmill was located, the Minister also required some sawmills from outside PHAs to send their chips to specified pulp mills. Finally, the Minister also stated that if there were insufficient supplies of fibre even after chips were directed to pulp mills, then the “third band” volume would be withdrawn from the sawmills and granted to the pulp companies (Crestbrook 1976, Weyerhaeuser 1976).

While Interior pulp mills found they had plentiful supplies of chips, they still felt that the 'third-band' wood had been promised to them through their PHAs and despite chip direction they had lost some control over their fibre supply. One response was to purchase sawmills for their harvesting rights. In other words, vertical integration was being encouraged.

25 “Canadian Forest Products agreed to use as much sawmill waste as was economically possible, and, like most other Interior pulp mills, it received an understanding from the government that the firm would have the exclusive right to purchase chips from other firms in the area covered by the Pulpwood Harvesting Agreement.” (Bernsohn, 1981: 98)

26 “Consequently, timber volume that had been made available to pulp mills under PHAs was now allocated to sawmills under Third Band Timber Sales...Although by-product chips largely replaced roundwood, pulp mills lost a degree of control over wood supplies. This promoted pulp companies to become involved in sawmilling in order to get an assured supply of at least some of the residual chips.” (Interior Pulp Industry 1975)
The chip direction policy was most often expressed as a condition of the cutting license, and was not formally incorporated in any of the PHAs.\textsuperscript{27} It was also in 1970 that Weyerhaeuser introduced fibre supply contracts tying residual chip prices to kraft pulp prices. Previously, prices had been fixed for an extended period of time (Weyerhaeuser, 1975). By 1972, Prince George Pulp & Paper had also moved to a pricing system relating the price of chips to the mill net price of pulp.\textsuperscript{28} This practice of \textit{formula pricing}, where the price paid for wood chips is based on a specified percentage of the pulp price, was widespread throughout the Interior pulp and paper industry by the early 1980s (Hay-Roe 1983).

\textbf{The Introduction of Minimum Chip Pricing and Export Restrictions}

The plentiful supply of residual chips helped fuel an expansion of the Interior pulp industry. The first signs of trouble came when prices in North American lumber markets dropped in the early 1970s, shortly after chip direction had been introduced. As sawmills shut down, pulp mills, enjoying good market conditions, increased the prices they were willing to pay for chips to keep the sawmills going. This coincided with the election of the NDP government in 1972. One of the first issues the government started to examine was the issue of chip prices. According to the Minister of Forests, Bob Williams, the province had:

\textsuperscript{27} An example of chip direction is contained in a letter dated March 4, 1970 signed by Ray Williston submitted by Inland Timber Management to the Pearse Commission.

"Established licensees within the above noted Public Sustained Yield Units will become eligible for additional cutting rights from 'third band' wood to be distributed on the basis of detailed mill studies being carried out by the Forest Service ... As a condition of qualifying for such additional cutting rights, it will be a requirement that existing timber sale licenses be converted to a timber sale harvesting license and that acceptable chip, sawdust, and hog fuel contracts have been executed with the holder of Pulpwood Harvesting Area No. 2 [Kamloops Pulp & Paper] ... Any established licensee not prepared to abide by such conditions will not be able to participate in any additional cutting right by reason of the distribution of 'third band' wood. Such licensees, however, would be required to operate to close utilization standards ... It is recognized that a fair price must be offered by the holder of Pulpwood Harvesting Area No. 2 for such wood chips, sawdust and hog fuel, and I am confident that this will be accomplished by individual negotiation." (L.J. Milner 1975)

\textsuperscript{28} Brief submitted by Prince George Pulp to the Royal Commission on Forest Resources, dated August 8, 1975, p.17.
"...a pulp market that is extremely buoyant, very profitable and a sawmill industry that is pushed against the wall ... the prices sawmills are receiving for their chips are by and large generally below what they should be... Mills in the United States ... are getting four, five and six times what producers in BC are getting." (Martin 1974).

At the same time, the BC government had commissioned a report to investigate what Coastal and Interior companies could afford to pay for wood chips as it contemplated changing the stumpage system to incorporate the value of wood chips. The first report were completed in late 1973, and suggested that pulp mills both on the Coast and in the Interior could pay more for their chips than they were currently paying.  

This led to the NDP government to introduce Bill 171 to establish minimum prices for residual chips along with incorporating the price of wood chips into the stumpage system. This move was viewed with skepticism by the industry which, although company leaders had acknowledged the problem of chip prices, were not sure that government controls on chip pricing were necessary. Ian Mahood, then President of the Truck Loggers Association, said:

"... [w]e ...deplore the fact that in the chip area it is apparent that transfer pricing is being advocated--taking some of the profit from the pulp mills and transferring it to the sawmills ... It is far better to have prices related to the costs of production rather than have artificial pricing" (Martin 1975).

Mahood argued that the only reason the government may have had to get involved was due to its stumpage policies in the Interior, and that when stumpage costs went up on the Coast the pulp companies voluntarily opened up their contracts with their chip suppliers and made adjustments.  

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29 Given then current prices of $210 per ADT for pulp, companies on the BC Coast were paying $26 to $32 per BDU delivered and could afford $32.75 to $41.75, while companies in the Interior were paying $15 delivered in the Interior ($20-$22 on the North Coast) and could afford at least $25 per BDU (Roberts and Sawadsky 1973, Alexander and Roberts 1973).

30 Stumpage rates in the Interior were derived from lumber values at the time, while stumpage rates on the Coast were determined by log values.
clauses relating to the price for pulp, and the Interior pulp mills were waiting to see what the government was doing regarding stumpage (Martin 1975).31

Despite these concerns, the provincial government proceeded with Bill 171 and the power to establish minimum chip prices was set through the Timber Products Stabilization Act in the Fall of 1974 (this provision still exists in Section 148 under the Forest Act). The price of residual chips was set initially at $35 per BDU (British Columbia 1978).32 In addition, the Act was used to bring residual chips under export controls for the first time. The Act also provided for the establishment of a marketing board for wood chips, although no such board was established at the time. Finally, the government simultaneously incorporated wood chip prices into the stumpage system for the Interior, using an administratively determined price that was lower than the minimum price set by the provincial government.

Initially the mandated chip price led to higher revenues for sawmills.33 However, the first signs of a problem soon showed up when pulp markets started to soften in 1975, followed

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31 The debate in the legislature sheds some light on the perceptions of the market at this time.

“G. Gibson (L): ... ‘even assuming chip prices are raised substantially, [it] is only helpful to the independent operators so long as the government forgoes its habitual taking of something over 80 per cent of the increase in prices ... What is happening, really, is that the government is finding another way to get revenue not out of the pulp mills but out of the pulp mills and the independents ... the worst part about this section is that it permits the government to put the squeeze on any pulp mill or any independent operator in this province ... I think most people on the floor of this House agree that a higher price should be paid for Interior chips. There's that monopoly buyer's market in the Interior...There's just no question that it has to be fixed up. But to have it fixed up with total discretion on the part of the Minister is wrong ... I suggest ... that what is required is a formula ... that will tie it to a free market.’”

Gibson goes on to suggest using the coastal market after adjusting for transportation, and notes that the government's estimates of chip prices coincide with then current prices on the Coast. (BC Logging News 1975: 22-23)

32 After pulp prices increased in the first part of 1974, the government commissioned another report on chip pricing in the Fall of 1974, which stated that while here were some old contracts in force with prices of $11-$12 BDU FOB the sawmill, newer contracts were being written at $20 per BDU, and there were reports of special contracts to produce chips at $40 per BDU (Alexander and Roberts 1974). Coastal prices were $50 to $55 per BDU, and the report stated that in the immediate short run Interior pulp mills could afford to pay $60.

33 “...[M]any middle size operators found that their chip cheque was actually greater than their operating profit.” (BC Lumberman 1975)
by a strike at the Interior pulp mills. When the pulp mills reopened after the provincial
government legislated the strikers back to work in October 1975, the pulp mills refused to
take all the chips offered to them (Bernsohn 1981). There was no requirement to purchase
all the chips produced by the sawmills, and chips started to pile up. Sawmills noted that at
$35 a unit, pulp mills were in no hurry to purchase wood chips. In some cases, the
growing chip piles meant that a sawmill had to shut down as it ran out of storage room.
One independent operator, Al Thorlakson, said "these chip piles are a monument to
bureaucracy...the Stabilization Act should be withdrawn and a more rational price for chips
should be allowed to develop."34

The Royal Commission on Forest Resources
It was against this backdrop that a Royal Commission, headed by Peter Pearse, was struck by the
Province to investigate issues of growing concentration in the forest industry and the role of
economic incentives in forest management. As part of its work, the Commission also examined
the issues of minimum chip pricing, chip direction policy, and chip export permits. Hearings were
held throughout the Province. Nearly every major company within the Province made a
submission to the hearing and it is clear from many of the submissions, from both pulp companies
and sawmills, that the supply and pricing of pulp fibre in the Interior had become a major issue
within the industry.

From the independent sawmill's perspective, chip pricing was the major issue, and there was a
consensus that chip direction had led to lower prices through reduced competitive pressures.
Consider these passages from three entities that testified before the Commission:

"The following conditions affect chip market opportunity:—
(a) Chip direction as a condition of most tenures.
(b) Freight rates and car supply availability on the British Columbia Railway seriously
limit additional delivery points.
(c) Export regulations effectively prohibit long term export. A producer of chips connot
[sic] contract to sell in the export market for more than a few months, whereas domestic
contracts cover periods of up to ten years. The market opportunity on the basis of a "spot"
type export contract is obviously much less favorable than on a long term contract.

34 See Chapter 23 in Bernsohn (1981) for a good description of these events.
In addition, “pulplog” harvesting, close utilization and chipping of residuals is effectively mandatory for the sawmill industry. Under the above circumstances, the CLMA reluctantly concludes that chip price regulation, although abhorrent in principle, is inescapable in practice.”

(Cariboo Lumber Manufacturers’ Association 1975)

“Direction of chips, restrictions on longer term exports and lack of boxcars have severely aggravated an intolerable situation of pulp chip over-supply in the BC interior and poor economics in sawmills. The rigid nature of the system of direction has forced the setting of minimum pulp chip prices, as natural market forces were not allowed to work. We expect that had these constraints not been on the system that chip prices would have followed the rise in pulp prices much more closely, and while prices in some areas may not have reached $35/BDU, chip producers would have been...generally better off.”

(Whonnock 1975)

“It is readily apparent that in the Southern Interior there is a considerable volume of tree material which is being burned at mills or on logged sites or left to rot even when pulp mills are operating. It is also apparent that some of the material licensees are required to remove costs more to deliver and process through sawmills than it returns.”

(Riverside Forest Products 1975)

The Interior pulp companies were concerned about what they felt had been the erosion in their harvesting rights, and especially any further weakening of the PHAs.

“It is evident from the foregoing that private contracts for the supply of sawmill residual chips are an important part of this firm’s raw material security. Frankly, the company would not have committed capital to the Kamloops pulpmill without these contracts. The extent to which they rested in chip direction by the Crown was held to be a necessary part of the arrangement.”

(Weyerhaeuser 1975)

“It is all very well to imply...that the availability of residual chips reinforced by the recently introduced “chip direction” policy assures the pulp mills of a supply of raw material, but this is not in fact the case. The sawmills are not obligated to produce sufficient chips, and even if they do, transportation or other difficulties may prevent delivery of the chips to the pulp mills. We feel strongly that we must continue to have protection against the possibility of finding ourselves dependent on the vagaries of the market for lumber products. This is why we consider the guarantees of an independent supply of wood contained in our PHA Agreements to be the cornerstone of our operations...

As a result of the ‘third band’ policy, which made available to the sawmill industry the remaining annual allowable cut resulting from the change from ‘intermediate utilization’ to ‘close utilization’, a potential conflict arose between the option granted to the pulp mill companies under their PHA agreements to harvest or to acquire up to a certain volume of roundwood if required and the cutting rights over the same wood granted to the sawmills.”

(Prince George Pulp and Paper and Intercontinental Pulp 1975)

“Soon after the first PHA agreement was signed, the government, apparently responding to pressure from sawmilling interests and to the realization that some PHAs contained unallocated wood which, if processed, could add to Provincial revenues one way or another, began promoting the use of this wood in sawmills. It appeared to reason that, if enough sawmills could be enticed into using the additional wood, there would be an ample
supply of pulp chips available without resorting to chipping pulpwood directly. The fallacy of this assumption is readily evident upon realizing that:

a) although some wood is sound, it is either too small to yield marketable lumber or, if sawn, it produces a preponderance of single dimension material such as 2”x4”s which, when marketed in large quantities, often suffers a fall in market value to a price below the cost of manufacturing.

b) some wood does not produce marketable lumber of any grade and should not be processed in sawmills.

Northwood agrees it was reasonable to allow the existing sawmilling industry or any new sawmills the rights to acquire unallocated wood, provided it was generally within the standards of utilization in force or developing at the time. However, the government not only allocated all the regular sized wood, but also the small and unmerchantable wood (for sawmilling) which in most cases formed the basis for part of the volume guarantees under the PHA agreement.

As matters stand today, sawmills complain, with considerable validity, that much of the wood being forced on them by the close utilization policy is creating financial hardships. The government has moved to establish a base price for chips, which action helps to compensate for the shortcomings of the close utilization policy but adds to the burden of the pulp mills...

(Northwood Pulp and Timber Limited 1975)

Adam Zimmerman, then President of Northwood Pulp and Timber, also pointed out that the introduction of the chip direction policy using PHAs had disproportionate effects:

“What was really the problem there was our ox was being gored [referring to chip direction], it was nice for some people but it wasn’t good for us, because we had a fully committed PHA and we bought chips from outside our own PHA ...but then this thing [chip direction]...eliminated our opportunity to acquire those chips, and I think to go back to your earlier point, probably impaired the market that existed, because there was no market....if we had been buying chips from someone in PHA number one, those would, in effect, be pre-empted by this provision, and the chips would logically then flow to Prince George Pulp. So it was nice for them and nasty for us.

(Pearse 1976a: 973-4)

David Schine, president of Canyon Creek Forest Products, a small sawmill in Valemount near the BC-Alberta border, talked about the effect changes in export policy had on their exports to a pulp mill in Alberta.

“.over the years, our export permits were getting lesser time and I think they were down to six months. And then finally in 1973 it was not renewed. And it was suggested very strongly that we ship our chips to someone in Prince George, which we did.”

(quoted in Pearse 1976a: 657-8)

Trevor Jeanes, a registered forester with Balco Industries (a firm with sawmills in the southern Interior), responded to a question from Dr. Pearse as to whether chip markets without regulatory constraints could be competitive. He said that:
“...there’s been a slump in the pulp market. There perhaps is not a competitive situation existing. Prior to that, I believe there was...Prior to direction of chips, we sold chips to the coast, to other pulp mills that weren’t able to be used, or weren’t able to be taken from our mill by the plant locally.”

(quoted in Pearse 1976a: 2842)

Marvin Persson, manager for Federated Co–op, a sawmill in the Southern Interior, described how the chip direction policy meant all their chips went to the pulp mill in Kamloops.

“..the direction is not there for the berth chips or for the T.F.L. chips [two area based forms of tenure different from the PSYU or volume based tenures through which the additional ‘third band’ wood had been issued]...the terms of our contract says that we will sell all chips manufactured in our operations, to the Weyerhaeuser Canada company.”

(quoted in Pearse 1976a: 3140)

Pearse went on to confirm that it was the contract, not the tenure, that required them to offer all of their chips to the pulp mill in Kamloops (Pearse 1976a: 3141).

Finally, Bud Nelson, forester for Galloway Lumber, a small sawmill in the southeastern corner of the Province, answered a question from Commissioner Pearse regarding whether his chips were directed to Crestbrook, the nearby pulp mill.

Commissioner: Are you free to sell them somewhere else?

Nelson: No, not really. At certain times now you can sell chips if you get the refusal of the pulp mill, but generally, when they refuse so does everybody else.[Laughter]

(quoted in Pearse 1976a: 3417)

Crown Zellerbach (now Fletcher Challenge), with sawmills in the Interior and on the Coast, and pulp mills on the Coast, provided a different perspective. The company noted that competition for supply contracts yielded the full competitive price, as was the case on the Coast, and that “as in any landlocked region, there is an unavoidable degree of regional imperfection in the chip market. There is now only one buyer at Kamloops.”³⁵ The company felt that government intervention was unnecessary because the Coast offered a viable outlet for chips in the Kamloops area, depending on export policy, transportation costs, and Coastal price levels. The company also stated that if

³⁵ Crown Zellerbach 1976
there was to be any chip direction that it should be matched by a requirement to purchase the directed volume.

In his final report, Pearse (1976b: 301) provided a detailed description of how the chip export system worked at that time. To receive approval for a chip export permit, a committee made up of Coastal buyers and producers determined whether the chips in question were surplus to the needs of Coastal pulp and paper mills. Also attending was a representative of the Interior buyers, who provided their opinion on whether the applicant's chips were surplus to Interior requirements. If the applicant received permission, the chip export permit was usually for a limited two year period, and contained a notice of need provision, which meant that either Interior or Coastal consumers could invoke the right to halt the export of those chips and have them redirected to their mill. Dr. Pearse felt that the difficulties in obtaining permits and their short duration also limited export opportunities and in turn the producers' ability to receive better prices and argued that the effect of all these practices was to limit market opportunities for wood chip producers.

Pearse (1976b: 302) recommended that the chip direction policy should be dropped (although the pulp mill to which the chips were currently directed should have a right of first refusal) and that minimum chip pricing should be exercised more selectively. Pearse suggested that a forest products board should be established to monitor chip prices and evaluate any structural impediments, such as inadequate transportation, that hampered the marketing of chips. Pearse (1976b: 302) also recommended that the government drop the export tax on wood chips as well as facilitating the export of wood chips.

The NDP government called an election in the winter of 1975 and lost to the Social Credit Party which obtained a majority. In response to the chip surplus, the newly appointed Minister of Forests, Tom Waterland, announced in March of 1976 that the minimum price would drop to $30 per BDU. He also announced that the government would proceed to
use a formula where the price was based on nine per cent of the average selling price per short ton of bleached Kraft pulp for the preceding six month period. The price would be adjusted every six months and the ceiling on freight costs borne by the pulp mills would be raised to $14 per BDU (any transportation costs in excess of that would reduce the minimum price)(BC Logging News 1976b).

The chip surplus continued to grow in the Interior, and the government pressed the industry to come up with a solution to the problem. Industry efforts to allocate the chips themselves had failed and the government threatened to establish a forest products marketing board in order to resolve the problem. In response, the pulp and paper companies announced that they would once again attempt to deal with the chip surplus. In the meantime, the government asked Hugh Cooper, a retired lawyer, to try and come up with a solution. Cooper's answer, after evaluating possible alternatives for wood chips such as fuel or food for livestock, led him to conclude that their highest value lay in making pulp. A tour of Europe and Asia convinced him that sufficient demand existed overseas to warrant the development of an export outlet for Interior wood chips (BC Logging News 1976c, Cooper pers. comm. 1995). By the summer of 1976 it had become clear that the problem could not be solved internally, and that exports offered the most promise for handling excess chips.

Although global pulp markets were poor, it was felt that exports at least meant that sawmills wouldn't have to burn their chips. However, pulp mills argued that while they were not adverse to the export of chips surplus to current needs, those chips may be required in future years for additional planned domestic pulp capacity. Estimates of the surplus ranged from 5% to 20%, and the Deputy Chief Forester said trying to get an exact

36 "Waterland said he had set no time table for the industry to reach a solution: 'They (the pulp producers) can see what the problems are and I know they will distribute the surpluses as evenly as possible.'" Vancouver Sun, Feb. 22, 1977.

37 "Forest Minister Tom Waterland has had enough of the bickering among the industry and has called a meeting for August 10 where he will read the riot act for what well could be the final time." Vancouver Sun, August 3, 1977.
figure was like “trying to grab a handful of jelly” (BC Logging News 1976c).

Responding to the pulp and paper industry’s concerns, the BC government stated that it did not want to discourage the establishment of pulp capacity in the province. Therefore, the permits would be for five years and would be non-interruptible, with provisions for renewal in the fourth year (although renewal was not automatic). It was felt that this was the time period necessary to satisfy buyers’ requirements for fibre (although they preferred 10 year permits) as well as the lead-in time to build new pulp capacity in the province (BC Logging News 1976c). In addition, the limit on total exports was set at the lower end of estimates of the surplus.

The Formation of Fibreco Export Inc.
The difficulty in obtaining individual chip export permits led a group of Interior sawmills in 1977 to incorporate a company called Fibreco Export, led by Cooper. The pulp mills continued to maintain their opposition to the idea of chip exports, and argued that exporting wood chips was in effect exporting jobs. Cooper accused the pulp mills of deliberately rejecting the concept of an independent exporter because it would usurp their control over the movement of chips.38

By 1978, however, the pulp and paper companies’ opposition had softened as it became clear that they could not consume all the chips being produced by Interior sawmills.39 In the meantime, the government announced that due to poor pulp market conditions it was lowering the minimum price to $25 per BDU. Pulp prices then were hovering around $300 per tonne (see Figure 2) (Vancouver Sun, December 24, 1977). Discussions now shifted

38 “[Hugh] Cooper [chairman of Fibreco] accused the pulp mills of deliberately rejecting the concept of Fibreco because it would usurp their control over the movement of chips...Says Cooper bluntly: ‘They (pulp mills) feel it’s their God-given right to control the movement of fibre in the province. They resent that there’s an upstart organization that will break that control.’” Vancouver Sun, August 3, 1977.

39 “‘We have never resisted a reasonable outflow of chip (but) naturally any pulp company would get concerned if there is a massive outflow,’ says Mark Gunther, President of Prince George Pulp and Paper. ‘And if you take it to its ultimate conclusion you will be exporting jobs.’” Vancouver Sun, August 3, 1977
to the length of export contracts, with independent sawmills pushing for 15 years, and the pulp companies arguing for no more than five years (Vancouver Sun, March 8, 1978). However, according to Hugh Cooper, by now Chairman of Fibreco Export, opposition to exports had still not ceased, and Fibreco Export had to go outside the province to find the financing for the export facility that had to be built in Vancouver.\textsuperscript{40}

Originally consisting of thirty independent sawmill companies scattered across the Interior, Fibreco was based on the concept of a cooperative to use individual chip contracts to come up with a pool of chips for the Japanese market. In order to make the consortium viable, the members agreed to pool transportation costs so that each member would receive a common net price by deducting the average transportation cost from the export price. As part of this arrangement, because some of the chips were coming from great distances, Cooper arranged for some of the Interior pulp mills to take their chips from closer suppliers (i.e., chip swaps). For example, chips from Fort Nelson went to Mackenzie, only a third as far as to the Coast. Cooper noted that it was not very difficult to get the pulp mills to agree to this when he could show them the cost savings (Cooper pers. comm. 1995).

Fibreco shipped its first load of chips September 29, 1979. Cooper had been successful in demonstrating that there was a substantial market for export chips with the strongest demand coming from the Pacific Rim. He signed a contract for 400,000 BDUs annually for ten years with Japanese pulp mills. The export facility was designed to handle up to a maximum of 750,000 BDUs annually. He noted that export buyers wanted three assurances: first, that the BC government would not change its mind and that contracts would be long term; second, that supply would be steady and not subject to interruptions; and third, that there be a good tidewater handling facility. Cooper emphasized that the first condition was extremely important. There was already a perception that BC was an

\textsuperscript{40} Cooper attributed the problem to the fact that every local bank had a pulp and paper company officer sitting on the board which had final approval of all loans. (Cooper 1995)
unreliable source of wood chips in the export market, based on a series of interruptions from the Coast to the US market in Puget Sound in the late 1960s.\footnote{Cooper (1981) stated that: "it was found in the first foray into the international marketplace that it was long recognized by the international buyers of wood chips that British Columbia was not the most reliable source of supply for wood chips. Over the years there had been a vacillating policy on the export of fibre from the province for various reasons: the vicissitudes of political and economic factors of changing governments and the lobbying pressures on governments by dissimilarly [sic] interested groups."}

Cooper pointed out that the Interior pulp mills were content to rely on just the residual chips that were an inevitable byproduct of lumber production, and were failing to utilize all of the wood in the forest (Hiballer, September 1979). Cooper also agreed that Fibreco's entry into the chip market could raise prices in the Interior and stated that BC's Interior pulp mills had the lowest fibre cost in the world (Martin 1979).\footnote{Export prices were US $ 91.25 per BDU in the fall of 1979 (Canadian Pulp and Paper Industry, November 1979), while Interior prices were $32 per BDU (the minimum price) (BC Lumberman, September, 1979). Coastal prices ranged between $60-$64, and Fibreco had obtained contracts for $56 per BDU (Globe and Mail, December 13, 1979).}

The creation of Fibreco Export appears to have coincided with the development of a quarterly report entitled the Region 1 Audit Committee Report, issued by the COFI Chip Task Force formed at the same time. The original report appears to have been drawn up in an attempt to quantify the chip surplus in the Interior, and split the province into three regions based on chip production and consumption: Region 1 covered the Northern Interior, including the North Coast; Region 2 covered the Southern Interior; while Region 3 covered the South Coast and Vancouver Island. The usefulness of this report appears to have led to its continuation on a quarterly basis, funded by the industry, and it is currently circulated among pulp mills within the region. It appears that some Coastal consumers also receive copies.\footnote{This observation is speculative but is based on conversations with industry participants.} The report purports to cover all production, consumption, and inventory changes for all producers and consumers within the region, with some information about exports outside the region (either to pulp mills outside the region or to the export market).
The Forest Act of 1978
In 1978 the BC government introduced a new Forest Act in response to changes in the forest industry and the recognition that timber quotas had become a de facto form of tenure (British Columbia 1978). PSYUs were replaced by Timber Supply Areas, and licensees were allowed to convert their TSLs and TSHLs into Forest Licenses (FLs), volume based tenures with fifteen year terms (Haley 1995). In terms of the PHAs, the government had realized that sawmills had dramatically improved their ability to use small diameter wood, making the definition of pulpwod even more ambiguous, and so had not issued any more pulpwod harvesting agreements after the initial flurry in the 1960’s. The Act changed PHAs to Pulpwood Agreements (PAs) replaceable every 10 years with 25 year terms. Pulpwood Agreements that were subsequently granted also differed from earlier PHAs by clearly specifying the wood that would be available under the license with the expectation that these licenses would be used for harvesting. This was a substantial change from the earlier agreements, which had originally been envisaged as providing a backup source of fibre (they had only been used to allow harvesting in one instance). Existing PHAs were converted into PA’s as their renewal terms came up, although the terms of the agreement remained unchanged until recently.

The following year (1979) saw a dramatic drop in the lumber market, which coupled with higher stumpage rates, was placing increasing pressure on sawmills yet pulp prices were rising. Hugh Cooper predicted that sawmills would close given current lumber and chip prices, which in turn would drive up chip prices as logging was curtailed (the minimum price of chips had now moved up to $40 per BDU) (Vancouver Sun, December 14, 1979).

Chip Direction Policy Dropped
In 1980, the government issued a notice of intent to award a new PA in the Williams Lake area in the Central Interior of the province. This would be the first such agreement

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44 Section 17A, Forest Act of 1978.
awarded under the new Forest Act, and it attracted a great deal of interest. Three companies, Northwood, Cariboo, and Quesnel River Pulp, applied for the wood, while several others made general submissions urging the government to consider the implications of awarding a new PA. The hearings themselves clearly identified chip direction as the major issue in the Interior pulp fibre market.  

Ultimately the Minister of Forests decided not to award a pulpwood agreement. The minister, however, did drop minimum chip pricing, and replaced the chip direction policy with the right of first refusal. This right meant that the purchaser which had previously enjoyed the chips under chip direction had the right to meet the best offer from another purchaser before a sawmill could sell to another pulp mill (although eligible buyers were restricted to other Interior pulp mills). The government also incorporated the full value of wood chips in the stumpage system starting in September, stating that the full regional market price would be used (Province, March 9, 1980).

Independent sawmillers welcomed the change, since they felt that removing these constraints would mean a market price more reflective of supply and demand conditions. Some, however, had some concerns about the change in stumpage policy. Some industry

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45 Quesnel River Pulp (QRP) proposed to build a TMP mill in Quesnel. West Fraser, which owned several sawmills in the Northern Interior, had a fifty percent interest in QRP and was in favor of dropping chip direction as West Fraser's chips that could go to their proposed mill were being directed elsewhere. Cariboo was in favor of continuing chip direction policy, since most of the chips they received were directed. Their chairman said "The whole basis of the operation and the future revolves around that chip direction policy". Northwood stated that it was opposed to chip direction policy but couldn't risk seeing its supply of chips jeopardized if an applicant in the area were able to get preferential treatment, as they anticipated acquiring additional fibre for a proposed expansion from the area advertised for the P.A., while Canfor stated that they relied on chip direction for their fibre needs. Crown Zellerbach urged the minister to reject all the applications and encourage an open market for chips (they required interior chips for an expansion of their Elk Falls plant), while Canadian Cellulose (with the pulp mill at Prince Rupert) was worried about a domino effect from chips being redirected. (Province of British Columbia 1981)

46 West Fraser, in a joint venture with Daishowa, proceeded to build a thermo-mechanical (TMP) pulp mill in Quesnel in the early 1980's despite the fact that they did not receive a PA.

47 "The stumpage system in the Interior at the time was based on the Rothery method. After computing the end product values that a log could yield, costs and an allowance for profit and risk were deducted to arrive at the appraised stumpage price. Chips were not originally included as an end product until 1973 and then they were valued at $2 per BDU, climbing to $10.50 by the end of 1980 (at which time the minimum price was $35.15 per BDU)." Province, March 9, 1980.
participants said that sawmills would receive less under the new system than under
the existing system (it was calculated that of the $10 used in the stumpage appraisal, the
sawmill kept $2), while others were concerned about what region would be used to
determine the price. Said one sawmiller: "Now that we have an export market, we're more
or less on an equal footing with the pulp mills...they now have to come up with their price
or we export" (Vancouver Sun, March 8, 1980).

Hugh Cooper, then chairman of Fibreco, was a bit more skeptical. When asked whether
the higher export prices would squeeze the Interior consumers, he thought it unlikely as the
Interior mills, being the major consumers, would purposely hold their prices below what
Fibreco was offering (Province, March 9, 1980). This viewpoint proved to be accurate:
while export prices paid to Fibreco members increased to US $99 per BDU for the next six
months starting January 1 (Globe & Mail, Feb. 18, 1980), domestic chip prices remained
unchanged. Cooper attributed this to the fact that the most likely buyers from outside the
region were not permitted to bid for chips in the region, and that pulp mills in the Interior
saw no need to raise prices.48

Cooper talked about the possibility of setting up chipping stations in Prince George,
Quesnel, and Kamloops (Province, March 12, 1980) to meet the demand in these other
markets.

48 "Regulations dealing with wood chips in the BC Interior took effect April 1 when Forests Minister
Thomas Waterland removed the floor price - which had been 9 per cent of the selling price of the
pulp. He also removed a requirement that sawmills in certain areas had to sell their chips to
designated pulp mills, holders of pulpwod harvesting area licenses. It was expected pulp mills
needing chips would bid, pushing up the price, but Mr. Cooper said this has not happened for two
reasons. Pulp mills were granted first refusal of chips in their harvesting area and option to buy at
the price agreed in the sale to 'others'. But the minister said only other Interior pulp mills could
get involved in this process, Mr. Cooper said. This excludes export buyers, who are paying about
$100 a unit, and BC coastal pulp mills, which are paying $91 to $93 a unit. Interior pulp mills,
which formerly kept their chip price at a minimum by agreeing that nobody would pay more, are
still doing the same thing despite a change in regulations, Mr. Cooper said. Chip prices are actually
slightly lower than before, he said. Supply has been curtailed as sawmill operators attempt to
withhold their chips to get a higher price, but the boycott is not being completely maintained.
The poor lumber market means 'everybody is scratching to pay his banker. They need the cash flow'.
As a result, Fibreco, which pays twice the pulp mills' price, 'is being deluged with chips,' he said."
Globe and Mail, April 9, 1980
The price of lumber continued to drop. At this point, it was quite clear that wood chips and lumber were co-products: at low enough lumber prices, chip revenues determined whether a sawmill stayed open.49 Mark Gunther, at Prince George Pulp and Paper, argued that Interior pulp mills provided long term markets for wood chips and could not be expected to pay the export price as it reflected spot prices.50 Gunther stated the answer was to tie chip prices to the price of pulp (much as the minimum price had been determined), while Hugh Cooper responded by noting that the pulp industry worldwide paid at least one-third of the selling price of pulp for their wood fibre. The Interior pulp mills responded to that argument by saying that they faced higher transportation costs, which raised the cost of fibre delivered to the mills.

Complaints about chip pricing started to surface again on the Coast in 1987 as the price of pulp started to increase.51 In December of 1987, Canfor announced that they were

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49 “Few mills have closed so far, according to E. V. Scoffield, manager of the Northern Division for COFI...The main impact of the ailing US market is on independent sawmillers, which unlike the larger, integrated companies, do not have fat pulp and paper revenues to offset the lean times for lumber...Sales of the byproduct chips can add $30 to $50 a thousand board feet to revenue, if they are sold for export. Sales of chips to Interior pulp mills would add only $20 to $25, because they have been holding the price down. However, it is generally recognized that their price will have to rise if they are to get chips as lumber production is curtailed...Counting in US dollar exchange and chip sales, the total return to the miller from sawing a thousand board feet of studs would be about $185 at export prices and about $165 at local pulp mill prices.” (The article goes on to estimate average production costs at $160 per thousand board feet). Globe and Mail, April 26, 1980

50 “The main fact probably is that there is still an oversupply of chips in the Interior...The Interior was set up by the government as a separate region for chips and it is a separate market,” said Gordon Thomson, vice-president, Pulp, for Northwood Pulp and Timber Ltd. of Prince George. “It is pointless to complain that prices there are not as high as elsewhere. We’re going to pay what the market requires.” Mr. Gunther [of Prince George Pulp and Paper] said it is government policy that chips should not be transported out of one region and that only chips that are surplus to domestic requirements may be exported. In his view, a surplus no longer exists. Globe and Mail, July 25, 1980

51 “Until recently, there was some negotiating involved in setting chip prices and some variation in the prices paid by the pulp producers. ‘This time, there were no negotiations,’ said Joe Frumento, vice-president of Doman. ‘The majors said this is what we’re paying and that’s it’... According to Mr. Frumento and other sawmill spokesmen, all of the pulp companies have offered the same prices, $70 a unit in the case of hemlock...Asked why all the major companies are offering the same prices for wood chips, Mr. Dent [general manager of raw material services for Macmillan Bloedel] said: ‘Companies are not going to pay more than other companies are paying...we do not sit down with other major buyers and decide what the price is going to be for the next quarter.’ According to Mike Thompson, manager of trading fibre supply for Crown Forest industries, prices as a percentage of the pulp price in 1981 were higher because supplies were tighter and mills were whole log chipping. He said that there was currently a surplus of chips on the Coast. The
undertaking a major expansion of their mill in Howe Sound. Peter Bentley, the chairman, stated that the expansion was partly conditional on chips currently being exported being re-directed to the pulp mill. Independent sawmillers pointed out that curtailing exports would reduce the pressure in the market and lower prices.

In 1987 the BC government adopted a new stumpage system in response to an American trade action launched against Canadian softwood lumber imports. The new system decoupled chip revenues from the stumpage system, using only lumber values to establish overall stumpage levels, while chip prices were used to distribute the stumpage charges. This system was known as the Comparative Value Pricing system, or CVP. The new system also meant a significant increase in stumpage prices in the face of poor lumber prices, while pulp prices had recovered from their lows in the first part of the decade.

Sawmills renewed their complaints about the prices they were receiving for their wood chips and the Minister of Forests, Dave Parker, took two steps. The first was to loosen export restrictions to make it theoretically easier to grant permits, and the second was to ask independents also said that if they could sell them in the US they would get much more for their chips; however, they can only get two year permits, which is not long enough to get a contract. "Globe and Mail, April 2, 1987.

Bentley said he expects the expanded pulp mill will need another 600,000 BDUs of chips annually...Sawmillers interviewed...said the Interior industry is currently producing about 700,000 more BDUs than it can sell. Vancouver Sun, December 9, 1987.

"...Surinder Ghog of Aspen Planers...on the export restrictions being sought: 'These companies, Canfor included, the ones that operate the pulp mills, use these means to regulate the price of chips. Curtailing chip export permits is going to give them a more closed, in-house, situation, which is what they want, so there will always be a surplus of chips to keep chip prices as low as possible.'...Tony Jarrett [ of Fibreco]: '...Restricting chip exports would ensure Canfor has the opportunity for a cheap chip supply...And what’s bad about that is Canfor would be riding on the backs of the non-integrated sawmill industry in the Interior.'" Vancouver Sun, December 9, 1987

Under the CVP system put into place, lumber prices determined an overall target revenue rate. Differences in end-product values (including type and species of lumber as well as chip prices) and operating costs were then used to distribute charges across firms cutting public timber. Recent changes to the system lowered the level of timber charges, and chip revenues are once again being used in determining the overall target revenue rate.

"For many large, integrated forest product companies, the weak lumber market has been offset by rising prices for other commodities like newsprint and pulp that are used to make fine papers. But sawmills are worried because their 'break-even range' is about $175 to $180 and their so-called 'shut-down range' is between $160 and $165, according to a recent Random Lengths survey of British Columbia. That is a big change from the early 1980's, when US sawmills were forced to close while their BC competitors, helped in part by low stumpage fees, kept producing even as the benchmark lumber price fell below $130 a thousand board feet." Financial Times, Sept. 26, 1988
the pulp mills in the Northern Interior to voluntarily raise their chip price. In the
Spring of 1988, Cariboo Pulp and Paper announced it was voluntarily raising its price $9
to $75 per BDU, while the pulp mills in Prince George took no action. A year later,
concerned that sawmills may shut down, Parker again approached pulp mills in the
Interior, threatening to invoke minimum chip pricing unless they raised their prices
(Financial Post 1989).

Appleby (1989) showed that although there was an overall small surplus of chips that went
into the export market in 1987, that surplus vanished within two years if planned
expansions in pulp capacity and reduction in sawmilling capacity were taken into account.

The Granting of `New' Pulpwood Agreements
One of the proposals the provincial government decided to investigate in 1990 was the
possibility of awarding pulpwood in the northwest area of the Interior. As had been the
case in 1980, nearly every company within the region either applied for the pulpwood
license or intervened in the hearings. Six companies applied for the fibre for a variety of
uses. Two different pulp and paper companies in the region, Canfor and Quesnel River
Pulp, wanted the fibre as a back-up source, while a consortium of sawmills and Alcan
proposed to build a pulp mill in Vanderhoof. One independent sawmiller wanted a portion
of the proposed area that lay near their existing cutting rights; and two other companies
proposed to use the deciduous species for solid wood products. Northwood applied for
intervenor status (along with many non-industry groups) to submit issues they felt that the
minister should address in terms of access to fibre (Province of British Columbia 1990).
By this time, the increase in pulp capacity had grown to the point that given the anticipated
increases announced and potential falldown in timber supply, all the pulp and paper
applicants were anticipating a shortfall in the amount of available chips relative to capacity.
The chip direction policy came up again in the hearings, somewhat surprisingly since it had supposedly been dropped ten years previously. The government was pressed on the implications for chip supply problems if one applicant or another received the fibre, and once again the provincial government decided not to award any of the pulpwood within the area. One striking feature in reading both pulpwood hearings is to note how little appears to have changed in the intervening ten-year period.

The provincial government subsequently solicited proposals for additional utilization of the forest resource for other areas in the Interior. This ranged from proposals to use aspen in the northeast corner of the province to produce pulp and OSB and proposals to use stands of small stagnated pine in the central Interior. The province had many applicants, with Louisiana Pacific (LP) winning the chance to set up first a CTMP mill in Chetwynd, followed by an Oriented Strand Board (OSB) plant in Dawson Creek (both relying on aspen). Ainsworth Lumber was successful in receiving the right to construct a fibreboard plant in the central Interior using the small pine found in the area. The government's main contribution was through the granting of cutting rights in the form of new Pulpwood Agreements that clearly specified the wood to be used for these facilities. In addition, Fibreco had previously built a chemi-thermomechanical (CTMP) pulpmill in Taylor (this pulpmill is now controlled by Slocan), and later it received a PA covering aspen in the surrounding area.56

'Chip Shock'67
In 1990 sawmills in the Interior approached then Minister of Forests, Claude Richmond, to again ask for the government to put pressure on the pulp companies to raise their chip prices. The minister replied that he would be unable to help and the NDP won the election.

56 The only additional facility using residual fibre since then has been a MDF plant in Quesnel built by West Fraser in 1997. The plant utilizes softwood chips, but West Fraser did not receive any additional cutting rights.

57 The phrase 'chip shock' was first used to describe Weyerhaeuser in the US suddenly doubling the price for its exported chips to Japan in 1980 (Marchak, 1995).
called shortly thereafter (Edgson 1995). Lumber prices languished until 1992, when the lumber market started to surge, followed by the pulp market in 1994.

In February 1994, Slocan (the largest independent sawmiller in the Interior) announced that it was putting the entire chip supply from its Quesnel sawmill up for bid. This had never happened before in the Interior market. Nearly all of the pulp mills in the region responded, with the winning bidder, Northwood, outbidding Cariboo Pulp, which had traditionally received all the chips from that particular sawmill. This activity was watched with a great deal of interest by other sawmills throughout the Interior, many of whom promptly put their chips up for bid, and many pulp mills found themselves signing contracts at substantially higher prices with new suppliers (Edgson 1995)(Bradford 1996). Prices of chips peaked in 1995 at levels four times greater than they had been only 18 months earlier.

Several pulp and paper mills filed a “notice of need” in 1994, a provision under which they can request the government to halt the export of chips and have them re-directed to their mill. The government response in 1995 was to not issue any new export permits and not renew to old ones as they expired. In addition, the provincial government revised stumpage rates in May, 1994, such that at higher prices for lumber the stumpage rate was significantly higher (the new stumpage rates became known as “Super Stumpage”).

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58 I was unable to find any participant who had any recollection of such an event or any record happening prior to this in the Interior. One participant (from a mid-sized sawmill) recalled that when they had offered some chips previously to a pulp mill which hadn’t purchased chips from them the pulp mill had indicated that they would be interested but first needed to “check” with the pulp mill that was currently purchasing their chips. After checking, the potential purchaser indicated that they were no longer interested.

59 This can be seen in the Chip Audit Task Force report as well.

60 Somewhat ironically, several Interior sawmillers suggested in trade discussions with the US forest industry that part of the reason for the success of the Interior forest industry lay in the chip prices they were receiving, due to the competitive nature of the market. The sawmillers suggested that pulp and paper mills in the US South had depressed chip prices.
To get more chips, several interior pulp mills also attempted to activate their cutting rights under their old PHAs that had been converted into PAs. This has presented a continuing problem for the provincial government due to the vague definitions of “material suitable for pulping” in the original agreements. Furthermore, the government found itself with the problem that some of this wood was either already committed, as part of long-range harvest projections, or fell under more than one license as the original PHAs had been explicitly overlaid on top of existing forest licenses when they were originally established. The problem was made more complicated because many sawmills had installed whole log chippers, giving them the capability to handle logs too small to saw.

Three of the original PHAs that have been subsequently renewed in the past several years have substantially changed terms. For example, the agreements are no longer renewable and expire at the end of their terms which usually consist of 20 years. Furthermore, pulpwood is now defined as pulp quality timber stands, and is no longer defined as being below sawmill utilization standards; rather, they may fall below sawmill utilization standards from time to time.

Finally, the original agreements stated that timber would only be harvested if the licensee was unable to obtain sufficient fibre below the cost of harvesting and processing roundwood itself. Two of the historical PAs (numbers 3 and 7) no longer require this condition to be met, rather, the company can invoke the PA if they feel the fibre available on the market is too expensive. To date, the BC government still has not indicated how they would handle a request to use such an agreement.

There have also been other noticeable developments. In 1995 Canfor, an integrated company with pulp mill operations in both Prince George and on the Coast, attempted a hostile takeover of Slocan. The purpose of the takeover was to secure Slocan’s supply of

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61 PA 1, held by Canfor and renewed November 22, 1993; PA 5, held by Cariboo Pulp & Paper and renewed December 16, 1996; and PA 7, held by Canfor and renewed January 24, 1997.
wood chips. In 1996, Orenda Forest Products, with cutting rights on the North Coast, announced that an offer had been made to purchase the company subject to it receiving approval to transfer the timber cut to Vancouver Island. The pulp mill in Prince Rupert that received part of its pulp fibre requirements from Orenda opposed the deal and subsequently acquired Orenda for its cutting rights.

Canfor's attempted takeover of Slocan raised an issue that has been of concern in British Columbia since the Pearse Commission in the mid-1970s. Press releases by the Ministry of Forest at the time of the proposed takeover suggested that Canfor, if successful, would control 50% of the local wood chip market. The takeover failed for at least two reasons: (1) the Minister stated that he would view the increased concentration with concern (and the BC government retains the right to refuse the transfer of cutting rights); and (2), a share buy-back by Slocan. In order to finance the share buy-back, Slocan entered into a long-term arrangement with Weyerhaeuser for 1 million BDUs over the next ten years; on an annual basis, this is about 16% of their 1993 production. As part of the buyback, however, Slocan agreed to Weyerhaeuser taking a 20% interest in Slocan in the event of a default. This has raised concerns among other independent sawmilling companies, since Slocan is the largest seller of wood chips in the Interior. Canfor has subsequently purchased a minority interest in three of the largest remaining independent sawmills in the Prince George area.

Poor pulp markets, coupled with high fibre inventories, following the spike in prices in 1995 led to chip prices tumbling back to the levels of the early 1990's. Subsequently, however, chip price levels have remained slightly above those in the past, while prices are more widely dispersed than in the past. Once again, the possibility of sawmills shutting down due to the state of pulp markets was being discussed.

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63 See, for example, the various articles that have appeared in the Vancouver Sun: BC Forestry in perilous position, November 29, 1996; Stumpage Fees going up, industry warned, November 29,
One of the major news stories over the past year in the forest industry has been the economic woes of the pulp mill in Prince Rupert owned by Skeena Cellulose. After missing much of the high pulp prices in 1995 due to a strike, the pulp mill came back on line just as pulp prices started to tumble. Shortly thereafter Avenor undertook discussions with the parent company, Repap, over purchasing Repap's assets. Due to Repap's high debt load, and the unattractive economics of Repap's BC pulp mill, which relies on pulp logs as well as wood chips from the Interior, Repap divested itself of its wholly-owned BC subsidiary (which also included several sawmills in the northwestern part of the province). This threw the BC subsidiary into bankruptcy and into the arms of the two banks, Toronto Dominion and Royal Bank, that held the major portion of the debt.

The provincial government made the policy decision that it could not let the pulp mill close due to the negative economic impact it would have on the surrounding region. Initial discussions led to the province advancing the company funds and then purchasing Royal Bank's interest, assuming a majority equity share in the company. The government has also provided financing assistance to defray logging and forest management expenses, as well as deferring stumpage payments and relaxing utilization standards. The total cost to taxpayers is estimated to be over $300 million, making it the most expensive aid package in the history of the province. However, the mill remains one of the highest cost producers in BC, due both to the nature of its fibre supply and its low labour productivity, and its prospects are somewhat uncertain in the face of current low pulp prices. One pulp line continues to remain idled as of early 1999 as pulp prices have failed to reach sufficient levels to warrant restarting the production line.

In summary, the development of the pulp and paper industry in the Interior has been intertwined with that of the sawmill industry and government policy. The creation of a market for wood,
previously wasted, simultaneously provided the basis for the pulp industry in the Interior in
the form of an abundant and low-cost source of fibre while bringing stands that were previously
considered unmerchantable within the economic margin of the Interior sawmilling industry. Both
sectors grew rapidly as harvest levels, lumber production, and residual chip production increased,
complementing each other, as seen in Figure 1 and Tables 2 and 3. Changes during that period
in both the allocation of timber rights and charges for timber have reflected that interdependence:
higher stumpage charges have led to increases in chip prices, while issues of chip and pulp fibre
supply has been behind much of the recent restructuring in the BC forest industry.65

In 1999, however, many of the issues facing the industry in the Interior arise from the implications
of decreasing fibre availability due to the reduction in AAC. The development of engineered wood
products has increased the demand for residual wood chips, while techniques such as finger-
jointing which utilize wood residue that was formerly chipped, have decreased the supply.
Overshadowing those trends have been reductions in harvest levels and greater reliance on poorer
quality timber that are also changing the structure of the Interior market with implications for the
cost of pulp fibre and the allocation of fibre.

The provincial government finds itself facing increasingly difficult policy choices. In the past, the
traditional approach to economic development in the forest industry has been to grant access or
tenure rights to process the fibre by industrial users. Now, however, it is difficult for the
government to find any uncommitted fibre. Furthermore, the price cycles are shorter and of greater
amplitude, and changing technology make it difficult to establish what uses will provide the highest
economic value in the future. Existing operators argue that any available fibre should be used to
sustain their operations and to maintain current employment.

65 On the BC Coast, MacMillan Bloedel spun off its pulp and paper division in two steps, forming two
new companies, Harmac Pacific in 1994 (subsequently acquired by Pope & Talbot) and Pacifica in
1998. Timberwest divested itself of its public cutting rights which were sold to Doman, which has
two pulp mills on the BC Coast.
Finally, increased stumpage charges over the past several years have led to much lower economic margins for the forest industry and losses for some, and the government now faces the additional issue of ensuring that stumpage prices are appropriately set and accurately measure timber values. This task also becomes more difficult in the face of rapidly changing product prices. At this point, then, it is instructive to examine the economic forces that determine prices for pulp fibre and what impacts these changes have on pulp fibre prices.
2. REVIEW OF ECONOMIC THEORY

"Theoretically, pulpwood markets can be characterized either as oligopsonistic or monopsonistic...the prevailing pattern of pulpwood procurement is that of buying from large numbers of small suppliers who sell to a single mill or to a few mills located in close proximity to one another. As a consequence of this type of market structure, price determination is dominated by the buyers... There is, of course, considerable incentive on the part of pulp and paper companies to keep the prices they pay for pulpwood as low as possible. And attempts to do so are facilitated by the fact that purchasers in an area are always few, and competing mills are well aware of the price their rivals are paying." Guthrie 1950

**Market Power and Price Discrimination**

Forestry economics has long recognized the potential for imperfect markets in forest inputs. The economics of processing raw material usually makes it is less costly to process it as close to the harvesting site as possible, given the high transportation costs per unit of raw material. Since forests tend to be quite widely dispersed and distant from end markets, it is quite common then for there to be limited numbers of potential buyers in standing timber markets (Gregory 1987). Mead (1967) investigated the issue of competition in his classic work on federal timber markets in the US Pacific Northwest and showed that as the number of buyers increased the winning bids for public timber were higher. Mead also showed that larger firms were able to successfully acquire federal timber at lower cost than their smaller competitors.

The problem of market power becomes even more acute in the pulp and paper industry, as the large economies of scale prevalent in the pulp and paper industry increase the size of harvesting areas, further reducing the likelihood of alternative buyers. The pricing of pulpwood and wood chips has not only been a concern in BC (Nelson et al. 1994, Gaston et al. 1995), but also in timber markets in Canada and the rest of the world: Quebec (Olson 1989); Ontario (Nautiyal 1995); New
Market power can be defined as the ability of one or more of the participants in a market to influence the price level on a sustained basis through their actions. This stands in sharp contrast to perfectly competitive markets, where there are so many buyers and sellers that no individual party has the ability to affect the market price level through their actions. In essence, there is no market power; all sellers are “price takers”; and firms as buyers are price takers as well. 66

The goal of firms with market power is to increase their profits, and the most common firms use to pursue that goal is through using their ability to affect price levels (Pindyck and Rubinfeld 1989). The standard model used to examine market power on the purchasing side is that of a monopsony, where a single firm is the only purchaser of a good or service. Because the monopsonist recognizes that as it increases its purchases that it raises the price in the market, it will choose the price and quantity combination that maximize its profits. Under such circumstances the monopsonist uses its market power to pay a price lower than would prevail in more competitive markets. Figure 4 shows that in a competitive market, the quantity OE would be purchased at a price of OB where supply (S') is equal to demand (D). A pulp mill with market power would choose to purchase the quantity OC and pay OM, where the marginal expenditure (ME) equals the marginal revenue (D). By paying a lower price, the pulp mill is able to extract producer surplus from the suppliers equivalent to the rectangle BMGH, while society faces a deadweight loss equivalent to the triangle FHJ.

66 The concept of a firm’s ability as a determinant of market power lies behind the idea of contestability used in the analysis of monopolies. Even though a monopoly may possess the power to change prices in its market, it may be unable to raise prices above its costs due to the possibility of entry by other firms. Although the firm can meet the demand in the market, if it attempts to raise prices another firm can enter the market at an infinitesimally lower price and supply the entire market. Airline routes are the typical examples of contestable markets.
Figure 4. Pricing Under Competitive Conditions and Under a Monopsony
A firm with market power will find that it may be able to increase its profits if it can pay different prices to different sellers of an input. In Figure 4, the pulp mill could increase its profits by the triangles AMH and GHI if it could pay just enough to each supplier to cover the costs of production (in this case, the line AI). In this case, the pulp mill is practicing *price discrimination*. Price discrimination occurs whenever a firm charges (or pays) different prices for the same good (where all differences in the product due to quality, date of delivery, quantity, or transportation costs have been accounted for) to different buyers (sellers).

As a general rule, profits increase under price discrimination. In the example above, the firm was practicing perfect or first-degree price discrimination: each supplier received just enough to induce them to offer their supply and the purchaser is able to completely capture all the producer surplus in the case of a seller practicing perfect price discrimination, it captures all of the consumer surplus).

A more common practice is *third-degree price discrimination* where customers (suppliers) can be separated into different groups that have different demand (supply) curves. The firm can then establish different prices for each group based on some characteristic that it can use to distinguish between the different groups (and must be able to prevent arbitrage). In order for this strategy to be successful, the purchaser has to be able to identify the source for a particular supply, as different prices may make it profitable for a group that receives a lower price to try and market its supply as coming from the higher priced group.\(^6\)

Note that even if suppliers in different locations receive the same net price, the purchaser is paying different prices as the cost of the good includes transportation costs. Any comparison of the prices paid for goods has to include all costs of getting the good to the mill, including any quality or transportation differences as well as transaction costs.

\(^6\) One common example of such arrangements for firms selling goods are special prices for students and seniors. In terms of such arrangements on the purchasing side, Binkley (1991) observes that pulpwood buyers in the American Southeast may set up area or zone-specific prices.
When there are few firms purchasing a good the market structure is described as an oligopsony. First or third-degree price discrimination may be present under an oligopsonistic market structure; however, the nature of the market may be such that the purchasers are unable to exercise any market power whatsoever. Oligopsonists face the problem that to the extent firms are successful in earning true or economic profits, an incentive is created for firms to try to “cheat” (paying slightly more to receive more of the good). If all firms engage in such behavior, the prices will revert to more competitive price levels (one example of this for an oligopoly has been the inability of the OPEC cartel to sustain the high oil prices they agree to in their annual meetings). The inability of firms to fully coordinate their behaviour in an oligopoly or oligopsony adds an additional layer of complexity in trying to understand the exercise of market power.

**Models of Pulpwood Markets**
Because pulpwood markets commonly exhibit the characteristics that are assumed to be associated with market power, such as limited numbers of purchasers relative to suppliers, several models have been developed to examine imperfect competition in pulpwood markets. Lowry and Winfrey (1974) pointed out that in the US Southeast that pulp and paper companies will source more expensive pulpwood from their own forestland at a cost that is higher than purchased pulpwood. They argue that the purchaser believes that the pulpwood supply curve is very inelastic; any increase in demand is likely to bring about rapid increases in price without increasing supply substantially.  Lowry and Winfrey also note that this practice will tend to depress the price of forestland, which aids in the acquisition of additional timberland. Bjuggren (1992) uses the same argument to explain why Swedish pulp mills will import far more expensive roundwood, rather than attempting to purchase more domestic roundwood when they require additional fibre, an argument also used by Johansson and Lofgren (1983) to explain apparent excess demand in the Swedish roundwood market. In these cases, firms exploit pre-existing market segments to take advantage of differing supply elasticities.

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68 They also argue that the price is sticky; once the price has increased, it is unlikely to fall as
Gaston, Nelson, and Stanbury (1995) use such a model to explain price discrimination in the BC Coastal pulp fibre market, where the relatively inelastic production of wood chips, compared to the more elastic supply of pulplogs, permits purchasers to pay markedly less for residual chips than for roundwood chips.

Another approach has been to incorporate the interaction between market power and location where firms act as spatial monopsonists and practice price discrimination. Binkley (1991) examined pricing systems for pulpwood in the US South and showed the advantages of zone pricing, where purchasers establish prices for a particular supply area to take advantage of differing supply elasticities. Lofgren (1985), using a spatial monopsony model, shows that the optimal pricing system depends on the elasticity of the supply curve, and argues that the resulting price system in Scandinavia therefore reflects a concave supply curve. Geldhart and Carroll (1980) propose a model of first-degree price discrimination where the delivered cost to the pulp mill varies directly with the transportation cost $t$ and the suppliers, or sawmills, are ordered by distance. In the model, all sawmills have the same cost of chipping and can produce equal amounts of chips if their supply price is met (the supply is fixed for each individual sawmill and overall supply is increased by purchasing from additional sawmills). If the pulp mill can pay supplier-specific prices, it will then purchase out to the point where marginal revenue equals the marginal cost, just covering the cost of suppliers become accustomed to the higher price.

Comparison of roundwood and residual chip prices requires taking into account differences in quality that may arise between the two different types of chips. These differences stem from such factors such as species, chip geometry, and the relative proportion of contaminants (bark, knots, etc.) which ultimately determine the quality. Variation between the two appears to be greater depending upon the specific producer rather than the specific process. In this case, roundwood chips were selling at 50% or greater premiums, well outside the normal variation associated with quality differentials. In US markets, the two types of chips are usually equivalent in price.

This suggests that the use of two-tier pricing in the early 1970's in the Interior, which paid a higher price for "incremental" volumes of chips, differentiated between the relatively inelastic supply of residual chips under "normal" conditions ion of chips, and the more elastic supply of wood that could be obtained by utilizing wood that was then currently being burned or put into landfills. However, the subsequent use of incremental prices in later years was more likely to increase the production of chips by chipping low-grade lumber, as by this time the amount of additional fibre that could be recovered at the mill was negligible.

Binkley notes the use of special non-cash tickets used in part to pay suppliers as a means of preventing arbitrage.
chipping and the transportation cost to that particular sawmill. The model then yields a uniform sawmill price which just covers the cost of chipping, and where increases in demand lead to the utilization of more and more distant producers from sawmill A to sawmill E (as seen in Figure 5). This model is discussed further in Chapter 3.

These models of pulpwood procurement assume firms act as monopsonists and do not incorporate interaction between firms. By turning to the broader literature involving game theory and industrial organization it is possible to find a rich set of models, which incorporate market structure, firm interaction, and price discrimination.

Models of Spatial Pricing and Market Power
What happens when market power is translated into geographic space? The starting point for most models is that of a spatial monopolist. A single firm faces customers with identical demands who are spatially dispersed (usually uniformly along a line segment for ease of exposition) and there are positive transportation costs, so their net demands as seen by the firm vary. The monopolist may choose to simply set their price at the factory gate and let customers arrange for transportation. If, however, the firm takes care of delivery and does not allow the buyer to pick up the good at the plant, then, the firm can practice a particular type of third-degree price discrimination called spatial price discrimination by charging customers prices specific to their location (net of transportation costs). These prices will be both a function of the distance between the customer and firm and the buyer’s demand elasticity (this price inclusive of all costs is commonly called the delivered price).

The price level or mill price (that is, the price at the firm’s location) and the slope of the delivered price schedule vary with these parameters. As demand becomes more inelastic, the price level will rise and the delivered price schedule will flatten (these and the following results also hold true when market power is on the purchasing side).\(^\text{72}\)

\(^{72}\)Varian (1989) shows that the delivered price depends on both the first and second derivatives of the demand function. When the demand function is linear, the price increases by one-half of the transportation cost, while if demand is exponential (more elastic), the price will increase by exactly the transportation cost. Perfectly inelastic demands will lead to a firm choosing a price equal to the
Figure 6 illustrates the delivered price schedule when a firm is setting prices for customers that are uniformly distributed along a line segment and have identical demand curves. As the firm takes care of delivery, the price the customer faces includes both the cost of the good, C, and the transportation cost, t, to the customer's location. Since demand effectively falls with distance (since more distant customers are facing higher prices due to higher transportation costs), the firm takes this effect into account when determining the delivered price. As demand becomes less price elastic (decreases from $\varepsilon_1$ to $\varepsilon_2$), the firm will raise the price level or mill price from $P_1$ to $P_2$, but decrease the slope of the delivered price schedule. Price discrimination increases, as measured by the difference in net realizations to the firm. In these models different spatial pricing systems simply reflect different underlying elasticities of demand or supply.\textsuperscript{73}

A well-known result in welfare economics is that where all markets are perfectly competitive (and so price equals marginal cost) the result is a Pareto Optimum. This result can be extended into space, where prices equal the marginal cost of production plus transportation costs to a customer's location. This type of pricing, also known as FOB pricing, is often used as a benchmark for competitive prices (see, for example, models by Mougeot 1975, Thisse 1975, and Greenhut et al. 1987). However, there are no such clear-cut results for imperfect markets when space becomes a factor. FOB pricing may or may not arise under competitive behavior, and cannot be used as the sole criterion to establish whether a market is competitive or not (Phlips 1983). Instead, competitiveness becomes a model-specific definition, dependent upon the assumptions of the model.

One of the ways the intensity of competition can be incorporated in the analysis is through different assumptions about the structure of the market. The classic model incorporating market structure customers' reservation values. Where these values are the same, this means the delivered price schedule will be perfectly flat.

\textsuperscript{73} It should be noted that more elastic demands will yield delivered price schedules that vary by more than the transportation cost to that location (this is called phantom freight). Such results are usually ruled out arbitrarily by the invocation of arbitrage so that prices will then follow an FOB system.
Figure 5. Price Discrimination in a Wood Chip Market

From Geldhart and Carroll, 1980
and locational differences is the spatial duopoly model used by Hotelling (1929) to study horizontal differentiation. In the basic model, two firms with constant marginal costs are located at opposite ends of a line segment. The firms face customers uniformly distributed along the line segment between the two, where the customers have identical unit demands and incur positive transportation costs in traveling to either firm. The Nash equilibrium yields prices based on the firms' marginal cost and transportation cost with positive profits; however, if transportation costs are zero the result is a Bertrand equilibrium with marginal cost pricing.\(^74\) When both firms are located at the same point, the equilibrium is again Bertrand with zero profits and marginal cost pricing regardless of transportation costs. The model suggests that the competitiveness of a market is determined by the location of firms, and that firms may be able to enjoy profits even in competitive markets. In the case of an oligopsony, this suggests that competition will lead to higher prices when firms are located coincidentally than when they enjoy local monopsonies. The model does not specifically address the issue of different pricing systems.

Greenhut and Greenhut (1975) address the issue of delivered pricing systems in their model. Firms have constant marginal costs and are located at the same endpoint of a line segment, with customers who have identical demands and who are uniformly distributed along the line segment. The firms' problem is to then maximize profits by deciding what delivered prices to set, when firms engage in Cournot conjectures about how the other firms will react. The firms take care of all transportation and the delivered price includes all costs to the customer's location. The slope of the delivered price schedule can range between 0 and 1, where 1 means that the delivered price varies by the actual transportation cost, and 0, where all customers, regardless of their location, pay the same delivered price. Where the price varies by the actual transportation cost, this is considered \textit{FOB pricing}, and when the delivered price is the same, this is called \textit{uniform delivered pricing (UDP)}. If the delivered price is somewhat intermediate then freight absorption is taking place, in

\(^{74}\) A Nash equilibrium is defined as the outcome when neither firm, given the other firms' actions, faces any reason to change its own actions (Tirole 1988). Games in which the firms' choice variables are prices are called Bertrand games; when quantities are the choice variable, they become Cournot games. In a Cournot game the market price is above the competitive level but below the below monopoly level.
the sense that given a common mill price, the delivered price is less than the full transportation cost to any customer.\textsuperscript{75} The authors then show that as more firms enter the same location, the mill price falls and the slope of the delivered pricing schedule increases. As the number of firms approaches infinity, the mill net price falls to marginal cost and the slope of the delivered price approaches the transportation cost. Figure 7 illustrates how the mill price falls from \( P_1 \) to \( P_2 \) and the slope of the delivered price schedule approaches actual transportation costs as the number of firms increases (from \( N_1 \) to \( N_2 \)). In this model, increasing competition (as defined by the entry of new firms at the same location) leads to FOB pricing at marginal cost, or non-discriminatory pricing.

For an oligopsony, FOB pricing is the equivalent of a uniform price at the purchaser’s gate, with each supplier’s net price differing by the transportation costs between their location and the purchaser. The equivalence in the case with FOB pricing arises from the fact that the firm perceives no difference in any supplier’s costs, regardless of the location of the supplier, while under FOB pricing the firm would see no difference in the net revenue from any customer, regardless of the customer’s location. In the model above, then, suppliers would receive rents as prices increase and locational rents as the market becomes more competitive and prices move towards a uniform price at the purchaser’s gate when firms are in the same location. Furthermore, price discrimination will decrease as competition increases.

Greenhut and Greenhut (1975) then look at the entry of firms at the other endpoint of the line segment and assume that there is complete market overlap. In this case, the endpoint with the greater number of firms determines the mill price and delivered price schedule. However, if the number of firms at each location is equal, then the delivered price schedule is perfectly horizontal (the same to any customer, regardless of location), and UDP prevails. As the number of firms

\textsuperscript{75} This term is somewhat misleading since the delivered price can be well in excess of the actual production and transportation cost, while the term is commonly used to suggest that somehow costs are being absorbed by the firm or by one set of customers at the expense of another set. So long as the delivered price exceeds all costs to any customer, the presence of freight absorption simply reflects the ability of firms to practice third-degree price discrimination.
Figure 6. More Inelastic Demand Leads to Greater Price Discrimination ($\varepsilon_1 > \varepsilon_2$)

Figure 7. Increased competition from firm entry reduces price discrimination ($N_2 > N_1$)

From Greenhut and Greenhut (1975)
increase, regardless of their location, prices move towards a UDP system, so price discrimination is increasing. Finally, the authors look at market areas that are only partially overlapped. In this case, the delivered pricing schedule will tend to be flatter in the overlapped area where there are more firms competing (that is, tending towards UDP). Figure 8 shows a kink in the delivered price schedule where there is market overlap between the N1 firms at one end of the line segment and the N2 firms at the other end (effectively, the number of firms serving this segment of the market is N1 + N2). Under this model, increased competition due to the presence of more firms within that market area leads to a flatter price schedule and increased price discrimination.

In the case of an oligopsony, then, movement towards a UDP pricing system (where the net realization decreases by the actual transportation costs) is the equivalent of purchasers moving towards paying a uniform price to the suppliers (USP) (where the total costs increase by transportation costs). Given a common price across suppliers, then, the available rents depend only on the price level and not on location. This model suggests that when firms are spatially separated increasing competition will lead to increasing price discrimination.

Norman (1981) has also offered several models in which the degree of spatial price discrimination relies on the amount of competition. In one model, spatial price discrimination is greater when two coincidentally-located oligopolists collude, while collusion between non-coincidentally located oligopolists leads to more ambiguous results. In another model, the firm chooses a linear pricing pattern, subject to the constraint of a ceiling or spatial limit price, where this limit price reflects competitive conditions and the potential entry of new firms, and where customers have identical demands. If the spatial limit price is not binding, the firm acts as a spatial monopolist, choosing the price at each location that equates marginal revenue and marginal cost (which is inclusive of the transportation cost). The slope of the delivered pricing schedule will then vary, depending on the elasticity of the individual demands, as in Greenhut and Greenhut (1975). However, as the spatial limit price becomes binding, the firm moves towards greater price discrimination, eventually
Figure 8. Increased competition from overlapping market areas leading to increased price discrimination

From Greenhut and Greenhut (1975)
establishing a uniform delivered pricing policy when the limit price binds over the entire market area.

These models show that the relationship the optimal pricing system may depend on a variety of factors: the degree of concentration (as expressed in the number of firms); demand or supply elasticities; and the location of firms. Furthermore, the presence or absence of discriminatory pricing arrangements cannot be used to establish the competitiveness of a market. Profit-maximizing firms can move towards either FOB pricing or UDP as competitive pressures become stronger, depending on the structure of the market and other assumptions. The same result carries over into an oligopsony setting; depending on the market structure (e.g. the number of firms and/or their location), increasing competition can lead to either uniform prices at the purchaser’s location or the supplier’s. We are then left with the rather inconclusive result Norman (1981) notes:

"The existence of spatial price discrimination in particular markets is not a priori evidence of lack of competitive pressures. But neither can a simple connection be drawn between the degree of competition and the degree of spatial price discrimination. Discrimination between spatially separated consumers...may indeed reflect and be the result of intense competitive pressures in particular markets, but this is more likely if the competitors in such markets are not themselves spatially concentrated. On the other hand, discrimination may be the consequences of collusive agreements between coincidentally located producers, or of attempts by such producers to anticipate the actions of their competitors."

Delivered Pricing Systems
One reason the issue of spatial price discrimination has received so much attention is that spatial variations in pricing are observed in a variety of markets. A common practice for many industries where transportation costs can be significant has been the use of delivered pricing systems. These systems calculate explicit spatial prices according to some specific formula employed by sellers in the industry. These type of systems have received considerable economic attention over the years. Some authors have noted that delivered pricing systems, by allowing the possibility of setting customer or supplier-specific prices, can lead to higher profits. This possibility may support more collusive behavior as firms perceive the benefit from coordinating prices. Other authors have countered that such systems instead reflect competitive forces and simply show how firms meet
competition on a spatial basis. These systems may or may not display spatial price discrimination, depending upon the formulas involved.

One example of a delivered pricing system is a *basing point system* (BP). In a basing point system, the price delivered to the customer's door is calculated as a common price at some particular fixed point (the base price), plus the notional transportation costs from that point to the customer’s location. Consequently, all firms charge the same identical delivered price to a particular customer’s location, regardless of any one seller’s location. In one variation, there may be multiple basing points, and firms may practice *alignment*, following specific rules about which prices apply.

Understanding the economic reasons for these types of systems has been the justification for much of the work done on delivered pricing schemes and especially basing point systems (see Fetter 1937, Machlup 1949, Loescher 1959, Scherer 1980, and Gilligan 1992 for various studies). Basing point systems were common in the United States in the early part of the century, until the Federal Trade Commission found such schemes lessened competition (Espinosa 1992). Empirical work by Greenhut, Greenhut, and Li (1980) has suggested that many highly concentrated industries with a high degree of spatial differentiation such as cement, steel, and corn, did use delivered pricing schemes in the US. Stigler (1949) offers instances where cartelization coincided with the dropping of an FOB pricing system and the introduction of a delivered pricing system. Stigler (1964) examined basing point systems and suggested they may be more likely to arise in industries where demand was geographically unstable (for example steel and cement). In his view, basing point systems offered an orderly way for firms to extend their sales area when they found demand was low within their area without the risk of precipitating price cuts. He noted that the system, while providing an outlet for some firms, tended to reduce the attractiveness of more

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76 The classic basing point system examined in the economic literature was the “Pittsburgh plus” system that expressed steel prices as the price of steel in Pittsburgh delivered to a particular location, even if the steel was supplied by a mill somewhere other than in Pittsburgh.

77 One common rule is that the lowest delivered price should apply.

78 This happened in both the German cement industry and the British bituminous coal industry.
distant markets. Leuschner (1952) also showed how a basing point system through the use of punitive bases could be used to punish a firm that deviated from the system.

Due to differences in antitrust law, delivered pricing systems are more common in Europe. Phlips (1981) discusses the use of uniform delivered prices in two markets where firms hold market power. The first case is that of British Plasterboard, which has a monopoly in the United Kingdom, and sells plasterboard at a uniform delivered price throughout the country. The second example is that of Belgium, where a cartel of cement producers charge the same delivered price throughout the country regardless of location of the buyer relative to the closest plant.

Haddock (1982) offered an alternative view of delivered pricing systems, arguing that basing point schemes can emerge in competitive markets as the result of different cost structures for firms at different locations. Gilligan (1992) argued that basing point systems reflected competition among firms located at the basing point, while firms elsewhere used the basing point system to align their prices with their rivals. Thisse and Vives (1988), however, showed that basing point pricing only emerges as the outcome of a non-cooperative game when one firm chooses a sub-optimal strategy (this model is discussed more fully in Chapter 3).

Espinosa (1992) argues that identical uniform delivered pricing systems can be very competitive. When all firms are charging the same price, any change in one firm’s price can cause a dramatic change in its market area and hence the other firms’ market area. Compared to a FOB pricing system, where the effect of a change is likely to be more localized, this greater degree of interpenetration means that such a system can lead to far more competitive behavior. Espinosa (1992) built such a model to examine the relationship between market structure, pricing systems, and changes in competitive behavior, and showed that competitive markets can have either uniform delivered prices or FOB prices depending on the location of firms. Furthermore, the degree of competition, and the type of system, depend on exogenous variables such as firm’s discount rates, transportation costs, and customers’ reservation values, and firms will switch between the two different pricing systems as these variables change (this model is also discussed more fully in
Chapter 3). Espinosa (1992) offered the observation that after the U.S. Supreme Court outlawed basing-point pricing systems in 1948, both the cement and steel industries moved to an FOB pricing system and both prices and revenues increased in each industry. She suggests that in this case the delivered pricing system facilitated competition, and that by dropping it such competitive pressures were eased, although she does not provide any detailed empirical data to support such a conclusion.

Duerr (1994) notes that in the US South, after WWII, pulp and paper mills moved from a uniform delivered pricing system for purchasing pulpwood to a system where mills set prices so that they were uniform across all suppliers (which he calls *local pricing*). Duerr attributes the change to increased competition, as the number of pulp mills in the area increased, although he does not provide any theoretical justification.

Espinosa's (1992) model incorporates the issue of firm interaction in a spatial context that is missing from the previous static models introduced. In doing so, she shows that firms, through recognizing their interdependence, may be able to sustain payoffs different than those under competitive assumptions through changing their responses to one another's actions. How these firms alter their responses, then, raises the issue of what factors may influence firm behaviour, as well as the idea that observed pricing systems may reflect something more than the underlying market structure.

*Firm Behaviour and the Effect on Market Outcomes*

Economists' main concern over oligopolies stemmed initially from firms acting in a coordinated fashion to sustain monopoly prices through cartels or other price-fixing agreements. Such overt collusion was common in North America in the early part of the century, but due to their anti-competitive nature many of the practices firms employed were eventually outlawed.  

79 Chamberlin

79 There are a variety of cases. One of particular interest was the investigation in 1956 of pulpwood procurement in Eastern Canada. A Royal Commission found that pulpwood buyers (mainly domestic pulp mills) had agreed on both prices and pricing practices. A conviction was obtained
(1929) was the first to suggest that firms, through their recognition of their mutual interdependence, might still act in such a way as to sustain the monopoly price without necessarily cooperating overtly. Although firms would still engage in non-cooperative behavior, their recognition of the nature of the market might be sufficient to deter them from competitive behavior. For example, a firm would realize lower prices might initially lead to greater market share for one firm, temporarily raising profits, but ultimately would yield a price war that would depress all firms' profits, including its own. Therefore, all the firms in the industry would mutually refrain from lowering the price, and in doing so raise their long-run payoffs above the minimum level. Such outcomes are said to be tacitly collusive. As Phlips (1981) states,

"...in a legal environment where explicit price agreements are not enforceable, so that joint profit maximization is not a possibility, oligopolists are supposed to replace explicit agreements by "tacit collusion" in the standard antitrust literature. These tacit agreements are supposedly reached through an exchange of information on prices, sales conditions, and possibly other relevant data such as production data and investment projects."

Phlips (1981) then points out that delivered pricing systems can also facilitate collusive outcomes.  

**Factors that Influence Firm Behaviour**

Scherer (1980) outlines a number of factors that can aid or hinder collusion. These include: the number and size distribution of sellers; product heterogeneity; cost structures; lumpiness and infrequency of orders; secrecy and retaliation lags; and industry social structure. All of these point to the two central issues. How easily can firms coordinate their actions to raise payoffs, and if firms are successful in raising payoffs, how can defection (or cheating) be discouraged?

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80 "The adoption of a particular pricing technique may, in a spatial framework, have direct implications for the probability of detecting deviating behaviour and thus for the ease with which equilibria are found and maintained." (Phlips 1981:46)
Scherer (1980) noted that few sellers (or buyers) ease collusion by reducing the number of potential players to coordinate and monitor, and also makes the effect of their own actions more obvious. As noted in the text, product homogeneity means that all firms' goods are similar, and by stripping away other attributes, it leaves pricing as the only issue to be resolved. By focusing on only one aspect, it reduces the coordination problem by both reducing the complexity of the problem as well as making it easier it is to identify when price concessions are given. Scherer (1980) identifies four classes of heterogeneity, one applicable in a spatial context. That is when products are differentiated by transportation costs, and Scherer (1980) refers to the literature on basing point systems as a means of addressing that heterogeneity.

The third factor is cost structure. Scherer (1980) argues that firms with high fixed costs will be more likely to deviate because in periods of high demand, falling average costs are an added benefit to increased production.

The frequency of orders is likely to determine how often firms interact. If, for example, there are large infrequent orders, firms may be more inclined to compete for them than if there was a more even flow of orders.

Secrecy is the critical factor in determining whether or not a collusive arrangement is sustainable. If firms are unable to monitor or determine when a participant is deviating from the system, the likelihood of such a deviation is increased. Furthermore, firms may have difficulty distinguishing between natural uncertainty and uncertainty about firm behavior. For example, does unexpectedly low demand for one firm signal that another is undercutting it or that demand has temporarily dropped?

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81 "The number of two-way communication flows required is given by the combinatorial expression N(N-1)/2; that is, for two sellers, the number of channels is one; with six, it rises to 15, and so on." (Scherer 1980: 200)
Along with secrecy, retaliation lags are also a factor. Much like infrequent orders, if a firm feels that any punishment for deviating is “far enough” away, it may not find the proposed punishment sufficient to deter it from cheating.

Finally, Scherer (1980) suggests that industry social structure may be important as well. Although economists usually shy away from anything that may involve personal attributes, Scherer (1980) suggests that certain social structures may be more conducive to collusive behavior. For example, participants may belong to the same social setting, and social stigma may attach to anybody that appears to be deviating from industry norms.

Spence (1978) has offered a model that examines a weaker form of tacit collusion which he terms *tacit coordination*. The information required to determine whether firms may be deviating from any kind of market-sharing or price setting agreement can be formidable. Spence has built a model with incomplete information, where firms receive signals about one another's actions masked by noise (a random variable in the model). Firms choose strategies based on the signals they receive that jointly move them towards the profit frontier and away from the less profitable Cournot-Nash equilibrium. In the model, the scope and profitability of tacit coordination increase as the signal becomes less noisy and the less profitable the profits when being punished.

The factors described by Scherer (1980) also hold true in Spence’s model. To the extent firms can minimize the noise or restrict the information required to monitor one another’s behavior, they will be more successful in raising profits above the non-cooperative outcome.

**Empirical Investigations of Noncompetitive Behavior**

Many of these factors may be quantified to test for collusive behavior. This approach, first pioneered by Bain (1956) and known generally as the Structure-Conduct-Performance (SCP)
paradigm, emphasizes variables such as the number and relative size of industry participants to investigate the competitiveness of markets as well as relying on extensive market studies.

Measures of noncompetitive behavior usually examine the premise that collusive behavior will raise firms' profits relative to more competitive outcomes. Much research has been aimed at examining what factors may affect how firms conduct their business and the resulting impact on the competitiveness of the market. As pointed out above, since the presumed goal of non-competitive behavior is to raise profits above competitive levels, the most direct approach would be to measure profits directly as a test of competitive behavior. However, there are a number of empirical problems associated with using publicly reported profit statements, such as differences between accounting requirements and theoretical constructions of what profits consist of, mainly having to do with the appropriate treatment of capital. Despite this difficulty, there is a considerable amount of work in this area.

Another approach is to simply examine price levels, under the assumption that, *ceteris paribus*, firms use higher prices to obtain higher profits. The explanatory variables in turn tend to be those measures, such as firm size and concentration, that are thought to be important determinants in collusive behavior and are usually available. An example of such work is Weiss et. al. (1989), which shows how concentration within regional markets leads to higher prices in the cement industry.

There is a potentially tautological question that has to be addressed in framing these types of investigations. Given that the main objective of collusion is to lessen competition, thereby leading to higher profits, does that mean that higher profits mean collusion? Demsetz (1968) has made the point that more successful firms would tend to have higher market shares than less successful firms, therefore leading to a correlation between market shares and profits. There may be other factors that support higher profits, such as successful technological innovation at the firm level, which in turn may be correlated with firm size. Therefore, higher profits in and of themselves may not necessarily be indicative of non-competitive behavior.
Another difficulty with these approaches is that the tests require some benchmarks for collusive behavior. Because the data tends to be aggregated, these measures are usually either cross-sectional across industries, or on a time series basis. Each of these approaches raises its own set of problems. Aggregation requires that all firms respond in the same manner, while cross-industry and time series comparisons require that the data be adjusted for any industry differences that may not be due to market power. Much of this work provides little if any institutional detail, and often provides no mechanisms by which non-competitive outcomes are sustained.

An approach that has become increasingly popular has been to note that if firms are engaged in competitive behavior then price will be greater than marginal cost. Economic theory can then be used to relate the difference to the underlying demand or supply elasticity and market power (Diewert 1971). This research offers the advantage of not having to rely on comparisons across different industries but instead looks for deviations between marginal cost and price in what is known as the New Empirical Industrial Organization (NEIO) approach. Applebaum (1979) shows how in an oligopoly firms will set the price equal to the marginal cost plus a factor representing their perception of how their actions affect market quantities. This perception is based on their expectations of how other firms will react to changes in the firm’s own actions, and the factor is commonly termed the conjectural variation. It can be shown that this factor, or $\theta$, is bounded between 0 and 1, and under the competitive market assumption of price taking $\theta=0$, while under a pure monopoly $\theta=1$. Tests for the exercise of market power then consist of whether or not $\theta$ is significantly different from zero.

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82 Because much industry data tends to be national in scope, which masks regional variations, comparisons are then made across industries which typically requires adjusting the data to account for differences between industries.

83 For example, price-cost margins are a common tool used to test for market power. However, firms with high fixed costs tend to have high margins, especially if the data is based on cash manufacturing costs, and any comparisons may yield spurious results unless the data is adjusted to reflect this fact.
Appelbaum derived the factor $\theta$ under spaceless conditions. Bresnahan (1981), in his work on the automobile industry, used a Hotelling framework to model product differentiation. The derivation of $\theta$ in this case has a component due to how different the product is from other firms' products, which is directly analogous to spatial differentiation. Murray (1996) used this framework to derive a $\theta$ that is explicitly due to spatial distances, and tested for market power in sawlog and pulpwood markets in the US for the period 1958 to 1988. Murray finds that although the null hypothesis cannot be rejected for sawlog markets, it is rejected for three of the five periods examined for the pulpwood market. Bernstein (1992) provided a similar examination for the forest industry in Canada, and rejects the hypothesis that there has been any noncompetitive behavior in the forest industry in Canada in either input or output markets.

This approach has its own set of problems. The main benefit of this approach comes from the fact that by embedding $\theta$ in a system of equations developed under the standard theoretical assumptions governing factor demand, the efficiency of the estimates are thereby increased, while the incorporated factor meets the consistency properties associated with such demand equations (convexity and homogeneity). There are, however, several problems with the estimation of marginal cost. The first is that the detailed data required for such estimation is usually available only on an aggregated basis. Although the difficulties of data aggregation can be theoretically handled (usually by assuming all firms are the same), firm level differences are wiped out. Mis-specification may lead to inaccurate estimation. As a case in point, Murray (1996) provides a simple example of a spatial monopsonist to show how distance can be a factor in the competitiveness of the market. He then uses fuel costs and a quadratic measure of capacity to construct $\theta$, arguing that increasing capacity and/or decreasing transportation costs should bring firms into increasing contact as their woodsheds expand, thereby leading to increasing competition. A closer examination of Murray's result shows that $\theta$ was at its highest point in the period 1958-62, and then subsequently fell in each succeeding four year period with the two lowest estimates
covering 1973-77 and 1978-82, when \( \theta \) is not statistically distinguishable from 0. His measure of market power then rose again in the last measured period to a level greater than any measured since 1967.

Murray (1996) argues that this pattern of decreasing and then increasing market power reflects the increasing and then declining use of wood chips, arguing that pulp mills enjoy less power in pricing wood chips than they do pulpwood. However, there is a much more plausible explanation which lies in the treatment of capital stocks. Murray treats the capital stock as an exogenous variable. Furthermore, instead of using actual capacity, Murray uses annual production. A potential problem then lies in the fact that the only place capacity (actual production) enters directly into the estimation is in the construction of the market power measure (as it is a quadratic measure of capacity). Therefore, Murray's measure of market power may simply be reflecting the correlation between high rates of production associated with high market prices, rather than the exercise of market power. This seems especially plausible given that Murray finds that market power 'vanishes' during the periods of market recession.

Bresnahan and Suslow (1989) provide another explanation as to why measures of market power based on output or capacity utilization may produce spurious results. They examined the aluminum market in the United States, and hypothesized that in the short run firms face constant marginal costs until practical capacity is reached, providing a backward-facing L-shaped supply curve (see Figure 9). Under this hypothesis, when capacity constraints are slack for the demand curve \( D_s \), market power is greatest and the firm sets a price in excess of marginal cost, where \( P_s > C \). When capacity constraints bind under demand conditions \( D_c \), and the firm wishes to operate at maximum capacity, there is no difference between the price the firm would choose versus the competitive price, \( P_c \). The capacity constraint is then reflected in the opportunity cost of capital (which is the equivalent of the forgone production, or the difference between the intersection of the demand curve, \( P_c \), and the constant marginal costs of production, \( C \)). They
Figure 9. Pricing with and without capacity constraints

from Bresnahan and Suslow (1989)
then estimate two cost functions, one under slack conditions and one operating under the assumption of capacity constraints and show that market power, greatest during periods of slack demand, has been falling over time (they examined a thirty year period).

These results suggest that improper specification of the cost curve may lead to an overestimation of market power if the formulation of the problem does not take into account the effects of possible capacity constraints. These type of marginal cost curves are usually associated with capital-intensive industries, which in turn tend to be those industries where there are relatively few firms. This then suggests that one should be extremely careful in using measures of output, capacity utilization, or concentration ratios in constructing measures of market power. Murray’s results may simply reflect the influence of capacity constraints and not market power, given that the profit function estimated does not distinguish between periods where capacity constraints may be a factor (which is a characteristic feature of the pulp and paper industry). This may offer an alternative explanation as to why Murray’s measures of market power fall to near insignificance during the recessionary periods of the 1970’s and 1980’s as capacity constraints were not binding during those periods. Murray also finds his measure of market power to be significantly less in the sawlog market. It may be the case that this simply reflects the fact that the sawmill industry is less capital intensive than the pulp and paper industry and that capacity constraints are not a factor.

Along the same lines, Bernstein (1992) provides an interesting contrast, having estimated a similar model for a Canadian data set. His approach is somewhat different in that he allows firms to have face adjustment costs for quasi-fixed factors so that short-run marginal costs may exceed long-run marginal costs. Under such circumstances, firms will not be in long-run equilibrium, and the fact that prices exceed long-run marginal costs reflects not the exercise of market power but rather the presence of these adjustment costs. Bernstein finds no evidence of market power in either the solid wood or pulp and paper industry in either output or input markets, but that each industry is characterized by substantial capital adjustment costs. Again, Bernstein relies on annual data at the national level.
Hunter (1982) analyzed pulpwood stumpage and delivered prices in the Southeastern US and shows that pulpwood stumpage prices are positively correlated with the number of bidders within 100 miles, and notes that all prices generally decrease moving inland from the Atlantic Coast. Although he included the number of bidders as indicative of competitive pressures, he also noted that the number of potential bidders may be a proxy for distance. Hunter did not make any attempt to analyze potential competitive pressures, and viewed the decrease in price levels as one moves inland representing general changes in species availability and land use patterns. An alternative hypothesis could be that transportation costs increase as one moves inland (due to the higher costs associated with trucking and rail relative to ocean transport), which lowers the number of potential buyers and effectively decreases competition.

Finally, there is a much smaller set of cases where the circumstances have lent themselves to more detailed analysis, and the impact of changes in the regulatory environment can be quantified. Asch et al. (1992) provide an examination of the dairy industry with a clear change in government policy, and use the price differential between two classes of milk as a measure of collusive behavior to show the impact of the change on firm behaviour. Fraas and Greer (1977) used a number of cases where the Federal Trade Commission (FTC) investigated non-competitive behavior (as defined by formal investigations) to measure factors other than concentration ratios that were important in supporting collusive outcomes.

Studies of Spatial Price Discrimination
Empirical studies of spatial price discrimination suffer from many of the difficulties outlined above. Data tends to be aggregated, requiring comparisons across regions and industries that may not incorporate all factors. Much of the work has relied on results from simple models of spatial monopolies to argue that any deviation between prices and marginal cost plus transportation costs represents the exercise of market power. The magnitude of the deviation is then used to quantify the degree of market power. Hwang (1979) provides an example of this approach, using the
difference between delivered prices and actual transportation costs in the pricing of coal in the US to measure the degree of market power in various markets.

Greenhut et al. (1980) and Greenhut et al. (1981) provide empirical investigations of spatial pricing policies and test factors outlined earlier thought to be important in determining the competitiveness of spatial markets (such as location, the number of competitors, and the nature of demand). These results suggest that FOB pricing is the exception rather than the rule, and that relative competition is the most important factor in explaining spatial prices (Greenhut et al. 1980). Greenhut et al. (1981) also show that there are significant differences in how firms set spatial prices between the US, West Germany, and Japan, and that price discrimination is more prevalent in the latter two countries. They also show that in Japan and West Germany delivered prices sometimes significantly decrease with distance, although this pattern is never observed in the US, and attribute the fact that the US has antitrust laws that forbid firms to charge less to more distant customers.\(^{84}\)

**Summary**

These sets of models and studies show that spatial price discrimination appears to be pervasive. However, a weakness of Greenhut et al (1980) and Greenhut et al (1981) is that their work relies on questionnaires to ask firms to rank the relative competitiveness of their markets. They also use firms in different industries without adjusting for industry differences, making it difficult to quantify the amount of competition and relate a specific market structure to a particular type of spatial pricing.

This ambiguity also appeared in the models studied throughout this chapter, where it was shown that no definitive conclusions could be drawn from the presence of discriminatory pricing. This then leaves the basic question unanswered: To what extent does price

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84 The Robinson-Patman Statute under the Clayton Act in the US restricts firms from setting different prices to the extent such discounts do not reflect differences in production costs. The Competition
discrimination represent the exercise of market power, or simply competitive behavior given the market structure? In order to answer the question, it is necessary to develop a model that accurately characterizes the market in question.

Act in Canada does not circumscribe spatial pricing so narrowly (see Director of Investigation and Research 1992).
3. Modeling the Interior Wood Chip Market

...oligopoly theory has long been claimed to involve indeterminate outcomes, so indeterminate that it is often said that for every economist there is another theory of oligopoly. (Greenhut and Ohta 1993: 399)

This chapter discusses the general economics of production and the special circumstances that apply to residual wood chip production. It also examines supply curves for wood chips in BC to the extent they have been identified, and how transportation costs may affect pricing for pulp fibre. Finally, a specific model is developed for the wood chip market that incorporates the salient features of wood chip production and market structure in the Interior, as well as firm interaction.

Supply of Single and Joint Products

The technology governing the production of goods may take one of two forms. Goods may either be produced singly or as joint products, when two or more goods are produced simultaneously. An example of single product supply would be where all the wood in a stand is harvested as pulpwood, making it straightforward to identify both the marginal and average costs of production. When pulpwood is produced jointly along with saw logs, neither the average costs nor marginal costs can be identified since it is impossible to attribute all costs to a specific product.

There are two types of joint production based on the production process: technically fixed proportions or technically variable proportions. In the case of fixed proportions, the relative proportions of pulpwood and sawlogs are exogenously fixed. No matter at what level or relative proportion the inputs are applied, every stand harvested will yield, for example, 20% pulp logs and 80% saw logs. Neither the level of harvesting intensity, the utilization of the tree, nor the design of the sawmill, can change that ratio.
In the case of technically variable proportions, the ratio of the two products can be varied. One can imagine harvesting five hectares with the overall output varying by the effort employed on that five hectares, but also with the relative proportion of each output varying in response to the demand for the two products. Substitution between the two outputs may lead to greater production of one at the expense of the other, or mean that the effort is redeployed towards producing more of one product. For example, in harvesting a stand of trees, relatively high prices for pulp fibre might mean that wood suitable for low-grade lumber would be chipped instead of sawed while small limbs and treetops previously left behind as logging debris would now be brought in to be chipped.

The importance of both of these cases is that although the marginal cost can be identified, given a prespecified level of production, the average cost of either output cannot because of the nature of the joint production. A more practical problem is that the different types of supply offer different binding constraints; for example, in the case of technically fixed proportions, increasing the production of one product requires increasing the production of the other. For technically variable proportions, it may be possible to make adjustments in product mix without increasing overall production. That is, the relative proportions of lumber to chips may be varied without changing log consumption.

**Sources of Heterogeneity in Wood Chips**
The goal of wood chip production is to produce a uniform series of rectangular pieces of the same thickness. Because of the nature of the production process, irregular and oversize pieces will be produced as well. The 1970s saw the introduction of the Kamyr continuous digester (the cooking vessel in which wood fibre is broken down into pulp) replacing the batch digesters used before. This in turn required more consistency in the wood chips, as variations in the size of chips affected the yield. Previously, it was possible to adjust the cooking conditions for each individual batch. Recently, many pulp mills have introduced pricing systems designed to encourage the production of certain chip sizes and penalize
those that fall outside what are considered acceptable ranges. As a consequence, while residual chips appear to have varied widely in the early stages of the development of the industry, such differences had vanished by the late 1980's.

The main differences between wood chips now lie in the species from which they are derived. As noted earlier, the predominant lumber milled in the Interior is spruce, pine, and fir, or SPF, and consequently the bulk of chips produced in the Interior are SPF chips. However, there are significant amounts of Douglas-fir, cedar, and hemlock in certain areas. The greatest difference between these tend to be process specific; for example, a TMP mill will prefer to use spruce, completely avoid Douglas-fir, and keep the pine content below certain levels, due to some of the extractives present in the latter two woods which affect the quality of the pulp. Cedar, because of its lower density and darker color, requires additional bleaching and takes up more digester space relative to the denser whitewoods and consequently sells at a discount to the whitewoods (Gaston et al 1995). Hemlock is a desirable whitewood, being naturally bright, but occurs in limited stands in the Interior but is common on the Coast. The most common problem associated with hemlock tends to be the fact that it may contain high amounts of decadent wood with the associated rot which needs to be screened out.

**Equilibrium with Joint Production**

In competitive product and factor markets all prices are simultaneously determined such that a sawmill producing both lumber and wood chips earns normal profits. In equilibrium, profit maximization means that the marginal value of each product equals the price of the input (alternatively, the ratio of the output prices equals the ratio of the marginal costs in terms of the input). In terms of the inputs, it is common to assume that most inputs are perfectly elastically supplied. 85 Hence all inputs would also be earning normal economic returns, with any excess returns attributed to any input that is fixed in nature. In the

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85 This simply means that any quantity of the input can be obtained at a given price.
context of the forest industry, it is standard to assume that any excess returns after the returns to capital are calculated can be attributed to the other fixed factor which is the resource itself. This is commonly called *economic rent* and is the payment in excess of that necessary to bring that factor into production. In the simple case of harvesting a homogenous stand of trees, the economic rent would consist of the value of those trees derived from the products they could produce, less the cost of producing those products and harvesting the trees (including a normal return to capital). The rent could be nonexistent if the value of those trees just equaled the cost of harvesting them and converting them into final outputs.

The goal of government policy is to collect this rent through charges for the access to public timber or stumpage (commonly defined as the price paid for standing timber). In order to calculate the possible rent, then, it is necessary to know both the value of products derived from a tree and the costs of producing those products (including harvesting). As outlined above, those costs cannot be separated; this means that any total measure of rent cannot be solely attributed to one product in the presence of joint production.

The issue of the appropriate level of rent capture has been of major importance in the BC forest industry for much of the last two decades (Schwindt and Heaps, 1996). Because an appraisal system is used to determine charges for Crown timber in BC, the complex interaction between joint production, coupled with substantially different end markets, with one good an intermediate good and the other a final good, make administering such a system extremely difficult. As Anderson (1980) points out, the potential exercise of market power in timber markets due to the prevalence of regional monopolies common to the forest industry only adds to the difficulty in ensuring that any stumpage system based on appraisals will generate the appropriate charges.
Input Prices Under Different Supply Conditions

It should be noted that because of the technology, the price of a product may have no bearing on the level of production at certain prices. For example, a firm may find that in producing solid lumber a certain portion of the log will end up as waste, either as sawdust or wood chips, and that portion cannot be minimized beyond a certain amount. The firm will maximize profits by setting the marginal revenue product of its input (assumed to be logs) equal to the price of the output, which would equal the value of the solid wood and wood chips and sawdust that log could produce. If there were disposal costs associated with any of the residual by-products, these would be subtracted from the output price. In this case, then, there is no tradeoff between the two products, and the firm's profits are maximized where the marginal cost of production equals the price of all the outputs.

Because residual wood chips are a consequence of lumber production, positive quantities will be produced even if the market price for wood chips is zero or negative (that is, there are disposal costs) so long as the net output price exceeds the costs of production. Notice that an increase in the lumber price may cause overall production of lumber and hence wood chips to increase, even if there is no change in demand for wood chips. Alternatively, at low enough lumber and chip prices, a sawmill may choose to shut down, causing the production of both to cease.

In this example, the quantity demanded of wood chips is less than the quantity supplied (or may even be nonexistent). The nature of the technology is such that positive quantities of residual wood chips are produced even in the presence of market signals (non-positive prices) that would lead to a reduction in production under other supply conditions. However, if the demand for wood chips increases to the degree that the sawmill perceives it is worth processing additional timber given current costs, then even in the case of technically fixed proportions, the output of residual wood chips will increase (as however would the production of lumber).
In the case of technically variable proportions, relative output prices will determine relative output proportions. In the case of a smoothly continuous technology, non-positive wood chip prices (and positive lumber prices) would mean no residual wood chips would be produced. Positive demand in this case would lead to positive prices for and production of wood chips. In this case, the marginal cost of wood chips could be the cost of the solid wood forgone at the expense of wood chip production.

For wood chips there are several possibilities in terms of supply, each with implications for how prices are determined. The first possibility is that wood chips are the sole product, and the price will equal the marginal cost of production. The second possibility is that they are a joint product, in which case the technology may be such that wood chips are produced in excess of the perceived demand and prices may be zero or even negative. At this point it is instructive to examine the actual mechanics of wood chip production in the Interior of BC.

Wood chip production in the Interior consists of two types of supply, roundwood chips and residual chips. Roundwood (or pulp log) chip production can be thought of as the single product type of supply and consequently all the costs associated with roundwood chips can be easily identified. Residual chips are jointly produced along with lumber, and it is impossible to clearly identify the costs of production of wood chips by themselves. While some costs such as conveying systems, storage bins, or chip handling can be directly attributed to the production of chips, overall costs of production cannot. Furthermore, the joint production is of the technically variable type over certain ranges of lumber and chip values, since low grade lumber can potentially be chipped depending on the relative prices (Nelson et al 1994).

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\[86\] This distinction might not be so clear-cut if both pulp logs and sawlogs are simultaneously harvested. In this case, both are joint products from harvesting, and the issues involved in allocating harvesting costs make it once again impossible to clearly identify the average costs. Also, some lumber may be recovered from pulp logs.
Lumber has consistently been more valuable than wood chips in the past, and sawmillers have tended to maximize lumber production. As a consequence, the production of chips has been minimized and wood chip production within the region appears to have been closely related to if not proportional to lumber production. Table 8 shows estimates of the chip recovery factor for different regions within the Interior for the past ten years, where the recovery factor is expressed as the amount of BDUs produced per cubic metre of log input.

**Table 8. Estimated chip recovery factors in the BC Interior 1987-1995 (BDUs per cubic metre of log input)**

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1986-87 are lumber mills only; 1990 includes chip mills; 1993 is lumber mills only; Prince Rupert Interior reported separately for 1986-87, combined subsequently
Source: Major Primary Timber Processors, unpublished data, MOF

More recently, increases in the price of chips relative to poorer grades of lumber has meant that at times some sawmills have chipped what would otherwise be termed utility grade lumber. This can either take the form of chipping a small poor quality log that would have only yielded utility lumber or chipping the utility lumber after it has been sawn (the latter would take place if the sawmill did not have a whole log chipper). The trend appears to be a continued emphasis on lumber production with some small scope for minor increases in chip production through changes in their optimization when prices warrant it. This suggests that the appropriate supply curve for wood chips in the Interior is relatively inelastic, although there is the possibility that a reservation price for chips (a minimum price sawmills must receive) may set a price floor. This reservation price would be negatively
related to the price of lumber as discussed in the preceding section, and would create an L-shaped supply curve.\(^{87}\)

**Figure 10** illustrates such a supply curve, where the horizontal portion is established by the reservation price, \(P_{wc1}\). If the sawmill receives a price equal or greater than this price it will produce the fixed quantity \(Q_{1}\). A higher price for lumber lowers the horizontal part of the L-shaped supply curve to \(P_{wc2}\) but has a more ambiguous effect on the vertical portion of the supply curve. The higher price might shift chip production inward through minor changes in optimizing behaviour, but higher lumber prices could also increase lumber production and hence chip production if higher prices increased the amount of timber that could be harvested or purchased. If the allowable cut was a binding constraint, however, a drop in allowable cut from \(AAC_{1}\) to \(AAC_{2}\) would shift the vertical portion of the supply curve for chips inward and reduce supply to \(Q_{2}\). Changes in technology that improved lumber recovery relative to chip recovery would also have the effect of shifting the vertical portion of the supply curve inwards.\(^{88}\)

Unfortunately, there does not exist the data to support a rigorous examination of the sensitivity of chip production to changes in prices, technology, harvesting practices, or log sizes. However, it is possible to construct a proxy for chip recovery factors to see whether the assumption of inelastic behaviour is unrealistic. **Figure 11** shows chips produced (in BDUs) per thousand board feet of lumber produced by forest region for the Interior and BC Coast.\(^{89}\) Given that sawmills will try to minimize sawdust and hog fuel production, for which they either receive nominal revenues or incur positive disposal costs, one can assume that an increase in chips produced per thousand board feet (Mfbm) comes at the

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\(^{87}\) The NAPAP model used by the Canadian Forest Service to model the North American pulp and paper industry assumes residual chip production in Western Canada is highly inelastic and perfectly inelastic in the Western US (Catimel, 1996).

\(^{88}\) This assumes that the effect of fixed costs being spread across lower production levels and raising average total costs can be ignored.

\(^{89}\) Proxies for chip recovery were constructed by taking monthly chip production by region and dividing it by monthly lumber production by region from Statistics Canada Catalog 35-003.
Figure 10. Supply Curve for Residual Chips with Reservation Price Based on the Price of Lumber

Figure 12. Discriminatory and Non-discriminatory Pricing for Wood Chips from Sawmills with Inelastic Supplies and Transportation Costs
expense of lumber produced. Therefore, the amount of BDUs per Mfbm then serves as a proxy for the chip recovery factor for sawmills, and should show how the price of lumber and the price of chips may influence chip production.

**Figure 11. Chip Recovery by Region 1993-1995**

![Graph showing chip recovery by region from January 1993 to December 1995.](image)

**Table 9** shows the correlation between the above measure of chip recovery and product prices for the three different forest regions in the Interior.

**Table 9. Correlation Between Product Prices and Chip Recovery, 1993-95**

<table>
<thead>
<tr>
<th></th>
<th>Southern (BDU/Mfbm)</th>
<th>Northern (BDU/Mfbm)</th>
<th>Central (BDU/Mfbm)</th>
<th>Std &amp; Btr ($/Mfbm)</th>
<th>Utility ($/Mfbm)</th>
<th>Economy ($/Mfbm)</th>
<th>Chip ($/BDU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southern (BDU/Mfbm)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northern (BDU/Mfbm)</td>
<td>.40</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central (BDU/Mfbm)</td>
<td>.39</td>
<td>.60</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Std &amp; Btr ($/Mfbm)</td>
<td>-.25</td>
<td>-.45</td>
<td>-.72</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Utility ($/Mfbm)</td>
<td>-.15</td>
<td>-.44</td>
<td>-.72</td>
<td>.91</td>
<td>.45</td>
<td>.74</td>
<td></td>
</tr>
<tr>
<td>Economy ($/Mfbm)</td>
<td>-.22</td>
<td>-.05</td>
<td>-.54</td>
<td>.47</td>
<td>.45</td>
<td>.74</td>
<td></td>
</tr>
<tr>
<td>Chip ($/BDU)</td>
<td>.19</td>
<td>.21</td>
<td>.74</td>
<td>-.56</td>
<td>-.71</td>
<td>-.74</td>
<td>1</td>
</tr>
</tbody>
</table>

Source: lumber prices from Madison’s 1993-95, Chip price reported for Northern Interior from WoodFibre Northwest 1993-95, Chip and lumber production from Statistics Canada 35-003
The results suggest that lumber prices are negatively correlated with chip recovery; as lumber prices increase, chip recovery declines as sawmills increase lumber recovery. The correlation between chip recoveries and their own price is quite low for the northern and southern regions, as would be expected with an inelastic supply curve. Surprisingly enough, however, the central region (corresponding to the Cariboo Forest Region), showed a much higher correlation between the chip recovery proxies and lumber and chip prices. This may reflect the fact that the central region is the smallest region in terms of chip production and the results may reflect more uniformity of firms within this area or the development of roundwood chipping capacities by sawmills within the region.

These results, however, are only suggestive. More rigorous analysis would require data on log inputs on a monthly basis as well as a more detailed description of the sawmills within each region (as chip recovery varies by the type of product produced, the size and species of logs sawn, and sawmill configuration). In addition, the period above covers significant changes in price levels for wood chips that may affect the apparent results; as well, some of the reported chip production may include roundwood chips. This in turn would raise the apparent chip recovery factor and would also affect the apparent responsiveness to changes in the chip price.

**Integrating Demand and Supply**

In order to integrate demand and supply, it is necessary to incorporate transportation costs. Sawmills tend to be located near their harvesting areas to minimize log-hauling costs and, as a consequence, are dispersed throughout the Interior. Pulp companies require both access to their raw material needs as well as the need to minimize their own transportation

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90 A firm processing raw material has to take transportation costs into account for both the unit of input and output. Because the processing of raw material may result in discarding a portion of the material, the firm will weigh the benefits of processing as close to the site as possible to minimize the transport of what will be waste material after processing. There is an added cost of being further away from its final markets, however.
costs to their final market. As noted earlier, their large raw material needs tend to limit the potential number of pulp mills in an area; however, the transportation network in the Interior limits the number of possible locations and has an opposite effect. Because wood chips are bulky, transportation costs are relatively high per unit. Therefore, transportation costs can be significant when evaluating alternative markets for wood chips.

Current transportation costs today range from approximately 10-20 cents per BDU per kilometer for trucks, and 7 cents per kilometer by rail when fixed loading and unloading charges are ignored. Based on interviews with industry participants, average transportation costs in the Interior range from $12 to $25 per BDU, depending on distances and haul roads (Kuan 1997, Edgson 1995, Pinette 1995). These costs appear to have remained unchanged for the past several years.\textsuperscript{91}

\textbf{A Model of Price Discrimination in a Wood Chip Market}

The model developed by Geldhart and Carroll (1980) to examine the Alberta wood chip market can be used to illustrate the relationship between price levels, price patterns, and competitive markets. Figure 12 illustrates what a supply curve would look like when a pulp mill receives wood chips from sawmills that lie increasingly distant and the quantity purchased varies directly with distance. The pulp mill, located at O, purchases chips that are supplied inelastically by a number of sawmills that lie along the line OE. Each sawmill is identical and has a reservation price or supply price, OA, that must be met before it will sell its chips. In addition, there are positive transportation costs, t, that increase directly with distance. Under these conditions the supply curve is AS, and the competitive price at the pulp mill gate is established by the intersection of the demand curve (D) with the supply curve (AS). Sawmill E is the marginal supplier and receives ED, exactly equal its reservation price, while the total quantity purchased is OE. In this case, the pulp mill pays

\textsuperscript{91} A contract between a trucking company and sawmill in the Interior dated 1987 works out to a rate of .15 per BDU per kilometer, based on a fuel cost of 39 cents per litre (now 50 cents for diesel) (DCT Chambers 1987).
the same delivered cost for all chips, OB, regardless of where they originate. Each sawmill then receives a different net price, BD, based on the transportation costs from their location to the pulp mill, with the net price falling for more distant sawmills due to their higher transportation costs (sawmill A receives the full price OB). In this case, there is no price discrimination, as the pulp mill pays the same price delivered to the pulp mill gate for all chips regardless of where they originate.

Under conditions of no price discrimination, then, the most likely explanation for the belief that prices are too low or uncompetitively low is that not all the costs associated with chip production have been identified. Assuming the supply price of sawmills does not take into account the alternative of having to incur disposal costs, it is easy to see why there may be a perception that prices are "too low". Even if the pulp mill is paying the same price delivered at the pulp mill gate to all sawmills, satisfying the competitiveness condition, there may be sawmills for which the net price does not cover their direct costs. As an example, imagine the pulp mill is paying $40/BDU delivered, while the sawmill estimates that it requires at least $45/BDU, so the sawmill perceives it is losing $5/BDU. However, the costs of disposing of unprocessed residue is $10/BDU, so the sawmill is actually making a surplus of $5/BDU by producing and selling the chips to the pulp mill.92

In the above example the purchaser paid the same delivered price to the pulp mill gate for all chips while the suppliers took care of transportation. If, however, the pulp mill take into account the effect it has on market prices by constructing a marginal expenditure curve (not pictured), it could restrict its purchases and thereby lower prices, increasing profits. Market power would in this case be expressed as a reduction in the price below OB, and the quantity purchased would correspondingly fall. However, there would still be no price

92 "There were producers who, for one reason or another, were not signed up to sell their chips to Interior pulp mills and if they wanted to dispose of them it was costing $8 to $10 a bone dry unit - about 2 1/2 tons - to put them into landfill or burn them.” Globe and Mail, September 22, 1979
discrimination as sawmills would still receive different net prices based on the transportation costs for their location.

Price discrimination is practiced when the purchaser pays each supplier the same price at the sawmill gate, as in Figure 12. The purchaser now pays each individual supplier OA, with the delivered cost equaling AS, the supply curve. Under such a pricing arrangement, sawmills are unable to derive a surplus from their location, and the firm is practicing discriminatory pricing by effectively paying more for distant wood chips, even though the value of the chips are identical once delivered to the pulp mill. The buyer captures the surplus by paying the sawmill's supply price and assuming the transportation costs. Note that the most distant sawmill supplying the pulp mill, E, is still located at the intersection of the demand and supply curves, and the amount purchased, OE, is unchanged from the competitive solution.

![Figure 13. Sawmill and Delivered Prices for Different Sawmills and Pulp Mills in the Interior for the Third Quarter of 1989](image)

The data shown in Figure 13 and Figure 14 show the price for wood chips at the sawmill gate and an imputed delivered price to the pulp mill. These figures suggest that a

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Transportation costs of 15 cents per BDU per km were added to the sawmill prices. Purchasers and sawmills differ between figures and consists of twelve different transactions in Figure 13 and thirteen different transactions in Figure 14, consisting of three different purchasers and seven different sawmills).
discriminatory pricing scheme does exist in the Interior of British Columbia. Regardless of their distance from the pulp mill, sawmills tend to receive similar prices for their wood chips. Does this mean that purchasers are exercising their market power and that the market for chips is not competitive?

Figure 14. Sawmill and Delivered Prices for Different Sawmills and Pulp Mills in the Interior for the Third Quarter of 1990

The models and empirical work in the preceding chapter showed that lack of competition may or may not lead to price discrimination. The ambiguous results reflect differences in market structure and assumptions about firm behavior. Therefore, in order to examine to what extent market power may be a factor in explaining prices observed in the Interior, it is necessary to use a model that accurately captures the characteristics of the Interior market. The previous chapter showed that there is no shortage of models in game theory. One of the reasons for such an embarrassment of riches is that many models are developed to investigate specific questions, such as how a particular market structure may influence outcomes. Consequently, the large number of models reflects the complexity of the economic environment and the modeler's need to simplify that complexity by choosing those economic variables that are deemed most important to that particular set of circumstances.
A Model of the Interior Wood Chip Market

The simple model of price discrimination by Geldhart and Carroll (1980) yielded a pattern of uniform prices across sawmills regardless of the distance between the sawmill and pulp mill. This pattern appears to reflect the practice of formula pricing observed in the Interior market. However, their model was based on a single purchaser, and cannot explain why a particular price level may be chosen, since under conditions of joint production the costs of chipping are not well identified. This issue becomes even more problematic as the number of buyers increase, since each buyer would presumably choose its own price level, and there is no reason to expect the buyers to choose a common price. Given differences in firm location, the presence of alternative buyers (whether they be other pulp mills or the export market), and the availability of residual chips (which would vary by region), the commonality of prices seen in Figure 13 and Figure 14 is even more striking (especially when compared to the prices for pulp observed in Figure 2). Furthermore, the model does not explain why prices increased so rapidly when pulp mills started bidding for chips.

None of the other models discussed earlier fit the Interior market any better. First, the market has been relatively static in terms of market structure, namely the distribution and size of purchasers over the study period. Therefore, in order to answer the question of whether the observed prices in Figure 13 and Figure 14 reflect the exercise of market power or simply the influence of competitive forces, it is necessary to use a model that examines both prices and pricing patterns.

In the case of the Interior market, Chapter 1 identified several important facts regarding the Interior wood chip market. As noted above, market structure in terms of the number of purchasers has been static. Most of the pulp mills in the Interior were completed by the early 1980's; of the two built since, both rely entirely on internal sources for chips (the Fibreco Mill in Taylor by Fibreco members and the Louisiana Pacific Mill in Chetwynd by the purchase of aspen pulp logs). Regional market structure varies in one of the two ways: either two different pulp mills (that is, pulp mills owned by two different companies) are found in the same town (as in Prince George, Mackenzie, and Quesnel); or there is only one pulp mill within a region (as in Kamloops,
Castlegar, and Skookumchuck) with alternative purchasers located at considerable distances (see again Figure 3).

Therefore, it is necessary to look at games that examine the interaction between different delivered pricing systems and firm behavior rather than those that rely on the number of firms. The main approach in modeling such games has been to use the Hotelling model as a starting point. Two of the models examined in Chapter 2 used such an approach; however, each model had important shortcomings. Espinosa (1992) restricted the actions a firm could undertake which a priori ruled out certain outcomes. Thisse and Vives (1988) did not examine the implications of repeated interaction, nor did they examine the implications of uniform delivered pricing systems. In addition, both of these models were concerned with market power on the demand side and neither paper attempted any empirical tests of the models.

This meant that it was necessary to develop a model that captured the characteristics of the Interior market while providing testable hypotheses. A model adapting Thisse and Vives (1988) along with Espinosa (1992) was used on a data set that would permit the examination of whether changes in firm behaviour could explain the pattern of prices observed in the Interior wood chip market.

The model is constructed in two parts. The first part examines the non-cooperative or Nash equilibrium for duopsonies under two different market structures; one where the firms are located together, and the other where they are spatially separated. The model then shows that different pricing patterns emerge as the unique Nash equilibrium based on the particular market structure.

The second part then examines the effect of repeated interaction. In trying to model tacit collusion, the favored approach has been to use infinitely repeated oligopoly games, or supergames. These supergames focus on the characteristics of the environment that firms find themselves in to see what factors may support outcomes that raise payoffs above the lowest level of non-cooperative (or competitive) behavior. The difficulty with such games is that they generate a number of possible equilibria, often sustained by punishments that are never observed. The punishment commonly
takes the form of a set of prices or actions by a firm designed to impose sub-optimal payoffs on the other firm(s) that deviate(s)). The threat of such punishment is usually sufficient in such games to ensure that firms collectively adhere to a more (collectively) profitable outcome and therefore firms will never deviate in equilibrium and hence these sub-optimal outcomes are never observed. It is customary in this type of modeling to choose the most severe punishment possible to arrive at the equilibrium (for example, a firm may threaten to set prices such that no firm will earn a profit in perpetuity if any other firm deviates).  

This model utilizes the non-cooperative outcome from the one-shot game (that is, without repeated interaction) as the punishment in modeling the supergame. It turns out that the basic model offers some powerful insights into how market power and firm location can interact to produce both changes in price levels and changes in pricing systems similar to those seen in the BC Interior wood chip market. The model shows that the pattern of common prices across suppliers (sawmills) does not emerge under the assumption of competitive behaviour, regardless of market structure, and that this pattern can only be sustained under certain conditions.

Because most models are configured with firms selling to spatially dispersed consumers, it should be emphasized that the model below has been adapted to have firms purchasing from spatially dispersed suppliers.

Firms are located under two different configurations. In the first, they lie at either end of a line segment of unit length (separate locations); in the second, they both lie at the same end of the line segment (coincident locations). Suppliers are distributed with unit density over the interval X=[0,1], with firm 1 located at 0 and firm 2 at 1 when they are separately located, and both at 0 under coincident locations. Firms purchase inputs from their suppliers and use a Leontief, or fixed

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94 The difficulty with this approach is two-fold: first, different assumptions about punishment will generate different equilibria and one never has an opportunity to observe any “punishment”; and second, the choice of punishment (as in the example) may not be plausible and appear somewhat arbitrary.
factor technology, to process the purchased input with other factors to produce outputs sold into competitive markets. Therefore, firms will have equal and constant marginal revenue products, \( R_i \), less the cost of other factors of production.\(^{95}\) Initially let Firm 1 be the low cost producer and Firm 2 the high cost producer such that \( R_1 = R \) and \( R_2 = R - c \) with \( c > 0 \), while suppliers provide a homogeneous input inelastically.

Note that these assumptions actually fit the Interior market quite well. The number of buyers is few, with only two buyers in any one location (such as Prince George or Quesnel), and in many cases sawmills find themselves lying between two buyers while export restrictions limit the effectiveness of the export market. In addition, wood chips are homogeneous, given the species. Due to their bulky nature, and a limited transportation network, transportation costs tend to be high relative to the value of the product. Chip production is fairly continuous. Often, because of limited storage space, sawmills cannot produce lumber for more than a few weeks if they cannot get rid of their chips. With the phasing out of beehive burners, sawmills face increasing costs if they have to dispose of their chips, mainly through landfiling, hence creating an inelastic supply of chips. Finally, marginal costs tend to be constant as the proportions of chemicals, energy, and labor used in the manufacture of pulp are fixed in the short run, leading to a constant marginal revenue product for the fibre input based upon the selling price of pulp (Armstrong, 1975).

Initially, this is a two-stage game, which means that firms may first choose to commit to a particular pricing policy and then choose their prices. In this case, the two pricing policies available to the purchasers are either *uniform pricing* (UP) or *discriminatory pricing* (DP). Under uniform pricing, the pulp mill chooses to set a uniform price for residual chips delivered to the pulpmill gate, regardless of the distance traveled. This means that the net price to the sawmill then falls as the distance between it and the pulp mill purchasing the chips increases. This type of pricing system is of interest since this is what would be observed under the rationale of the "Law of One Price"; that is, the pulp mill pays the same for all chips, regardless of where they originate.

\(^{95}\) \( R \) will be dependent on the output price. If, for example, there were no other costs, and 2 units were need to make one unit of output sold for \( p \), then \( R = p/2 \).
Under discriminatory pricing, firms retain their freedom to choose to compete over the entire range of the market in prices, resulting (as I will show) in a Nash Equilibrium in prices at the supplier. Discrimination refers to the fact that net prices to the supplier, or alternatively, the delivered price to the mill-gate for two goods coming from two different locations may vary by other than the actual transportation costs between those two points. Notice that this type of pricing does not restrict the firm to any particular type of delivered pricing system, of which uniform pricing is a subset.

In addition, firms anticipate the equilibrium prices under the different pricing systems when choosing among pricing schemes. Because there may not exist a pure Nash equilibrium at the second stage when one firm chooses uniform pricing, it is assumed that the firm that chooses to price uniformly becomes the price leader while the other firm will react optimally to the first firm's prices. Under these assumptions, there are four possible outcomes. Figure 15 shows the game tree for these outcomes, where both firms either both choose to price uniformly, or both choose to price discriminate, or one of the two firms becomes the price leader by choosing to price uniformly.

The latter two cases lead to the pricing system called basing-point pricing (BPP). Under these circumstances, this type of pricing arises under competitive behaviour. Suppose firms (sawmills) are situated in different locations, and Firm 1 chooses to price uniformly. Firm 2 can then choose to set its price fractionally higher, or an epsilon above Firm 1's net price to the supplier wherever the net price plus transportation costs to Firm 2 are less than its marginal revenue product. Figure 16 shows that Firm 1 will set a price of P at the pulp mill gate; Firm 2 then prices discriminatorily such that it pays the same net price as a supplier would receive from Firm 1 (PP'). Firm 2 would then purchase out to where the delivered cost (the net price plus the transportation cost for that supplier) will just equal the marginal revenue product for Firm 2 (R2), yielding the market
Figure 15. Game Tree for Firms that Either Commit to Price Uniformly (UP) or Retain Their Freedom to Price Discriminate (DP)

Drawn from Thisse and Vives (1989)
Figure 16. Basing Point Pricing with Firm 1
the Price Leader
boundary between the two firms (BB'). It can be seen that Firm 2 will enjoy larger profits than Firm 1 (this is shown in the next section); consequently, no firm would choose to be a price leader given the assumption of non-cooperative behaviour.

The next section looks at the sub-game equilibria of the game under each of the two scenarios.

**Coincident Location**
With coincident location, Bertrand competition means that the only sub-game perfect equilibrium is where both firms choose uniform pricing. If $c > 0$, then Firm 2 will be shut out of the market and Firm 1 will price an epsilon above $R-c$ and secure the entire market. If $c = 0$, both firms price at $R$ and earn zero profits.

*Proof*: If either Firm 1 or Firm 2 choose a price such that $p(x) < R-c-tx$ at any point, then the other firm could purchase from the supplier at that point and earn a positive profit. If, however, $p(x) > R-c-tx$ at any point, Firm 2 will earn negative profits by purchasing from that supplier and since they have the option of not purchasing and earning zero profits, will not pay that price. Firm 1, given that price, can increase profits by lowering the price it pays; therefore, any prices strictly greater are not stable. Therefore, the only subgame perfect equilibrium is where $p(x) = R-c-tx$ which is equivalent to uniform pricing where $p = R-c$ when both firms are located coincidentally.

**Separate Locations**
Under separate locations, however, both firms (pulp mills) can remain in the market under either price system, so long as $t > R-c$. In this case, then, there are four possibilities, outlined below.

Case 1. (UP, UP): The market boundary between the two firm's area is given by the location $x$ of the supplier indifferent between the two net prices offered:

$$p_1 - t \bar{x} = p_2 - t(1 - \bar{x})$$
which yields:

\[ \bar{x} = (p_1 - p_2 + t)/2t \]

Given that suppliers are distributed uniformly, profits are then given by:

\[ \pi_1 = (R - p_1)\bar{x} \]

and

\[ \pi_2 = (R - c - p_2)(1 - \bar{x}) \]

Using the first order conditions, this then yields equilibrium prices

\( (R - t - c/3, R - t - 2c/3) \)

respective market areas

\[ \left( \frac{c}{6t} + \frac{1}{2}, \frac{1}{2} - \frac{c}{6t} \right) \]

and respective profits

\[ \left( \frac{(\frac{c + t}{3})(3 + ct)}{6}, \frac{(\frac{2c + t}{3})(3 - ct)}{6} \right) \]
Case 2. (DP, DP): When both firms choose to retain their freedom to price discriminate in the second stage, then the equilibrium price schedule is:

\[ p^*(x) = \min \{ R-c-t(l-x), R-tx \} \]

with \( x \) between \([0,1]\) as Bertrand competition drives prices up to the lowest net revenue of the two firms at that location. The market boundary then becomes

\[ R - c - t - +tx = R - tx \]

\[ \Rightarrow x = \frac{c}{2t} + \frac{1}{2} \]

Equilibrium profits then become

\[ \pi_1 = \int_0^x \left[ R - (R - c - t(1 - x)) - tx \right] dx \]

for Firm 1 and

\[ \pi_2 = \int_x^1 \left[ R - (R - tx) - (c + t(1 - x)) \right] dx \]

for Firm 2.

Case 3. (UP, DP): In this case, Firm 1, the high revenue producer, is the price leader and chooses to set a uniform mill gate price of \( p_1 \). Firm 2 then matches the price wherever it can and the market boundary is then determined by the indifferent supplier, or:

\[ p_1 - tx = R - c - t(1 - x) \]

Profits for Firm 1 are given by
which, given the first order conditions, yield the optimal price for Firm 1 and market boundary

\[ p^*_1 = R - \frac{c + t}{2} \]
\[ x^* = \frac{c}{4t} + \frac{1}{4} \]

The equilibrium price schedule for Firm 2 then becomes

\[ p^*_2(x) = \min \{ p^*_1 - tx, R - c - t(1 - x) \} \]

and profits are then

\[ \pi_2 = \int_{x^*}^{1} [R - (p_1 - tx) - c - t(1 - x)] dx \]

Case 4. (DP, UP): In this case the lower revenue or more inefficient Firm 2 is the price leader and prices uniformly, with firm 1 then matching the price wherever possible.

The market boundary then becomes

\[ \frac{1}{x} = \frac{R + t - p_2}{2t} \]

and following the same arguments as above, the optimal price and market area for Firm 2 become
\[ p_2^* = R - \frac{(c + t)}{2} \]
\[ x^* = \frac{1}{2} + \frac{c + t}{4t} \]

and profits for Firm 1 are then

\[ \pi_1 = \int_0^1 \left[ R - tx - (p_2^* - t(1 - x)) \right] dx \]

Table 10 then shows the equilibrium payoffs for each firm. Several points then emerge. First, discriminatory pricing emerges as a dominant strategy for both firms and, as such, is the unique subgame-perfect equilibrium. However, the payoff for both is greater if each use uniform pricing rather than both practicing discriminatory pricing.\(^96\) This is the classic prisoner's dilemma, and suggests that discriminatory pricing emerges as the non-cooperative equilibrium in a one-shot game (that is, without repeated interaction). While each firm perceives it would be in their mutual self-interest if both chose uniform pricing, each recognize that the other will not adhere to such a system, and that the firm that continues to set uniform prices will be worse off. Therefore, to forestall such an outcome, each firm chooses a discriminatory pricing system, fulfilling their expectations about the other's behaviour.

Table 10. Firm Payoffs Under Different Pricing Strategies

<table>
<thead>
<tr>
<th>Firm 2</th>
<th>Uniform Pricing</th>
<th>Discriminatory Pricing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firm 1 Uniform</td>
<td>( \frac{(c + t)}{6} \left(3 + ct\right) )</td>
<td>( \frac{(c + t)^2}{8t} ), ( \frac{(c - 3t)^2}{16t} )</td>
</tr>
<tr>
<td>Pricing</td>
<td>( \frac{(2c + t)(3 + ct)}{6} )</td>
<td></td>
</tr>
<tr>
<td>Discriminary</td>
<td>( \frac{(c + t)^2}{16t} ), ( \frac{(c - t)^2}{8t} )</td>
<td>( \frac{(c + t)^2}{4t} ), ( \frac{(c - t)^2}{4t} )</td>
</tr>
<tr>
<td>Pricing</td>
<td>( \frac{(c + t)^2}{16t} ), ( \frac{(c - t)^2}{8t} )</td>
<td></td>
</tr>
</tbody>
</table>

\(^96\) The payoffs become clearer if \( c=0 \) with no loss of generality. Profits when both price uniformly equal \( t/2 \) versus \( t/4 \) from both practicing price discrimination, while the greatest profits come from practicing price discrimination while the other firm prices uniformly.
Figures 17 and 18 show the equilibrium price patterns for each of these outcomes. In Figure 17, the firms (pulp mills) are free to choose the price schedule. Under these circumstances, each firm (pulp mill) calculates the maximum amount the other firm (pulp mill) could afford to pay, and then sets its prices to its own suppliers (sawmills) accordingly. Under this discriminatory pricing arrangement, the prices paid to the supplier (sawmill) increase with distance from the purchaser (pulp mill) since the rival purchaser (pulp mill) can afford to pay more as the distance between it and the supplier (sawmill) decreases. The market boundary is then determined by the supplier (sawmill) whose delivered cost just equals the marginal revenue product of either purchaser (pulp mill), \( R \) (in the figure firms have a common marginal revenue product and \( c=0 \)).

In Figure 18, firms (pulp mills) are now constrained to follow a practice of setting prices at the pulp mill gate. Firm 1 now takes into account the fact that Firm 2 looks at the delivered cost of purchasing from Firm 1's suppliers, given that each firm is committed to using uniform prices. Firm 1 finds that by reducing its price, although it loses its more distant suppliers to Firm 2 (those firms in the segment AB), the increase in profits derived from lowering the price from \( P \) to \( P' \) to its closest suppliers (segment OA) more than compensates for the lost supply. Each firm then takes this effect into account when determining its prices, leading to lower equilibrium prices since each firm knows the other cannot raise the price to increase its supply area without raising the price across all of its own suppliers. This constraint is the reason that uniform pricing, when practiced by both firms, yields the greatest profits of the two different systems.

Furthermore, since \( \partial p/ \partial R = 1 \), this means that as \( R \), the marginal revenue product, increases, localized Bertrand competition drives up the purchase price by an equal amount. This is why \( R \) does not appear in any of the payoffs and does not affect any of the outcomes, as any increase in end product prices is completely offset by higher input prices.
Figure 17. Discriminatory Pricing by Firm 1 and Firm 2

![Diagram showing discriminatory pricing with price, delivered cost, and distance between firms represented.](diagram.png)
Figure 18. Uniform Pricing by Firm 1 and Firm 2
Therefore, the model predicts that in a non-cooperative game, discriminatory pricing will emerge for spatially separated purchasers, while uniform pricing will emerge as the equilibrium outcome for firms located coincidentally. Prices can be expected to move proportionately with changes in the end product price, but pricing systems will not change.

Note that neither price pattern is that observed in the BC Interior. For coincidentally located pulp mills, the predicted outcome is for uniform pricing, which means lower prices for more distant suppliers (sawmills) as the purchasers (pulp mills) incur higher transportation costs, while for separately located purchasers, suppliers will find that their prices increase the closer they are to an alternative purchaser. Although discriminatory pricing incorporates the possibility of setting uniform prices across suppliers (since firms are free to choose any price system they wish), this type of pricing does not emerge as the solution in the unconstrained game. Therefore, it is necessary to model uniform net prices across suppliers to see the potential payoffs from this type of pricing system.

**Uniform Supplier Pricing**

Pricing systems in which firms charge identical prices to all customers, inclusive of delivery costs and regardless of their location, are commonly called *Uniform Delivered Pricing* (UDP) systems (they are also sometimes called *postage stamp systems*). The equivalent pricing system from a purchaser's point of view would be one where they pay the same price to all suppliers, with transportation costs then added. To distinguish it from the four schemes discussed earlier, it will be termed Uniform Supplier pricing (US) to reflect the fact that prices are set identically across all suppliers (which in this case are sawmills).

Case 5. (US, US): Under uniform supplier pricing, how market areas are determined becomes important. Because suppliers (sawmills) receive the same price while the purchaser (pulp mill) pays for the transportation costs, the total delivered cost varies directly with location so that the chips from the most distant sawmill supplying the pulp mill are the most expensive. If both
purchasers choose a common price, then, the suppliers will be indifferent to selling to either purchaser and, making the common assumption in these models that suppliers will sell to the nearest purchaser in the event of a tie, the market is then evenly split between both firms.

Under such assumptions, there is a large discontinuity between the payoffs from continued market sharing and deviating slightly from the common price, as the deviating firm can potentially seize the entire market supply of the other firm (since any supplier would be willing to offer their supply regardless of their location). Depending on the current price, the market area for the deviating firm may effectively double while the market area for the other firm will collapse to zero. However, at higher prices, the deviating firm may not want to purchase from the most distant firms (those closest to the rival purchaser) as the delivered cost of goods from those suppliers may exceed the marginal revenue of the input.

Therefore, the model appears in a slightly different fashion from above. The assumptions employed in the previous model still hold (although the assumption \(c>0\) is dropped for ease of exposition). First, the firms calculate the payoffs if they choose a common price (how they arrive at that common price is left aside for the moment):

\[
\pi_{i,j} = \int_0^{1/2} [R - p - tx] dx
\]

and then the payoffs from deviating from that price

\[
\pi_i = \int_0^1 [R - p - tx] dx \text{ when } p \leq R - t
\]

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\[ \pi_i = \int_{0}^{x} [R - p - tx] \, dx \text{ where } x = \frac{R - p}{t} \text{ and } p > R - t \]

which equals \( \frac{tx^2}{2} \).

The payoffs from not deviating when the other firm deviates are then:

\[ \pi_j = 0 \text{ when } p \leq R - t \]

or

\[ \pi_j = \int_{0}^{1-x} [R - p - tx] \, dx \text{ which equals } Rx - px - \frac{tx^2}{2}. \]

This assumes that the firm, when deviating, continues using US and prices an epsilon above the other’s price (and is unable to reduce the price over its closest suppliers for fear of losing them) when \( p \leq R - t \). The deviating firm practices discriminatory pricing otherwise, in which case profits become \( \frac{3t}{8} \) when firms are sharing equal market areas.\(^98\)

Figure 19 shows the payoffs based on the market price for market-sharing (having a common price) and the payoffs for the deviating firms when one firm wins market share and the other loses market share and both are following a uniform supplier pricing system.

\(^98\) This makes the assumption that the deviating firm prices such that any supplier within their natural market area is indifferent to selling to the other supplier, or \( p_1 = p_2 - t(1 - x) \). This can be thought of as a natural arbitrage condition.
It can be seen that at prices below $R-t/2$ the payoffs from defection dominate the other two strategies. Bertrand competition drives prices up to $p=R-t/2$, which is a weak Nash equilibrium in the sense that it is a strategy where the payoffs from all three are equal and firms will be indifferent between cooperation and defection. However, the payoff from practicing price discrimination is greater than from using US pricing when the other firm is practicing US pricing. Therefore, the only Nash equilibrium when firms both practice US pricing yields payoffs of $t/8$, less than the payoffs from retaining the freedom to price discriminate of $t/4$ (where $c=0$), so discriminatory pricing remains the dominant strategy.

Even when firms are constrained to follow Uniform Supplier (US) pricing, the same points still hold as in the unconstrained game (where firms are free to choose the pricing system). The payoffs from market sharing (where both firms choose a common price level) form once again the classic prisoner’s dilemma, and increases in the marginal product translate into a proportionate change in prices even if both firms adhere to US pricing. Although firms find that they can increase profits if they choose a low enough price under a US pricing system, firms individually face the possibility of greater profits from increasing the price fractionally given the dramatic changes in market area. In the Nash equilibrium, each firm will choose the price that ensures their market area, and that the price level will fluctuate directly with changes in the end product value. However, the Nash
equilibrium under joint US pricing has lower profits and is dominated by the equilibrium where firms are free to choose whichever prices they want. Therefore, US pricing does not emerge as the outcome of the unconstrained non-cooperative game. Note that for firms located coincidentally, Bertrand competition continues to drive prices up such that uniform mill pricing is the dominant outcome (unless firms are constrained to follow uniform sawmill pricing).

The models of non-cooperative behaviour outlined above show that the pattern of prices observed in the Interior of supplier prices invariant with respect to distance cannot be expected to emerge as the natural outcome of either type of market structure given no constraints on how firms can set prices. The models predict that when firms are located coincidentally that uniform mill pricing remains the unique Nash equilibrium with prices paid to supplies falling with distance. In those markets where purchasers are spatially separated, the model shows that prices paid to sawmills should increase with distance.

In order to understand how such systems may develop, then, it is necessary to examine what happens when firms interact on an ongoing basis, given that the models above are one-shot games.99

Repeated Interaction

What happens when firms take into account the likelihood that their present actions will have an effect on future prices? Firms now take into consideration not only how their current price or action may affect current profits, but also the effect on future profits since their choice may cause the other firm to alter its behavior. It turns out that the possibility of future profits tempers competitive behavior, and that more profitable strategies may emerge for both firms than in a one-shot game.

Espinosa (1992) incorporates the effects of this interaction through having firms engage in an infinitely repeated game or supergame. Two firms face spatially distributed customers with unit
inelastic demands and simultaneously choose pricing strategies and prices at the beginning of each period. The firms then compare the payoffs from continuing to follow the current pricing system against deviating from that pattern. If a firm deviates, it enjoys the profits for one period, after which both firms revert to what is termed a punishment path, or a set of prices designed by the other firm to reduce the profits for the deviating firm to the lowest possible level:

\[
\frac{1}{1-\delta} \pi^c = \delta \pi^d + \frac{\delta}{1-\delta} \pi^p.
\]

In Espinosa's (1992) model, firms have the option of choosing one of two pricing systems: Uniform Delivered Price system (UDP), (where customers pay the same delivered price at their location); and FOB pricing (where customers pay a common factory gate price plus the transportation costs to their location). In maximizing their profits, the firms are taking into account the benefits of continued cooperation versus the one period gain from defection. The result of such assumptions is that the pricing scheme and price level adopted by both purchasers will be the same in equilibrium with the choice of prices and pricing systems dependent on the exogenous parameters within the model. The model has three such parameters: \(\delta\), the discount factor or rate; \(t\), transportation costs; and \(R\), the reservation value of the customers. In this model, the discount rate measures the relative payoffs from continued cooperation and possible defection and is bordered by \([0,1]\), where 0 can be thought of as ignoring the future payoffs while 1 values future payoffs equally with the current period (no discounting).

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99 This terminology reflects the fact that firms only have one chance to determine how they will set their prices.

100 FOB pricing is equivalent to Uniform Pricing when the firm is exercising market power on the purchasing side, while UDP is a type of discriminatory pricing (as the net realization for different customers varies) and is equivalent to Uniform Supplier pricing (US).

101 The reservation value is the maximum value a customer is willing to pay or the minimum price a seller must receive. These values are imposed to provide a bound on prices under the assumption of perfectly inelastic demand (supply) curves.
The most profitable pricing scheme, regardless of the firms' locations, is to set prices as high as possible; in other words, equal to the customers' reservation values. Consequently, firms will follow a Uniform Delivered Pricing system. When firms are purchasing their inputs, the equivalent system would involve setting the purchase price as low as possible. If suppliers all had to receive the same minimum price to supply a good, this would then yield a Uniform Supplier pricing system (where the purchasers would pay the common minimum price plus the transportation costs).

As the exogenous variables change, however, the prices and pricing systems may no longer be the optimal choice. For example, as the discount rate decreases, *ceteris paribus*, firms find that the gains from unilaterally defecting outweigh those from continuing to follow the prevailing prices. To forestall such actions, firms will lower the price level to offset the gains from potential defection. Espinosa (1992) then showed that at certain values and combinations of these exogenous parameters, the pricing scheme would also change as collusion became easier under the alternative pricing system. Since the potential profits and the payoffs from defecting are different under the two pricing schemes, given the same parameters, the firms adjusted their prices and chose the strategy that yielded the highest discounted stream of future payoffs to forestall the threat of defection. Ultimately, conditions become such that the equilibrium price level reaches a point at which there are zero or minimal profits. This point is used as the benchmark for competitive prices and price system, and this benchmark differs depending on firm location.

Espinosa (1992) shows that for coincidentally located firms, the equilibrium outcome for \( \theta \leq 1/2 \) is for FOB Pricing where the price to the customer consists of only the transportation costs to that location (plus any costs incurred in the production of the good). For discount rates greater than 1/2, any price level or system can be sustained, and given that Uniform Delivered Pricing is the most profitable, that will be the observed price system.
For spatially separated sellers, prices will move from Uniform Delivered Pricing through FOB pricing before returning to Uniform Delivered Pricing again as the discount rate increases (the equivalent for a purchaser would be moving from Uniform Supplier Pricing system to Uniform Pricing and returning to a Uniform Supplier system).

However, Espinosa (1992) restricts the firms to the choice of only the two pricing systems even if they are deviating in the main part of the model, which rules out the Nash equilibrium developed in This and Vives (1988). What happens, then, if the model is broadened to include this possibility?

**The Importance of Punishment Paths in Determining Nash Equilibria**

One critical assumption that Espinosa makes is that the punishment path chosen by the firms yields an effective payoff of zero economic profits (i.e. the firm earns only the normal rate of return).

Abreu (1988) shows that any path can be sustained in a perfect equilibrium when firms revert to the worst possible outcome after a deviation. To create a punishment path where the payoffs equal zero for eternity, the model requires the firms to punish one another by committing to a series of prices such that if one firm deviates, the other will price such a way in the next period that although it loses money in that period, the other firm makes zero economic profits. From that point on, both firms will make zero economic profits *ad infinitum*. While the likelihood of firms committing to such a range of action seems questionable, as noted earlier many of these models have outcomes where these punishment paths are never observed as the threat of such action is sufficient to forestall any deviation.

Even if the firms do not revert to the punishment path, their promises to follow such a path have to be plausible, or *sub-game perfect*. That is, if firms did arrive at the point where they had to follow the punishment path, would they prefer to follow another set of actions? For example, imagine a firm promises to price below cost to drive the overall price level down if another firm deviates from their market-sharing agreement. However, if the other firm does deviate, then that firm will find
that it incurs losses by selling at such low prices, while the other firm will simply shut down and earn zero profits. The firm could instead punish the deviating firm by pricing at cost, still lowering the price level and having the other firm earn zero profits, but no longer incurring losses itself. Therefore, the threat to price below cost is not consistent and neither firm would expect the other to behave in such a way.

It turns out that in the model developed by Espinosa (1992) that the chosen punishment path is unsustainable for firms in separate locations when discriminatory pricing is allowed. Firms can sustain positive profits when they revert to the Nash equilibrium in the one-shot game, and neither firm can drive the other’s profits down to zero without consistently incurring losses itself: therefore, such punishment paths no longer become plausible. Firms instead would revert to the non-cooperative equilibrium after deviation and earn profits of $t/4$, and therefore the results from Espinosa’s (1992) model no longer hold and firms no longer switch back and forth between different pricing systems.102

In this case, it is the Discriminatory Pricing system and the Uniform Supplier pricing system that are of interest, since the first reflects the outcome under deviation (or competitive behavior) while the latter represents the potentially most profitable system and the hypothesized pattern in the Interior market. In the first case, the payoffs from discriminatory pricing are:

$$\frac{1}{1 - \delta} \left( \pi - \frac{t}{2} \right) \geq 2\pi - \frac{t}{2} + \frac{\delta}{1 - \delta} \left( \frac{t}{4} \right).$$

Note that this assumes that the deviating firm will sets its price fractionally above the other firm’s prices, and that both firms then revert to the one-shot Nash equilibrium payoffs of $t/4$. In this case, the payoffs from deviation always outweigh the payoffs from cooperation when the discount rate is less than 1/2, and when the discount rate is greater cooperation is the preferred strategy. This happens as the gains from deviation are twice that from cooperation when the long term
effects of reverting to the non-cooperative outcome are taken into account. Since any price can be sustained when the discount rate is greater than 1/2, the maximum profits that can be obtained under this pricing arrangement are \( R/2-t/4 \) (the firm sets a price of zero for the closest supplier).

Turning to uniform supplier pricing, the profits again from cooperation versus deviation are:

\[
\frac{1}{1-\delta} \pi^c = \delta \pi^d + \frac{\delta}{1-\delta} \pi^p.
\]

Once again, cooperation can be sustained for any discount rate in excess of 1/2 and any price can be chosen. In this case, the firms choose the monopsony solution, maximizing profits by setting the purchase price to zero, and realizing profits of \( R/2-t/8 \). Therefore, the profits are higher than those that can be obtained under discriminatory pricing.

These results are different from those found using the Espinosa (1992) model when pricing systems are constrained to follow either a uniform delivered price or a uniform purchase price. In that model, firms alternate between the two systems, adjusting prices in response to changes in the exogenous factors (the discount rate, transportation cost, or reservation value, equivalent to the net revenue in this model). In a broader sense, the Espinosa (1992) model is unrealistic in its suggestion firms costlessly switch between pricing systems and adjust prices smoothly without reverting to what are termed the punishment path strategies. Furthermore, as a theoretical question, it is not clear why firms, if they do decide to deviate, should be constrained to either the FOB or uniform pricing systems when the above model shows that both strategies are dominated by discriminatory pricing. As such, it suggests that Espinosa's (1992) model needs to be modified by incorporating the possibility of a reversion to a discriminatory pricing system. It may be the

\[102\text{ This shows how dependent the equilibrium may be on the choice of punishment.}\]
case that the principal result, namely that uniform delivered pricing systems may reflect the possibility of either very competitive or collusive behavior, is incorrect.\textsuperscript{103}

Allowing for repeated interaction shows that supra-competitive profits may be sustained if firms can choose and follow a particular pricing system that yields greater profits than the non-cooperative outcome. In other words, the jointly beneficial outcome in a prisoner's dilemma that is not sustainable under one-shot Nash games become supportable with repeated interaction. There is a range of potential equilibria, all equally supportable depending so long as the discount rate firms use exceeds a critical value. The most profitable equilibrium is that where firms can minimize the purchase price and then pay transportation costs; if suppliers share a common minimum price, the result would be a US pricing system. However, the model suggests that firm behaviour and prices can change sharply if the discount rate falls below the critical value, and firms then move from a tacitly collusive outcome to the non-cooperative outcome. Firms then revert to the model described by the one-shot game.

Shapiro (1989) notes that while the discount rate in games of repeated interaction is commonly used to represent the value firms place on future actions, it can also be thought of as characterizing how quickly firms may respond to one another's actions or the firms' beliefs about how likely the game is to continue.\textsuperscript{104} It can be shown that the discount rate decreases as the reaction period lengthens or the firm thinks that the game will end sooner than it previously believed.

Finally, this model brings to the forefront an important issue that is typically glossed over in most game theory models. Since any equilibrium can be sustained when the discount rate is greater than

\textsuperscript{103}Espinosa (1992) argues that there is no sustainable equilibrium in FOB prices below a certain discount rate and therefore the equilibrium must take the form of a uniform delivered pricing system. However, under such a system, firms are forgoing potential profits by not charging more to their nearest customers which they could do by altering their prices and hence the solution is not a Nash equilibrium.

\textsuperscript{104}"Formally, \( \delta = ve^{iT} \), where \( v \) is the hazard rate for the competition continuing (i.e. the probability that the game continues after a given period, given that is has not previously ended), and \( e^{iT} \) is the pure interest component of the discount factor, with period length \( T \) and interest rate \( i \)." (Shapiro 1989:365).
1/2, how do firms arrive at a particular Nash equilibrium? In particular, given the inherently unstable market areas under a uniform supplier pricing system, how do firms arrive at a common price? Kreps (1990: 529-531), in his textbook on microeconomics and game theory, discusses this very question:

What’s wrong with the game theoretic approach?

The discussion above centers on the (in)ability to monitor [referring to a lengthy discussion of models involving noisy market prices and whether or not changing prices reflect deliberate deviations or demand shocks]. But there is another problem, intuitively similar, to contend with in applications. What do you monitor? When we have symmetric firms, it seems “obvious” that we should look for symmetric equilibria wherein every firm acts in the same way. But in an oligopoly of asymmetric firms, it won’t be crystal clear just what is the “rule” each is supposed to follow...

We have returned to two closely related weaknesses of this approach: The twin problems of too many equilibria and the selection of one of them. Compare the model of this section with the Cournot, or Bertrand, or von Stackelberg model. In the three classic models, a definite prediction is made about what will happen. One can (and we do) argue that this definiteness arises speciously. Insofar as the repeated play model is the right model, the classic models make an ad hoc assumption about rivals’ conjectures, which is virtually equivalent to assuming which equilibrium pertains. Unless there is some reason given for the ad hoc assumption, nothing has been gained except perhaps to explain what sort of conjectures lead to certain equilibrium outcomes....

A second lacuna in the theory is apparent when we examine closely the claim that specifying institutions helps us to understand outcomes, at least in noisy environments. This may be true as far as it goes...But it leaves open the question, Where did the institution come from? More generally as we look across industries, do variations in the “rules” reflect uncontrollable environmental differences, or are institutions the result of some conscious or unconscious choices by participants? We will not resolve these puzzles at this point. In fact, we won’t resolve them in this book at all; their full resolutions are over the horizon of economic theory at this point.”

In this case, the influence of government policy may well provide the missing pieces identified by Kreps (1990) on how a particular equilibrium may be sustained. This model shows that when firms can coordinate their actions under certain conditions, it may be possible to sustain supra-competitive outcomes. However, a characteristic of such
equilibrium is that if they are disturbed, the reversion to more competitive behavior can happen quickly and prices can change significantly.

Figure 20 shows several different price series for residual wood chips in the BC Interior. The first, Actual, is the average price paid to sawmills in the Interior over the study period (the data used to derive these series is discussed more fully in the next chapter). The next two series illustrate the non-competitive and competitive outcomes suggested by the model.

The next series, Percentage, is constructed by taking 9% of the selling price of pulp, reflecting the use of government-mandated minimum pricing restrictions during the initial development of the market through the 1970s, and is meant to reflect non-competitive price-setting.

The final series, Margin, is constructed by deducting cash manufacturing costs (chemicals, labor, overhead, and energy) from the selling price of pulp, adjusted for yield for a kraft pulp mill, and is meant to reflect competitive price-setting. If we assume that pulp mills face constant marginal costs, Margin then provides a measure of the marginal net revenue product value of wood chips which would equal the price in competitive markets (Armstrong 1975). This has also been the approach used in other studies to estimate the (imputed) value of pulpwood (Nautiyal et al. 1995, Runyon 1983).

Figure 20 shows that the actual prices closely track the fixed percentage of the pulp price over much of the time period, and then more closely match the series derived from net revenues. This is consistent with the idea of firms following a specific pricing system and then reverting to the sub-optimal outcome as the fundamental dynamics of the prisoner’s dilemma reassert themselves.

105 Costs were conservatively set at $400 per metric tonne to include overhead and delivery costs but to exclude fibre costs, based on reported costs for the Interior pulp industry derived from Table A113, BCMOF (1995). No allowance was made for inflation.
While the model shows that a move towards more competitive behaviour will be marked by higher prices, the increase in prices observed in Figure 20 may reflect other forces at work in the market. In order to test the model, it is necessary to examine whether or not the increase in price levels can be attributed to the change in firm behaviour noted in the Interior. In addition, the model also shows that the pricing pattern of uniform sawmill prices observed in the past cannot be explained by competitive behaviour. Furthermore, the model shows that more competitive behaviour will lead to a change in spatial pricing patterns. Finally, the model suggests that as competitive behaviour increases, interaction between firms may also increase since they will now use the other firms prices (or estimates of the other firms values) in determining their own prices. The next chapter proceeds to test these hypotheses to see whether the changes in prices and pricing practices are consistent with the model outlined above.
4. Tests of Price Discrimination in the Wood Chip Market in the British Columbia Interior

This chapter empirically tests for the presence of market power using two approaches. The first relies on a comparison of the Interior residual wood chip market with other markets, and tests for differences between market price levels. The second approach tests whether changes in prices and the pattern of prices at the firm level match those predicted by the model as firms move towards more competitive behavior.

Tests of Market Price Levels
The intuition behind the first approach is the ‘Law of One Price’, which says that for units of an “identical good...[one price] is indeed a logical consequence of economic rationality and competitive markets.” (Caves, Frankel, and Jones 1990). This logic underlies spatial equilibrium models, where regional markets clear as arbitrage dictates that goods move between markets to the point where equilibrium prices in each market will differ only by the transportation costs between each market. If the difference in equilibrium price between a market is less than the transportation cost to any other market, that means that demand and supply will equilibrate within that one market. In the absence of market power or any kind of export restrictions one would a priori expect all sawmills to receive the same price for their wood chips, less the difference in transportation costs between their location and the market with the highest equilibrium price.

The main difficulty of these approaches is separating the effect of market power from other factors that may affect local markets, such as changes in regional demand, supply, or technology that will affect prices. For example, changes in the demand for pulp can affect
the price of wood chips, while the adoption of different technologies, such as CTMP, could also be expected to affect the demand and hence price for wood chips.\textsuperscript{106}

It is also possible to use this reasoning to examine the pattern of prices paid in local markets. When firms are located coincidentally, the uniform supplier pricing system means that a purchaser will utilize more distant chips that are more costly than nearby local chips if local markets are unable to satisfy their demand. Using data on prices and volumes, it is possible to calculate the difference between what a purchaser actually paid for their chips and what they would have paid had they been able to acquire the same amount of fibre at a lower cost. Under a Uniform Supplier pricing system, a pulp mill could save money by no longer purchasing chips from its more distant suppliers and replacing them with chips from a closer sawmill (since the chip price would be the same but the pulp mill would save on transportation costs). However, that sawmill is supplying the rival purchaser and the firm has to weigh the benefit from reducing its fibre cost against the possibility that such action may lead to higher prices (and both purchasers will end up paying more in the long run). The potential gains are calculated by summing up the cost of acquiring an equivalent amount of fibre from the closest sawmills and then deducting the cost of supply from existing suppliers using imputed transportation costs.\textsuperscript{107} Table \textbf{11} shows the actual differences for two pulp mills in the Prince George Forest Region for selected months (the months were chosen for a representative range of suppliers and to coincide with the period under which it is assumed firms were following a US pricing system). The differences are considerable, and are the more striking for their persistence. Such differences would not be expected to last under the assumption of competitive behaviour.

\textsuperscript{106} It should be noted that the prices observed in Figures \textbf{13} and \textbf{14} are inconsistent with such models. However, as noted in Chapter 3, spatial price discrimination is not inconsistent with models of competitive behavior, especially at the firm level.

\textsuperscript{107} Transportation costs were assumed to be constant at 15 cents per BDU, and it was assumed that the price paid to a competitor's supplier was infinitesimally greater. Supply was aggregated based on distance, moving from the closest to next closest supplier to satisfy the reported purchases for that period. These estimates are conservative, as not all suppliers would be listed for each month.
Table 11. Potential Gains in the Prince George Forest Region from Changing Suppliers

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchaser A</td>
<td>$305,000</td>
<td>$370,000</td>
<td>$615,300</td>
<td>$160,000</td>
</tr>
<tr>
<td>Purchaser B</td>
<td>$760,000</td>
<td>$526,400</td>
<td>$545,700</td>
<td>$130,000</td>
</tr>
</tbody>
</table>

Figure 21 shows quarterly price indices for wood chips over a ten year period in three distinct markets: the BC export market (North Vancouver); the Northern Interior market (otherwise known as the Prince George market); and the Puget Sound market for Douglas-fir chips in the Pacific Northwest. The wood chips sold in these three markets are very similar; in fact, some of the chips sold in North Vancouver originate from the Northern Interior. Similar species in terms of quality are used (it should be noted that Douglas-fir is regarded as slightly less desirable than the export mix of chips sold in North Vancouver, which is at least 50% spruce and the rest pine and true firs). Therefore, while actual prices in these regions would differ due to region specific transportation costs and other costs of pulp production, such as labor and energy, relative price levels should be similar, according to the 'Law of One Price'.

However, there is one substantial difference between these three markets. There are no restrictions on the export of wood chips from the US; consequently, any supplier is free to sell their chips into the well-developed export market that exists on the West Coast. Within BC, restrictions on chip export restrict the possibility of such arbitrage, but the participation of limited volumes in the export market does offer a measure of the value of those chips. Export volumes ranged between 6% and 15% of total Interior production over the period 1987 through 1995 for which data was available (see Table 3 and Table 4).

---

108 The prices in all three markets were comparable in 1986.
109 The Puget Sound market is felt to be very competitive, as suppliers are free to sell into the export market if they are unhappy with the price offered by local purchasers. (Ekstrom, 1996).
A well-known example of market comparisons has been work examining the impact of log export restrictions on log prices on the BC Coast. Margolick and Uhler (1992) showed that export restrictions have depressed domestic prices in the Vancouver log market, compared to log prices in the US log market in Puget Sound.

Figure 21 shows the trend for prices in Puget Sound, the export market, and the BC Interior, based on Canadian dollars. Prices in Puget Sound closely follow export prices, reflecting the interaction between those two markets, while BC Interior prices followed both markets until 1990 when price levels started increasing in those markets but remained flat and even trended downwards. Interior prices continued to diverge from prices in the Puget Sound and export market until 1994, at which point interior price levels rose rapidly, and prices in all the markets were again moving in tandem. This evidence suggests that there are factors at work in the Interior market not present in the other two markets.

110 The increase in the late 1980's has been generally attributed to concerns about reduced harvest levels in the Pacific Northwest due to the spotted owl.
Figure 21. Relative Price Changes in Three Wood Chip Markets

Source: WoodFibre Northwest, quarterly reports

Figure 22 looks at the relative production of chips in the Interior to examine the possibility that there may have been some region-specific supply shock, or that the pattern of prices may mechanically reflect change in pulp prices due to formula pricing. It can be seen that chip production has remained relatively constant over the eight-year period.

Figure 22 also shows quarterly indices for Interior wood chip prices along with pulp prices for 1987 through 1996, again based on Canadian dollars. The sharp increase in chip prices starting in the second quarter of 1994 is immediately apparent (prices nearly doubled), while pulp prices did not exceed the high from the previous cycle until the beginning of 1995, nearly one year later.
Figure 22. Relative Change in Prices and Production 1987-1996

Are there other factors specific to the Interior that might explain the different price patterns?

As noted in Table 6, with the exception of the expansion in pulp capacity at Celgar, annual pulp capacity in the Interior has changed little since 1989-90, the last high point in the pulp price cycle. There have not been any recent entrants into the Interior industry. The only pulp mill built since 1987, the Louisiana Pacific pulp mill in Chetwynd, relies solely on aspen roundwood chips. There were no significant changes in ownership within the industry over the same period. Policy changes regarding stumpage and environmental regulation postdate the change in prices (the impact these change might have on future supplies is discussed more fully in Chapter 5).

Therefore, at the time wood chip prices shot up, industry structure had remained remarkably stable and the industry had not yet faced any significant policy changes. Furthermore, pulp prices and chip production levels in the Interior chip market were not
substantially different than they had been in previous periods. This suggests that changes in industry structure or regional demand and supply are unlikely to explain the change in Interior prices.

**Testing for Changes in Market Price Levels**
The existence of an export market provides the means to test whether the hypothesized change in market behaviour explains the increase by using the export market as a measure of the true marginal value of wood chips. This approach follows Madhavan et al. (1994), which examined the market for dairy products in the US and found significant differences between the margin for two types of milk (equivalent in quality) sold by dairy cooperatives before and after an antitrust decree. By assuming that prices in both the export and Interior market will respond equally to any overall changes in world demand for pulp, expressed as changes in the price of pulp, it is possible to distinguish to what extent factors specific to the Interior market are influencing prices in the Interior market.

In the case of the Interior market, we are interested in testing two variables that may explain differences in price levels while holding the effect of pulp prices constant. All of the variables are quarterly. The first variable of interest is *Excess*, which equals the production of pulp fibre within the Northern Interior less consumption within the region. The region is a net exporter of pulp fibre so that production historically exceeds consumption within the region. The difference between the two is a measure of the relative availability of residual chips; increases in demand or decreases in supply would decrease the amount of available fibre, which would be expected to lead to price increases in the Interior under competitive conditions.

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This data was derived from the COFI Chip Audit Task force, described in both the data appendix and in Chapter 6. The data set covers production and consumption of all pulp fibre, including roundwood chips, on a quarterly basis within the northern Interior (the Prince George, Prince Rupert, and Cariboo Forest Regions). This is the same region where chip prices first started to increase.
The second variable of interest is Change. It is constructed as a dummy variable designed to measure the presumed change in market behaviour between the two periods, and equals 1 after the first quarter of 1994 (as February 1994 was the month the chips were put up for bid). Any change in the behaviour of relative prices in these two markets after this date not picked up by the other variables will show up as a significant coefficient on this variable.

The third variable is Pulp, which equals the value of bleached kraft pulp exported from BC for that quarter, and accounts for changes in the price firms pay in the Interior due to formula pricing. The fourth and final variable is Time, to allow for the possibility that there was a dynamic component affecting prices not picked up in the other variables.\textsuperscript{112}

The dependent variable is Margin, and equals the Export price less the Interior price, divided by the export price. It therefore shows the difference between the two price levels expressed as a percentage of the export price, and ranges between 0 (when the two prices are equal) to 1 (when the domestic price equals zero). The higher the margin, then, the greater the discrepancy between prices in the two markets. Equation (1) shows the model that was estimated. The data used in the estimation are discussed in the section Allowing firm interaction.

\begin{equation}
\text{Margin}_t = \beta_0 + \beta_1 \times \text{Excess}_t + \beta_2 \times \text{Time}_t + \beta_3 \times \text{Pulp}_t + \beta_4 \times \text{Change}_t + \epsilon_t
\end{equation}

**Results from Testing for Changes in Price Levels**
Table 12 reports the results of a regression corrected for auto-correlation. While the coefficients for Time, Pulp, and Change were all significant, the measure of local demand relative to supply, Excess, was insignificant although in the correct direction (since decreased availability in the local market should raise the price in the local market relative to
the export market and therefore decrease the margin). This suggests that changes in local demand relative to supply do not explain differences in price levels; rather, the explanation lies in a change in market behaviour.

Table 12. Margin as a Function of Demand and Market Power, n=30

<table>
<thead>
<tr>
<th>Variable</th>
<th>Constant</th>
<th>Excess</th>
<th>Time</th>
<th>Pulp</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coefficient</td>
<td>.767</td>
<td>-3.49*10^{-3}</td>
<td>4.49*10^{-3}</td>
<td>-5.17*10^{-4}</td>
<td>-3.34*10^{-3}</td>
</tr>
<tr>
<td>t-ratio</td>
<td>(4.52)</td>
<td>(.26)</td>
<td>(2.16)</td>
<td>(7.16)</td>
<td>(1.98)</td>
</tr>
</tbody>
</table>

Critical value of t for 95% level of confidence=1.96
Durbin H Statistic=.58; R^2=.91

The sign of the Change variable is consistent with the hypothesis; a move towards more competitive behaviour would be expected to lead to higher prices in the domestic market relative to the export market, leading to a decrease in the margin. In addition, the positive and significant sign on the variable Time shows that the margin was growing over time (this can be seen in Figure 21). The negative sign for Pulp suggests that the margin decreased as the price of pulp rose (although this effect was an order of magnitude less). This suggests that the difference in price levels between the two markets shrinks in relative terms as the overall price level rises.

Table 12 shows that there was a significant shift in relative price levels in the Interior and export markets between the first period covering prices through 1987 and the first quarter of 1994, and the second period covering the second quarter of 1994 through 1996. These two periods were chosen to reflect hypothesized differences in firm behaviour based on differences in how contracts were put up for bid and signed within the Interior market. Prices in the Interior market during the second period moved closer towards the export

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112 Excess is based on the consumption and production of pulp fibre within the Central and Northern Interior (also known as Region One).
price, consistent with the idea of increased competition in the Interior market. Can more competitive behavior also be seen at the firm level?

**Tests of Firm Prices and Pricing Patterns**

The model developed in Chapter 3 showed how a specific pricing pattern, namely a Uniform Supplier pricing system, where the price paid to suppliers was the same regardless of their location, could lead to greater profits than more competitive behaviour. The model also showed that more competitive behavior was associated with increasing prices and a change in the spatial pattern of prices. The first part of this section tests two hypotheses: first, prices have been set in the Interior as a percentage of the pulp price and have been constant across sawmills; and second, there was a significant change in prices and pricing patterns. Due to data limitations, however, the period tested only covers the first few months of the hypothesized change in market behaviour.\(^{113}\)

The second set of tests are derived from the other predictions made by the model and rely on changes in firms' prices relative to other prices and exogenous changes in the value of wood chips.

**Testing for Formula Pricing**

If purchasers are indeed setting prices according to a common Uniform Supplier pricing system, then the price paid by individual purchasers to their suppliers should reflect this practice. Specifically,

\[
(2) \quad P_r = R_t + t_r + P_{ri} + e_t
\]

\(^{113}\) Information identifying individual suppliers and purchasers was not available due to a change in data collection methods.
The price paid to sawmills, $P$, is derived from the presumed formula which is assumed to equal a fixed percentage of the pulp mill's net selling price, $R$.\textsuperscript{114} Transportation costs, $t$, are replaced by distances in the estimation, which assumes constant per unit transportation costs per measure of distance across the region. If pulp mills in the Interior have practiced third degree price discrimination and set prices on a uniform sawmill basis then the coefficient on distance should be zero. $P_n$ is the price of lumber, and is included to test whether lumber may influence chip prices (see Chapter 3 for a discussion of how lumber prices may provide a floor). In addition, a time trend is incorporated.

The model contains two distinct breaks, separating the study period into three intervals. The first interval covers the period from December 1987 through the end of 1989, when the provincial government was trying to raise chip prices in the Interior market through moral suasion (see the section entitled “Chip Direction Policy Dropped” in Chapter 2). Within this period, it is assumed pulp mills are following formula pricing but may have responded differently (if at all) to government pressure to raise prices. The second interval covers the period from April 1989 through February 1994, during which period pulp mills were presumably practicing formula pricing without any government pressure. The third interval comes after the change in purchaser and supplier behavior in February, 1994, when chips were put up for bid, and the purchasers were deviating from the old formula pricing system.

Data
The data set for this estimation consists of 2,562 individual arms-length transactions for wood chips in the Interior of British Columbia for the period December 1987 to July 1994. Purchasers include ten of the pulpmills within the region and the largest purchasers of

\textsuperscript{114} Recall that the reservation value in the models discussed in Chapter 3 provided an upper or lower bound. The results for the Uniform Supplier model showed that a non-competitive equilibrium could be sustained if firms were able to agree on a common price that fell within the range of reservation values (in the case of residual chips, this would be a minimum that sawmills would need to receive to stay open and the maximum the pulp mill would be willing to pay). Needless to say, these values are constantly changing and the range can be quite large.
residual chips from 52 sawmills within the region. Both prices and quantities are reported for each transaction but not all transactions are necessarily reported for each month. However, each pulp mill and sawmill is represented in the data set. Several months of data in 1988 and 1989 are missing, so the total number of months covered is 68.\textsuperscript{115}

The dependent variable is the observed price of residual chips in Canadian \$ per Bone Dry Unit in the transaction, FOB the sawmill, for purchasers located in the Interior. Distance is measured between the sawmill and the purchaser in kilometers, while Pulp is the average monthly gross price reported for bleached Kraft pulp exported from British Columbia by Statistics Canada in \$ per metric tonne. Before is a dummy variable for the period January 1987 to March 1989, signified as Period I, and is chosen to coincide with government intervention to raise chip prices in the Interior in the spring of 1989.\textsuperscript{116} After is a dummy variable for the period February 1994 to July 1994, signified by Period III, and is chosen to coincide with the hypothesized change in firm behavior (again distinguished by a change in how chips were bought following the chips put up for bid in Quesnel). Both Before and After are interactive dummies with the lagged pulp price, while only After is interactive with distance. Lumber is the price per thousand board feet of SPF 2x4 lumber, random length, Standard and Better, from the Interior from Madison's Canadian Lumber Reporter, while Time is a monthly time trend that increases by one with each month over the sample period. All prices are in nominal Canadian dollars, reflecting the fact that these were the prices firms were using in their decision-making.\textsuperscript{117}

Equation (3) shows the exact model where A...J represent ten purchasers in the interior (all pulp mills), with \(i\) the chip purchases from that individual sawmill.

\textsuperscript{115} Appendix 1 provides a more detailed analysis of this data set.

\textsuperscript{116} As discussed in the section entitled Chip direction policy dropped in Chapter 3.

\textsuperscript{117} The lumber price was reported in U.S. dollars and converted into Canadian dollars.
Model Estimation and Discussion of the Results

The main purpose of this model is to determine whether a uniform pricing system was practiced within the Interior and the relationship between product prices and chip prices. **Table 13** reports the results of estimating equation (3) for each of the ten purchasers separately with t-ratios reported below the estimated coefficients, as well as summary statistics. Coefficients significant at the 95% level are in bold.

The equations have been corrected for autocorrelation where present. To preserve the confidentiality of the individual purchasers, only the difference in the percentage of the pulp price between period II (the longest interval in the data set, covering April 1989 to February 1994) and the two flanking periods are reported (these periods are marked I and III) respectively. The purchasers include: Cariboo Pulp and Paper, Canfor, Celgar, Crestbrook, Eurocan, Finlay, Fletcher Challenge, Northwood, Quesnel River Pulp, and Weyerhaeuser. As an additional precaution, individual sample sizes are not reported: the smallest sample contained 45 data points, while the largest sample contained 624.

The first set of coefficients, Price of Pulp, can be interpreted as expressing the chip price as a percentage of the pulp price. For example, purchaser A increased the price paid by .60% of the price of pulp between Period I and Period II, and then by 3.44% between Period II and Period III. For all purchasers, the price of pulp was highly significant, and ranged between 7.2% to 9.91% for the individual purchasers, with an average of 8.8% for nine of the ten purchasers in period II.\(^{118}\)

\(^{118}\) Purchaser F was excluded due to an estimate four times greater than that of the other firms. The higher estimate offsets the significantly larger negative constant term for this firm. The sample size for this firm was quite small (N<50) reflecting the fact that they are not a major purchaser of chips in the Interior market, and these results may reflect a different pricing practice.
Table 13. Estimating Wood Chip Prices as a Function of Product Prices and Distance Paid by Pulp Mills in the BC Interior

<table>
<thead>
<tr>
<th>Firm</th>
<th>Price of Pulp (% of pulp price)</th>
<th>Distance cents/km</th>
<th>Lumber cents/Mbf</th>
<th>Time cents/month</th>
<th>Constant</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I-II</td>
<td>III</td>
<td>I-II</td>
<td>III</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>-0.6 (1.12)</td>
<td>*</td>
<td>3.44 (4.28)</td>
<td>-0.9 (1.00)</td>
<td>3.1 (1.72)</td>
<td>-0.9 (1.44)</td>
</tr>
<tr>
<td>B</td>
<td>-0.5 (1.14)</td>
<td>*</td>
<td>4.47 (6.90)</td>
<td>-0.1 (0.22)</td>
<td>2.0 (1.56)</td>
<td>-0.5 (0.55)</td>
</tr>
<tr>
<td>C</td>
<td>-0.5 (0.71)</td>
<td>*</td>
<td>4.0 (8.08)</td>
<td>-3.5 (3.73)</td>
<td>-2.4 (1.07)</td>
<td>-2.1 (0.15)</td>
</tr>
<tr>
<td>D</td>
<td>-0.1 (0.15)</td>
<td>*</td>
<td>4.9 (11.15)</td>
<td>-2.4 (3.86)</td>
<td>0.8 (1.07)</td>
<td>-1.3 (1.28)</td>
</tr>
<tr>
<td>E</td>
<td>-1.0 (1.46)</td>
<td>*</td>
<td>8.4 (7.56)</td>
<td>0.3 (4.3)</td>
<td>8.6 (5.24)</td>
<td>-1.4 (1.13)</td>
</tr>
<tr>
<td>F</td>
<td>na</td>
<td>*</td>
<td>5.1 (5.23)</td>
<td>0.2 (1.15)</td>
<td>5.2 (1.51)</td>
<td>1.92 (1.85)</td>
</tr>
<tr>
<td>G</td>
<td>-1.9 (1.71)</td>
<td>*</td>
<td>na</td>
<td>-22.2 (2.10)</td>
<td>na</td>
<td>2.2 (0.87)</td>
</tr>
<tr>
<td>H</td>
<td>-0.2 (0.18)</td>
<td>*</td>
<td>6.3 (5.07)</td>
<td>0.9 (0.59)</td>
<td>7.5 (2.56)</td>
<td>1.8 (1.02)</td>
</tr>
<tr>
<td>I**</td>
<td>-0.9 (1.92)</td>
<td>*</td>
<td>-2.1 (10.23)</td>
<td>-2.2 (4.00)</td>
<td>4.7 (2.55)</td>
<td>3.8 (3.23)</td>
</tr>
<tr>
<td>J***</td>
<td>0.2 (0.33)</td>
<td>*</td>
<td>4.2 (11.32)</td>
<td>0.3 (1.07)</td>
<td>-0.9 (0.75)</td>
<td>-1.0 (0.91)</td>
</tr>
</tbody>
</table>

* suppressed
na=not available
**current
***lagged two periods

Critical value for t for 95% level of confidence = 2.306

Eight of the purchasers showed an increase in the price paid between Period I and Period II; however, the difference was only significant for purchaser I. Eight of the purchasers showed significant increases in the price paid between Period II and Period III, while purchaser I showed a slight but insignificant decrease.

Because the pulp price used is based on the price at the point of export, and it could not be specified how long the time lag would be between what firms would receive versus when pulp would be shipped, various time lags were used to calculate which period would provide a better fit. In terms of timing, the pulp price lagged one period provided the best...
fit. The two exceptions were purchaser I, where the current period provided the best fit, and purchaser J, where the price two months ago provided the best fit. This may be due to differences for those purchasers between processing and shipping or may reflect different pricing practices.

The second set of coefficients in Table 13 show how the prices paid to sawmills differed by their location; for example, sawmills which sold to purchaser A found that the price they received was lower by .9 cents per BDU for every kilometer of distance between them and purchaser A during Periods I-II, while in the Period III the price rose by 2.2 cents per BDU per km (3.1 cents -.9 cents). Three firms, C, D, and I paid prices during the first two periods that significantly fell with distance; however, the change in price was much less than the actual cost of transportation (prices dropped between 2 and 4 cents per BDU per kilometre but the actual cost of transportation is closer to 15 cents per BDU per kilometre). This may reflect a historic pricing practice involving the treatment of freight costs under the old stumpage system; freight costs in excess of a certain amount were disallowed and some more distant sawmills apparently received less for their chips as a result (Cooper 1995). Purchaser G did show prices that fell and that were comparable to the magnitude of actual costs; however, these results were significant at the 90% level. For the remaining six firms, prices did not vary significantly with distance. Three of the firms, E, H, and I, saw a significant change in the influence of distance on price in period III, where the price now fell for E and H while the price rose for Firm I.

The next set of coefficients in Table 13 shows how the price paid for chips was influenced by the price of lumber. For example, a $1 increase in the price of a thousand board feet dropped the price paid by purchaser A .9 cents per BDU. Only one purchaser, I, showed a significant effect: a $1 increase per thousand board feet of lumber led purchaser I to raise its price by 3.8 cents per BDU. For the most part, other purchasers reported negative but insignificant effects.
Finally, the Time variable shows the time trend for chip prices, holding all the other variables constant. For example, in the case of purchaser A, the price was increasing by 27 cents per BDU per month over the time period. Two of the ten purchasers, D and F, showed significant increases while the rest showed no significant change.

Quite clearly uniform sawmill pricing, or formula pricing based on a percentage price of pulp explains the price of residual wood chips quite well for most of the purchasers in the BC Interior. Prices ranged around the percentage used as the minimum price by the government originally.\textsuperscript{119} While most of the purchasers increased the price slightly from the first period to the second in response to government intervention, all but one significantly increased the price they paid well above previous levels during the third period (which is chosen to cover the period during which it is hypothesized pulp mills reverted to more competitive price-setting behavior).

The evidence is somewhat more mixed in terms of the spatial pattern of prices. The model predicts that the prices received by sawmills from pulp mills will vary with distance (the net price decreasing if both purchasers are located together and increasing with distance if the two purchasers are located separately). While several purchasers did show significant changes in the price paid as a function of distance, only two purchasers, E and H, showed prices actually varying in magnitude comparable to actual transportation costs. In terms of market structure (i.e. prices rising under separate locations and falling under coincident locations), the changes were in the predicted direction for six of the nine firms (A, B, C, H, I, and J) (no data was available in this period for firm G). These mixed results may reflect the fact that the data available for this estimation covers the first several months only of the hypothesized change in firm behaviour, and that not all the price changes are fully captured.

\textsuperscript{119} The original percentage was based short tons, while pulp today is sold in metric tonnes. To convert from a short ton to a metric tonne, divide by 1.1.
An indirect confirmation of the spatial change in pricing practices comes from information released by the Ministry of Forests, which reports the average price of chips for different points within the Province that coincide with the location of sawmills. While the reported prices include both an imputation for transport costs and the effects of averaging across all mills within a region, these prices do provide some additional information on spatial patterns when prices peaked in 1995.

Table 14. Reported Average Chip Values by Location in the Northern Interior in 1994 and in 1996 ($/BDU for whitewood)

<table>
<thead>
<tr>
<th>Period</th>
<th>Prince George</th>
<th>McBride East Line</th>
<th>Vanderhoof East Line</th>
<th>Burns Lake East Line</th>
<th>Houston East Line</th>
<th>Smithers East Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994 (Period II)</td>
<td>$60</td>
<td>$55</td>
<td>$55</td>
<td>$55</td>
<td>$54</td>
<td>$57</td>
</tr>
<tr>
<td>Difference from Prince George price</td>
<td>-</td>
<td>$5</td>
<td>$5</td>
<td>$5</td>
<td>$6</td>
<td>$3</td>
</tr>
<tr>
<td>1996 (Period III)</td>
<td>$200</td>
<td>$180</td>
<td>$192</td>
<td>$188</td>
<td>$186</td>
<td>$178</td>
</tr>
<tr>
<td>Difference from Prince George price</td>
<td>-</td>
<td>$20</td>
<td>$8</td>
<td>$12</td>
<td>$14</td>
<td>$22</td>
</tr>
</tbody>
</table>

(Source: Interior Average Chip Values Effective July 1, 1994 and July 1, 1996, from BCMOF Interior Valuation manual)

Table 14 shows reported average chip values for two different regions in the Interior: the West Line, the rail line extending west from Prince George to Prince Rupert with several sawmills located along the way; and the East line, the same rail line running east through Valemount. The model predicts that competitive pricing should lead to the two purchasers paying a uniform delivered price in Prince George, with the price paid to sawmills falling the further away they lie from Prince George.\(^{120}\)

Although these reported values include adjustments for delivery points and freight costs, the underlying formulae were not changed during the two periods, and are based on prices from the preceding year with a three-month lag. Therefore, the increase in the difference between the value of residual chips in Prince George and of other chips in the surrounding

\(^{120}\) These prices include prices paid by firms other than the three mills in Prince George.
area between July of 1994 (based on average prices from April, 1993 through April, 1994) and July 1996 (based on April, 1995 through April, 1996) is due to changes in the prices paid for chips between each of the different locations. Quite clearly, price levels fall much faster as you move away from Prince George in 1996, compared to 1994, with the difference comparable to actual transportation costs.\textsuperscript{121}

\textbf{Market Power and Firm Reactions}

The results presented in Tables 13 and 14 are strongly suggestive of a change in chip price determination in the Interior beginning in 1994. However, they are restricted by data limitations and by the form of estimation, which examined how changes in end-product prices affected the prices paid by firms for wood chips.

Quite clearly, another factor in terms of the how firms set prices is how they will respond to changes in each others' prices. The model shows a potentially abrupt discontinuity as firms move from a relatively stable pricing system to a more competitive pricing scheme, as firms instantaneously switch pricing systems and change price levels.

The real world is more complicated. Firms (pulp mills) may not immediately recognize deviations from existing pricing systems; alternatively, they may resist raising prices at first until the possible risk of losing a chip supplier becomes clearly established. Furthermore, the model suggests that firms can costlessly and smoothly switch to the optimal pricing system under competition. However, transaction costs may be significant, and firms may not recognize the optimal system, especially under rapidly changing conditions and imperfect information. Firms may decide to simultaneously increase all their prices without changing the pricing system; this may be even more likely if the firms have had a long history of following certain pricing systems.
A more plausible formulation is that firms, instead of instantaneously moving from one equilibrium to another, effectively enter a transition state where the prices they set would depend in part upon what they think others are paying. In some sense, firms would develop reaction functions, which would dictate how they would respond to another firm’s prices.

There are many models within game theory that examine how assumptions about reaction functions can change outcomes. It should be stressed that in these models, reaction functions have a functional stable form; that is, while prices may be changing, the firms’ behaviour remains invariant.

**Estimating Response Functions**

Models that empirically examine firm interaction are rare, reflecting the difficulty in obtaining sufficient firm level data. One model that does is Slade (1986), who specifically examined firm interaction in her study of gasoline pricing during a gasoline war in Vancouver in the summer of 1985. In the model, a firm's demand curve is based on the prices set by itself and other firms and on other exogenous factors. It is then possible to derive the parameters of the demand curve and identify the predicted reaction function of the firms. The model can then be used to estimate the firms' reaction functions—how firms alter their prices in response to changes in other firms' prices—and tested against the behavior predicted under certain conjectural assumptions. Slade (1986) collected prices from both major and independent gasoline stations in Vancouver during a price war to see how closely the actual outcome matched theoretical predictions of cooperative and non-cooperative behavior. The actual estimation within the model gauged how each type of

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1. It is approximately 200 km from McBride to Prince George and 98 kilometres from Vanderhoof, suggesting imputed transportation costs on the order of 10 cents per BDU per km in 1996.
firms' prices change in response to changes in the other's prices, and showed that increased responses were correlated with greater competition.\textsuperscript{122}

\textit{Examining Firm Interaction}

The model developed in Chapter 3 does not have explicit reaction functions. Buyers practice Bertrand pricing, which means they anticipate that the rival buyer will pay slightly more if the firm attempts to purchase the good for less than the maximum the other firm is willing to pay (in some sense this is a kind of instantaneous ratcheting up of the price). Under the assumption that firms are using a Uniform Supplier pricing system and that firms use a fixed percentage of the price of pulp to coordinate prices, we should then observe a switch to prices based on marginal revenue when firms start to behave competitively. Firms do respond to one another's prices only in the sense that they will match each other's prices in the competitive equilibrium. Specifically, firms will respond to the other's individual marginal revenue in gauging what price to set, and they may use the price paid by the other firm as an indication of their marginal revenue (as it would be in a competitive market).

There are two hypotheses that can be tested. The first is an explicit prediction of the model: if firms do switch from following some kind of pricing system to a set of more competitive prices, there should be a measurable change between the two periods; that is, a significant difference in how prices evolved within each of the two periods.

The second hypothesis is more indirect and looks for how individual firm responses to one another may have changed between the two time periods. \textit{A priori}, one would expect that under a perfect pricing system all firms would use a fixed percentage of the pulp price and ignore changes in one another's prices, while under the assumption of a complete reversion

\textsuperscript{122} Slade (1986) notes that her model was limited to examining the behavior of gasoline stations only during the price war, as the uniformity of prices during periods of price 'peace' meant that there were no significant differences to be examined.
to the Prisoners' dilemma firms would immediately start paying the full residual marginal value. The truth is likely to lie somewhere in between the two (for example, suppose one firm follows a pricing system, and other firms base their prices on the price leader); however, one would expect increased firm interaction as firms move towards a more competitive outcome. Given that the data set covers a period of rapidly rising prices, and the assumption that prices will be moving towards more competitive levels, one would expect to see a positive increase in firms' responses.

The estimation procedure used is based on the Vector Autoregressive (VAR) model used in estimating dynamic simultaneous equations. Judge et al. (1988) provide an overview of this approach, which is used for multiple time series where there is interaction between the variables. The approach involves running simultaneous equations of different autoregressive processes that may include exogenous explanatory variables. The advantage of this approach is that it allows for error terms to be correlated across the equations which allows for greater efficiency in estimation.

Data
The data set used to estimate individual pricing patterns ended in July 1994 as access to the database was terminated. Further research identified a set of monthly prices for the five largest purchasers within the Interior from January 1995 through February 1996, yielding an additional 100 data points. As these prices were those reported by the purchasers for all their transactions, the individual transactions from the previous data set were aggregated to produce weighted average purchaser prices to make the two sets comparable. The total number of months covered between December 1987 and February 1996 was 80. However, due to missing transactions (either no information was available for a specific month or

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123 This approach is similar to one followed by Slade (1986), which uses Granger causality to test for price exogeneity as a means of determining market boundaries.

124 This appeared to reflect a growing uneasiness about looming trade actions vis-à-vis the Americans coupled with a change in how the data was collected.
there was no information on one of the five purchasers for that month), the final period covered was from the beginning of 1990 through February, 1996.

One problem with estimating time-series equations is that the process may be non-stationary due to the presence of time trends, seasonal patterns, or time-varying variances. The problem appeared in the latter part of the period and it was necessary to take first differences to ensure the process was stationary.

**Modeling Firm Interaction**
The model permits two specific formulations to be tested, using either a fixed percentage of the pulp price during the period of price coordination, or the residual value of the chips during the period of competitive behavior, as was done in Figure 20.

The model forces no restrictions on what period firms observe the price of pulp or the margin available other than that they do not forecast future prices. However, the differences in firms observed other firms’ chip prices are restricted to periods prior to the current period in which the firm is setting its own chip price. Given the secrecy with which chip prices tend to be guarded, it is not possible to specify how quickly pulp firms may learn about one another’s prices. Therefore, a one and two period lag were examined to see which provided the best fit. Pulp prices were transformed by taking 9% of the current price so that the magnitude of the response was comparable to other firms’ prices; this did not change the overall fit and meant that the coefficient could be interpreted in terms of how well the price changes matched changes in the percentage selling price of pulp.

Allowing for firm interaction and the possibility that firms did respond to one another’s prices changes leads to equation (4), which shows the price paid by a firm as a function of changes in the price of pulp and changes in other firms’ prices:
(4) \[ \Delta P_u = \beta_i \times \Delta Pulp_{t-a} + \sum_{j \neq i} \beta_j \Delta P_{j,t-b} \quad \text{where } a \geq 0 \text{ and } b \geq 1. \]

Allowing for prices to respond to changes in the marginal value product leads to equation (5). In this case, marginal value product is constructed as in Figure 20 by subtracting $400 from the price of pulp, correcting for the yield (about 45%), and deflating to convert current costs into nominal prices for previous periods.\(^{125}\) The specific equation is:

(5) \[ \Delta P_u = \beta_i \times \Delta Margin_{t-a} + \sum_{j \neq i} \beta_j \Delta P_{j,t-b} \quad \text{where } a \geq 0 \text{ and } b \geq 1. \]

Results from Estimating Firm Interaction

Tables 15 and 16 show the results of the estimation. The first column shows the firm, the second the effect of Pulp or Margin on the firm's price, with the subsequent five columns the effect of that particular firms' price. T-ratios are reported under each variable and coefficients significant at the 95% level are in bold. The \( R^2 \) follows each equation, and the Akaike Information Criterion (AIC) is also reported for each set of equations.\(^{126}\)

In addition, both sample periods were evaluated using the alternative measures Pulp or Margin to see which provided the better fit within each period. It turned out that the previous period pulp's price, as suggested in Table 13, provided the best fit during the period of assumed price coordination, while the current margin provided the best fit during the reversionary period.\(^{127}\) Akaike's AIC criterion was minimized to determine that a process of order 1 best fit the available data in each period.

\(^{125}\) This was the cost per tonne of producing pulp in BC, excluding fibre costs, in 1994 (BCMOF 1995). Because the recovery rate is 45% (that is, one tonne of wood chips will yield .45 tonne of pulp), the marginal value of wood chips is arrived at by deducting the manufacturing cost of chips from the selling price and then multiplying by .45.

\(^{126}\) Strictly speaking, the T-ratios show whether or not Granger causality exists, defined as to whether or not that variables improves the ability to predict the price of the variable in question. With a process of order 1, the test for Granger Causality is the equivalent of a T-test.

\(^{127}\) Best fit was that set of equations that minimized the AIC within that order. In addition, the \( R^2 \) for the individual equations was greater for three of the five equations, compared to those using pulp.
Table 15. Price Behavior under Assumed Price Coordination, 1990-February, 1994 (n=51)

<table>
<thead>
<tr>
<th>Firm</th>
<th>Pulp</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>.14</td>
<td>.47</td>
<td>-.06</td>
<td>.02</td>
<td>-.06</td>
<td>.03</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(.27)</td>
<td>(.95)</td>
<td>(.38)</td>
<td>(.11)</td>
<td>(.34)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>.61</td>
<td>-.11</td>
<td>.03</td>
<td>-.07</td>
<td>.19</td>
<td>.30</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(4.38)</td>
<td>(2.47)</td>
<td>(.54)</td>
<td>(1.21)</td>
<td>(2.84)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>.38</td>
<td>-.16</td>
<td>-.31</td>
<td>.59</td>
<td>.13</td>
<td>.26</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.09)</td>
<td>(1.47)</td>
<td>(.88)</td>
<td>(4.01)</td>
<td>(.76)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>.68</td>
<td>-.05</td>
<td>-.25</td>
<td>-.15</td>
<td>.02</td>
<td>.11</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.10)</td>
<td>(.44)</td>
<td>(.85)</td>
<td>(1.40)</td>
<td>(.15)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>.63</td>
<td>.27</td>
<td>.21</td>
<td>-.01</td>
<td>-.21</td>
<td>.16</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.09)</td>
<td>(3.63)</td>
<td>(.70)</td>
<td>(.11)</td>
<td>(1.64)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Critical Value of t for 95% Level of Confidence (One-Sided) = 1.94**

AIC = 16.418

In the first period, pulp prices are significant for firms B, D, and E, and comparable in magnitude, while pulp prices are positive but insignificant for the other two firms. In terms of the timing of the response, prices paid by other firms for residual chips using a two period lag provided a slightly better fit than one or three period lag. There was limited firm interaction, with B showing a negative response to firm A's price and a positive response to E's, while firm E showed a positive response to firm A's price. Firm C also showed a positive response to changes in firm D's price. Firm A lies between B and E, while Firm D is the closest firm to C, suggesting a geographical reason for some of the interaction.

The second period, when open bidding for chips occurred, provides more ambiguous results. While firm A shows that the available margin played a significant role in determining its prices, three of the four firms show the margin had a positive but insignificant effects while the fourth, C, shows a negative but insignificant effect. Firms B, C, and D show strong and significant responses to changes in Firm A's price and negative responses to Firm E. In addition, Firm B shows a negative response to C's price.
Table 16. Behavior of Prices After Open Bidding
Commenced: March, 1994 - February, 1996 (n=16*)

<table>
<thead>
<tr>
<th>Firm</th>
<th>Margin</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>.43</td>
<td>-.20</td>
<td>.44</td>
<td>-.22</td>
<td>.13</td>
<td>.48</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3.10)</td>
<td>(.94)</td>
<td>(1.28)</td>
<td>(.60)</td>
<td>(.65)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>.09</td>
<td>2.81</td>
<td>.64</td>
<td>.58</td>
<td>-1.83</td>
<td>.60</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(.59)</td>
<td>(2.91)</td>
<td>(2.12)</td>
<td>(1.56)</td>
<td>(2.08)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>-.06</td>
<td>3.34</td>
<td>.15</td>
<td>.15</td>
<td>-2.62</td>
<td>.73</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(.59)</td>
<td>(7.49)</td>
<td>(1.56)</td>
<td>(9.3)</td>
<td>(6.35)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>.12</td>
<td>1.78</td>
<td>-.01</td>
<td>.03</td>
<td>-1.18</td>
<td>.55</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.06)</td>
<td>(2.79)</td>
<td>(.06)</td>
<td>(.15)</td>
<td>(1.97)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>.18</td>
<td>.32</td>
<td>-.01</td>
<td>.33</td>
<td>-.39</td>
<td>.21</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.05)</td>
<td>(1.22)</td>
<td>(.05)</td>
<td>(.74)</td>
<td>(.85)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*reflects missing months
Critical t for 95% (one-sided)=1.94; AIC=23.663

Prices paid by other firms in the past period now provided a slightly better fit, suggesting the timing of their responses had shortened. Interaction between firms increased, both in the number of inter-firm responses from three in the first period to seven in this period, as well in the magnitude of the overall responses for most firms. Summing across the response by each firm to each other firm’s price to create an overall reaction, three of the five, B, C, and D showed an increase in their reaction, moving from the period of assumed price coordination to the reversionary period. For example, Firms B’s reaction increased from .04 to .92, Firm C’s from .25 to 1.02, and Firm D from -.43 to .62. Firm E remained relatively unchanged, with .26 in the first period and .25 in the second, while Firm A’s overall reaction dropped from .37 in the first period to .15 in the second.

This pattern of reactions can be explained in part by the location of the various firms. Firm E is located the furthest from the other four firms, while firms B, C, and D are the closest to each other. Firm A is located relatively equidistant to the other four. The individual responses suggest that Firm A was acting as a price leader, at least for firms B, C, and D. Firm E appears to have lagged other firms initially in raising its prices but then followed Firm A very closely, and this may explain the apparent negative response by the other firms to its price changes.
Table 16 suggests prices did not immediately and simultaneously move towards a system of price based on the marginal value of wood chips. While the model shows that firms will respond immediately by increasing the price to the maximum point they are willing to pay when coordination fails, the results suggest actual firm behavior was more complex and that one firm became a price leader, with the responses differing among the individual firms. In part, data limitations restricted the number of firms that could be included in the sample (although the five firms included are the largest purchasers within the Interior) and the time period that could be used in the estimation. Given the long history of following a specific pricing system (e.g. formula pricing based on a percentage of the output price), it is not surprising that it may take time for firms to adjust their expectations about how other firms will act.  

It should be noted that the model developed does allow for price leadership which in turn, depending on the firm configuration, may lead to a Basing Point system. Recall that the model showed that firms do not want to practice price leadership, but would rather instead follow a price leader. It may be the case that price leadership in this case may reflect a transitory stage between the US pricing system and discriminatory pricing.

The results do show that there was a change in the pricing process consistent with those expected under increased competitive behavior. Why did firm behaviour change? Recall that the discount rate can reflect firms expectations as to how long a particular game to last (or in another sense how long firms will behave according to the same rules). The fact that a sawmill (and perhaps most importantly the largest sawmill company in the Interior) was willing to put its chips up for bid, coupled with a willingness by at least some purchasers to respond, appears to have led to pulp mills rapidly revising their beliefs in the stability of both formula pricing and the fixed nature of their historic market areas. The dynamics of the prisoners' dilemma asserted themselves with a vengeance, as purchasers realized that continuing to follow the old system meant that they would

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128 In an interview with George Edgson, then vice-president with Slocan, the company that first offered its chips up for bid in the Interior, he noted that the initial bids by companies varied quite widely and that one company submitted a bid that basically reflected past practices. Even after giving the company another chance to resubmit its bid, they left the bid unaltered. The only explanation Edgson could offer was that they felt that no other company would try to purchase chips from that sawmill.
likely lose a significant portion of their supply. The end result was a move away from chip prices based on a low percentage of the pulp price towards prices based on the marginal value of wood chips, along with increased firm interaction as pulp mills actually competed for suppliers.

**Summary**

In summary, the significant increase in price levels of pulp chips starting in 1994 is associated with a change in market power due to a change in firm behavior. While it appears somewhat puzzling how such a change can have such an abrupt impact in terms of such rapid increase in price levels, as seen in Figures 21 and 22, such an increase is consistent when the participants find themselves in a prisoners’ dilemma. The participants move from a beneficially joint outcome to a less desirable outcome (and remain there) so long as each firm anticipates the other firms will no longer adhere to a particular set of rules. In this case, the firms' ability to coordinate prices among themselves diminished sharply as they moved away from formula pricing, and the result was a significant increase in the overall price level.

Traditional explanations of market power in this context would have missed much of the explanation for the change in prices. Neither market structure nor market concentration, the classical determinants of market power, changed over the study period. Utilization rates, while peaking in the summer of 1995, post-dated the change in behaviour of some chip sellers, and would be misleading if used as the sole criterion. While the relative demand and supply of chips influenced the degree of the price move to some extent, it was ultimately a change in firm behaviour most responsible for the dramatic change in prices. Historic supply relationships that had existed unchanged since the introduction of chip direction twenty years earlier dissolved as sawmills put their chips up for auction and pulp mills bid against each other.
Pulp mills within the area, by virtue of their size and location, do enjoy inherent structural market power, much as an isolated sawmill will enjoy market power in its local log markets. However, government policy during the initial development of this market helped to reinforce the pulp mills’ market power. For example, chip direction provided a way for firms to organize their suppliers without having to compete for them. Chapter 1 showed that many of the pulp companies felt that the main problem associated with the proposed PA’s in the 1980’s and 1990’s was the introduction of uncertainty as a result of the loss of directed chips and a potential re-ordering of supply relationships. Restrictions on the export of chips also reduced potential competition from purchasers outside the region, along with the uncertainty associated with the potential for market entrants. In addition, the cooperative nature of Fibreco Export, through its average cost pricing, also lessened the potential for competitive pressures from the export market. Finally, even when the chip direction policy was dropped, purchasers retained the right of first refusal, which was the right to meet any other potential purchaser’s offer for chips within their area. This appeared to work much like clauses among retailers guaranteeing that they will match or beat the lowest advertised price; under such conditions, firms are unwilling to lower prices to attract additional customers because any price cuts will be matched, reducing the likelihood of any increase in market share. Chip direction helped define where pulp mills received their supply; once that concern was sorted out, purchasers could focus on the issue of what prices to pay.

The introduction of minimum pricing provided an explicit signaling device. Burns (1936, p. 84) provides an analogy in the introduction of minimum pricing for steel in the US in the 1930s and how it led to price uniformity among the major steel producers.

129 “Alberta also introduced ‘chip direction’ in the 1970’s which still exists today. Sundance (a sawmill in Edson) has asked the provincial government to axe chip direction, which severely depresses chip prices.” Koch, 1995

130 Other potential purchasers include pulp and paper mills on the BC Coast. The key for them is transport costs for Interior chips and the cost of alternative supplies.

131 In the technical language of game theory, this provides a focal point which enables participants to choose among a variety of potential equilibria.
Minimum chip pricing did much the same in the Interior by providing a structure (a percentage of the pulp price) that reduced the computational uncertainty in trying to figure out what other buyers were paying. As Scherer (1980) pointed out, identifying prices at the purchase point removes some of the uncertainty relative to reporting prices delivered at the mill, where changes in prices could either reflect changes in transportation costs or changes in the purchase price.132

The COFI Chip Audit report, which shows the consumption and production of pulp fibre in the northern Interior on a quarterly basis and circulates within the pulp and paper industry. It provides a means for firms to monitor one another’s actions. By identifying suppliers and inventory levels, it further reduces the uncertainty surrounding the supply of chips in a large part of the Interior and helps facilitate price coordination (recall the quote from Philips (1981) in Chapter 2). The presence of such a report, along with the reliance on the percentage set by the government initially, suggest that these information requirements are quite important in leading to these types of tacitly collusive outcomes. More generally, see Howard and Stanbury (1990).

Along the same lines, it is interesting to note that under conditions of oligopsony, firms appear to prefer setting prices at the supplier’s location as opposed to the purchaser. For example, the Federal Trade Commission in 1934 issued an order requiring that large mills purchasing cottonseed to stop publishing bid prices which were calculated at the shipping points, as it was felt that such a practice led to non-competitive prices.133 A report issued by a Congressional committee in 1939 also noted that in the scrap metal industry, where

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132 This point is made by Philips regarding the introduction of the multiple basing point pricing system in Europe for steel, where he states that “The basic ingredient of tacit collusion is perfect information on actual prices, here delivered prices. Tacit collusion is therefore much easier with basing point prices than with f.o.b. mill prices. With the latter, there is uncertainty as to the exact delivered price... buyers may exploit this to obtain secret price reductions and then may carry out arbitrage through resale, so that general price levels may fall through the weakening of the geographical structure of delivered prices.” Note that is for firms selling as opposed to purchasing goods, but the basic principle of removing potential uncertainty remains the same. Philips, (1983: 306-307).

133 Temporary National Economic Committee (1939: 293).
there were very few buyers relative to a large number of small sellers, prices were quoted FOB shipping point.\footnote{Ibid. (p. 341).}

Along the same lines, a Royal Commission investigated pulpwood purchasing practices in Eastern Canada in 1958 after allegations of collusion in terms of bidding. Among the various memos and discussions between the various pulp companies provided to the Commission regarding their purchasing practices, is one where a participant notes that purchases: "should be FOB [rail]car and that FOB mill pricing was a dangerous practice."\footnote{Ibid. (p. 341).} Prices here were for the most part determined at the supplier's shipping point. Lofgren's (1985) observation that the practice of setting uniform roadside prices in Sweden for pulpwood reflects concave supply curves may be incomplete; this method of quoting prices also has the strategic effect of enabling firms to more easily coordinate prices and thereby limit competitive behaviour. This also suggests that Duerr's (1994) observation about the introduction of local pricing in the U.S. South for pulpwood may be backwards; that is, local pricing was introduced to hinder the emergence of more competitive behaviour and did not reflect increased competition. The widespread coincidence of roadside or sawmill pricing within pulpwood markets around the world likely reflects participants' awareness that this method of quoting prices may avert or at least dull competitive behavior.

As shown by the model, the dramatic increase in prices suggests that once tested, this particular price equilibrium was not very stable as pulp mills engaged in competitive behavior as chips were put up for bid. In the model, the discount rate is exogenous, and even a slight change in the discount rate can be sufficient to lead firms to move from one outcome to another. While it is not possible to weight how much firms' evaluation of future benefits and costs changed, it seems unlikely that either reaction periods (that is, the amount of time it would take firms to respond to one another's price changes) or interest rates changed significantly. The most plausible explanation for the change in the discount factor is likely due to firms' changing belief about how likely the previous system of fixed
market areas and formula pricing would last. Individual firms' perceptions of how circumstances had changed appeared to vary quite substantially at first. George Edgson, of Slocan, said that companies submitted widely varying bids with one company resubmitting the same price schedule that it was currently using (Edgson, 1995). However, once suppliers started to switch, purchasers appeared to feel that they could lose any portion of their chip supplies if they did not match the price changes, and as one fibre supply manager noted: “every time some chips jumped from pulp mill A to pulp mill B, the price went up by another $10 per BDU”. 136 While some firms initially signed contracts linking chip prices to the price of pulp at higher percentages than previous contracts, prices soon started to exceed these ‘formula’ prices. These ‘bonuses’ quickly vanished when pulp prices started to decline. 137

The circulation of information on chip production and consumption within part of the region suggests that pulp mills are well aware of the potential competition for suppliers and believe they must monitor one another's actions. This suggests that the information requirements to sustain these types of non-competitive outcomes are quite important and it is not clear to what extent information on both prices and quantities are needed. It does suggest that how prices evolve over future periods will be strongly influenced by how purchasers perceive the security of their local market areas and how they respond to one another's actions. To the extent that pulp markets soften and demand lessens, firms may feel that the potential competition has lessened, decreasing the perceived elasticity, and the price will drop. If new purchasers enter an area, disrupting supply patterns, prices may rise. It is unlikely prices will continue to remain a constant fixed percentage of the pulp price if firms continue to worry about securing their fibre supplies.

136 The manager wished to remain unidentified but represented a large consumer of pulp fibre in the Interior.
137 This fact emerged in a series of interviews with sawmillers throughout the region.
Formula pricing is simply another type of delivered pricing system where in this case prices are set uniformly across all suppliers regardless of location. This type of pricing offers several advantages to purchasers that practice it. First, by using a percentage of the pulp price to set the same price to all its suppliers and paying for all the transportation costs, the pulp mill ensures that it captures any locational rents and allows it to selectively purchase from its suppliers if it chooses to do so. For example, if the pulp mill wanted to increase its purchases of wood chips, it could purchase chips from more distant sawmills that it currently didn't buy from without having to raise the price across all of its suppliers (where the net price received the sawmill is the same but the chips are more costly due to the increased transportation costs). Second, this method of price-setting enables firms to coordinate prices and monitor one another much more easily by significantly reducing the computational uncertainty in determining prices. Under formula pricing, a purchaser can assume that if they learn the price paid by a rival purchaser to any one supplier that the price will be representative of all the other rival's suppliers. Purchasers don't have to worry about changes in transportation costs, which are a significant part of the delivered cost of fibre, and would likely affect the overall price level under another type of pricing scheme. This also reduces some of the uncertainty in price setting.

This type of pricing also has the benefit of reducing any incentive for sawmills (or a third party) to try and arbitrage to take advantage of the difference in delivered costs. As each sawmill receives the same price for its chips, and since pulp mills take care of all transportation, no sawmill or other party perceives any benefit from trying to buy and resell chips since all chips are price the same. Finally, this type of pricing has a superficial appeal in that equal prices seem “fair” to at least some of the sawmill supplying chips.

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138 This is only true to the extent there may be sawmills with uncommitted chips.

139 Opinions among sawmillers are divided but a surprising number felt this way. As one sawmill operator told me, “if we’re [their sawmill] getting the short end of the stick [through a low price], then at least everybody else is as well [referring to other sawmills supplying the pulp mill].”
In terms of economic theory, these results suggest that explicit delivered pricing systems do facilitate less competitive outcomes through making price coordination easier. Furthermore, as suggested by the magnitude of the price change, such systems can lead to outcomes that take on the characteristics of a prisoners’ dilemma. The pricing system may not be explicitly (overtly) organized to facilitate collusion (or as in the case of the Interior market reflect the unanticipated effect of policy choices). By reducing uncertainty and providing a mechanism by which firms can establish common prices, however, firms may now be able to reach tacitly collusive outcomes. Contrary to the results in Espinosa (1992), the more general economic model developed in this thesis, supported by an examination of actual market behaviour, suggests that uniform prices do not necessarily reflect the competitive outcome. Instead, these types of pricing patterns should be viewed with skepticism and examined to see to what extent they may permit price coordination.
5. The Policy Implications of Market Power

"You have to wonder if the price [of chips] can ever go as high again or the premiums paid over the formula prices can ever be realized again," says analyst Hamish Kerr...I don't think you need to go to $220 per bdu to get enough wood." as quoted in the Logging & Sawmilling Journal, June 1996

As noted in Chapter 1, the BC Interior market differs quite substantially from other pulp fibre markets in North America by the degree to which residual chips make up most of the furnish. The inelastic nature of chip supply, coupled with the joint nature of chip and lumber manufacturing, means it is difficult to identify the costs of chip production. Together, these factors have had the effect of making pulp fibre production in the Interior relatively insensitive to prices. In addition, the market for pulp chips is highly concentrated on the demand side and much less so the seller side. Throughout much of the Interior, there has historically been only one or two chip purchasers for most sawmills.

Furthermore, the fact that the provincial government owns most of the forest land within the province gives it a great deal of control over the industry. For example, cutting rights cannot be transferred between companies nor can existing facilities be shut down without government approval. Because the government regulates so many aspects of the industry, even relatively "minor" policy changes can have widespread effects.

In the wood chip market, provincial government policy designed to protect both parties ended up creating a particularly stable pricing structure that persisted past the official discontinuation of any explicit policies regarding chip pricing or production. Given the structural characteristics of the market, such as an inelastic chip supply function and a very limited number of buyers, this led to an unusually rigid market where neither prices nor quantities fluctuated a great deal until the past two years. In fact, the analysis in Chapter 4 shows that much of the recent change in prices reflected changes in firms' behaviour and expectations rather than changes in demand or supply conditions.
While these structural characteristics continue to influence the Interior market, there are also several trends both inside and outside the province that will also affect the market. In some cases, they may affect the supply and or demand for chips directly, while in other cases, they indirectly affect the market through their effect on lumber manufacturing. The following sections outline these trends and their potential effect on the Interior market. The primary issue, at least for the Interior, is not necessarily the physical availability of supply but rather the costs of that supply.

**Global Trends in Demand for Pulp Fibre**

A common denominator throughout North America has been the increasing use of sawmill residuals by pulp and paper companies as the economics of using these residuals (as a lower cost source of fibre relative to pulpwood) have proven increasingly attractive to pulp mills. As a result, most sawmills now find their sales of residual chips an integral part of their cash flow, and would be unable to operate if they could not sell their chips. However, the use of residuals has peaked, and analysts expect roundwood chipping to become increasingly important in BC while sawlog costs will continue to increase as firms move into more marginal timber stands (Anonymous 1995).

At the same time, both pulp and lumber markets have become noticeably more volatile in recent years. While no definitive analysis has been offered as to the source of the volatility, some possible explanatory variables include the growing integration of the world economy, which turns local markets into global markets, and fibre shortages in traditional timber-processing areas such as the Pacific Northwest during peak market conditions.  

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140 This trend has been most marked in Quebec, which has seen lumber shipments soar as pulp mills have both bought and built sawmills to take advantage of the economics of extracting as much lumber as possible out of what was previously considered pulpwood. *Pulp and Paper Wood Report*, October 1995, Miller Freeman.

141 See, for example, Cockram (1995) and Songehen and Haynes (1994).

142 It may be the case that initially the entrance of other firms from outside the local market may have dramatic effects on prices depending on the market structure as local firms may find regular
These localized fibre shortages induce price rises (where localized may mean as large an area as the West Coast of North America), which in turn makes other markets more attractive as increased prices cover the transportation costs of purchasing from more distant markets. As exchange rates and local economic conditions fluctuate, so too does the relative attractiveness of these markets, and changes in demand from outside the traditional market area can lead to sharp swings in prices.\(^{143}\) Hagler (1996) has suggested that small changes in demand for wood pulp can lead to large changes in price due to the emergence of a two-tiered global supply curve, reflecting the high cost producers in North America and Scandinavia and the emergence of low cost producers in Asia and elsewhere. In some cases, uncertainty about future fibre supply have only added to the volatility of markets.

Another explanation that has been offered as an explanation for increased volatility in the industry has been changes in the structure of the industry. Increasing substitution between hardwood and softwood pulps and the growing number of firms that can divert pulp from their own paper mills into the market pulp trade have added to short term uncertainty, although these factors may moderate price changes in the future. An increasingly complex distribution network also makes it more difficult to evaluate the demand and supply conditions for pulp. In some instances, inventories may be held in five different places, and the lead-time for firms to ship pulp from BC to Europe can be from 30 to 45 days (Geist, 1996). As a consequence, when firms perceive a potential market shortage, they simultaneously increase their inventories and prices quickly rise, creating a self-sustaining prophecy. This mechanism also works in reverse. As perceptions change, firms liquidate inventories and prices fall. There is some suggestion that even moderate adjustments of demand/supply patterns disrupted. Over the longer term, as markets become more globalized, the increasing number of firms and consumers participating may act as a check against sudden changes in prices due to local market conditions (e.g. increased imports of orange juice from Brazil when frosts reduce harvests in Florida).

\(^{143}\) In a paper presented at a conference in Atlanta in May of 1996, the consulting firm Jaakko Poyry suggest that big swings in the price of export logs from New Zealand in recent years can be attributed to the participation of the Japanese buying logs in the export market. (Jaakko Poyry, 1996)
inventories can lead to major swings in pulp shipments as this aggregate behaviour accentuates rather minor changes in demand (Geist, 1996).

Another long-term global trend is that of increased cost of fibre supplies, not only in Canada, but world-wide. McLaren (1996) reflects the thinking of a number of analysts who believe there will be a physical scarcity of fibre as demand for wood and paper products outstrips the supply of wood fibre. Hagler (1996) argues that there is a regulatory scarcity of fibre as policy-makers have reduced harvest levels to accommodate environmental concerns. The net effect, regardless of the reasons involved, is to reduce the volume of fibre available and to make the remaining volume higher cost. Songehen and Haynes (1994) noted that real prices for stumpage in the Pacific Northwest have shown a steady increase since the early 1900s; they also noted that the margins between lumber and stumpage in the region have steadily shrunk over time. It may be the case that a similar trend is underway for pulp fibre.

**Provincial Forest Policy Initiatives**

Many of the same trends described above are also evident in BC. In response to both environmental concerns and a mandate to pursue sustainable levels of harvest, the government has undertaken a series of policy initiatives that can generally be grouped under constraints on harvesting. These include initiatives that will lead to a direct reduction in what is called the "conventional cut" which will physically reduce the amount of wood available from Crown forest lands, as well as raising harvesting costs by directly mandating certain operational procedures.

The first set of policy initiatives can, generally, be grouped as environmental and land use initiatives. The government created the Commission on Resources and the Environment

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144 Given current supply and demand trends, a recent report issued by the International Institute for Environment and Development states that the world will need an 85% increase in the production of
In 1992, a provincial body charged with developing and implementing a regional land use planning process. The province also announced the Protected Areas Strategy (PAS) in 1992, pledging to increase the amount of parks within BC to 12% of the provincial land area by the year 2000 (by mid 1999 BC had hit approximately 11.2%). In addition, the province has developed specific land use plans for areas such as Clayoquot Sound in response to political pressure. The land use initiatives can generally be thought of as an attempt to identify which areas are considered suitable for timber harvesting and which areas will be managed for other priorities.

In 1993 the province also introduced the Forest Practices Code (FPC) in response to environmental concerns about harvesting methods (Province of British Columbia, 1994). The Code is directly concerned with harvesting practices and prescribes in a very detailed manner how harvesting can be carried out.

The provincial government has also undertaken a series of initiatives that can be grouped as forest management initiatives. The most prominent of these is the Timber Supply Review (TSR). The TSR is being undertaken in anticipation of the falldown in harvest rates as the forest industry moves from the existing mature forest with higher volumes per hectare into second growth forests that are harvested at a younger age. To reduce the impact of the reductions in harvest rates on what is called the conventional AAC (softwood sawlogs), the government is attempting to increase the harvest in what it calls non-conventional types through the partitioning of cutting rights. The non-conventional partition consists of deciduous species, smaller wood than traditionally has been harvested in the past, and wood that in the past was considered inaccessible or too costly to harvest. The provincial government completed the first timber supply review in 1997 (termed TSR 1) with a negligible reduction in the provincial AAC of 1/2 a percent. This, however, was due to pulpwood over the next 50 years and that there will be continued upward pressure on pulpwood prices. *Pulp and Paper Week*, August 12, 1996, page 5.

CORE recommended land use plans for Vancouver Island, the Cariboo-Chilcotin, and the West and East Kootenays. The government incorporated these suggestions in developing land use plans for the area. The Commission is currently quiescent and there are no signs of the government reviving it.
the increase in the non-traditional harvest types (the conventional softwood AAC decreased from 66.8 million cubic metres to 63.4 million cubic metres or by 5.2%) (Timber Supply Branch, 1999). It is anticipated that the ongoing review (TSR 2) will lead to a greater reduction in the AAC as the full impact of increased environmental regulations and set-asides are felt.

The provincial government also increased stumpage rates in May of 1994. The higher rates were designed, in part, to fend off potential trade action by U.S. lumber companies, as well as to fund a set of policy initiatives that can generally be classified as transition/mitigation (Price Waterhouse, 1995). These include the Forest Renewal Plan, the Forest Sector Strategy, and the Forest Jobs Commission. These are meant to provide assistance to workers from job losses resulting from land use decisions and to develop a strategy for the BC forest sector.

**Impacts of Forest Policy Initiatives**

The main effect to date has been both a reduction in the amount of fibre harvested per hectare, as well as an increase in the cost of the available fibre (above and beyond that attributable to the lower yield per hectare). A report commissioned by the provincial government showed that the cost of delivered logs in the Interior rose by $32.46 between 1992 and 1996, while the cost of logs on the BC Coast rose by $46.35 (KPMG 1997).

The increased cost stems both from the increase in stumpage rates as well as from such items as increased road construction costs, due to more stringent design requirements, increased roading as a consequence of different harvesting practices, and environmental regulations that now require operations to take place in more inaccessible areas.

Increased costs also arise from the increased planning requirements and need for detailed planning.

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146 These rates were reduced in June of 1998 and have been contested under the Canada-US Softwood Lumber Agreement (SLA). A settlement was reached in September 1999 that left rates unchanged but imposed higher export fees for BC under the SLA.
harvesting plans. Firms also lose flexibility in scheduling their harvest, as planning requirements require the licensee to have drawn up a detailed cutting plan at least two years in advance. Firms now find that if changes in market prices have changed the desirability of their operational plan (for example, during times of high pulpwood prices, firms may choose to undertake thinning or harvest more marginal stands than they otherwise would), they are limited by the need to obtain regulatory approval. Finally, the licensee becomes much more constrained in what they cut on the site and may be unable to adjust their harvest profile to market conditions (in other words, bringing in additional lower grade material or leaving more behind depending on prices).

The net effect of all these initiatives will be to reduce the area available for timber harvesting thereby reducing the amount of sawlogs, which in turn will decrease the amount of residual chips available. The net effect of these reductions is discussed in more detail in Nelson et al. (1997), but is sufficient to create a deficit of residual sawmill chips in the Interior based on the average historic operating rate for the pulp and paper industry in the province. Interior pulp mills will likely look to roundwood chips to meet their fibre needs.

Tenure Policy
While these initiatives affect the cost of fibre, the government also influences the pulp fibre market through its practice of timber allocation. It has been a long-standing feature of government policy to award long-term cutting rights to timber processors. In recent years, the government has responded with several programs to complaints that it is difficult for operators without cutting rights and new entrants to acquire fibre for processing. The most important of these, in terms of size, is the Small Business Forest Enterprise Program.

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147 One case study from the southern Interior suggested harvesting levels would drop by 31% while overall operating costs would increase by 32%, with roadbuilding costs increasing 87% (Thibodeau, 1995).

148 The Ministry of Forests has to approve a forest management plan and grant a cutting permit before a licensee is allowed to harvest any timber.

149 Licensees still retain the right to adjust their overall harvest levels within prescribed amounts over one and five year terms.
(SBFEP) which provides short term cutting licenses. These are awarded on the basis of either the highest bid or on how well an application satisfies certain criteria such as the amount of employment created or economic value added to the processed timber.

Because most timber is held through long term cutting rights, licensees develop trading relationships and other arrangements with other licensees to come up with the best species mix for their particular mill. However, it has been acknowledged that licensees are uninterested in trading fibre unless they can obtain fibre in return (BCMOF 1993). The result of this is that there are virtually no substantial quantities of fibre freely available on the open market. The net effect has been to create a substantial secondary market for fibre that requires participants to have fibre to trade. This is best illustrated on the Coast, where the Vancouver Log Market mainly functions as a trading mechanism for participants to obtain desirable species and quality mixes for their fibre. There has been little such trading in the Interior to date, although pulp mills in the Interior do engage in chip swaps to both rationalize transportation costs and to obtain certain species mixes. However, such chip swaps are on a one-for-one basis; that is, there are reciprocal flows of chips which avoids the need to set prices (Henricksen 1995).

The BC government also encourages such secondary trading (not all of it need take place between pulp mills and sawmills) through its policy of allocating timber directly. In some cases, firms may apply for a Small Business Sale even though they have no intention of using the logs directly or may even be unable to use all the logs they harvest. In fact, the government now permits applicants to apply for timber sales even if they cannot use the logs directly but show that they can trade the logs for suitable fibre. Such arrangements are likely to take the form of long-term contracts or supply arrangements geared towards the particular requirements of that licensee, further reducing the volumes that may be available on the open market.
The BC government has also undertaken to award the wood that would previously have been categorized as useable only by the pulp industry. This includes some small scale salvage programs, where the applicant enters the logging area to retrieve logging waste, and the granting of timber licenses for smaller wood (sometimes termed problem forest types). This in turn reduces the potential supply available to the pulp industry. The net effect of all these policies are to further reduce the ability of market participants to respond to changes in market conditions.

To the extent that all of the BC government's fibre is committed, one likely response of purchasers is to enter into long-term agreements with specific suppliers and to develop their own capacity to produce pulp fibre from within their own cutting rights before turning to the open market. The size of that market is likely to shrink to the point that purchasers may no longer regard it as a significant source of supply. To the extent supply patterns become fixed, prices will trend downwards as that market shrinks in importance.

**Stumpage Policy**
In Chapter 1, it was noted that the production of wood chips has gradually become an integral part of sawmills' operations. Figure 23 shows the average value of lumber and chips produced per cubic metre of log input on a quarterly basis, termed *Product Value*, in the Interior from the third quarter of 1990 through the end of 1998. Figure 23 also shows the average stumpage charge in the Interior expressed as a percentage of the product value for the same time period, showing the relative change in stumpage values over the past seven years.

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150 *Product value* was constructed by using the price of SPF random length lumber and multiplying it by .250 (the Lumber Recovery Factor) and adding the chip value (multiplying chip prices by .15 or the Chip Recovery Factor) per cubic metre of log input. Clearly, this measure would vary widely depending on company-specific products and recovery factors. It should be noted that to the extent a firm is operating in areas with high pulp log concentrations that the ability to pay would be shifted downwards significantly (although stumpage charges would also have to be adjusted to reflect minimum stumpage for pulp logs).
The introduction of 'Super Stumpage' in May of 1994 can be clearly seen, which established higher stumpage rates when lumber prices exceeded certain values\footnote{Specifically for the Interior, three different formula are used, where the cutoff is based on the Statistics Canada index used to track price movements for lumber produced in the BC Interior. The net effect is to shift the effective rate up over higher prices.}. Note that even after the stumpage reduction that took effect in June, 1998, stumpage expressed as a percentage of product value has been consistently higher over the past four years (1994-98) than in the previous four (1990 – 1993).\footnote{At the end of 1997, stumpage as a percent of product value was once again around 23\%, based on a lumber price of approximately $(US) 300 per Mbf and chip prices of $85 per BDU.} Given the increase in costs associated with the Forest Practices Code, this suggests that the annual margin for stumpage payment in the sawmilling industry has shrunk in recent years (a point echoed by Binkley 1995).

The implications of this phenomenon for chip pricing are several-fold. First of all, the stumpage system in use for the past decade used only lumber prices to determine overall
Wood chip prices were used to help distribute charges within the Interior but did not affect the overall level. This meant that when chip prices increased four-fold between 1994 and 1995, the increase had no effect on stumpage rates although it clearly affected sawmill's ability to pay that stumpage. Discussions with industry participants suggest that the record prices paid for chips helped cushion the effect of the increased costs discussed earlier in the face of falling lumber prices. However, when chip prices fell and chip shipments were curtailed, some sawmills found themselves unable to operate and either closed or reduced shifts as stumpage levels remained unchanged. This was a significant change from the previous system (pre-1987) where chip and lumber revenues and costs were used in determining stumpage.

Due in part to the realization that chip revenues affect a sawmills' revenue, the provincial government incorporated chip prices in stumpage determination when it revised stumpage rates (though in a somewhat convoluted fashion). The basic mechanism of the stumpage system remains unchanged, however, and whether or not stumpage rates will be responsive to changes in economic operating conditions remains an open question (in large part because costs are still not taken into account in determining the overall level of charges).

Second, chip prices also effect the economics of marginal operations. Several sawmills stated that during the peak in chip prices they considered commercial thinning; however, as prices fell, they could no longer justify the operations (Mayes 1995, Pinette 1995). High chip prices also substantially improved the ability of sawmills to buy wood on the open

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153 The specific formulas used in determining stumpage are set forth in both the Coast and Interior Appraisal manuals. In addition, there have been several explanatory papers written about the mechanics of the stumpage system. A fairly concise view of the stumpage system established in 1988 can be found in Deloitte, Haskins and Sells (1988).

154 This was changed when stumpage rates were reduced in June, 1988. A weighted average of the appropriate lumber index and the index for chip prices in BC are constructed for both regions in establishing stumpage rates.
market, an important consideration where many sawmills in the Interior are increasingly relying on purchased wood. However, when pulp prices fall, utilization standards may require firms to bring out wood that is uneconomic and that would be left behind based on the costs of harvesting and transport.

Finally, because of the high degree of reliance by the pulp and paper industry on residual chips, low lumber prices can influence the availability of pulp fibre supply since firms will shut down when they are unable to operate profitably. The ability of pulp mills to offset the effects of lower lumber prices by paying more for their fibre depends on the state of pulp markets, and the two market cycles may not necessarily coincide (a high pulp market offsetting a low lumber market). One consequence in the past has been government intervention, as noted in Chapter 1, when sawmills lobbied the government to increase chip prices in response to increased stumpage costs during previous market cycles with low lumber prices.156 157

The Interaction Between Formula Pricing and Firm Behavior
Finally, formula pricing has been a long-standing feature in both the Coastal and Interior pulp fibre markets. In the past, it provided a simple means of establishing fibre prices in the face of abundant supplies of low cost residue that would otherwise be considered waste. It allowed sawmills to receive more revenues when the output price rose. However, this means of determining prices is a crude measure of demand. It fails to recognize the

155 Wood classified as suitable for pulp is charged at the minimum rate of 25 cents per cubic metre and is incorporated in determining the relative value of a stand of timber but does not affect the overall stumpage levels.

156 "Resource Minister Bob Williams dropped several hints during the weekend about government assistance to B.C.'s hard-pressed lumber industry...He said independent sawmills are 'being exploited' by pulp companies which pay low prices for wood chips and that legislative action was one measure of ensuring a better price." (Prince George Citizen 1974)

157 "The other controversy in BC (regarding the introduction of the new stumpage system in 1987) surrounds wood chip pricing in the Interior of BC. All pulp mills in the Interior of BC use wood chips generated as a by-product from sawmilling operations. The sawmills would like to see chip prices regulated (increased) by the Provincial Government, while the pulp mills are resisting such a move. Our sense is that the government does not really want to get involved in chip price
effects of changing supply on prices. With all types of fibre becoming scarcer, and relative end product prices changing more quickly, pulp companies may find themselves at a disadvantage to the extent they rely on fixed formulae to establish prices that do not reflect changing relative prices of available fibre. For example, the cost of residual chips was greater than that of roundwood chips on the Coast during parts of 1994 and 1995. This reflected in part the fact that some of the chip contracts were tied to lagged prices of pulp while the roundwood market was reflecting current demand and supply conditions. In some cases companies were unable to adjust their prices rapidly enough and overpaid for their chips where they had made provisional payments in the preceding time period (Kuan 1997).

However, formula pricing, by linking the input price of wood chips to the output price for pulp, has the virtue of reducing uncertainty for the pulp mill of one of its major costs of production. Pulp mills still largely rely on the spot market to set prices for pulp, even under long-term contracts, and as noted market pulp prices have been volatile in recent years. This practice helps reduce some of the risk from entering into fibre supply contracts with suppliers.

**The Effect of Imperfect Markets on Social Welfare**

As discussed in Chapter 2, there is no general rule about what constitutes a Pareto optimum in markets characterized by space and market power. Instead, the set of prices that maximize social welfare depend on the assumptions of that particular model. In the model developed in Chapter 4, total surplus remained constant: the only difference between the various pricing schemes lay in how the surplus was distributed among suppliers and between consumers and suppliers.

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158 Alfred Marshall is known for characterizing the determination of prices as akin to that of the action of two scissors blades on representing demand and the other supply.
This means that there are no deadweight losses that are commonly associated with the presence of market power. However, there are implications for the forest industry and provincial economy as a whole arising from the historic behavior of wood chip prices within the Interior market. These implications stem from the dual role prices serve both as a means of allocating the surplus generated by pulp and paper production, and in the signals they send to the marketplace. What may have been the effect of a non-competitive equilibrium on the Interior market?

As Anderson (1985) has pointed out, when timber tends to be Crown granted and administratively priced, the corrective tendency of increasing timber prices under market-based systems to signify increasing scarcity is absent. To the extent prices are distorted, firms may make the wrong decisions. Anderson pointed out that one likely effect would be towards over-investment, as firms would inaccurately perceive investment decisions as profitable based on incorrect prices. To what extent, then, might low chip prices have led to over-investment within the pulp and paper sector in BC?

Investment and Estimates of Rent
In order to examine the question of whether over-investment may have taken place, it is necessary to have some measure of the economic performance of the pulp and paper sector. One such measure is the amount of economic rent generated within that sector. The definition of Ricardian rent, the most common rent associated with forestry, is that it equals the final sale value of timber less the costs of harvesting it. Calculating the available Ricardian rent in the BC forest sector involves estimating the final sale value of timber by the value of shipments of the wood products industry and subtracting the wood industry's total harvesting costs, and doing the same for the pulp and paper industry. Much of this data is available on an annual basis from Statistics Canada, which reports expenditures on materials, supplies, and fuel as well as labor expenditures by industry group within the forest sector. However, it is also necessary to calculate the cost of capital used in the industry. The standard approach is to estimate the user cost of capital, which is

\[\text{159 The available data does not permit sectors to be regionally disaggregated.}\]
usually constructed as the opportunity cost of the capital stock plus depreciation. The opportunity cost requires choosing a rate of return which can include a risk premium. For these calculations, the average annual prime rate plus 2% for risk was used as the rate of return. The detailed methodology and calculations behind the estimates can be found in Grafton, Lynch, and Nelson (1998).

Earlier work only estimated rents in the solid wood sector of BC (Copithorne 1979; Percy 1987; Grafton, Lynch and Nelson 1998). Why might rents exist in the pulp and paper sector as well?

Pulp and paper mills in BC consume some fibre directly (approximately 17% - see Table 5) and resource rents may appear for the same reason they appear in the solid wood sector. More importantly, as discussed in the previous chapter, has been the effect of an “artificial” market equilibrium creating the possibility of “monopoly” rents as lower chip prices effectively transferred producer surplus from sawmills to pulp mills (note that if sawmills had received higher prices this would result in higher estimates of the resource rent).

Figure 24 shows yearly estimates of rent in the solid wood and pulp and paper sectors along with the charges for Crown Timber. Several features are immediately apparent, most noticeably the increasing amplitude of the estimates for both the solid wood and pulp and paper sector. This in part is due to the influence of inflation, but also represents the increasing size of both industries, although the solid wood sector has consistently been larger than the pulp and paper sector in terms of rent. In addition, it can be seen that both sectors are reasonably well correlated over most of the time period in question, with the exception of the last few years. Timber charges appear fairly synchronized with rent estimates over much of the period with the exception of the past few years which coincides with the introduction of the CVP system. Most noticeable, though, are the large negative estimates for the pulp and paper sector in the early 1980’s and again in the early 1990’s.

1994 and 1995 are estimated based on historic relationships between shipment values and rent estimates as the Statistics Canada data used to derive earlier values was not available.
Figure 24. Annual Resource Rent in British Columbia by Sector, and Timber Charges in 000’s of Dollars

Table 17 separates the rent estimates into three different periods that correspond to changes in the stumpage system used by the province. The 1994-95 rent numbers are estimated and in current dollars. Each entry represents the cumulative total of rent or charges for that period.

The .77 can be used as an approximate conversion figure to translate current $ into Constant $.

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Table 17. Estimates of Rent and Charges over Three Different Periods (in millions of current and constant $)

<table>
<thead>
<tr>
<th>Period</th>
<th>Solid Wood Rent in Current $</th>
<th>Solid Wood Rent in Constant $</th>
<th>Pulp &amp; Paper Rent in Constant $</th>
<th>Total Rent in Constant $</th>
<th>Charges in Constant $</th>
<th>Charges As a Percent of Estimated Total Rent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970-80</td>
<td>$4,426</td>
<td>$8,551</td>
<td>$1,422</td>
<td>$9,972</td>
<td>$3,953</td>
<td>40%</td>
</tr>
<tr>
<td>1980-87</td>
<td>$2,490</td>
<td>$2,362</td>
<td>($1,477)</td>
<td>$915</td>
<td>$1,385</td>
<td>151%</td>
</tr>
<tr>
<td>1988-93</td>
<td>$6,713</td>
<td>$5,551</td>
<td>($789)</td>
<td>$4,762</td>
<td>$3,450</td>
<td>75%</td>
</tr>
<tr>
<td>Total</td>
<td>$13,269</td>
<td>$16,464</td>
<td>($1,336)</td>
<td>$15,560</td>
<td>$8,788</td>
<td>57%</td>
</tr>
<tr>
<td>1994-95</td>
<td>(all estimates in current dollars)</td>
<td>$3,612</td>
<td>$1,412</td>
<td>$5,024</td>
<td>$3,991</td>
<td>80%</td>
</tr>
</tbody>
</table>

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161 .77 can be used as an approximate conversion figure to translate current $ into Constant $.
Table 18 presents the same information, excluding pulp and paper rents, on a per cubic metre basis to account for changing harvest levels over the different periods. The amount of rent has, unsurprisingly, varied dramatically throughout the years, reflecting for the most part cyclical changes in lumber and pulp prices (see Figure 2). When the effects of inflation are removed, recent high lumber and pulp prices can be seen to be comparable to those in earlier years. The level of rent collection has dramatically increased in recent years; in fact, these estimates suggest that in four of the past eight years, more rent was collected through timber charges than was available (in theory) in the solid wood sector. Clearly, such levels of rent capture cannot be sustained in the long run without implications for capital re-investment.

Table 18. Estimates of Resource Rent and Timber Charges on a Per Cubic Metre Basis, 1970-95

<table>
<thead>
<tr>
<th>Period</th>
<th>Harvest (millions of m³)</th>
<th>Solid Wood Rent in Constant 1986$ / m³</th>
<th>Charges in Constant 1986$ / m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970-80</td>
<td>714</td>
<td>$11.98</td>
<td>$5.54</td>
</tr>
<tr>
<td>1980-87</td>
<td>508</td>
<td>$4.65</td>
<td>$2.73</td>
</tr>
<tr>
<td>1988-93</td>
<td>479</td>
<td>$11.58</td>
<td>$7.19</td>
</tr>
<tr>
<td>Total / Average</td>
<td>1,701</td>
<td>$9.68</td>
<td>$5.17</td>
</tr>
<tr>
<td>1994-95 (est. in current ₹)</td>
<td>152</td>
<td>$23.76</td>
<td>$26.24</td>
</tr>
</tbody>
</table>

The large estimates of "negative" rent for the pulp and paper industry reflect the capital intensity of the industry and the fact that prices often fall to near cash costs during recessions when firms are unable to cover their costs of capital. Over the market cycle, however, firms would recover those costs given that the optimal level of capacity existed in the industry. Persistent losses, however, would be a sign for some capacity to exit the market.

Consequences of Uncollected Rent

These estimates of rent also suggest that significant amounts of rent were not collected through timber charges over the period 1970 through 1980. As noted earlier, leaving some rent uncollected will not affect the level of output. However, to the extent the remaining rent represents a payment
in excess of all economic costs, those payments may have a long term impact. Suggestions that have been made include: higher wages; rent dissipation; X-inefficiency; increased firm profitability; and excess wood-processing capacity. Examinations of some of these possibilities have noted that while wages do appear higher in the forest sector, historic rates of return for BC companies have been below their peers for much of the past decade (Schwindt, 1979; Pearse, 1976; Copithorne, 1979; Price Waterhouse, 1996). Table 19 shows the rates of return by product for forestry companies operating in BC.¹⁶³

<table>
<thead>
<tr>
<th>Table 19. Return on Capital Employed by Product</th>
</tr>
</thead>
<tbody>
<tr>
<td>-------</td>
</tr>
<tr>
<td>Lumber</td>
</tr>
<tr>
<td>Market Pulp</td>
</tr>
<tr>
<td>Newsprint</td>
</tr>
</tbody>
</table>

Source: Price Waterhouse, 1996

One possibility is that the rent retained by the firms signified individually the marginal profitability of increasing capacity. Although resource rent is a price-determined economic residual from an industry perspective, it appears as a cost of production to individual firms. In the case of uncollected rent, the excess returns are likely to be attributed to the other commonly fixed factor, capital, and provide the incentive to expand output by investing in additional capital. There has been some institutional bias behind this; one means of increasing harvesting rights in earlier years was to increase the sawmill capacity and apply to the government for the additional wood requirements. However, despite the individual firm's perceptions, firms in aggregate faced overall constraints in harvest levels. As early as 1980, Ministry officials within BC were warning of an eventual fall-down effect as harvest levels dropped to reflect the move into second-growth forests.

¹⁶² Different assumptions about the interest rate would lead to different estimates. However, even setting the risk premium to 0 still yields negative estimates over the period 1970-93 for the pulp and paper industry in BC.

¹⁶³ Background information used to prepare these reports distinguish market pulp production between the BC Coast and the Interior. The Interior has consistently been more profitable than the Coast over the past eight years as measured by operating earnings expressed on a per metric tonne basis (Price Waterhouse, various).
(Ministry of Forests 1984). The end result has been an over-investment in capacity, with the remaining rent dissipated across now excess capacity. This is the equivalent of the common resource property in fisheries that leads to over-investment in fishing effort until returns and the stock are driven down to the point where no rent remains. Here, firms undertook investments predicated on incorrect assumptions about wood costs that did not yield a sufficient return.

Adding the current estimates of rent (for the two years 1994-95) to the estimates from the previous two periods (1980-87 and 1988-93) show that the pulp and paper industry lost approximately $1.2 billion over the entire time period. Using the same method, the solid wood sector would have earned $10.7 billion over those 17 years (see Table 16). This result suggests that there has been an over-investment in pulp and paper capacity in the province. From the pulp mill's perspective, increasing capacity appeared profitable at the margin using the prevailing "market" prices for residual wood chips. However, from an economic perspective, the "market" price for wood chips did not reflect the actual economic opportunity cost of that fibre. The end result was a collective over-investment in pulp capacity.

The implications, then, are quite dramatic. Short term government intervention in the Interior residual chip market, designed to address specific concerns, had unintended consequences even after the government ostensibly withdrew from involvement in the market. As prices of chips remained essentially frozen, reflecting the peculiar characteristics of both the commodity and market structure, firms did not receive the types of signals they otherwise would reflecting changes in market scarcity, with the result that short-term prospects led, in aggregate, to long-term losses.
6. CONCLUSIONS

The world of business is a world of oligopoly. No inductive leap (a la F. Knight, 1921) from pure competition is truly feasible for policymakers, save a leap into the world of oligopoly... (Greenhut and Ohta 1993: 398)

In summary, the pattern of prices observed in the BC Interior wood chip market over the period 1987 to 1996 cannot be explained by a simple model of competitive behaviour. Instead, the level and pattern of prices in the wood chip market reflect both the significant influence of government intervention in that market as well as non-competitive behaviour. A model of spatial price discrimination shows how price coordination can effectively lead to non-competitive outcomes. In the Interior wood chip market, price controls enacted by the government in the early stages of the market (from the early 1960s through 1980), coupled with restrictions on who could purchase chips, effectively froze the market. No individual purchaser had any incentive to deviate from historic supply arrangements so long as other firms also adhered to the same arrangements. In terms of general economic theory, the results suggest that in this case, a delivered pricing system reduced effective competition by permitting firms to engage in tacit coordination.

The model of spatial price discrimination also showed that these types of outcomes have the characteristics of a prisoner's dilemma. Such equilibria can be inherently unstable, especially as firms change their beliefs about the environment in which they operate. Various empirical tests show that prices in the Interior market were below those in other markets, and remained relatively fixed until a breakdown of historic supply arrangements. This change in firm behaviour and beliefs led to a rapid increase in prices as firms reverted to the dominant equilibrium in the Prisoner's dilemma (which in this case is associated with higher prices).

What might happen in the future? There is a considerable degree of indeterminacy of chip pricing that is not found in pulpwood pricing. While lumber prices may provide some
theoretical floor for chip prices, the increasing volatility of lumber markets, coupled with the increased costs noted above, make it difficult to identify the minimum prices necessary for sawmills to remain profitable over the long run. This indeterminacy provides a great deal of scope for bargaining over chip prices, which may be one reason chip pricing has been so contentious in the past (as seen in Chapter 1). Chip pricing will continue to be a major issue given its role in affecting the ability of sawmills to pay stumpage and consequently operate, the importance of operating levels for stumpage revenues to the government, and the fact that fibre costs are the most significant issue facing pulp and paper firms in the province today. Consider the fact that at historic levels of production of around six million BDUs annually, a $10 increase in the price per unit raises revenues in the Interior sawmill industry by $60 million, and these revenues flow straight to the bottom line.

As noted above, residual chips will no longer provide enough raw material for the Interior pulp industry (Nelson et al. 1997). While their availability may vary depending on sawmill operating rates, shipments to the Coast, and the export market, an increasing amount of fibre has come and will continue to come from the utilization of roundwood chips. In effect, they will act as the surge (or buffer) for pulp fibre supply, much as is the case in the Pacific Northwest. How these fibre sources are developed, however, can have important implications for the Interior industry. Both the inherent market structure, coupled with government policy regarding both harvesting and stumpage, have led to an increasingly inflexible market. Unchanged, this is likely to lead to a market that alternates between periods of relative quiescence and periods of sharp volatility.

The structure of the pulp and paper industry, given the regional concentration and relative size of most pulp mills, is conducive to the exercise of market power. This is offset

164 A recent issue of Madison’s Canadian Lumber Reporter alludes to the ongoing tension in this market with an article entitled “Chip Wars”, which discusses the importance of chip revenues to the sawmill industry without coming to any conclusions (Madison’s, November 29, 1996).
somewhat by the participation of other purchasers from outside the region, namely the export market and pulp mills on the BC Coast, although the export of wood chips, as noted in Chapter 1, has long been a contentious issue.\textsuperscript{165}

To the extent sawmills and pulp mills continue to focus on chip prices and regard pricing as a zero-sum proposition (in other words, any increase in price comes straight off one party's bottom line and increases the other's), their relationship will continue to be adversarial. In addition, so long as participants regard the system as being unresponsive or inflexible, the government will continue to face pressure from both sides as each propose their own solution to the problems of pricing and supply. However, as noted in this thesis, past government intervention has often had unintended consequences, and more intervention would likely lead to even less flexibility for participants in the chip market. However, given that chip prices have little impact on production decisions, why should policy makers care whether the market is competitive or not?

There are several reasons. As discussed in the preceding chapter, incorrect prices can lead firms to make incorrect investment decisions. But perhaps more importantly, competitive markets provide a means of allocating goods and distributing funds that are more responsive than the command and control techniques associated with government regulation.

A competitive market promotes economic efficiency in two ways: (a) allocative efficiency; and (b) technical or x-efficiency. In terms of the wood chip market, this means that market prices send accurate signals about the utilization of the resource. Forest policy in BC has been characterized by a reliance on regulations to achieve economic goals. One of these goals is improving the utilization of the resource, processing wood that would otherwise be

\textsuperscript{165} Gillis (1989) notes that debates over the export of pulp wood in Ontario and Quebec in the first part of the twentieth century were very similar, and notes that the main reason local pulp mills were unhappy with exports was that US buyers effectively paid higher prices.
considered waste. To encourage the use of this fibre, the government mandates the recovery of certain volumes. This wood may face full stumpage charges or qualify for minimum stumpage (set at 25 cents per cubic metre). In addition, the volumes harvested may or may not count against a licensee’s allowable cut. However, it has been shown that such utilization standards may require firms to bring in uneconomic material; that is, the fibre costs more to harvest and transport than it is worth (Uhler and Morrison 1986). At times, the costs associated with processing such material can lead to a curtailment in logging activity, as firms cannot profitability process the whole stand given the utilization constraints.

Another characteristic of an efficient market is its ability to equilibrate demand and supply. In a freely open market, prices adjust to bring supply and demand into balance. Because much of the timber within BC is tied up in long term cutting right, there is not much available on the open market. This reduces the ability of participants to turn to that market to meet their needs.

The practice of granting long-term cutting rights to specific facilities also frustrates the kind of responses that would be expected under competitive markets. For example, the Kraft process requires twice the amount of pulpwood per unit of output compared to the mechanical pulp process. It may be that switching pulping processes will be one of the ways the pulp and paper industry adjusts to the decreased availability of fibre. To the extent volumes are tied up in tenures committed to certain facilities, these type of adjustments will be retarded.

An example of some of these forces at work can be seen in the short-term collapse of the pulp log market on the Coast in 1996 (Truck Logger 1996). Integrated companies on the BC Coast, fearing a potential shortfall of pulp fibre during the market peak in 1995, imported significant quantities of pulp logs from outside BC as that was the only market that could provide significant volumes quickly. However, when pulp prices collapsed,
firms found themselves with soaring inventories and the domestic market for pulp logs came to a virtual standstill (Truck Logger, 1996). This in turn led to a sharp reduction in logging, and calls for the government to reduce stumpage until the pulp log price recovered as prices for pulp logs were less than their harvesting costs. In some case, firms continued to import fibre that was now substantially more expensive than domestic fibre.

The same calls for changes in stumpage have been made in the Interior, where firms with a high proportion of pulp material in their cutting areas have made proposals to the Ministry to change the stumpage system. They have argued that they should face reduced stumpage charges to reflect their relatively higher cost and lower valued timber stands (although under the current system such proposals would simply increase charges within other regions of the province) (Repap 1996).

Another benefit from competitive markets is that firms, if they feel wood chip volumes are freely available on the open market, will carry less inventories, reducing the amount of capital tied up while improving the quality of the pulp produced.

The provincial government has a claim to the rents generated by the forest industry through stumpage payments. Because most of this stumpage flows from the primary processors, sawmills are responsible for paying most of the stumpage. At the same time, the stumpage system does not use pulp fibre revenues to establish the level of charges.166

Despite the advent of market pulp made from de-inked paper and the development of new plantations, the consensus within the pulp and paper industry appears to be that when cyclical changes are ruled out that fibre costs will continue to increase. Increased world trade in fibre is expected as supplies decrease within traditional processing areas. At the same time, technological advances permitting the use of lower grade pulp in paper-making

166 This may change with the introduction of new stumpage calculations. However, modification of the current system depends in part on the impact it may have on the Softwood Lumber Agreement (SLA) with the US, and it is not clear yet whether the stumpage changes will meet with US approval.
reduce the ability of firms in British Columbia to charge the traditional premium for their higher quality pulp. At the same time, it is reasonable to expect that a larger proportion of fibre will be flowing into the pulp and paper sector given a decline in wood quality. Under such circumstances, it is likely that in the future the government may seek to establish a stumpage system that uses pulp fibre values. Again, a competitive market provides an accurate assessment of those values.\textsuperscript{167}

Finally, competitive markets also play a distributive role. As noted earlier, a feature of the model developed was that total production remained unchanged between the various equilibria, but the distribution of the surplus changed dramatically. From the perspective of a sawmill, higher chip prices are an unalloyed benefit, improving their bottom line, while a pulp and paper mill sees them as wreaking havoc on their bottom line, turning them into uneconomic producers. As noted above, the government also has an interest in any rents generated by pulp and paper production. Stigler (1971), in his seminal work, advanced the theory that most government regulation is a response to agents attempting to further their economic interests. Forest policy in BC has long been marked by political claims to the wealth generated by the forest (Marchak 1983; Schwindt and Heaps 1996).\textsuperscript{168} Groups establish claims to the resource rent through attempts to influence government involvement in the allocation and pricing of fibre, and the pulp fibre market is no different. Competitive markets provide a means of allocating and pricing fibre, relatively free from costly political involvement.

In terms of policy recommendations, the results suggest that in general the government should minimize its direct regulation of the wood chip market, and in particular, any

\textsuperscript{167} Accurate values for pulp fibre also are important in determining appropriate transfer prices. This is an area of particular concern as a significant portion of pulp produced in BC is transferred to an affiliate or partner in a joint venture elsewhere, allowing for the companies to shift profits between different jurisdictions. An example of this is the dispute between Crestbrook Pulp and Paper and Revenue Canada (Pratt and Urquhart, 1994).

\textsuperscript{168} BC is by no means unusual. Hansing and Wibe (1992) show how laws meant to ration timber in Sweden have helped the existing industry to deter entry.
regulations having to do with pricing and/or restrictions on where wood chip producers can market their chips. The evidence suggests that the Interior market can function competitively (given the existing market structure during the study period). The existence of a large market for wood chips, not often present elsewhere in Canada, offers an opportunity for policy makers to help establish competitive prices for pulp fibre. This offers many of the advantages outlined above, as well as providing more reliable values that can be used in decision-making. For example, the government has indicated a preference for more intensive silvicultural treatments. Because of the long time frame involved, the economic payoffs tend to be marginal. One of the ways in which these treatments can become profitable is through the use of various thinning techniques that provide volumes of wood earlier in the treatment period than the standard practice of harvesting at maturity. Recognizing the true economic value of this fibre, much of which is suitable for pulping, will help to determine where such treatments are feasible. In addition, the choice of end-product mix (for example, the proportion of sawlog versus pulpwood quality timber) is also dependent on the relative values of the products involved.

Another consideration the government faces is in establishing the trade-offs between the benefits and costs of environmental regulation in the forest industry. For example, the government is currently considering regulations that stipulate how much debris should be left on site after logging operations (this coarse woody debris being considered is different from the utilization standards currently in place). Some of this debris may be suitable for pulp fibre, and to the extent the government restricts firms from utilizing it, it places additional pressure on maintaining harvest levels. Establishing appropriate values will aid in making these kinds of decisions.

The government is likely to continue its tradition of encouraging economic development through granting access to wood fibre. However, much of the uncommitted wood fibre

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169 This includes ownership patterns, the number and distribution of pulp mills and sawmills, control of cutting rights, and harvest levels.
remaining today is non-conventional (e.g. is small, crooked, or insect-damaged); the pulp and paper industry is one of the most likely consumers of such fibre. This thesis has also shown that market power is a perennial concern throughout pulp fibre markets in Canada (Geldhart and Carroll 1980, Olson 1989, Runyon 1983, Nautiyal et al. 1995). If pulp and paper firms receive access to fibre through long-term commitments such as pulpwood agreements, market concentration and the potential for the exercise of market power can be expected to grow. The government should encourage the development of additional sources of fibre outside of integrated companies and should not permit the utilization of unused Pulpwood Agreements.

The provincial government may also want to review its policies on pricing for pulp fibre, recognizing that historic prices may not be a good predictor for future pricing. The tendency in the past, as noted in Chapter 1, has been to mechanically link charges to output prices. The government should also take into account the variability in end-product prices in designing an appropriate system of charges, recognizing that the ability to pay for pulp fibre differs substantially over the market cycle.

The government should also develop a consistent export policy. The current practice of on-again, off-again exports minimizes the benefits of having an effective market outlet for suppliers, as foreign customers regard BC chips as unreliable and price them accordingly. As discussed above, analysts have forecast increasing prices in the global marketplace for pulp fibre. Access to this market offers the possibility of increased competition in the provincial pulp fibre market and could offset the effects of local concentration. If the province reduces the ability of firms to participate in the export market, domestic chip prices will be lower in the long run.

The issue of whether or not residual chips should be retained to provide fibre supply for domestic pulp mills is another manifestation of the mercantilist’s debate about providing jobs by restricting imports (in this case, exports). As Margolick and Uhler (1992) show,
these policies provide direct benefits to the processors (in this case pulp mills) but the
benefits are outweighed by the losses suffered by the producers and the government. The
benefits of the export market in providing a competitive outlet should be recognized.\(^{170}\)
The previous chapter showed that the most likely outcome of this policy of retaining fibre
for domestic use has been an over-investment in pulp and paper capacity. Restricting
exports now will not address the fundamental issues underlying the long-term
competitiveness of the pulp and paper industry in the province.

Finally, there has to be a recognition that the definition of pulp fibre is always changing due
to new technology. It depends on the particular type of fibre, species involved, location,
transportation infrastructure, processing capacity, and market conditions. For example, on
the BC Coast, small logs can either be chipped or sawed, depending on the state of the
lumber and pulp markets. This presents difficulties in BC, where the tenure system is
designed to provide wood fibre to specific end users and then to calculate the appropriate
charges. The government should strongly resist the temptation to create or tie wood
volumes to specific uses and/or licensees and instead, increase the amount of wood that can
be brought to the open market that is uncommitted. In turn, the prices derived from open-
market purchases will help send the appropriate signals about the utilization of the timber
resource to companies, and also help firms and the government to establish competitive
prices for pulp fibre.

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\(^{170}\)The potential role of the export market in increasing competition by allowing alternative markets
has been recognized within the industry since the first debate over allowing pulpwod exports from
Canada to the US in the early 1920's. "The truth, however, was that the total quantities involved
were small in relation to the volume of wood cut on Crown Land. The importance of the export
trade, from an industry standpoint, was that exported fibre set the prices paid for fibre..."(Gillis
and Roach 1989:199)
References


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*Vancouver Sun*. 1978. B.C. wood chip exports can benefit all in the forest industry, if.... March 8: B1.


Appendix A. Data Sources

Several different data sets and sources were used to construct the tables and figures within this thesis. While some data does exist in the public domain, much of it is not publicly reported. Some of the most detailed data is only available on a proprietary basis. This appendix discusses those data sources used that are not easily available.

Ministry of Forests Data Set on Wood Chip Transactions

The stumpage system introduced by the province in 1997 requires information on end-product values for sawmills in the Interior. Consequently, the Revenue Branch within the Ministry of Forests started collecting information on wood chip transactions in December 1986. The government attempts to collect all arms-length transaction between buyers and sellers in the Interior on a monthly basis, including sales outside the region. Starting in 1994, the government discontinued its policy of identifying specific purchasers and instead reported transactions solely on the basis of the supplier’s location. Table A.1 shows the total number of transactions in the data set, by month. This includes reported sales to Fibreco; these sales and others to infrequent purchasers were omitted in the data set used to evaluate price levels and patterns in the Interior. A substantial number of transaction were reported for sales to Fibreco; however, these values varied widely, reflecting the use of chip sales by members to pay off loans incurred in the construction of the Fibreco pulp mill, resulting in a reduction in apparent chip prices. The government over this time frame found the prices too be unreliable and did not use the prices in calculating stumpage charges. This data was provided under conditions of strict confidentiality.
Table A.1. Ministry of Forests data

<table>
<thead>
<tr>
<th>Year</th>
<th>Months</th>
<th>Transactions</th>
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<tbody>
<tr>
<td>1987</td>
<td>7</td>
<td>134</td>
</tr>
<tr>
<td>1988</td>
<td>6</td>
<td>445</td>
</tr>
<tr>
<td>1989</td>
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<td>263</td>
</tr>
<tr>
<td>11/89-10/90</td>
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<tr>
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<td>684</td>
</tr>
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<td>11/92-4/93</td>
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</tr>
<tr>
<td>5/94-7/94</td>
<td>3</td>
<td>185</td>
</tr>
<tr>
<td>Total</td>
<td>75</td>
<td>4293</td>
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Table A.2. Sawmill data

<table>
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</thead>
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<td>1/95-2/96</td>
<td>14</td>
<td>70</td>
</tr>
</tbody>
</table>

Supplementary Data on Wood Chip Prices

As noted above, the government no longer identified specific purchasers starting in 1994. In order to extend the data set, a series of interviews were carried out through the Interior in the summer of 1996. Industry participants were able to provide information on prices paid by the five largest purchasers in the Interior from the beginning of 1995 through the first two months of 1996. The information was only available as an average price paid by the purchaser and not as individual transactions.
Chip Audit Task Force Report

This report has been circulating for at least twenty years. It is well-known within certain parts of the forest industry (certainly the pulp and paper industry). It is an extremely valuable source of information in terms of providing data on consumption and production for one region in the Interior. An industry participant kindly loaned me his copies for the period from 1987 through 1996, under conditions of strict confidentiality.

Woodfibre Northwest

This quarterly publication based in Bothell, Washington, tracks pulp fibre prices throughout Western North America. The publisher generously gave me permission to use certain historic data series on prices for various markets within the region.

Economics and Trade, Ministry of Forests

This branch of the Ministry tracks annual production and consumption of pulp fibre in the province. While the results are not publicly released, they are available to the public. In addition, this branch can provide information on chip exports, as well as information on different measures of production for various parts of the forest industry.