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THE UNIVERSITY OF ALBERTA

The Utilization of Wood Chips in Alberta

by

© Alexander Paul MacDonald

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Abstract

The purpose of this study is to analyze the impact of monopsonistic competition on the residue utilization of wood chips in Alberta. Although previous research has identified the presence of monopsonistic competition in chip marketing in Alberta, this study proposes to measure the present and potential levels of residue utilization in Alberta's sawmills.

The measure of a firm's performance is evaluated on the basis of economic efficiency. To measure economic efficiency the study considered three measures of a firm's performance : Net Present Value (NPV), Internal Rate of Return (IRR) and the Profitability Ratio (P/R). [1] All three methods were tested for their sensitivity to changes in prices, costs and discount rates. Twenty-Five sawmills in Alberta were surveyed. Thirteen of these firms chip sawmill residues.

This study also discussed the information base regarding the costs of production for the chipping operation, the rate of return available for the sawmills, identification of cost constraints that specifically affect rates of return, the impact of size of operation on costs of production, the effect of location of mill on rates of return, transportation costs, the cost of wood chips to the producers of pulp and the economic impact of the price policies employed by the pulpmills.

[1] The Profitability Ratio is a Benefit-Cost Ratio used for cashflow analysis.

The Cost-Price-Firm analysis examined the extent to which the price of chips is a limiting factor in achieving a high IRR, when high annual or initial costs prevail. Some of the firms' problems which tended to reduce the IRR were : choice of equipment, type of maintenance required, and the mill layout. Where a high Chip Recovery Factor (CRF) existed i.e., amount of chips on a (BDU) basis / per Mfbm, high variable costs of production were the cause of a low rate of return (IRR).

The evaluation of various supply-demand scenarios concluded that in determining the economic impact of potential sources the expansion by the existing pulpmills and the addition of new developments had to be taken into account because of increased demand for cheaper sawmill residues. As the current prices (Freight On Board)(f.o.b) sawmill demonstrate, more competition would assist sawmills in obtaining prices for their chips closer to that of the pulpmills' costs of production.

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I. The Problem and Its Significance

A. Introduction

Determining how much of a tree's residue is economically useable is of concern to forest companies and government administrators. Each group is interested in efficiency, but from a different perspective. The forest company is interested in maximizing profit, while government administrators may be interested in resource utilization from a social viewpoint which includes: [2]

1. Yield Volumes (maximization)
2. Harvest Volumes (maximization)
3. Processing Utilization (maximization)

Recently, greater attention has been given to increased utilization of trees as the costs of fibre resources have risen. The specific aspect of utilization considered in this study is the production of chips by sawmills as wood input to Alberta's pulp and paper industry.

Previous research has indicated that chips are sold in imperfectly competitive markets (Geldart, 1978). Therefore, this study will examine the affect of the market on the efficiency of residue utilization. [3]

---

[2] Maximization is from both a biological and an economic viewpoint

[3] Economic efficiency is the ratio of the values of outputs obtained from an economic process to the value of inputs necessary to produce them. The higher the value of output per dollar's worth of resource input, the greater the efficiency of the process (Leftwich, 1976:389).

Residues and Their Uses

Wood residues are wood fibre left out of any conversion process. Some residues are recoverable as solid wood such as stemwood and industrial waste, e.g. offcuts, slabs, peelers, and cores. The residues must be chipped before they can be used by the pulp and paper, particle board, and fibreboard industries. Branches, stumps, slabs, or edgings are chipped at the logging or mill site. If the bark is removed, finer materials such as sawdust and shavings from sawmills and other forest mills are suitable as raw material for the pulp and paper, particle board, and fibreboard industries. Bark is used as a horticultural bedding material. Any remaining material which does not have potential as a wood-based product may be used for energy production.

Advantages of Chipping

Until the early 1950's cheap efficient equipment was not available for the debarking and chipping of trees. Mechanical debarkers and chippers for larger operations were developed first. Equipment is now available which allows most operations to bark logs and sell residues (Manning, 1972:1).

Since the 1960's, there has been an increase in the use of chipping equipment. Wages, capital investment costs, and the cost of raw materials have risen in the sawmill industry relative to chip prices. The price of lumber, (at least until the mid-to-late 1960's) remained relatively constant in real terms thereby intensifying a cost/price squeeze in the sawmill industry. As a result, the industry has become increasingly interested in extracting all marketable products, such as pulp chips, from roundwood.

The introduction of chipping into the sawmill industry has the following consequences:

1. " A broader economic base is established.
2. Industrial and technological changes occur.
3. Milling efficiencies encourage growth.
4. Resource management policy can be modified to provide additional timber requirements through implemetation of stricter utilization standards and timber distribution" (Bongalis, 1975:4).

The introduction of chipping and debarking equipment will affect the costs of other parts of the lumber production process. The cost of the equipment can be charged to both lumber and wood chip production accounts. For example, without debarking and chipping facilities saw maintenance is more frequent which affects the rate of lumber production. The cost to the sawmill for producing pulp chips may be viewed as an additional cost which results from sawlog debarking and chip production activities. The sale of wood chips also eliminates the cost of residue disposal.

B Problem Definition

As previous research has demonstrated, there are inefficiencies in the marketing of chips in Alberta (Geldhart, 1978). An efficient processing and marketing system is necessary for optimum resource utilization. It appears that in the present marketing system the buyers of chips are in a monopsonistic position and buy chips at the lowest price possible.[4] Sawmills close enough to the pulpmill to be able to sell their chips, have an opportunity cost for their residues equal to what the pulpmill is willing to pay. If they can not sell their chips, the residues have an opportunity cost that is equal to a disposal cost.

A price sensitivity analysis was undertaken to calculate the economic efficiency of sawmills to determine how sensitive they are under various pricing regimes. Chip production improvements were recommended based upon a firm's present production levels per output of lumber (Chip Recovery Factor). [5] Where a monopsonistic market exists, the question arises as to whether the price of chips is too low. More specifically, when given the production efficiency and location of a sawmill, does the price offered by the pulpmill provide a "fair" return for the sawmill?

This study examined the affect of transportation costs on the price of chips. Since some pulpmills have taken over the responsibility of transporting chips from the sawmills, prices (f.o.b pulpmill) were estimated. Calculating the

[4] Monopsonistic competition as opposed to monopolistic competition is the case of a single buyer of an input.
[5] The Chip Recovery Factor is defined as the amount of chips converted from sawmill residues and is measured on a BDU per Mfbm basis. A good level of Chip Recovery would be .6 BDU/Mfbm. See Chapter 5 for a discussion on Chip Recovery in Alberta.

price was useful because by estimating the cost of chipping at the pulpmill, a comparison between the costs at the sawmill and at the pulpmill was made. The role of the monopsonist pulpmill is central to ensuring residues are utilized. This role will change as the industry expands. Therefore, the dependence of sawmills of selling to only one buyer will change with new developments. Supply-demand scenarios were also set up to evaluate the impact of demand by present users of residues.

C. Objectives of the Study

The objectives of the study were twofold. The study evaluated the prices of chips as offered to the sawmills and determined the affect of prices on the rates of return of the firms. The study also investigated the costs of production and potential quantities for chipping from both the sawmill's and pulpmill's viewpoint.

D. The Relevant Facts

A number of studies were reviewed to help clarify the problem. For example, increases in residue utilization across Canada have been dramatic since the development of debarkers. "With the introduction of debarkers in the 1950's, mills started chipping up their residues and selling them to pulpmills" (Keays, 1979:1). From 1950 to 1970, "...wood residues as input by the pulp industry has also increased, ... from 2 percent of raw material input to 26 percent..." (Manning,1972:1). Manning (1972) attributes some of the increases of chipping in the 1960's to the cost/price squeeze that occurred when wage rates increased and the price of lumber essentially remained constant.

Wood residues as an input to the pulpmill vary across Canada, "representing from 56% of raw material in British Columbia to 12% in Ontario" (Manning,1972:13). In a mill study by Styan (1977) in Alberta, "40% of these potential residues were being utilized for pulping," and of the chippable residues, 25% were disposed of by landfill or burning. The corresponding figure for British Columbia was 4%. Styan (1977) concluded that mill residue was used efficiently in British Columbia (Styan,1977:4).

In Alberta, transportation inefficiencies caused some of the problem, as stated by Rodger (1977), "It would appear that some of the factors keeping chip prices down in Alberta, as opposed to B.C., were transportation costs and an inefficient freight system. "These factors alone tend to drive up the final cost of chips to the pulpmill"(Rodgers, 1977:38).

In northern Alberta, the railway system is viewed as being particularly inefficient, "For example; if chips were to come by rail, they would arrive at the railway terminal at Grimshaw, go through another interchange to the Northern Alberta Railway, take a long loop east through Peace River and then double back to Grande Prairie" (Rodgers,1977:38). An increase in the efficiency of the railway system would involve, " closer co-operation among the supplier, the receiver, and the railway company" (Rodger, 1977:38).

In North America, sawmilling has become more centralized and automated thereby reducing some of the effects of the increasing costs of transportation. In a study by Paul H. Jones (1977), the trend toward fewer sawmills would affect the work force - a, "... declining number of small sawmills, coupled with an increase in the number of larger productivity-low manpower sawmills, a declining work force will result," (Jones, 1977:40). This means sawmills would evolve into larger, more centralized and integrated operations. Burns (1968) stated:

> "it appears likely that integrated wood-using industries will develop in Alberta during the next decade and will reach an advanced stage of development by the end of this period" (Burns, 1968:26).

Burns stated also that the extent of the development would depend on the market situation. Due to slumps in the market in 1974, 1978, and 1981, industry response has contradicted predictions made in the 1960's.

Extensive use of the forests and the problems this poses for increased utilization is a situation created in part by government. As suggested by Burchell (1969) some provincial governments have been too lax in creating employment opportunities by continually adjusting their policies regarding natural resource based industries, "...by offering larger concessions of land to anyone who will create an industry" (Burchell,1969:88). Additional comments by Burchell (1969) suggest the problem was especially true of provincial government actions in Western Canada. More recently, Rodger (1977) states that such action was implemented as it was, "...not possible in the past to get pulpmills to establish in the province unless some incentive was added" (Rodger,1977:38).

This problem was also stated by Fraser (1978): due to the "...psychology of abundance for so many years, we tend to waste much of the fibre" (Fraser,1978:45). Firms did not place a sufficiently high value on the wood fibre input as much was available, and stumpage prices, or financial tariff to the government for utilizing the timber resource, were low. Industrial processing of residue generally begins with a situation in which price is low in comparison to the traditional wood raw material. Such is the situation in Alberta. The pulpmills buy chips as long as they are a cheaper source of wood fiber than their own roundwood supplies and as long as production is profitable at least in the short run.

E. Outline of Thesis

This concludes the first chapter and the defining of the problem. Chapter 2 outlines the theoretical tools relevant in evaluating the residue utilization problem. Chapter 3 outlines the cashflow approach undertaken in the study.

Chapter 4 details the assumptions needed in setting up the cost data. Chapter 5 is an evaluation of the data collected emphasizing production, capital costs, and the sensitivity of the sawmill industry to different discount rates and price changes. Chapter 6 discusses the pulpmill's cost of chipping and the impact of supply and demand. Chapter 7 contains the direction for improving wood residue utilization in Alberta, with conclusions.

II. Markets and Pricing of Wood Chips

A. Monospolistic Competition

The theoretical analysis is concerned with the definition of the type of markets in the sawmill and pulpmill industries in Alberta, and the pricing policies established.

The sawmills sell their pulp chips to one of two pulpmills, depending on location. For the study it is reasonable to assume that either pulpmill is a single buyer in their own defined market space. [6] Therefore, the pulpmills are monopsonistic in buying chips. One could consider the situation as oligopsonistic if both pulpmills were part of the same market for chips, but since they do not compete except at the outlying edge of their respective markets it was decided to consider the case of monopsony.

In contrast, buyer behavior under the conditions of pure competition are, "where a good is sold to very many small buyers, none of them buys enough that he can hope to influence the market price of the good"(Bain,1952:377). This supply is perfectly "elastic or horizontal at the going price, regardless of the shape of the industry curve"(Bain,1952:378).

The monopsonist faces an upwardly sloping supply curve "The upward slope of the resource supply curve faced by the

---

[6] A monopsonistic market exists where there is only one buyer.

monopsonist gives monopsony the characteristics that distinguish it from pure competition"(Leftwich,1976:331). The monopsonist pays higher and higher prices to obtain larger quantities of chips up to some optimum point.[7]

B. Marginal Productivity Analysis

Under the assumption of pure competition firms acquire inputs until the marginal revenue of the output equals the cost of the input. Whenever the marginal revenue exceeds the marginal cost of the input the firm can increase profits by acquiring more units of the input.

Marginal productivity analysis helps determine the firms derived demand for any given input. The derived demand for an input is prompted by the demand for the final product. A model that establishes the price of an input or inputs has to incorporate marginal productivity analysis, which essentially evaluates the demand for every input, with supply information of each input. On deciding on the level of output of pulp a pulpmill must consider the mix of inputs that will produce the level of output desired. Output can be shown as either total sales or as a total amount produced. Input will consist of identifying the quantities of raw material, labor, amount of capital equipment and other services required in the production of the output.

---

[7] Assume the monopsonist seeks the maximum profit from his operations.

Knowledge of the production function presupposes that a set of optimality calculations have been carried out. In order to minimize the cost of production the marginal product obtained from spending the last dollar on factor A must equal the marginal product obtained from spending the last dollar on factor B. More precisely:

> "an optimal combination of any two inputs I and J requires that the ratio of their marginal products be equal to the ratio of their prices."
> (Baumol, 1977:279)

$$MPi \ / \ MPj = Pi \ / \ Pj$$

As profit maximizers the firm will seek the optimality condition. A locus of input combinations can be created, all of which are capable of producing the same output level. The expansion path of a firm show the optimal input combination. will vary as the firm expands chip production.

> "Because the monopsonist has a control on input prices they are able to affect a change in price and therefore the slope of the price line. This control ultimately allows the firm to get to an optimality condition. The change in slope due to price changes allows a greater level of input and hence greater level of output for the same expenditure."
> (Geldhart, 1978:76)

In moving along an isoquant the use of different input combinations must satisfy the constraint that the last dollar spent on factor A must equal the marginal product of the last dollar spent on B.

From the firm's expansion path it is easy to find the firm's total and average cost curves. The expansion path shows the total cost of inputs needed to produce one specific level of output. Plotting all output points that make up the expansion path against costs of production will give the total cost curve.

Whether the firm is a perfect competitor or a monopsonist in the factor market, the equilibrium condition for factor hire is the same. Equilibrium factor employment occurs when the Marginal Revenue Product (MRP) of chips equals the Marginal Cost (MC) of chips at the pulpmill. When the firm is a perfect competitor in the factor market the MC of chips at the pulpmill equals the price of chips Price (P). In equilibrium the MRP of the pulpmill equals the MC of chips at the pulpmill, which equals the delivered price of chips P.[8] However, if the firm is a monopsonist the MC of chips to the pulpmill is greater than the price of chips P. The supply curve is the summation of the marginal costs of buying chips from all firms. The monopsonist will buy until the marginal cost equals marginal revenue. The marginal cost of chips at the pulpmill (MC pulpmill) represents the amount the pulpmill's expenditure on chips will rise as successive amounts of chips are purchased.[8]

[8] The assumption is made that the buyer buys each unit of any amount at the same minimum supply price (Bain, 1952:384).

Monopsony, Oligopsony and Perfect Competition

With the discussion already illustrating the equilibrium conditions necessary for monopsony and perfect competition it is worthwhile to illustrate the affect of these different forms of competition on the price of chips and quantity of chips supplied.[9] Graph 2-1, Page 15 shows the resulting prices and quantities bought. The monopsonist will maximize his profits by buying quantity Q1 chips at price P1. Buying more than Q1 chips would increase the monopsonists costs more than his revenue. This is because buying Q1 also corresponds to the intersection of the monopsonist's marginal cost and marginal revenue curve. Buying more than Q1 would take the firm beyond the point of intersection of the marginal revenue and cost curves.

In an oligopsonistic market, the marginal cost curve of the pulpmill will be less steep, as indicated by MC (Oligopsony) in Graph 2-1. The intersection of MC (Oligopsony) and MR (Pulpmill) shows that price P2 and quantity Q2 chips would be bought in an oligopsonistic market. Therefore more chips would be bought at a higher price assuming that the MR (Pulpmill) curve is the demand curve for factor inputs and MC (Oligopsony) is the supply curve of chips.

In a perfectly competitive market the Marginal Cost of chips to the pulpmill is the same as, MC (Chipping + trans)

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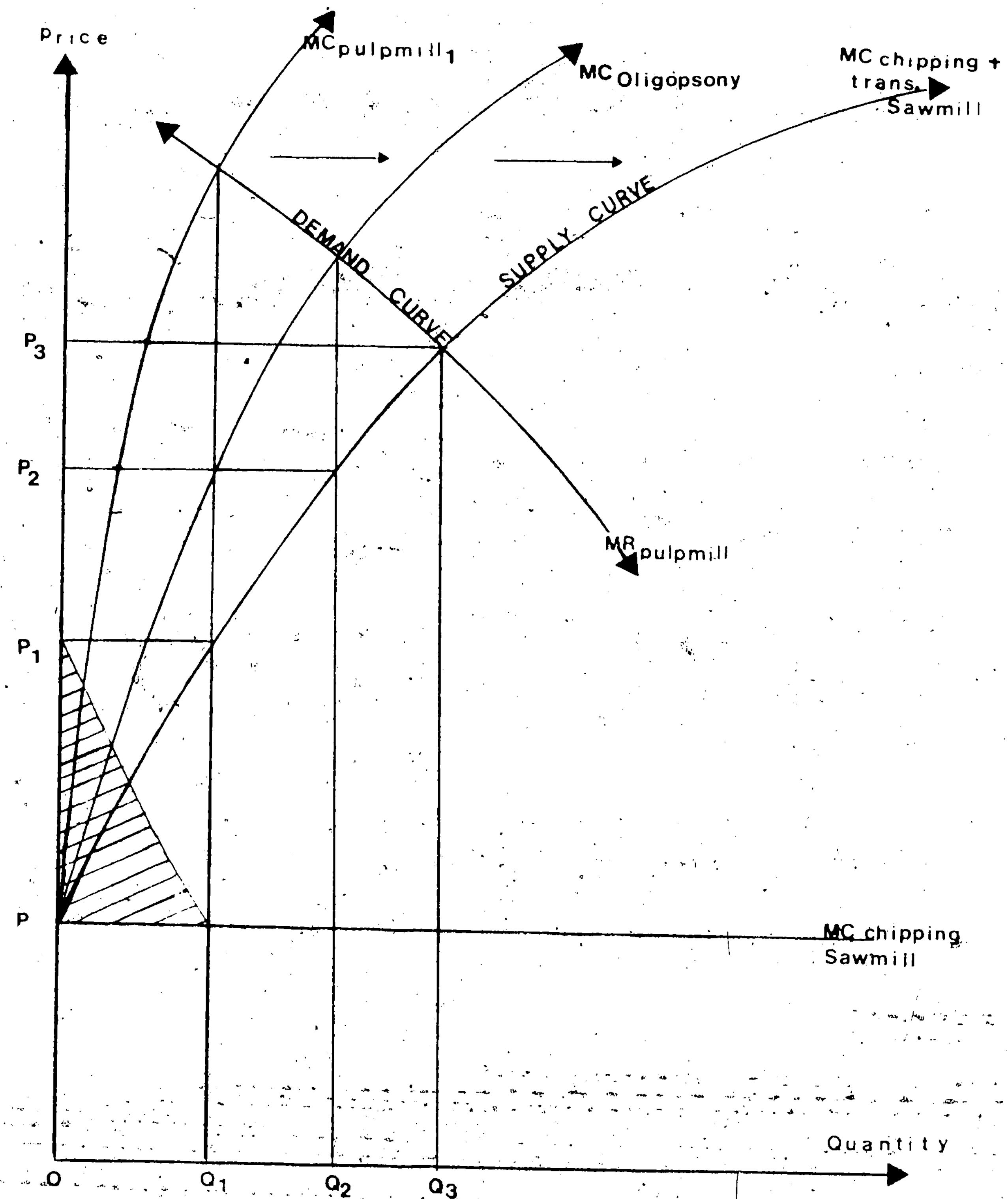
[9] Assume that the total pulp industry is the same size under all three forms of competition and the marginal revenue curve for the pulpmill is the demand curve for factor input.



Source:Adapted from;Carroll,M.R.,1981

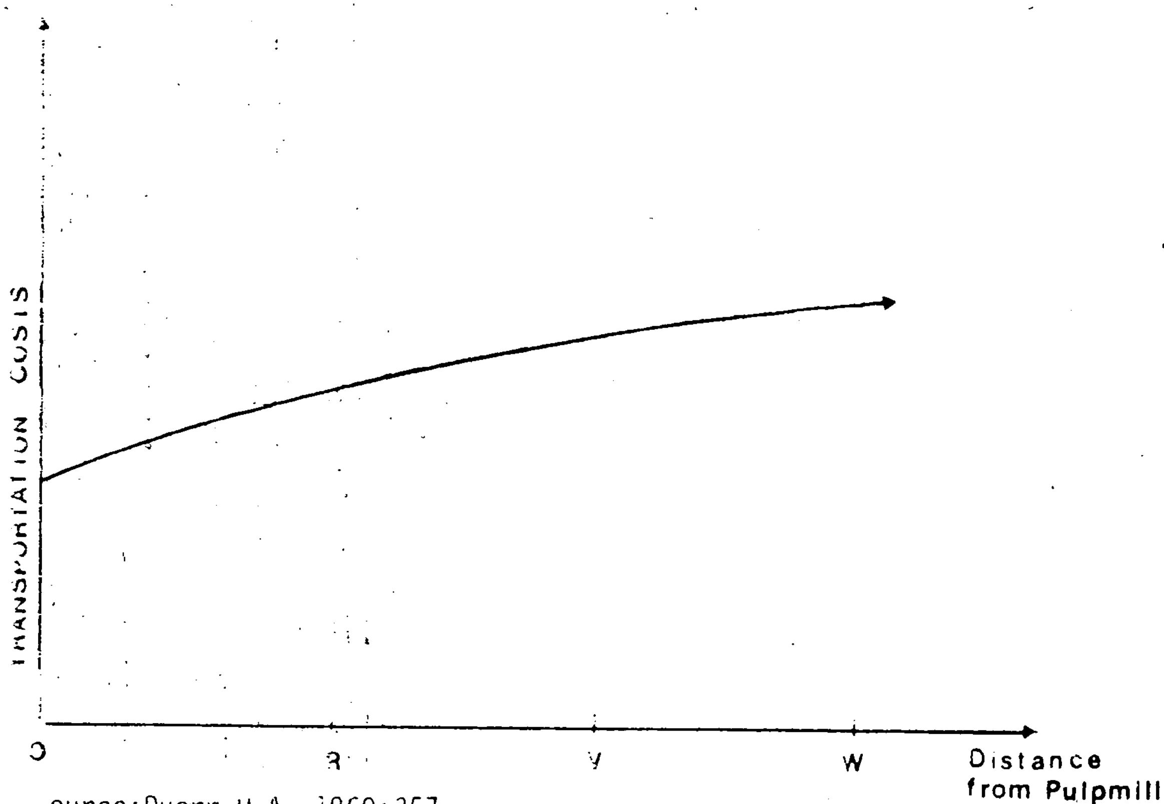
GRAPH 2-1 Monopsony,Oligopsony and Perfect Competition for the sawmill, the supply curve for the industry. As was assumed before the Marginal Revenue Curve for the pulpmill MR (Pulpmill) would be the demand curve for factor inputs. At the point of intersection of these two curves Q3 chips would be bought at price P3. Therefore under a perfectly competitive scheme the most chips would be bought Q3, at the highest price P3.

Effect of Transportation Costs Due to a Uniform Price Policy

The affect of transportation costs on the production of chips is introduced here. As shown in Graph 2-2, Page 17, the transportation costs will increase (but at a decreasing rate). In Graph 2-3, Page 18, in part A, point 0 is defined as the site of the pulpmill. The amount supplied by a sawmill will be dependent upon transporation costs and other variable and fixed costs of production. The firm will require a certain price (f.o.b. sawmill) to cover these necessary costs of production and an additional amount to cover the transportation costs.[10]

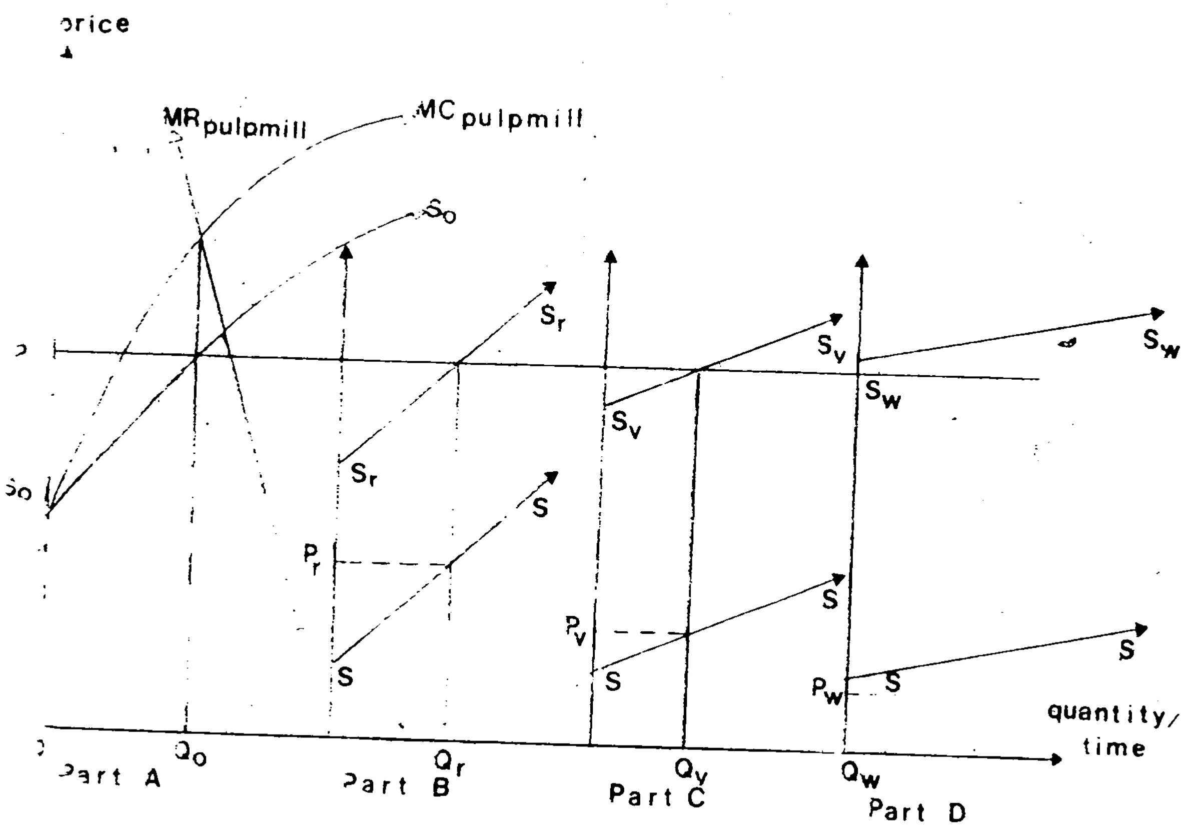
The SS lines in part B, C, and D, Graph 2-3, Page 18, represent the quantity of chips that a sawmill at locations R, V, and W, in Graph 2.2 respectively will supply. For this analysis, it is assumed that all firms have the same marginal costs of production regardless of location. The prices needed to cover their transportation costs which

[10] f.o.b. signifies freight on board and designates that either the supplier or buyer will be responsible for transporation costs i.e., f.o.b. supplier, the supplier is responsible.



Source: Duerr, W.A., 1960: 357

GRAPH 2-2 Effect of Distance



Source: Duerr, W.A. 1960:357

GRAPH 2 - 3 Individual Supply Curve

would induce them to supply chips to the pulpmill are represented by lines SrSr, SvSv, and SwSw in Graph 2-3. These lines were drawn at a distance above the SS lines equal to the variable cost of transportation for locations R, V, and W (from Graph 2-2). Adding the supply lines SrSr, SvSv, and SwSw together produces the aggregate supply curve SoSo in Graph 2-3. The MC pulpmill curve is the marginal cost curve for chips at the pulpmill derived from SoSo. The price P is the monosponist's optimum price found on the aggregate supply curve So.[11] The quantity Qo will be bought by the pulpmill at the intersection of the marginal revenue product (MR Pulpmill) and marginal cost curve (MC Pulpmill), in Graph 2-3.

For a delivered price P (f.o.b. pulpmill), sellers at R, in part B of Graph 2-3, Page 18 will supply quantity Qr and the local price (f.o.b. sawmill) will be price Pr. A similar analysis can be done for point V i.e., Qv and Pv. At point Qw the price P offered by the pulpmill is not enough to cover transportation costs for any sawmills located at point W, (from Graph 2-2), therefore no chips would be supplied by the sawmill. The analysis shows that if a sawmill was responsible for its own transporation costs after the costs of transportation were deducted, the price available to a sawmill decreases to such a point that a sawmill may not be able to supply chips. This concludes the

---

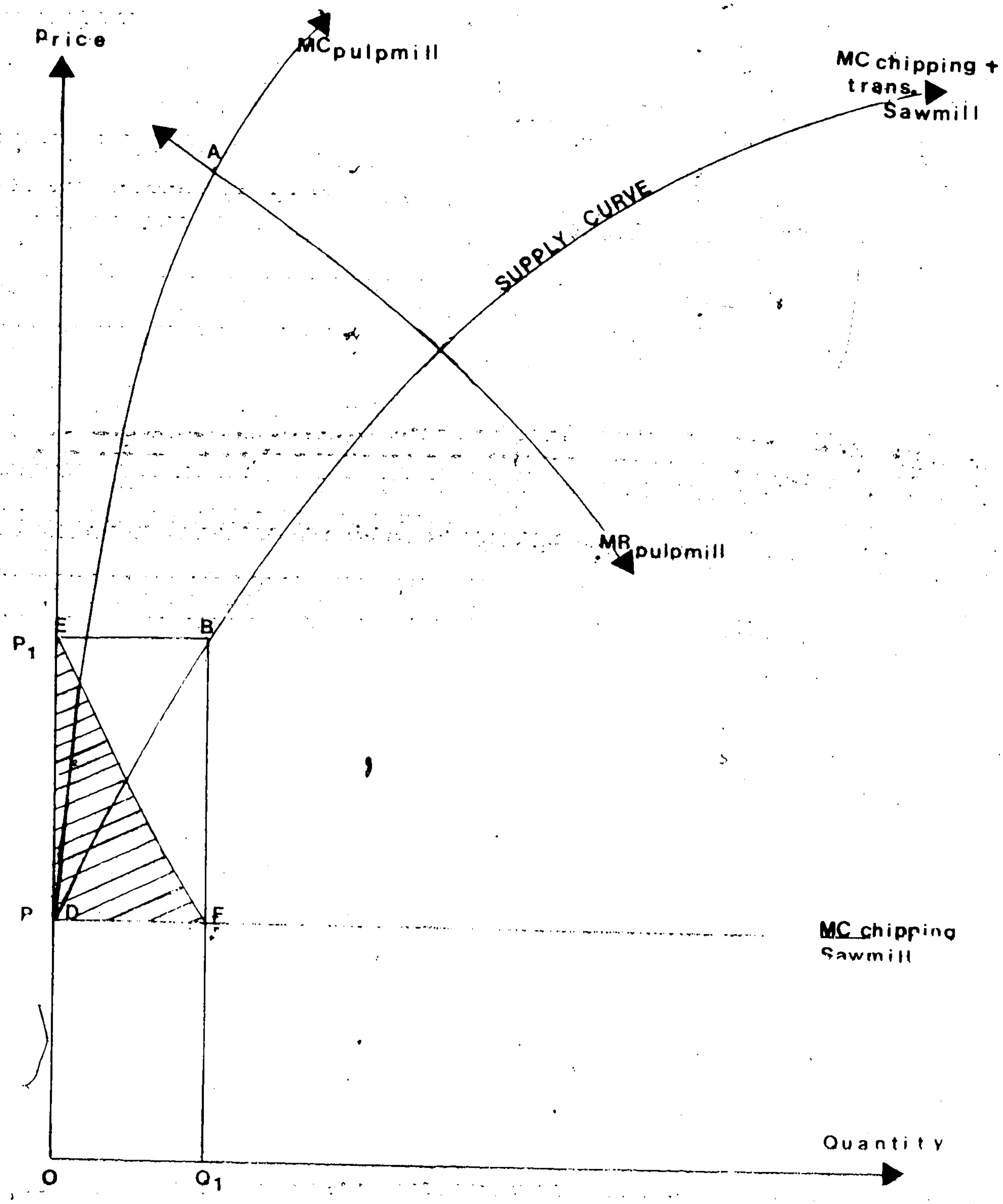
[11] This is the optimum point for the monopsonist where MRP=MC.

discussion of a uniform price policy.

Discriminatory Price Policy: A Comparison

The discussion will now compare the affects of the uniform and discriminatory pricing policies on the price of chips available to the sawmill. It is assumed that the marginal cost of chip production (MC chipping) to the sawmill in Graph 2-4, Page 21, is constant. The optimal price and quantity for the monopsonist would be Q1 chips at price P1. The monopsonist should relate the point of equality of marginal costs and revenues (at point A) to the supply curve of the sawmill (at point B).

As the previous section demonstrated, in assuming a pricing policy that is uniform, (nondiscriminatory), a sawmill's transportation costs are subtracted from the price the pulpmill would pay (f.o.b. pulpmill) to arrive at a price that is f.o.b sawmill. Sawmills are willing to sell at any price above P (f.o.b. sawmill)(see Graph 2-4). If the pulpmill buys at price P1 a sawmill with no variable transportation costs, i.e., at point D, would capture its producer surplus derived from P1 - P, times the quantity produced by the sawmill, at D. A sawmill at point F has no producer's surplus ((P1 - P) - (transportation costs) = zero). All sawmills between D and F have some producers surplus, the total of which is indicated by DEF (shaded area). The breakeven point for transporting chips (f.o.b. pulpmill) is where the sawmill would only be able to balance the costs (fixed and variable) of chipping and the price the



Source: Adapted from; Carroll, M.R., 1981: 4

GRAPH 2 4 **Monopolistic Competition with Transportation Costs** pulpmill charged for chips.

With a discriminatory price policy, the monopsonist discriminates between sawmills by offering a price P that just covers their marginal costs of chipping (MC chipping sawmill). By paying the price P, the producer's surplus (DEF) is transferred to the pulpmill as consumer surplus (DEB). The pulpmill could use the consumer surplus to buy more chips from sources beyond where the breakeven point occurs. Such a redistribution of benefits away from the sawmill would not encourage sawmills to locate near the pulpmills. A discriminatory price policy allows the monopsonist to take full advantage of his ability to charge a minimum price, equal to the marginal costs of chipping.

Conclusions

The emphasis of this chapter was to discuss the effect of monopsonistic competition on price and levels of utilization. With the significant effect transportation costs have on the variable costs of production and where the pulpmills have taken over the responsibility of transporting the chips, a firm's location becomes a prime factor in a pulpmill's decision to buy that firm's chips. This description of discriminatory monopsonist pricing behavior explains the way that prices would theoretically be expected to be set in Alberta if it is assumed that the pulpmills are monopsonists in a large part of their market area for chips.

III. Costs, Cashflow, and Efficiency in Chipping

A. Introduction

Two cost elements affect chip utilization: the cost of production and cost of transportation. This study looks at revenue and cost from the point of production and price levels necessary to provide an adequate rate of return. The analysis involves testing a wide array of discount rates and price changes.

B. The Cashflow Approach

A cashflow approach is desirable when calculating the economic efficiency of a project. Such an approach shows revenues and costs in a format that is "relevant to evaluating capital investments" (Clifton, 1977: 135). A cashflow statement accounts for both the magnitude and timing of expected cashflows in each period of a project's life. A cashflow approach provides for the differences in the timing of cashflows by discounting them to a defined point in time.[12] The three discounted cashflow methods used were the Net Present Value (NPV), the Internal Rate of Return (IRR), and the Profitability Ratio Approach (P/R).[13]

---

[12] For the study all costs and prices were evaluated at July 1, 1981.

[13] For a cashflow approach it is more appropriate to consider the Benefit-Cost-Ratio as a Profitability Ratio. Therefore although the study refers to a Profitability Ratio the study is essentially performing a specialized form of benefit-cost analysis for the private sector.

There are two ways this study will define a cashflow approach.

1. Cashflow approach with taxation.
2. Cashflow approach without taxation.

As outlined in "Chipping For Profit In A Small Sawmill", by Dobie(1976), a period's net cashflow with taxation should include depreciation and cashflows in excess of depreciation, termed net income, or profit after taxes. Depreciation is deducted from annual revenues when determining taxable income. Depreciation reduces taxable income, thereby reducing the amount of tax incurred. The rate of taxation is assumed to be 50% for this study. The cashflow with taxation formula for each year in the period is as follows:

Cashflow With Taxation

$CF=(NR-D)(1-t)+D$ Where:

NR=Net Revenue

D =Depreciation

t = taxation rate

(Dobie,1976:2)

The cashflow approach does not treat depreciation or other noncash expenses as defined in an accounting approach, but uses only depreciation for the interim tax calculations (Clifton, 1977:23).

The cashflow without taxation formula for each year in the period is as follows:

Cashflow without Taxation

Cashflow = (GR) - (AC) where:

GR = Gross Revenue

AC = Annual Costs

This method does not include taxation, therefore depreciation is not required.

(1) The Net Present Value Method NPV

The Net Present Value method NPV is a discounted cashflow approach where all costs and revenues are evaluated at one specific point in time. The discount factor $1/(1+i)^5$ is used to discount cashflows. (5) is the life of the project and (i) is the discount rate. The discount factors may be found by referring to the present value table (see Table D 24 i.e., Appendix D, Table 24, Page 159). If a NPV is calculated that is greater than or equal to zero then the project is feasible. The discount factors, when multiplied by the appropriate annual cashflow, yield a net present value over the five year planning period as follows: [14]

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[14] Cashflows are evaluated from the end of year one to the end of year five.

Net Present Value

NPV =-ICo + CF1/(1+i)^1+....+CF5/(1+i)^5 where;
(5 yr)= Expected life of the project,
(ICo) = Initial cost of the investment in year 0,
(i) = Required rate of return,
CF1...CF5 = Cashflows in year 1 to year 5 respectively.

(2) The Internal Rate of Return IRR

The internal rate of return is the discount rate (r) which yields a net present value of zero. A project is economically feasible if the IRR is greater than or equal to a predetermined minimum acceptable rate of return. This minimum level is generally determined by a firm based on its cost of capital. The formula for net present value can be used in a stepwise series of calculations to find the rate which yields a net present value equal to zero. The Internal Rate of Return formula by this method is as follows:[15]

Internal Rate of Return

NPV = 0 = -(ICo)+ CF1/(1+r)^1+...+CF5/(1+r)^5 where:
(5 yr)= Life of the project,
(r) = Internal rate of return,
(ICo) = Initial cost of the investment in year 0,
CF1...CF5 = Cashflow in years 1 to 5 respectively.

(3) Profitability Ratio P/R

The P/R ratio or benefit cost ratio is the present value of future net cash flow over the initial cash outlay (Van Horne, 1975:162). Any ratio that is equal to or exceeds

[15] Cashflows are evaluated at the end of year one to year five.

a 1:1 ratio is considered to be economically feasible. An essential part of the analysis, (true also of the other two methods), is that the stream of revenues and costs have to be considered over the life of the project at a common point in time. Therefore, all revenues and costs are discounted to the present so that they can be compared as follows: [16]

Profitability Ratio

P/R= $(CF1/(1+i)^1 ... + CF5/(1+i)^5)/ICo$ where:
(ICo) = Initial costs of the investment.
(i) - Discount rate.
CF1. CF5 Cashflow in year 1 to 5 respectively.

Using the Internal Rate of Return the Net Present Value, or the Profitability Ratio will lead to the same acceptance or rejection of a project (Clifton, 1977:36). The advantage of the NPV method over the other two methods is that NPV will show the absolute magnitude of return while the P/R ratio and IRR method show only the relative rates of return.

C. Choice of a Discount Rate

This study considers various discount rates. In choosing an acceptable discount rate there are two schools of thought, the opportunity cost or the social time preference. The minimal acceptable rate will involve choosing a rate that reflects either the social time

[16] Cashflows are evaluated at the end of year one to year five.

preference or the opportunity cost approach.

A further consideration in a cashflow analysis is whether or not a nominal or money rate or a real or adjusted rate of interest should be used. To show the nominal approach and real aproaches; if 17% is the rate of interest at the bank for captial lending and 12% is the rate of inflation, then 17% is the nominal rate of return and 5% is the real rate. [17] If cashflow is inflated, then nominal rates are appropriate and if cashflow is not inflated then real rates are appropriate. If the method is consistent it makes no difference to the validity of the study whether inflation is included or excluded. This is expressed in the following:

> Thus we conclude, "In the case of inflation there is no difference whether we use benefits and costs all stated, in the construction period, prices and a discount rate containing no inflationary premium or benefits and costs in the prices of the period in which each is incurred and a discount factor that fully compensates for the rate of inflation". (Howe, 1971:81)

The rates used in this study are real. A range of 5% to 10% was classified as an acceptable range for the rate of return on an investment. The social time preference rate is reflected by a rate of 5% while the higher rate of 10% will reflect the opportunity cost orientation. Three rates of return were chosen for use in the analysis: 0%, 5%, 10%. The

[17] One also has to assume the absence of risk.

rate 0% was chosen to show the affect of no discounting.

D. Treatment of Depreciation

Chipping and debarking equipment were depreciated on the basis of straight line depreciation for the life of the project of 5 years. Depreciation on equipment is the first component part and is included in the annual depreciation amounts for debarkers and chippers. The second component is depreciation on buildings which was taken as an average value for the province based on data from the Canadian Forest Service Survey of Sawmills of Alberta. (C.F.S Survey Information, Oct.1981). Accounting Method (1) included depreciation of equipment plus depreciation on buildings. Accounting Method (2) used depreciated equipment adjusted with 50% of the debarking costs subtracted plus depreciation on buildings.

These methods are employed as the use of debarkers is not just attributable to chipping. When setting up a chipping operation, chipping equipment is a necessity. The assumption is that even though the debarker is already in place, half of the cost has been allocated to the initial cost of chipping. Even when the debarker is bought before the rest of the chipping equipment, because the equipment is for the sawmill's saw maintenance, some cost has to be allocated to chipping due to the joint nature of production for lumber and sawmill residues.

To adjust the initial costs to the 50% level, 50% of the total debarker cost (this includes installation costs) are subtracted. To adjust annual costs to the 50% level, 50% of the labour, power, and maintenance costs attributable to the debarker are subtracted.

By using the relevant information concerning cost, a firm's cashflow may be calculated. To evaluate economic efficiency using the three methods outlined, calculating the cashflow is necessary.

IV. Data Collection and Documentation

To estimate the net present value, internal rate of return, and profitability ratio for sawmills, the cost of chipping had to be formulated. A survey was carried out to collect sawmill information on chip output, chipping equipment, costs, and prices. Cost information from the survey was minimal, therefore an "engineering" approach was used for costing and assessing the capital expenditures and annual costs of production, given the equipment used, and scale of output. The "engineering" approach uses established current prices for equipment in a defined layout. Well documented cost data from the survey was used as a check on the engineering cost estimates.

A. Sawmill Survey

Interviews were undertaken to collect data and answer questions regarding sawmill equipment, chipping equipment, chip outputs, and the variable and fixed costs of production. Two questionnaires were devised, one for firms that were presently chipping, and one for firms that were not (See Appendix B, Page 118).[18] Personnel from 25 sawmills and 2 pulpmills in Alberta were interviewed (see Appendix C List 1, Page 123).[19] Not all of the 25 sawmills presently

[18] 1) Sawmill Operations with Chipping Facilities.
2) Sawmill Operations without Chipping Facilities.

[19] Any table, graph or list that refers to a part of the Appendix will be designated by a letter listed at the beginnning of the label, i.e. List A-1 refers to list 1 in Appendix A.

chip, but because they produce at least 4 million bd. ft. per year they were considered to be potential chip suppliers.

The proposal was endorsed by Arden A. Rytz, general manager of the Alberta Forest Products Association (AFPA), who sent a letter to all members of the AFPA informing them of the study. A letter of introduction was then sent out on June 8 1981 to the 25 sawmills and two pulpmills. Also included was a copy of the survey that would be used later as the basis for a personal interview. A follow up letter was sent on June, 16, 1982. (see Appendix A, Page 113)

Reliable data was obtained on total production of lumber, shifts per year, annual chip output, chip recovery factor, kind of equipment, labour inputs, price of chips, distance to pulpmill, distance to logging sites, transportation methods, number of BDU's per load, and mixture of timber species. Costs which were difficult to establish included: power, income taxes, building depreciation, equipment depreciation, and initial equipment costs. When determining the actual cost for equipment, additional information was obtained directly from manufacturers to ensure that the costs used for the study were for replacement and not for initial costs (see Appendix F, Page 176)

B. Cost Information from Suppliers of Equipment

Information was collected on initial costs for chipping and debarking equipment, labor, maintenance, and parts. All equipment firms that supplied machinery for chipping in Alberta were contacted. A list of manufacturers and the information they provided is listed in Appendix F. All prices for the equipment were adjusted to July 1st. 1981. [20] Equipment costs were itemized as shown in Table 4-1, Page 34.

Debarker Costs

As Table 4-1 indicates, the first costs to be included were debarker costs The debarker costs that needed to be researched included the initial cost of the equipment and accessory costs. Most of the sawmills gave the initial cost of the equipment.

The costs of the debarkers, equated to 1981 dollars, were treated as the replacement costs for equipment. This information was provided by the suppliers. The accessory costs were assumed to be an additional 25% of the total cost of debarkers. This cost included both transportation costs from Vancouver, and installation costs. At $1.75 per running mile, the cost for transportation was in the order of $5000 to $10,000 The various accessories needed to hook up the equipment were also included in this 25%

[20] According to the price indices in Statistics Canada, Catalogue 62-011.

TABLE 4 - 1

List of Cost Items of Production

Name of Firm______________ Production/Year________

1) Cost of Debarkers
   A) Initial Cost of Debarkers
   B) Accessory Costs
   C) Total cost
   D) Depreciation per year /year

2) Chipper Cost
   A) Initial cost of chipper
   B) Motors and installation
   C) Conveyors : infeed
      outfeed
   D) Screens
   E) Surge bins
   F) Metal Detector
   G) Vibrating Conveyor
   H) Chip Blowing System
   I) Storage Bins
   J) TOTAL COST
   K) Depreciation per year /year

3) Accessory Costs
   A) Engineering Cost
   B) Hydraulic Equipment
   C) Compressor Equipment
   D) Conveyors
   E) Electrical
   F) TOTAL COST /year

TOTAL INITIAL COSTS 1) (100%)
(adjusted for debarker 2) (50%)
costs for Accounting Methods one and two)

Table 4-1 (continued)

	100%	50%
A) Fixed Costs		
1) Property Taxes		
2) Insurance		
TOTAL COSTS A		
B) Fixed Costs		
1) Depreciation on Building		
2) Depreciation on Equipment		
TOTAL COSTS B		
C) Variable Costs		
1) Labor		
2) Power		
3) Maintenance Costs		
TOTAL COSTS C		

TAL FIXED COSTS A + VARIABLE COSTS C = 1) ________ (100%)

= 2) ________ (50%)

Chipper Costs

The costs needed from suppliers (see Table 4-1, Page 34) were the initial cost of the chippers, accessories i.e. motors and installation, conveyors, screens, surge bins, metal detectors, vibrating conveyors, and the chip blowing and storage bins. The motors and installation costs of the chipper were set at 125% of the cost of the equipment after discussions with suppliers. Indications are that conveyors cost an additional 100% of the initial cost of the chippers.

The conveyor costs tended to show that the outfeed conveyors cost 1/3 and the infeed conveyor 2/3's of the overall conveyor cost. Chip screen prices were taken from the various equipment operators and supplemented with price information obtained from equipment manufacturers. The cost of a surge bin was assumed to be $10,000 for those firms producing 4-15mm fbm, $20,000 for those firms producing 15mm fbm to 49mm fbm and $40,000 for operators over 49mm fbm.[21]

The cost of a chip blowing system was a difficult cost to estimate as each sawmill had their blowing system designed specifically for their own operational needs (Appendix F, Page 176). An engineer of Radar of Canada Ltd. suggested $30,000 for those mills producing 4,000,000 fbm; $60,000 for those producing up to 25,000,000 fbm; $80,000 for those producing under 49,000,000 fbm and $100,000 for those producing over 49,000,000 fbm. The cost for storage

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[21] Exceptions were made for firms that did not include a surge bin in their operation, i.e., no cost was included.

bins included a charge of $1000 per B.D.U. capacity.

Accessory Costs

Additional costs such as engineering expenses, hydraulic equipment, compressors, additional conveyors, or special electrical work necessary for the system to be incorporated into the sawmill were included under accessory costs. These costs were calculated as a percentage of the total cost for the chipping system and were included as an additional 20%, (for firms 25mm fbm or less), or 40% (for those firms producing over 25 million fbm).

Fixed Costs Of Production

The next step was to calculate the fixed costs (see Table 4-1, Page 35). The fixed costs included insurance, property taxes, depreciation on buildings, and depreciation on equipment. Insurance charges were based on a study done by Nick Bonaglis (1975). The figure of $4.50/$1000 (1975 dollars) for investment in equipment was adjusted to 1981 dollars, of $6.60/$1000 of investment (Statistics Canada, Industrial Prices for July 1st, 1981, Cat. 62-011). Property taxes were taken from the survey as a percentage of the total property taxes for the firm. A cost of $5.00/fbm was assessed for depreciation on buildings, based on the findings of the Canadian Forest Service Survey (Carroll, 1981). For this study 20% of this charge was allocated to the chipping operation. The depreciation on equipment included depreciation on debarkers, chippers, buildings, and the additional accessory charges.

Variable Costs of Production

The variable costs included labor, power, and maintenance costs. The cost of labor was based on current wage rates per hour for debarker and chipper operators and was calculated for the total number of shifts worked in the sawmill per year. In some cases operators did not operate just one piece of equipment. In such cases, a 1/2 day charge was assessed instead of a full day charge, i.e.:[22]

2 operators on debarker $10.00/hr and.
1 operator on chipper $10.00/hr where,
($30.00/hr * 8 hrs.) * 273 days/yr = $65,520.00/yr
+ 30% benefits ($19656.00) = $85,176.00/yr

Power costs were difficult to calculate as most firms in the survey did not have adequate information on these costs. A sawmill manager with the most accurate data suggested using the following formula:

Chippers 600 Hp. at
approximately 65% efficient utilization
Chip screens, blowers, storage bins
300 Hp. at 65% efficient utilization
Debarker 2?0 Hp. for 2 debarkers
Power [illegible]

In a study called Economics of Barking and Chipping by I. R. Mann (1963), a specific formula was devised to convert from horsepower to $/hour as follows:

[22] * denotes multiplication

- HP.of equip.* 8 *.746(conv.to kwh) * 10/9 *2.4¢:
- 8 was an 8 hr. shift ,
- 10/9 was 90% efficiency and,
- $.024 for kwh. for power,
  kwh is kilowatt hour.

The actual figure used was 65% efficiency (instead of 90% as outlined by Flann (1963)), and both 2¢/kwh and 4¢/kwh were tested.

Debarkers required from 100 to 200 horsepower each, chippers needed from 150 to 300 horsepower, and the chip blowing system, (which included conveyors) required from 500 to 600 horsepower each. The specific horsepower requirements were taken from the technical literature submitted by the various equipment operators. An example of the calculation of power cost is given below.[23]

2 debarkers (100) hp * 2 = 200 Hp.
1 chipper = 200 Hp
Blowing system = 600 Hp
(0.65*1000Hp*2¢/kwh) *16*8hr day*240 = $[illegible]4,003.00

Maintenance costs were estimated if not included in the original sawmill survey. A minimum of $5000 was set for the chipper and $5000 for general maintenance or 10% of the value of the equipment, whichever was greater. Five thousand dollars was included for general maintenance for chippers. This included at least three changes of knives (every 4 months).

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[23] * denotes multiplication

The maintenance costs for the debarker varied depending on the make of equipment and type of useage. They were assessed to be equal to one year's depreciation or 20% of the total value of the equipment. Some discussion may be directed to this allocation of costing as the assumption allows for the more expensive equipment to cost more to repair.

A more useful analysis of the maintenance costs would involve individual costing of the various pieces of equipment. Such an approach could not be carried out as firms do not keep the necessary cost documentation. Considering the variability that was found in the data, three different levels of costs were used in a sensitivity approach (see Chapter 5). To manipulate the data for the purpose of calculating the Gross Revenue (GR), Net Revenue (NR), Annual Cost (AC), and cashflow and to evaluate economic efficiency, (i.e., IRR, NPV and P R), three computer programs were developed. These programs are presented in Appendix F, (Page [illegible])

V. Analysis of Sawmill Performance

A. Introduction

In this study, the cost and profitability of chipping is of primary concern. Considerable differences among firms existed. Some of the factors influencing the net returns expected from the manufacture of chips include:

1. Capital Cost of equipment
2. Annual operating costs
3. Lumber production per annum
4. Chip yield per mfbm of lumber(Chip Recovery Factor)
5. Chip price

The total lumber production of all 25 respondents was 973.28mm fbm during 1980-81. This was over 90% of the total lumber production in Alberta for that same period (see Appendix C, Page 123).

The 13 sawmills which produced chips, out of the total 25 sawmills surveyed, are analyzed in this section. The 13 sawmills ranged in annual production from 4mm fbm to 126 mm fbm. Their total annual combined production was 591.48 mm fbm of lumber and 350,000 BDU's of chips.

The 13 firms were evaluated with a range of annual costs. This resulted in 3 Cost Cases (see Table D.14 Page 150). Cost Case 1, defined power, maintenance, property taxes, and insurance by the procedures described in chapter 4 using sawmill and supplier information on equipment. Case 2 evaluated changes in maintenance, property taxes, insurance, and power based on the best documented data from the sawmill survey establishing representative firms for costing. This process is described in Appendix G.[24] Case 3 considered changes which would arise from Case 2 with an increase in power costs from $.02 to $.04 per Kwh (see Table D-14, Page 150). The power company could not give reliable estimates of $/Kwh.

Chip Recoveries

Before considering the sensitivity analysis an evaluation of the production of chips by all firms surveyed is appropriate. Throughout the Cost-Price-Firm Analysis, the most important indicator in evaluating the efficiency of production was the Chip Recovery Factor (CRF). The CRF indicates the weight of chips produced per 1000 fbm of lumber production.[25]

The recovery levels varied from .3214 BDU per 1000 foot board measure (Mfbm) to 1.2 BDU per Mfbm. The survey indicated considerable variablity. The survey also found that that chip recovery varied according to the kind of timber being cut, size of log, amount of taper, type of saw, and sharpness of the blades. The time of year, angle of chipper knives, speed of intact to the chipper, percent of bark, type and length of storage also affected the resulting quality of the product.

[24] Since cost estimates were not statistically quantified an attempt was made to set costs at 2 different levels to test the effect on results.

[25] (1 Bone Dry Unit) BDU is 2400 lbs. of wood dried to 0% moisture.

In some cases the lower recovery levels were due to mechanical breakdowns in the debarking system or to a poorly designed mill operation. If the debarker broke down, logs would be sawed with the available slabs sent directly to the burner instead of to the chipper, as the wood would not be bark-free. In some cases a better than average level of recovery, was due to the introduction of a chip-n-saw which contributed to the recovery of smaller dimension material.

B. Introduction to the Cost-Price-Firm Analysis

For this part of the analysis all firms were analyzed using the costing of Case 1 which calculated the firm's cashflow using the procedures discussed in Chapter 4. For the Cost-Price-Firm Analysis, the IRR was used. "Use of the IRR in the private sector stems from the general case in which capital was the most limiting factor to maximize profits" (Phillips,1981:65).[26] The accounting stance that referred best to the firm's point of view was Accounting Method 2 with taxation. Where IRR was given for the firm the relevant values were taken from Table D-2, Page 129 (includes taxation) and Table D-4, Page 131 (excludes taxation). All the data that was used in the Cost-Price-Firm Analysis is presented in raw form listed in order of firm number 1 to 13 in Table 5-1 to 5-3, pages 44-46.

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[26]Assume initial costs and annual costs and changes in prices were on a BDU basis.

Table 5-1
Changes in Annual and Initial Costs, IRR and CRF

Firm No.	Level of Annual Costs % Above/Below Average		Level of Initial Costs % Above/Below Average	
1	30%	above	4%	above
2	1%	above	18%	above
3	7%	below	18%	below
4	26%	below	26%	below
5	10%	above	14%	above
6	52%	below	42%	below
7	53%	above	64%	above
8	7%	above	2%	below
9	55%	below	49%	below
10	77%	above	58%	above
11	1%	above	17%	below
12	36%	below	30%	below
13	10%	above	13%	above

Firm No.	Present % Above/Below Average Price		Loss Incurred Accounting Method 2
1	17.5%	below	-30,313
2	14%	above	
3	19%	above	
4	17%	below	
5	61%	below	178,619
6	15%	below	
7	56%	above	
8	32%	below	38,000
9	15%	below	
10	21%	above	14,511
11	9%	above	
12	20%	above	
13	17%	below	30,410

The study involved a sample of 13 firms. Annual and Initial Costs were collected and evaluated as above or below the average for all 13 firms. The average values were not be disclosed to discourage the identification of specific firms. The present price was also evaluated on the basis of being above or below the average of the sample of 13 firms. The Loss incurred column shows the amount those firms in particular are losing under Accounting Method 2. Accounting Method 2 used depreciated equipment adjusted with 50% of the debarker costs subtracted plus depreciation on buildings.

Table 5-2
Present IRR and the Affect of Changes Due to Price Increases

Firm No.	Present IRR Accounting Method 2 tax(nontax)	Price %inc. or %dec. to yield an IRR of: (Accounting Method 2) 0% tax	0% (nontax)	5% tax	5% (nontax)	10% tax	10% (nontax)
1	+1(+2)%	+27%	-1%	+43%	+11%	+59%	+25%
2	+17(+32)%	-21%	-39%	-4%	-28%	+23%	-17%
3	+26(+49)%	-32%	-45%	-24%	-37%	-14%	-29%
4	+17(+33)%	-18%	-36%	-7%	-26%	+6%	-16%
5	negative	+66%	+25%	+90%	+44%	+114%	+64%
6	+32(+60)%	-44%	-55%	-35%	-48%	-26%	-40%
7	+9(+19)%	-7%	-23%	+3%	-12%	+20%	+1%
8	negative	+38%	+13%	+56%	+29%	+76%	+45%
9	+36(+73)%	-49%	-61%	-41%	-54%	-33%	-47%
10	+1(+3)%	+22%	-4%	+38%	+10%	+54%	+25%
11	+22(+42)%	-18%	-39%	-8%	-32%	+4%	-23%
12	+34(+68)%	-49%	-58%	-42%	-51%	-34%	-44%
13	+1(+3)%	+21%	-4%	+38%	+10%	+57%	+25%

The study also involved calculating the relevant internal rate of return for the 13 firms. There are 2 values presented in column 1. The first value is the tax value and the second value is the nontax value. Price increases and decreases demonstrate the affect that higher levels of production have on the IRR of the Firm. The need for a specific price to guarantee a specific rate of return increases with increases in the discount rate from 0% 10%

Table 5-3
The Affect of Improvements
in the Chip Recovery on the IRR of the Firm

Firm no.	Present Chip Recovery % Above/Below Average	%Changes in Chip Recovery Factor which would yield IRR of: 0% tax	0% (nontax)	5% tax	5% (nontax)	10% tax	10% (nontax)
1	32% below	-3%	-25%	+9%	-15%	+22%	-3%
2	54% above						
3	28% below	-53%	-62%				
4	average					+6%	-16%
5	31% below	+26%	+15%	+43%	+36%	+62%	+55%
6	17% above						
7	44% below	-28%	-42%				
8	22% below	+17%	+7%	+31%	+25%	+47%	+41%
9	29% above						
10	7% above						
11	100% above						
12	11% below						
13	48% below	-35%	-50%				

The Chip Recovery Factor is defined as the amount of chips converted from sawmill residues and is measured on a BDU per Mfbm basis. A good level of Chip Recovery would be .6 BDU/Mfbm. As with the 2 previous tables 5-1 and 5-2 13 firms were compared to the average of all firms which is why the chip recovery is represented as being above or below the average. Changes in the Chip Recovery would, by increasing production, reduce the need for the firm to have to have a specfic price to yield a 0,5 or 10% IRR. As the positive and negative values demonstrate at a higher level of discounting the need for a specific price for chips increases.

For the Cost-Price-Firm Analysis firms were grouped into 1 of 3 groups. Group 1 was for firms that were not able to achieve an adequate rate of return of 5 to 10% under the assumptions of Cost Case 1. Group 2 was for firms that were able to achieve an adequate rate of return of 5 to 10%. Group 3 was for firms that were not included in the final conclusions of the analysis because they were outside the market area of either pulpmill.

Cost-Price-Firm Analysis for Group 1

Firm 1 had fairly high annual costs which were 30% above the average of all firms and also had initial costs 4% above average.[27] The present price the firm received for chips was 17.5% below average. A 27% increase (1% decrease) in price was needed for a 0% IRR, a 43% (11%) increase for a 5% IRR, and a 59% increase (25% increase) for a 10% IRR.[28] Using the present price for chips, a loss was incurred in the amount of $30,313 (Accounting Method 2) annually. The (CRF) was 32% below the provincial average.[29] If the chip recovery improved to the provincial average the price for chips could decrease 3% (decrease 25%) for a 0% IRR, increase 9% (decrease 15%) for a 5% IRR, and increase 22%

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[27] The provincial average for initial costs were $12.63 per BDU and for annual costs, $15.53 per BDU. The study also refers to a percent of average price for chips but the Analysis will not disclose what the average or present price was for chips.

[28] Increases in price are documented in Table D 15, Page 151 for Accounting Method 2

[29] As noted in the Chip Recovery section chip recoveries varied from .3214 to 1.2 BDU/Mfbm. The exact CRF for the firm or the average of the industry will not be disclosed.

(decrease 3%) for a 10% IRR, due to the affects of increased production.[30] [31] [32]

A higher price per BDU was needed to offset the high annual costs for the debarker. An improvement in the chip recovery rates would result in the firm not needing higher prices to achieve a 0, 5 or 10% IRR. The firm could possibly change the kind of equipment being used to reduce the high level of maintenance costs and change the mill layout to improve the level of chip recovery. A significant shift in chip prices would be needed to initiate any action that would significantly improve the rate of return for the chipping operation.

Firm 5 had above average annual costs, i.e., 10% and above average initial costs, of 14%. With the present price for chips being 61% below average, to achieve a 0% IRR prices would have to increase 66% (25%), increase, 90% (44%) for a 5% IRR price, and finally increase 114% (64%) for a 10% IRR. Due to the present price and costs there was a loss in the chipping operation of ($178,619.00) annually.

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[30] By becoming a more efficient producer it is possible to create an additional supply of chips from material that is not being produced into chips because of needed improvements in mill design or due to poor equipment.
[31] Reference is made to price increases and decreases to demonstrate the effect that higher levels of production have on the IRR for the firm. The need for a specific price to guarantee a specific rate of return decreases with increases in production.
[32] The study assumed that no extra capital investment was required to yield the improvements in production discussed. It did not determine the exact problems causing the firm to have a low (CRF). If any additional capital was required, the IRR increase would be less than that shown.

(Accounting Method 2). The (CRF) was 31% below the provincial average. An improvement would result if prices increased 26% (15%), for a 0% IRR, increase 43% (36%) for a 5% IRR and increase 62% (55%) for a 10% IRR. The firm had annual costs which were not high, but they did have debarker maintenance costs which were marginally higher than average. The price for chips was probably the most significant factor affecting this firm's ability to achieve an adequate rate of return.

For Firm 10, initial costs were the second highest in the sample, 58% above average. Also the firm's annual costs were the highest, 77% above average. The price for chips was 21% above average but the price still had to increase an additional 22%, decrease (4.0%) for a 0% IRR, increase 38% (10.0%) for a 5% IRR, and increase 54% (25%) for a 10% IRR. The firm incurred a loss of ($14,511.25) annually (Accounting Method 2). The (CRF) was 7% above average. With the present chip production level there was little concern as to how the operation was being run on a per unit basis. Unfortunately, with a lumber production level 70% of capacity, increasing production and acquiring a larger supply of timber would increase revenues and consequently reduce annual and initial costs per BDU (assuming the same number of shifts of production).

Firm 13, had annual costs 10% above the provincial average and initial costs 13% above average. The price for chips was 17% below average and a 21% increase (4.0%

decrease) in price was required for a 0% IRR, a 38% (10.0%) increase for a 5% IRR, and a 57% (25%) increase for a 10% IRR. Their chipping operation was loosing ($30,410.00) annually (Accounting Method 2). The (CRF) was 48% below all firms sampled! If production improved 48% the IRR would increase and the price of chips could decrease 35% (58%), to achieve a 0% discount rate. An improvement in chip prices or the (CRF) would be needed to improve the IRR for the firm.

Cost-Price-Firm Analysis for Group 2

Firm 3 had initial costs below the average 18% and had annual costs 7% below the average. The firm received a price for chips that was 19% above average. Due to the below average annual and initial costs, the price needed to achieve a 0% IRR was 32% (45%) below the firm's present price. Therefore, with the present price the firm received a more than adequate 26% (49%) IRR. The firm has to account for a level of chip recovery that was 28% below the industry average. A 28% improvement in production would allow the price of chips to decrease even more to achieve a 0% IRR, i.e. decrease 53% (62%).

Firm 4 was one of the largest in Alberta. The firm had both initial and annual costs 20% below average. The price for chips was 17% below average. With low annual and initial costs the price needed for a 0% IRR was 18% (26%) below the firm's present price. The present IRR was 17% (33)%. Therefore, for only a 10% IRR the price for chips would have to increase 6.0% (decrease 16%). The firm's (CRF) was at the provincial average. Increases in production to offset costs were not required.

Firm 6 had very low initial costs, 42% below average, and had annual costs 52% below average. The price needed for a 0% IRR was 44% (55%) below the firm's present price. With the present price the IRR was 32% (60%). The (CRF) was 17% above average, so few improvements in production or price were needed.

Firm 9, had the lowest initial costs, 49% below average, and had annual costs 55% below average. The price for chips was not the highest, but the price needed was very low as the initial costs and annual costs were low. The present IRR was 36% (73)%. With a chip recovery that was 29% above average few improvements in production were necessary.

Firm 12, similar to firms 4, 6, and 9, had low annual and initial costs. The price for chips was 20% above the industry average but even with a (CRF) that was 11% below average the firm had the second highest IRR of 31% [illegible]

Cost Price-Firm Analysis for Group 3

Firm 2 was the smallest firm in the study and consequently the initial and annual costs were higher. The level of chip recovery was good, contributing to the firm's 17.0% (32.0%) IRR. The price needed for a 0% IRR was 31 [illegible]

[illegible]

price of chips have to increase 23% (decrease 17%).[33]

Firm 7 received a higher price per BDU for their chips than most firms. The firm achieved an internal rate of return of 9% (19.0%). This could be improved if annual or initial costs per BDU were reduced. The (CRF) was 44% below average. For example an improvement in production of 44% would result in prices being able to decrease 28% (42%) for a 0% IRR.

Firm 8 had good initial costs 2% below the average, and had annual costs 7% above average. The firm's level of chip recovery was 22% below the provincial average. They needed a 28% (13%) increase in the existing price for a 0% IRR, 5[illegible]% (29%) for a 5% IRR, and [illegible]% (45%) for a 10% IRR. There [illegible] loss incurred of $38,000 (Accounting Method 2). If chip production increased 2[illegible]% to the provincial average the price would have to increase 17% ([illegible]%) for a 0% IRR, 31% ([illegible]%) for a 5% IRR, and 47% (41%) for a 10% IRR. The low price and chip recovery affected this firm's ability to [illegible] adequate rate of return.

Comparing Firm 10 to Firm 11, annual costs per BDU were close. Both firms had a similar mill capacity. In Firm 11's favor was the fact that the level of lumber production was 6[illegible]% higher than Firm 10's and the firm had a chip recovery that was double Firm 10's. Firm 11 [illegible]

[33] The firms in Group 3 will be disregarded in terms of any final conclusions that will be made in the Cost Price Firm Analysis, because the firms were not in the market area of either pulpmill.

chip recovery was a more efficient operation which resulted in a good IRR of 22 (42)%.

Summary of the Cost-Price-Firm Analysis for Group 1 and 2

The firms of Group 1, (1, 5, 10, and 13) were at a disadvantage as their initial and annual costs of production were too high to warrant chipping as a profitable venture. Firms 1, 5, 10, and 13 needed a higher price for chips to offset the higher costs. For a 5% IRR a 38% increase would be required for firms 10 and 13, a 13% increase for firm 1 and a 90% increase for firm 5. Firm 5 had the lowest price for chips in the province. The level of Chip Recovery would have to improve 30% and 21% respectively for firms 1 and 5. Firm 13 would have to improve the CRF the most, [illegible] below average. Firm 10 could use a 50% increase in lumber production [illegible] as the initial and annual costs [illegible] high for the firm to operate efficiently.

The firms of Group 2, (3, 4, 6, 9, and 12) had better rates of return. The requirement for a higher price for chips was not as significant a factor in producing an adequate rate of return. The CRF varied from 22% below [illegible] above average. These firms were the more efficient utilizers of [illegible] when producing chips. Of special note, firms 6 and [illegible] had the highest IRR [illegible] could produce [illegible] and yet [illegible]

C Effects of Changing Costs

To account for the differences between Cases 1, 2 and 3 both accounting methods were presented in Table 5.3 and 5.4 Page 55-56.[34] As discussed in the firm analysis, from the firm's point of view only Accounting Method 2 was necessary for this Analysis.[35]

The analysis of the 3 Cases resulted in changes in the IRR predominately due to changes in annual costs. (see Appendix G, Page [illegible] and Tables 5.3 and 5.4, Page [illegible] and 56)

Comparison Conclusions

These 3 Cases were estimates based on different procedures as described in Chapter [illegible] for Case 1, and Appendix G for Case [illegible] and 3. As demonstrated, for increases in power costs, when the costs were taken as $.04/Kwh instead of $.02/Kwh, a higher price [illegible] was required to yield the same rate of return.

The Firm of Group 1

For firm 1, under the assumption of Case 2, a 59% increase in price was required to yield a [illegible] IRR versus

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[34] Cost Case 1, defined power, maintenance, property taxes, and insurance using the procedures set up in chapter 4. Case 2 evaluated changes in maintenance, property taxes, insurance and power based on the actual survey information. Case 3 considered the effect of an increase in power costs from $.02 to $.04 per kwh (see Table D-14, Page 150). This was necessary as the power company could not give a reliable estimate for $/kwh and as such there were different values available for the study.

[35] It was assumed that operators presently chipping would split the cost of the debarkers between the sawmill operation and the chipping operation equally.

Table 5.4
Changes in Initial and Annual Costs for Case 2

Firm No.	Changes in Initial Costs Acct. Method 2	Case 2 Annual Costs Acct. Method 2	Changes to IRR
1		+54%	decrease
2		+9%	decrease
3		+50%	decrease
4	+5.5%	-9%	increase
5	+7.0%	same	decrease
6		+24%	decrease
7		+17%	decrease
8		+5%	decrease
9		-8%	increase
10		-19%	increase
11	+20%	+17%	decrease
12	+25%	+11%	decrease
13		7%	i[illegible]

% Changes in Annual Costs for Case 3

Firm No.	Case 3 Annual Costs Acct. Method 2	Changes to IRR
1	+78%	decrease
2	+72%	decrease
3	+79%	decrease
4	+26%	decrease
5	+29%	decrease
6	+52%	decrease
7	+37%	decrease
8	+154%	decrease
9	+32%	decrease
10	+24%	decrease
11	+55%	decrease
12	+45%	decrease
13	+60%	decrease

Case 1 is based on the assumptions of Chapter 4. Case 2 is based on changes in any annual costs that were adjusted (see Appendix G, Page 181). Case 3 refers to the doubling of power costs over those defined in Case 1. The first part of the Table looks at Case 2. Some changes in initial costs were made as outlined in Appendix G. Also some changes in annual costs were indicated ie., as either positive or negative. Changes to the IRR determines the relative outcome (increase or decrease) in the IRR from Cost Case 2 or Case 3 as opposed to cost Case 1.

Table 5-5
The Affect of the Three Cost Cases on the Internal Rate of Return (IRR) for Accounting Method Two.

Firm #	IRR for Three Cases		
	Case 1	Case 2	Case 3
1	1%	<0%	<0%
2	17%	16%	9%
3	26%	18%	12%
4	17%	18%	13%
5	<0%	<0%	<0%
6	32%	29%	27%
7	9%	7%	3%
8	<0%	<0%	<0%
9	36%	38%	35%
10	1%	5%	<0%
11	22%	19%	8%
12	34%	33%	27%
13	1%	2%	<0%

<0% - negative IRR

- Taken from Table D-2, Page 129

This table shows the IRR for all 3 cases. Therefore one can compare what happened to the IRR's from the different costing methods employed for the 3 cost cases.

27.5% for Case 1. Price increase requirements were significant. The IRR decreased from 1.0% to less than 0%. (Table 5-4) The firm which had specific problems identified i.e., low price, and high annual costs under Case 1 had these problems further magnified under Case 2. [36]

For firm 3, the IRR went down from 26% (Case 1) to 18% (Case 2). The firm achieved a favourable rate of return with either Case, well within the requirements of a 5 to 10% rate of return.

For firm 5, the IRR was still less than 0%. This firm needed a significantly higher price to produce chips for both Cases 1 and 2.

For firm 10, the IRR increased from 1% to 5% which showed the firm in a slightly more favorable position for Case 2 then Case 1.

For firm 13, costs changed fron 1 to 2% so there was little difference in the IRR's.

The Firms of Group 2

For firm 4, there was a slight change in the IRR, between Case 1 and 2, i.e., 17% to 18%, but there was no significant difference between Case 1 or Case 2.

For firm 6, the increases in annual costs from Case 1 to 2 resulted in a slight reduction in the IRR from 32% to 29%. The firm achieved a favorable rate of return, under either Costing procedures.

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[36] All comparisons for IRR involved Table D-2, Page 129 or Summary Table 5-5, Page 56.

There was a slight change in annual costs for firm 9. The IRR was 36% for Case 1 and 38% for Case 2. Both Cases offered a high rate of return, Case 2 slightly better than Case 1.

This was also true of Firm 12 which had a slight decrease in IRR from 34% to 33%.

The Firms of Group 3

Firms 2, 7, 8 and 11 (Group 3) will be disregarded in any final conclusions made in this part of the Cost-Price-Firm Analysis because these firms were not in the market area of either pulpmill in Alberta.

For firm 2, the IRR decreased 1%, 17% to 16%. There was no difference between either Case (1 or 2).

For firm 7 , there was a decrease in the IRR from 9.0 (Case 1) to 7.0 (Case 2). This indicated that the firm was within the acceptable range for IRR so that no increase in price was needed to achieve an adequate return of 5% to 10%.

For firm 8 the IRR was still less than zero. The firm needed a significantly higher price to produce chips for Case 1 or 2.

For firm 11, the slight decrease in IRR from 22% to 19% did not change the conclusion that the firm was doing well in the chipping operation.

Conclusions

To conclude, there were some significant differences apparent in the IRR's with the different costing procedures. Although changes in the IRR were evident, in the 3 Cost

Cases they were not enough to prevent some firms from achieving an adequate return of 5% to 10%. Where there were differences as for Case 2 they tended to confirm the results of the Cost-Price-Firm Analysis (Case 1).

With the increase in power costs for Case 3 the result was a decrease in the IRR between Case 2 and 3. Firms in Group 2, (3, 4, 6, 9 and 12) had a rate of return above the minimum of 5 - 10% for Cases 1, 2 or 3. Firms 1, 5, 10 and 13, of Group 1 which already had below minimum rates of return had decreased rates of return which were even lower under Case 3 assumptions.[37] Overall, the differences in Costing for Case 1, 2, or 3 did not change the conclusions evident with the Cost-Price-Firm Analysis which was tested with Cost Case 1 and this indicates that the procedures for calculating the IRR, NPV, and P/R using Case 1 were reasonable.

The analysis indicates that the availability of chips and the profitability of the sawmill determines what amount of chips will be available for the pulpmill. It is obvious that in time the smaller firms could go out of chip production because size is of such importance regarding a firm's ability to return a profit. The price of chips for the majority of firms is acceptable in allowing the firm to achieve an adequate rate of return of 5 to 10%. Of the 4 firms, 1, 5, 10, and 13 which need price increases, firm 5 is the only firm where price is the only limiting factor to

[37] (see Appendix Table D-2, Page 129)

the firm's ability to achieve an adequate rate of return. The other 3 firms have other size factors, management, and equipment problems that have limited the firm's ability to chip for a profit.

D. **Evaluation of NPV, IRR, and P/R**

This section deals with a discussion of the results that were generated in the analysis of the firms. As was originally noted the study was set up to evaluate 4 price changes and 3 discount rates for 3 criteria of economic efficiency IRR, P/R, and NPV. In setting up and organizing the various tables it was noted that it would be worthwhile to discuss the effect of taxation and price increases on the 3 methods of economic efficiency separately and note any differences between firms.[38]

The Effect of Taxation

The effect of taxation was only measured for those firms with an IRR greater than zero, P/R ratio greater than 1, and an NPV greater than zero.[39]

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[38] All the Tables referred to in this section may be found in Appendix D with a corresponding D in front of the table number. Reference to the Appendix D Tables for IRR D-1 to D-4, Page 128-131, Profitability ratios D-5 to D-7, Page 132-143 and NPV D-8 to D-13, Page 144-149, show the affect of four price changes from 0 to 50% ; 3 discount rates 0, 5, 10% and; 2 accounting methods 1 and 2.

[39] The affect of taxation can be compared between firms by studying Tables D-1 and D-3 IRR, Accounting Method 1, Tables D-2 and D-4 IRR, Accounting Method 2, Tables D-5 and D-7 P/R where the tax and-nontax ratios were side by side for 3 discount rates 0, 5, 10% , Tables D-8 and D-9 for NPV 0% discount rate , Tables D-10 and D-11 NPV 5% discount rate and between Tables D-12 and D-13 for NPV 10% discount rate.

A 50% tax rate caused a reduction of 50% in the IRR. For example for firm 2, Case 1, (Accounting Method 1), the IRR was 6% with taxation,[40] and 12% without taxation.[41] Compared to Case 1, Accounting Method 2, the IRR was 17% with taxation,[42] and 32% without taxation.[43] Other comparisons of values between a nontax and a tax rate show the IRR for the nontax values were double the taxed IRR.[44]

The effect of taxation was illustrated for P/R ratios in Tables D-5, D-6, and D-7, (The tax and nontax P/R ratio were side by side, the larger value being the nontax value). Taxation was only measurable where the P/R ratio was greater than 1.0. Any amount greater than 1.0, at a 0% discount rate was broken down such that 50% was taxes. For a P/R ratio of 1:2, [45] compared to 1.4, the nontax value, the .4 component was reduced to .2. For Tables D-6 and D-7, the affect of taxation was illustrated the same way except that in comparing the tax and nontax ratios the difference between the 2 ratios was more than 50% for ratios greater than 1 because of the affect of the discount rates of 5% and 10%.

The residual amount that is available to the firm after a ratio of 1:1 is found, is split equally between the government and the firm. A discount rate evaluates the

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[40] Table D-1, Page 128.
[41] Table D-3, Page 130.
[42] Table D-2, Page 129.
[43] Table D-4, Page 131
[44] In some Cases the values were not double due to the rounding off of values.
[45] firm 2, Case 1, including taxation, no price change (Table D-5, Page 132)

affect of time, thereby increasing the difference between the residual amount so that the difference is more than just 50%. For example, for firm 2,[46] the non-tax ratio was 1.21, while the tax ratio was 1.04. The difference was .17. Without showing the affect of a discount rate the tax ratio would have been 1.105 i.e., 1.21 - 1.0 =.21/2 =.105. The discount rate reduced the ratio so the difference between the 2 ratios for the residual amount greater than 1 was larger than 50% i.e., .04 instead of .105 .

When the NPV was negative, the taxation effect was not illustrated, i.e., for NPV, firm 1, Case 1, tax included, Table D-8, -$395,107 which was the same value found in Table D-9, for no tax.[47] For positive net present values, the NPV value without taxation, was twice the size of the taxed NPV value i.e., Firm 2, Case 1 $71,819 versus $143,638. For Tables D-10 to D-13, as the discount rate (i) increased from 0 to 10%, the NPV decreased.[48]

The Effect of Price Increases

The effect of price increases were also illustrated.[49] As prices increased, the ratio between the initial costs of the investment and the cashflow decreased, which resulted in

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[46] Case 1, Table D-6

[47] The effect of taxation for NPV values was illustrated in Tables D-8 to D-13; by comparing Table D-8 to D-9 , D-10 to D-11 and D-12 to D-13.

[48] With the present value method all cashflows were discounted to the present using the required rate of return where: $NPV = -ICo + CF1/(1+r)^1 + \ldots CF5/(1+r)^5$

[49] Tables D-1 to D-4, for price increases of 0, 10, 30 and 50 %.

a higher IRR. [50]

As prices increased to 50% the IRR improved such that most firms were able to achieve a minimum IRR of 5% with the 50% tax rate. [51] The Cost-Price-Firm Analysis pointed out that one firm needed as much as a 66% price increase in price to achieve an adequate rate of return. [52]

As prices increased the NPV was less negative for NPV's that were originally less than zero and more positive for NPV's that were originally greater than 0.[53]

Conclusions

. The changes between cost Case 1 and 2 tended to reinforce the findings of the Cost-Price-Firm Analysis. The differences in costing of Case 1 and 2 did not result in any differences in relative results. The affect of increased power costs in Case 3 did not affect those firms already achieving a rate of return in excess of 5% to 10%. Although rates of return were considerably lower in some cases, firms still achieved the minimum 5% to 10% level of return. Thus, even though power costs varied significantly, the rate of return was still acceptable.

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[50] Initial Cost / Discount rate = Payback Period. To find the corresponding rate of return the value for the payback period was evaluated in Table D-24, Page 159. The value for the payback period in the table will correspond to a particular value of interest which is the IRR for the project.

[51] In Tables D-5, D-6, and D-7 the effect of price increases of 0, 10, 30, and 50 % were also illustrated.

[52] To compare the affect of price increases on the firm's ability to achieve a 0, 5, or 10% IRR refer to Table D-15 and D-16, Page 151.

[53] The following tables: D-8, D-9, D-10, D-11, D-12, D-13 show four price increases which range from 0 to 50 %.

In the analysis of the 3 Cases there was a choice of 3 discount rates for the NPV and P/R ratio's. All 3 (IRR, NPV, and P/R ratio) emphasized the difference between a nontax and a tax approach. This was further broken down for the IRR approach to consider Accounting Methods 1 and 2. By comparing Accounting Method 1 and 2, it was evident that the IRR was higher for Method 2 as all the costs were not allocated to the chipping operation.

Finally, 4 prices changes 0, 10, 30, and 50% were considered for all 3 methods of economic efficiency. As prices increased from 0 to 50% the IRR, P/R ratio, and NPV increased for the firm. For all firms except 4, 6, 9 and 12, of Group 2 a price increase of at least 10% was needed and the increase would have to be as high as 66% for firm 5 (Accounting Method 2) for a 0% IRR and 90% for a 5% IRR (See Table 5-2, Page 45, Prices Needed for a 0, 5, 10% IRR).[54]

F Industry Cost Model

To further examine the IRR for different cost levels, another approach was taken. The full set of cost figures were examined and representative firms were created in a model which examined the implications of the Alberta chip price levels. The representative firms are based on the average cost levels for 2 size classes 4 50mm fbm and 50mm fbm plus.

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[54] Note that firms 2, 7, 8 and 11 were left out of the final conclusions because they were not in the market area for either pulpmill.

An analysis was set up to determine annual and initial costs for 2 price Cases and determine the affect of costs on the IRR, NPV, and P/R ratio. Thus the analysis considered increases in the quantity of chip production, initial costs, annual costs, and the price of chips. The range of values for quantity of chips, initial, and annual costs were based on the selection of a low, average, and high value for both group 1 and 2 (see Tables D-17 and D-18, Page 152-153).

As stated, there was a wide assortment of combinations of annual and initial costs that could be used in the model. Out of the 9 annual costs available, 4 were selected which would represent the range of values. Three levels of initial costs were paired against the 4 annual costs resulting in 12 combinations of costs (see Table D-19, Page 154).

Four tables were set up to analyze the 12 combinations of annual, initial costs, and prices for chips. Class 1 for firms 4-50 mm fbm was set up in Table D-20 and D-21 and Class 2 for firms 50 mm fbm plus was set up in Tables D-21 and D-22. For Tables D-20 to D-23, Page 155-158, increases in the quantity of chip production were evaluated with the lower production of chips paired with the low initial costs, the average production of chips paired with the average initial costs and the high initial costs paired with the high production of chips.

Results of the Industry Cost Model

For Size Class 1, 4-50mm fbm, the $26.11 price per BDU was not adequate to produce a minimal rate of return of 5%

to 10% for a production level of 9.6, 23.23, or 34.8mm fbm. The price only produced an IRR greater than 0 with the lowest annual costs of $165,000/year, with a production of 14,420 and 21,600 BDU's of chips. As such with a price of $26.11, annual costs could not exceed $12.59/BDU, with initial costs of $13.52/BDU. With initial costs of $15.85/BDU, annual costs could not exceed $10.26/BDU.[55]

For a price of $37.42/BDU the IRR was only acceptable with annual costs of $165,000 and $288,888 and a production of 14,420 and 21,600 BDU's. Therefore, with a price of $37.42 per BDU and with initial costs of $13.52/BDU, annual costs could not exceed $23.00/BDU and with initial costs of $15.85/BDU annual costs could not exceed $2[illegible].57/BDU.

For Size Class 2, 50mm fbm plus, firms were generally able to achieve the minimal rate of return (i.e., [illegible]% to 10%) under the full range of annual costs. With a price of [illegible] per BDU, with initial costs of $7.[illegible]8/BDU, annual costs should not exceed $18.53/BDU. With initial costs of $6.[illegible]8/BDU, annual costs should not exceed $19.4[illegible]/BDU. With the higher price of $37.42/BDU, and with initial costs of $10.01/BDU, annual costs should not exceed $27.11/BDU. With initial costs of $7.58/BDU, annual costs should not exceed $29.84/BDU. For initial costs of $[illegible].68/BDU, annual costs should not exceed $30.74/BDU.

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[55] Assume that the firm allocates funds to pay off the initial costs of production first (calculated on a BDU basis). The residual is allocated to pay the annual costs of production. Regardless of what initial costs were, annual costs could not be greater than the residual.

As size increases, it is possible to incur higher annual costs and still achieve an adequate rate of return at the 2 price levels surveyed. For the larger firm initial costs were lower (per BDU) than the smaller firm.

Although it was not possible to discuss scale specifically, the data show that the larger firms were more profitable. The number of negative results suggests that in the short run profit maximization is not the only motive for chipping. Some output maximization is also one of the firms objectives. A more detailed study of management behaviour and objectives would be useful as residues are a by-product and hence are not a simple part of production management decision. Analysis of chipping was not [illegible] straight [illegible]

[illegible]

VI. The Pulpmill: Demand, Supply, and Costs

The previous analysis discussed the sawmill's rate of return and specific price changes which would yield an adequate rate of return. The availability of chips to the pulpmill depends on production economics of the sawmills and as concluded in Chapter 5 the behaviour and objectives of sawmill managers. This chapter deals with the pulpmill, in terms of the quantity of chips utilized from both sawmill residues and roundwood, the potential expansion of chip production to the industry, and potential demand by new pulpmill developments. Price movements within the present pricing formulation used by pulpmills were also examined.

The Alberta Forest Service, in a study completed in Feburary 1980, delineated six chip supply regions in Alberta: Footner, Grande Prairie, Edson Whitecourt Slave Lake, Rocky Bow Crow, and Athabasca Lac La Biche. This regional description is provided in Appendix C.1, Page 123. Four scenarios were developed as illustrated in Table 6-1, Page 69. Scenario 1 included the 25 sawmills surveyed, scenario 2 only those 13 sawmills actually chipping, scenario 3 the Berland Fox Creek development, and the 12 firms presently chipping and scenario 4 includes the Brazeau development, the 12 firms and the Berland Fox Creek development.

TABLE 6.1 PROVINCIAL SUMMARY
Lumber and Residual Chip Production

Scenario	Actual lumber produc mm fbm	Actual Chip produc MBDU	Potential Chip produc MBDU
1) 25 Sawmills of survey	716.28	350.7	468.40 [a]
2) 13 Sawmills chipping	591.48	350.7	391.00 [b]
3) 13 firms + Berland Fox Creek	771.48		(460.7 [c] -530.7 [d])
4) 13 firms + Berland + Brazeau	921.48		(553.0 [e] 680.7 [f])

Explanation of Chip and Lumber Production:

Actual Lumber Production for scenario 1 and 2 was from survey information. For scenario 3 assume a production of 180 mm fbm and for scenario 4 assume a production of 150 mm fbm.
Actual Chip Production is 350,000 BDU's which is taken from survey information.

a) and b) With 591.48mm fbm Chip production should be 366,720 BDU's for (b)(CRF of .62BDU/Mfbm) Chip production improvements proposed, increase Chip production to 391,000 BDU's (b),(an additional 24.220 BDU's). This additional amount is also added to (a) for a potential of 468,400 BDU's for (a). Originally this amount would have been calculated as 444,180 BDU's for (a) for a lumber production. of 716.28 mm fbm but because of the additional improvemen's of 24,220 BDU's proposed in the cost price-firm analysis of Chapter 5 this is increased to 468,400 BDU's

c) Based on Chip Recovery of .62 BDU/Mfbm 350,700 BDU's + 110,000 BDU's.

d) Based on Chip Recovery of 1.0 BDU/Mfbm 350,700 BDU's + 180,000 BDU's

e) Based on chip recovery of .62 BDU/Mfbm plus minimium of scenario 3(460,700 BDU's+93,000 BDU's)

f) Based on chip recovery of 1.0 BDU/Mfbm plus maximium of scenario 3(530,700 BDU's+150,000 BDU's)

A. Scenarios 1, 2, 3, and 4

Scenario 1, Table 6-1, Page 69, summarizes the potential and actual amount of chipping and present lumber production in Alberta.[56]

For scenario 2, Table 6-2, Page 71, outlines the breakdown of the chip supplies into chip supply regions, as indicated in a report by the Alberta Forest Service. Knowledge of chip production on the basis of chip supply regions was not necessary for the present analysis.

For scenario 2 the present production of chips in Alberta is 350,000 BDU's annually. Proctor and Gamble (P and G) are buying 288,160 BDU's or 82.16% of the province's production. St Regis is buying 33,650 BDU's or 9.59% of the present production.[57] The previous chapter indicated that some firms might find it economically advantageous to make improvements in the present chip recoveries as their CRF's are under the minimal efficient rate of .62 BDU/Mfbm (Bongalis, N.:1975). An additional 40,946 BDU's or approximately 41,000 BDU's of chips (see Table 6-3, Page 72) is available through better recovery methods.

To calculate scenario 3 (Berland-Fox Creek-Development) information was acquired from the relevant Forest Management

[56] Actual chip and lumber production is calculated from survey results. Potential chip production is calculated from potential lumber production based on a .62 BDU per fbm chip recovery factor with an additional 24,200 BDU's added in for the chip recovery improvements of some firms discussed in the cost-price-firm analysis (Chapter 5). See Table 6-1 for additional discussion, Page 69.

[57] The residual of 9% is bought by 2 Building Products firms in Alberta.

TABLE 6.2 Provincial Summary of Lumber Production by Forest

Forest	Actual Prod.of 25 sawmill mm fbm	Actual Prod. of 13 firms surveyed	Actual Prod. of 13+scena no3	Actual Prod. of 13+scena no. 3 +4
Footner	102.0	102.0	102.0	102.0
Grande Prairie	143.0	131.0	131.0	131.0
Athabasca	14.7			
Whitecourt	368.88	297.28	477.28	477.28
Rocky	45.0	31.5	31.5	181.5
Bow ,Crow	42.7	29.7	29.7	29.7
Edson				
TOTAL	716.28 mmfbm	591.48 mmfbm	771.48 mmfbm	921.48 mmfbm

Provincial Summary of Forest Chip Production
Present Chip Production

Forest	13 firms Chipping M(BDU's) .62 CRF	13 firms +Scenario no 3 M BDU's .62 CRF	13 firms +Scenario no 3 M BDU's 1.00 CRF	13 firms +Scenario no 3 & 4 M BDU's .62 CRF	13 firms +Scenar no 3 & 4 M BDU's 1.00 CRF
Footner	72.0	72.0	72.0	72.0	72.0
Grande Prairie	70.6	70.6	70.6	70.6	70.6
Athabasca					
Whitecourt	183.9	293.6	363.9	293.6	363.9
Rocky	7.5	7.5	7.5	100.5	157.5
Bow Crow	16.6	16.6	16.6	16.6	16.6
Edson					
TOTAL	350.7 mm fbm	460.3 mm fbm	530.66 mm fbm	553.30 mm fbm	680.70 mm fbm

Table 6.3 Improvements in Chip Recoveries

Firm	Percent below Average	Amount of Improvement
1	32%	3433.6 BDU's
2		
3	30%	9140.0 BDU's
4		
5	31%	6920.0 BDU's
6		
7	77%	4073.0 BDU's
8	21.6%	1490.0 BDU's
9		
10		
11		
12	12.3%	3350.0 BDU's
13	48.0%	12540.0 BDU's
	TOTAL	40946.6 BDU's

Agreement (FMA). This indicated a total of 180 mmfbm lumber production. [58] Assuming a CRF from .62 BDU/Mfbm to 1.0 BDU/Mfbm, 10,000 to 180,000 BDU's of sawmill residue chips would be produced from the Berland-Fox Creek F.M.A. and 460,000 to 530,000 BDU's of sawmill residues would be converted to chips. [59]

For scenario 4, predictions regarding the extent of development for the Brazeau development were based on a publication by the Timber Management Branch (July 1979) which suggested a total cut of 150 mm fbm. Based on a .62 BDU/Mfbm and 1.0 BDU/Mfbm level of chip recovery, 93,000 to 150,000 BDU's of sawmill residue chips would be produced. This would result in 553,000 to 680,000 BDU's sawmill residues being converted to chips if the Berland-Fox Creek (Scenario 3) and Brazeau developments (Scenario 4) (see Table 6.1, Page 69) were included.

B. St Regis

St Regis buys 33,000 BDU's of chips annually. Based on their production of 464 tons per day the firm produces 194,000 tons per year. [60] The pulpmill needs 928 BDU's of

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[58] The Grande Cache sawmill would produce 80mm fbm minimum capacity and a sawmill at Knight would later produce 100mm fbm annually.

[59] This study assesses only the chip supply available to the firm created from sawmill residues.

[60] Divide by 418 operating shifts per year and consider an average of 2.0 BDUs of chips are needed to make a ton of pulp. This is taken from a study written by Eli Sopow (1979) that quoted 2.2 BDUs. For Alberta this was adjusted to 2.0 BDUs.

chips per day or 388,000 BDU's of chips per year to operate. With St Regis buying 33,000 BDU's of chips, 355,000 BDU's have to be supplied from the FMA. The firm is operating at approximately 85% capacity. (Assuming 418 shifts per year and 540 tons per day is maximum operating capacity). At 100% production capacity the firm would produce 225,720 tons of pulp annually.

St Regis is also considering expanding its operation as a result of the B.C.F.P. Forest Management Agreement (Berland Fox-Creek). An agreement to buy 50,000 BDU's of chips within a 10 year period exists. (The Alberta Gazette, Oct. 15, 1980) By assuming this level of expansion the pulpmill may have to increase the size of the firm, from the 100% daily capacity of 540 tons to 616 tons per day. [61] To operate at an 85% operating capacity, assuming 616 tons per day is the maximum, would require the firm to produce 524 tons of pulp per day. If the firm produced 524 tons per day or 220,000 tons/year they would require 438,000 BDU's of chips.

[61] By producing an additional 25,000 tons of pulp per year the firm would be producing 219,000 tons of pulp per year. Assuming that 418 is the maximum number of shifts per year and 540 tons per day is maximum designed capacity some expansion may be necessary to incorporate the additional 50,000 BDU's of chips into production.

C. Proctor and Gamble (P and G)

P and G, with a production of 280,000 tons per year (1978), needs 560,000 BDU's of chips to produce at the 1978 level of pulp production. The firm, following a similar chip production level as 1978, acquired 243,000 BDU's of chips from the FMA and had to buy 317,000 BDU's sawmill residues. The pulpmill has a designed capacity of 925 tons per day, but only produces 580 tons per day, (63% level of capacity). [62] Assuming an 85% level of capacity the firm could produce 786 tons per day or 378,000 tons of pulp per year and could use an additional 196,000 BDU's of chips.

If both firms considered the expansion discussed, P and G would need 756,000 BDU's, and St Regis 438,000 BDU's chips or a total of approximately 1,195,000 BDU's would be demanded.

D, Potential Quantity of Supply

The two pulpmills had a combined Annual Allowable Cut (A.A.C.) of 77,200,000 cubic feet of wood, for 1976-1977. [63] The solid wood equivalent of the total A.A.C. of both pulpmills would be $1.9084 * 10^9$ lbs.. [64] When divided by

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[62] This is assuming 280,000 tons are produced. Taken from A.F.S. Directory page 285, for 1978-79 production.
[63] (Geldhart, 1978:51 and 58) For P and G, $4.15 * 10^7$ cubic ft. and for St. Regis, $3.57 * 10^7$ cubic ft. which adds up to $7.72 * 10^7$ cubic ft. . Assume that the 1976-1977 A.A.C. is the same as the A.A.C. that would be available for July 1st, 1981.
[64] Conversion to lbs from cubic foot taken from (Dobie, 1975a:13) for an average of three species ; Jack Pine, Lodge Pole, and White Spruce or (26.21+25.50+22.45 lbs. per cubic foot) / 3 = 24.72 lbs/cubic foot.

2400 lbs per BDU this equates the A.A.C. of the pulpmills to 795,000 BDU's of chips. The pulpmills used a total of 598,000 BDU's of chips from their own A.A.C. for their pulping operations (1978 production levels).[65]

In 1980, 97,000,000 fbm of lumber was produced by P and G, while 60,000,000 fbm was produced by St. Regis (a total of 157,000,000 fbm of lumber).[66] Subtracting the additional 97,000 BDU's created as sawmill residues for a .62BDU/Mfbm would leave a total of 495,000 BDU's of chips being required by the pulpmills from their FMA.[67] If 795,000 BDU's is the A.A.C. as converted to a BDU basis, and 495,000 is the amount required from the FMA then 300,000 BDU's is the amount converted to lumber on a BDU basis.[68] As this indicates there is nothing left to cut on the FMA's with the conversion numbers that have been presented in this study.

Scenario 1 and 2

If one included the combined totals of chips bought by both pulpmills the following supply would be available;

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[65] P and G needed 243,000 BDU's from their FMA since they bought 317,000 BDU's from the sawmills as residues. St Regis needed 355,000 BDU's from their FMA since they bought 33,000 BDU's from the sawmills as residues. Therefore 243,000 + 355,000 BDU's = 598,000 BDU's.

[66] C.F.S.Survey information, from A.F.S. Directory For St Regis (1978-1979) production level page 285. Data for P and G taken from my study's survey July, 1981.

[67] A study by Fogh (1961) stated that to produce mfbm of rough lumber 185 cubic ft of wood was required.

[68] 157,000,000 FBM / 185 = 299,000 BDU's.

795,000 BDU's (potential quantity of chips from pulpmills A.A.C.)
350,000 BDU's (present quantity of supply of chips by sawmills)
41,000 BDU's (improvement available from sawmills due to CRF improvements)

Total = 1,186,000 BDU's (potential quantity of supply)

Including the 12 firms not chipping (Scenario 1) (as Table 6-1, Page 69, outlines) would involve an additional poptential supply of 77,400 B.D.U's which would increase the total amount of sawmill residues to 468,400 BDU's. The maximum amount of chips available, assuming all sawmills chipped residues, would be an additional 77,400 BDU's and the total available would change to 1,263,400 BDU's from 1,186,000 BDU's.

E. Potential Demand for Scenario 1 and 2

The following hypothetical chip markets are described to show the quantity of chips available under various assumptions of pulp production. Present demand by the two pulpmills is 948,000 BDU's. The 2 pulpmills from their own FMA's supply 598,000 BDU's, requiring 350,000 additional BDU's of chips from the sawmills. For scenario 2, potential demand varies, depending on whether one considers St Regis's expansion only, or if the expansion of P and G is also included. One limitation for any of the potential sources of supply is the cost of transporting the chips to the pulpmill.

TABLE 6.4 Potential Quantity Supplied and Demanded for Case 1 and 2

Potential Quantity Supplied

Case 1 - Assume Pulpmills supply maximum of 795,000 BDUs available from own F.M.A.
- Assume 3 potential situations are available for sawmill residues as follows;
  1) Present supply of 350,000 BDU's.
  2) Add improvement in CRF from Table 6.3 to make total 391,000 BDU's.
  3) Consider Max. of all 25 sawmills Table 6-1 to make total 468,400 BDU's.
  1) 795,000 + 350,000 = 1,145,000 BDU's
  2) 795,000 + 391,000 = 1,186,000 BDU's
  3) 795,000 + 468,400 = 1,263,400 BDU's

Potential Quantity Demanded

Assume that in terms of expansion available both pulpmills expand and demand 1,195,000 BDU's.
The residual amount is;
  1) 1,145,000 - 1,195,000 = -50,000 BDU's
  2) 1,186,000 - 1,195,000 = -9,000 BDU's
  3) 1,263,400 - 1,195,000 = 68,400 BDU's

Potential Quantity Supplied

Case 2 - Assume the pulpmills supply the max. of 795,000 BDU's.
- Assume same 3 situations for sawmill residues as outlined in Case 1 as follows;
  1) 795,000 + 350,000 = 1,145,000 BDU's
  2) 795,000 + 391,000 = 1,186,000 BDU's
  3) 795,000 + 468,400 = 1,263,400 BDU's

Potential Quantity Demanded

- Assume that in terms of expansion, P and G stays at the existing demand level of 560,000 BDU's per year and St Regis expands using an additional 50,000 BDU,s from Berland Fox Creek so that demand is 998,000 BDU's. The residual amount is;
  1) 1,145,000 - 998,000 = 147,000 BDU's
  2) 1,186,000 - 998,000 = 188,000 BDU's
  3) 1,263,400 - 998,000 = 265,000 BDU's

TABLE 6.5 - Potential Quantity Supplied and Demanded for Case 3 and 4

	Potential Quantity Supplied
Case 3	- Assume that the pulpmills supply the same amount as that supplied from their FMA's at the time of the survey, i.e., 598,000 BDU's - Assume the same three supply situations for sawmill residues outlined in Case 1, as follows; 1) 598,000 + 350,000 = 948,000 BDU's 2) 598,000 + 391,000 = 989,000 BDU's 3) 598,000 + 468,400 =1,066,400 BDU's
	Potential Quantity Demanded
	- Assume that in terms of expansion available both pulpmills expand to 85% capacity and demand 1,195,000 BDU's. The residual amount is; 1) 948,000 - 1,195,000 = -247,000 2) 989,000 - 1,195,000 = -206,000 3) 1,066,400 - 1,195,000 = -128,600
	Potential Quantity Supplied
Case 4	- Assume that the pulpmills supply the same amount as they supplied from their FMA's at the time of the survey, ie., 598,000 BDU's - Assume the same three supply situations for sawmill residues outlined in Case 1 as follows; 1) 598,000 + 350,000 = 948,000 BDU's 2) 598,000 + 391,000 = 989,000 BDU's 3) 598,000 + 468,400 = 1,066,400 BDU's
	Potential Quantity Demanded
	- Assume that no expansion occurs and as such the demand for chips by the two pulpmills is 948,000 BDU's. The residual amount is; 1) 948,000 - 948,000 = 0 BDU's 2) 989,000 - 948,000 = 41,000 BDU's 3) 1,066,400 - 948,000 =118,400 BDU's

As Table 6-4, Page 78 shows, 3 supply situations are outlined for Cases 1 and 2.[69] For supply situation 1, with the present supply of 350,000 BDU's of chips also available from sawmills, would mean a total potential supply of 1,145,000 BDU's. For supply situation 2, as previously outlined with a CRF improvement of 41,000 BDU's, from Table 6-3, Page 72, the potential supply would be 1,186,000 BDU's. For supply situation 3 if one included the 12 firms not chipping an additional 77,400 BDU's of chips would be available, which would mean a potential supply of 1,263,400 BDU's.

Case 1 demonstrates that assuming 100% utilization of the A.A.C and expansion by both pulpmills as proposed under the three supply situations a shortage of up to 50,000 BDU's would exist. Assuming as in Case 2 that St Regis expanded its operation and required an additional 50,000 BDU's of chips, and including the assumption that 795,000 BDU's were utilized 147,000 to 265,000 BDU's would be available.

For Table 6-5, Page 79, Case 3 and 4, the supply by the pulpmills is 598,000 BDU's and includes the same three supply situations discussed for Case 1 and 2, Table 6-4. For

[69] The 4 Cases in Tables 6-4 and 6-5 assume different levels of chip amounts that the present two pulpmills will utilize from their A.A.C.. For Case 1 and 2 i.e., Table 6-4 the pulpmills will supply a total of 795,000 BDU's which is the combined A.A.C. based on data for A.A.C. for 1976-1977 for both pulpmills converted to a per BDU basis. This was calculated in section D, "Potential Quantity of Supply." Case 3 and 4 in Table 6-5 assumes the pulpmills supply 598,000 BDU's. This is the present utilization of their A.A.C., as discussed in Chapter 6, in section B, for "St Regis", and Chapter 6, Section C for "Proctor and Gamble".

Case 3 assuming, as in Case 1, both pulpmills expanded operations, a shortage of 128,000 to 247,000 BDU's of chips would result.

As tables 6-4 and 6-5, Page 78-79, illustrate, for Case 1 and 2 with both pulpmills expanding and relying more on their own supply of wood as input, the sawmills present supply of chips to the pulpmills would not be fully utilized. The present amount of 350,000 BDU's supplied by the sawmills is due to the fact that they are a cheap source of wood as input in the production of pulp, and are therefore in demand by the pulpmills. The existing supply of 350,000 BDU's of chips from sawmill residues is 75% of the potential supply that is available.[70]

It is important to note that the 2 pulpmills do vary significantly in terms of the amount of chips that they buy as a % of total chips utilized. Somewhere between the extremes of Case 1 and Case 4 there would be 265,000 BDU's to 247,000 BDU's of residue available. This would depend on the level of expansion within the present pulpmill industry and the availability of increased sawmill residues.

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[70] As was illustrated in Table 6-1 468,400 BDU's is the total that could be supplied by all the 25 sawmills assuming a .62BDU/Mfbm Conversion Factor. With the present supply being 350,000 BDU's this represents 75% of 468,000 BDU's.

F. Conclusions

The 12 mills which are not chipping, have a potential of 77,400 BDU's available and the improvements in Chip Recovery which are available to the 13 firms that presently chip, could produce 41,000 BDU's more sawmill residue chips. The 12 firms which are not chipping, produce less than 22 mm fbm per year suggesting that the size of the mill affects the probability of producing chips. As the industry model showed, a larger firm producing 44mm, 100mm, or 160mm fbm could incur higher annual costs on a per unit of production basis. As the Cost Price Firm Analysis showed, the smaller operator has a higher level of annual and initial costs on a per unit of production basis. Alternatives such as combining mills into a chip network may be required to minimize costs for the smaller operator not yet chipping.

G. The Cost of Chips (FOB) Pulpmill

Comparing the cost of chipping, reflected in the pulpmill's position as buyer of the residue chips produced by the sawmills, leads to the question: what is the cost for pulpmills to produce chips? Both pulpmills in Alberta produce chips from both pulpwood logs and sawmill residues, as both operations are integrated within a sawmill. The logging cost attributable to chipping from pulpwood logs would include 100% of the cost of logging as the log is destined for pulp only. The other cost situation occurs where the pulpmill saws logs into lumber which produces sawmill residues. The logging cost could then be split between the cost of producing lumber and chips.

From a pulpmill's point of view one could attribute some of the logging cost to chip production from sawmill residues because of the joint product nature of sawmill residues at the pulpmill. Chips produced by a sawmill have an opportunity cost equal to only a burning cost. Sawmills have to produce lumber before they can produce chips. Chips treated as a residual by-product have no logging costs included.

The cost accounting most appropriate for this analysis for pulpmills is to split the cost of logging between lumber production and sawmill residues.[71] Both levels of chippable residues were considered in determining the amount available. Chips would incur a level of logging costs associated with chipping from 25% to 33% of the total cost.

Graph 6-1, Page 85, shows the effect of higher utilization on logging costs as one decreases the minimum size from 7" to 5" (see Table 6-6 Page 84). The portion for chipping column in Table 6-6 shows the amount that logging costs are included in the cost of production at a pulpmill for sawmill residues for the two levels of 25% and 33%. Average Annual and Average Initial Costs are taken from a

[71] 185 cubic feet of lumber is required to produce 1000 fbm of rough sawn lumber. About 1/3 of that or 60.17 cubic feet is chippable residue. This calculation of chippable residue was based on a study by Fogh (1961) which determined that 33% was chippable residues. A mill survey by Styan (1977) determined that 45 cubic feet or 25% was chippable residue.

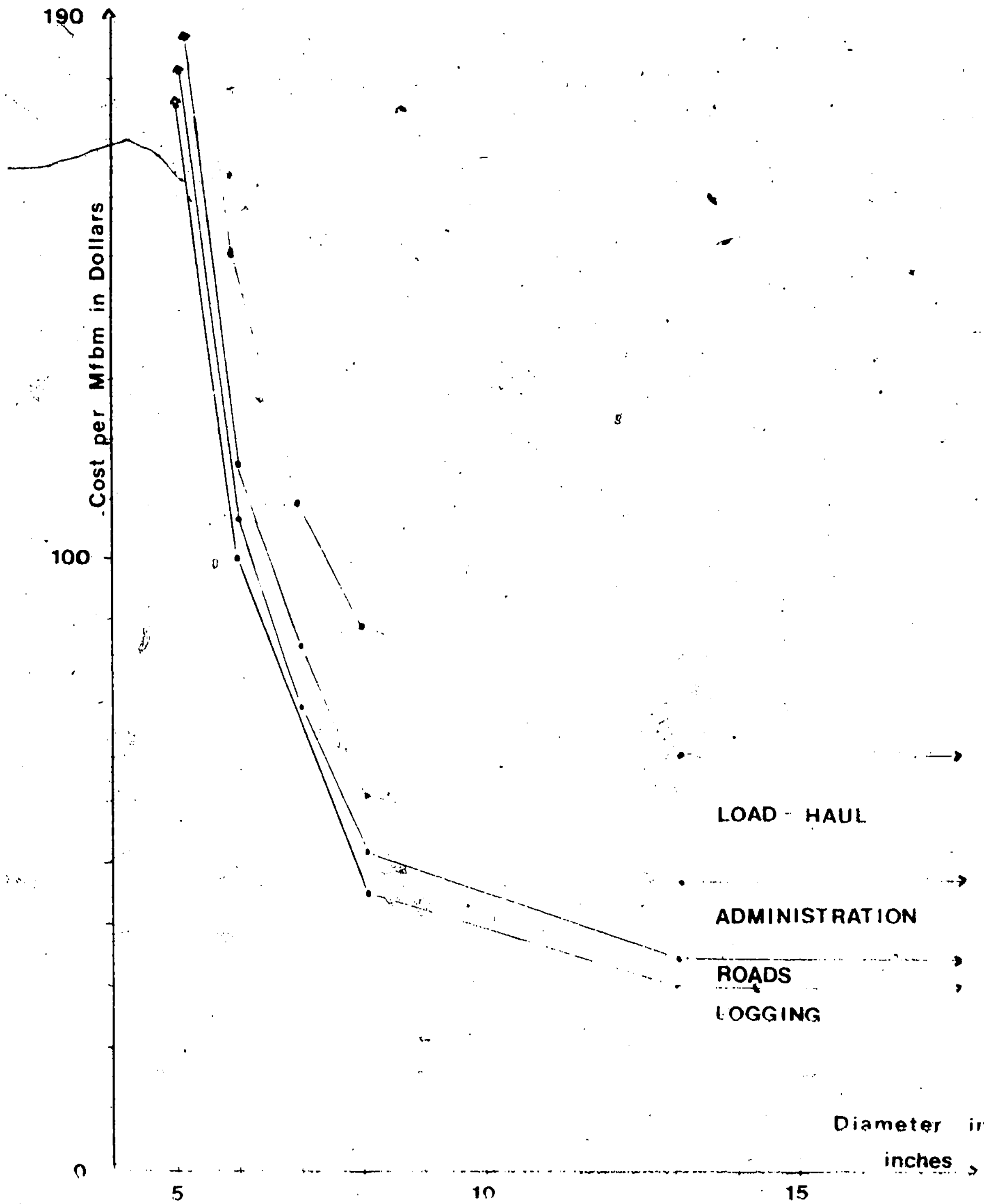
Table 6.6 The Cost of Producing Chips at a Pulpmill

Size of Log	Cost of logging+	Portion for chipping	AV. annual costs	AV. initial costs	Total cost per BDU
5"*	$220(est.)	$72.60	$16.93	$8.12	$97.65
6"	$185	$61.05	$16.93	$8.12	$86.10
7"	$118	$38.94	$16.93	$8.12	$63.99

*Assume 1/3 of the log or 60.17 cubic feet/Mfbm is available

5" **	$220(est.)	$55.00	$16.93	$8.12	$82.05
6"	$185	$46.25	$16.93	$8.12	$71.30
7"	$118	$29.50	$16.93	$8.12	$54.55

** Assume 45 cubic feet/Mfbm is available,
\+ Cost of logging includes hauling, logging, administrative costs which were derived from Graph 6.1, Page 85.



Source: Clark, J.D., 1980

GRAPH 6 1 Average Butt Diameter

Harvested Effect on Cost per Mfbm

sawmill that was a similar size as the pulpmill's sawmill.[72] Total costs varied from a minimum of $54.55 per BDU to a maximmum of $97.65 per BDU.

The prices offered (f.o.b.) pulpmill can be determined by adding transportation costs to the (f.o.b) sawmill prices of the 13 sawmills surveyed. For P and G, prices would range from $26.86/BDU to $50.06/BDU. For St Regis, prices would range from $45.00 to $47.65/BDU. For this study using a $50.00/hr. transportation charge and by determining the distance from the sawmill to the pulpmill the costs f.o.b. pulpmill were calculated. [73] P and G has a lower range of prices because of the lower base price offered (f.o.b. sawmill). This is outlined in the pricing formula (see next section "Effects of Changing the Price of Chips").

For P and G, at a minimum of $26.86/BDU, (which is the cost of sawmill residues to the pulpmill, including transportation costs) to produce chips instead of buying them is an additional 100% of cost compared to the price offered to the sawmills. For St Regis; the minimum price offered (f.o.b pulpmill), is $45.00/BDU. This price is 20% below the minimum cost of the pulpmill. For P and G, with a maximum cost of $97.00, the price offered (f.o.b pulpmill), is again 100% less, at $50.06 per BDU. For St Regis, with a maximum cost of $97.00 per BDU, the price of $47.65 per BDU

[72] Assumed that the costs at both of the pulpmills were the same.

[73] The specific firms costs will not be revealed. Only the range of costs (f.o.b pulpmill) will be given.

is a cost that is about 50% less than their own production costs.[74] P and G can buy chips which cost 100% less than the firm can produce, for both the minimum and maximum costs of production. St Regis can buy chips at a price 20% less than it costs to produce chips (assuming the minimum cost of production). At a higher cost of production, they could buy chips that cost 50% less than they can produce.

Effects of Changing the Price of Chips

Determination of a price policy is dependent upon changes in the Canadian dollar, the price for a short ton of Kraft Pulp, and the base price for wood chips. The price of chips is defined by the pulpmills by the formula :

1. A/C= X/B where;
2. A= Base price for wood chips per BDU f.o.b.carrier vehicle at seller's mill site.
3. C= being the base agreement price for Canadian bleached Kraft softwood pulp per air dry short ton in Canadian dollars.
4. B= is the previous six month average price (listed in the Paper Trade Journal) for Canadian bleached Kraft softwood pulp per air dry short ton in Canadian dollars.
5. X= the price for chips at the sawmill.

The pricing formula is relevant to our discussion because it demonstrates how the pulpmills calculate the price of chips for the sawmill. Understanding this process will help in showing how limited the sawmill's position is

[74] As can be noted in this comparison the cost of logging is the same for both pulpmills although P and G has an average haul that is 20 miles longer than St. Regis.

regarding price.[75]

See Table 6-7, Page 88, for an example of a six month average price which is $574.51. Consider the movement of the U.S. price for Kraft pulp for a short ton from a price of $480.00 to $520.00 (American dollars). The Canadian dollar has also varied from .75 to .82 cents U.S..[76] Using Table 6-8, Part A, Page 90, the price for Kraft pulp varies. The average price on July 1st 1981 was $574.51, for a short ton of bleached Kraft pulp.[77] Consider the difference in the two base prices offered in Alberta of $35.00 per BDU, (St. Regis) and $20.00 per BDU, (P and G). The price per BDU of chips varies with changes in the Canadian dollar and the price of Kraft Pulp (see Table 6-8, part B and C, Page 90).

This comparison demonstrates the differences between the two base prices. Using a $35.00 base price, the price movement in chips is from $35.64 to $42.22 , a 19% increase. For a $20.00 base price, the movement in chip prices is from $20.37 to $24.12, a 18% increase. Considering that some firms in the previous analysis (Chapter 5) needed as much as a 66% increase in price for a 0% I.R.R., the price movement allowable with this formula of pricing would not be adequate under present market conditions to guarantee firms an adequate price for chips. The radical price changes needed

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[75] This suggestsa pulpmill has monopsonistic power.
[76] These ranges in prices and costs show the extreme range of what could have happened in the market after July 1st 1981.
[77] Assume a contract is set up for a five year period, starting from July 1st 1981.

TABLE 6.7

Price of Chips Determination Applicable at July 1st, 1981

Month	Price Spread U.S.$ per short ton	Average U.S.$ short ton	Exchange Rate Month Average	Price Canada $ per short ton
JAN 15	480-482	481.00	0.84028	$572.43
30	480-482	481.00	0.84028	$572.43
FEB 15	475-480	477.50	0.83446	$572.23
30	475-480	477.50	0.83446	$572.23
Mar 15	475-480	477.50	0.83932	$568.91
30	475-480	477.50	0.83932	$568.91
APR 15	475-480	477.50	0.83939	$568.87
30	481-485	483.00	0.83939	$575.42
MAY 15	481-485	483.00	0.83287	$579.92
30	481-485	483.00	0.83075	$581.40
JUNE 15	481-485	483.00	0.83075	$581.40
30	481-485	483.00	0.83075	$581.40
	Kraft bleached softwood, Canada	$480.38 Average	0.83618 Average	$574.51 Average (B)

Source: J D Clark, Woodlands Division St Regis.

Chip price effective from July 1, 1981
as follows:

A/C=X/B where: A= $35.00/BDU (BaseValue)
B= $574.51
C= $534.20 (Base Pulp Price)
X= ($35.00*$574.51)/$534.20=$37.64

TABLE 6.8 A

Variation in Price of Kraft Pulp Due to Changes in the Canadian Dollar and Price of Pulp (U.S. dollars)

		75¢	78¢	80¢	82¢ (Canadian Dollar)
(Price	480	640	615	600	585
for a	490	653	628	612	597
short ton	500	666	641	625	609
of pulp in	510	680	654	638	621
U.S. $)	520	693	666	650	634

TABLE 6.8 B

Variation in Price of Chips per BDU Due to Changes in the Base Price

	75¢		80¢		82¢ (Canadian Dollar)	
(Price for	640	22.27	600	20.88	585	20.37
a short	653	22.37	612	21.31	597	20.78
ton of	666	23.18	625	21.76	609	21.20
pulp in	680	23.67	638	22.19	621	21.62
U.S.$)	693	24.12	650	22.63	634	22.07

This is for a base price of $20.00/BDU

TABLE 6.8 C

Variation in Price of Chips per BDU Due to Changes in the Base Price for Chips

	75¢		80¢		82¢ (Canadian Dollar)	
(Price for	640	38.98	600	36.55	585	35.64
a short	653	39.78	612	37.28	597	36.37
ton of	666	40.57	626	38.08	609	37,10
pulp in	680	41.43	638	38.84	621	37.83
U.S.$)	693	42.22	650	39.60	634	38.62

This is for a base price of $35.00/BDU

to improve some firms rate of return would not occur.

H. Summary

This chapter discussed the quantity of supply and demand from present and future pulpmills. The significance of new developments cannot be overemphasized. If residue utilization is to continue, the impact of such developments must be considered carefully regarding the demand and quantity of supply. As the study demonstrates, the quantity of chips supplied appears likely to meet the quantity demanded for the future but this can only be determined if the amount needed can be more accurately calculated in terms of economic availability.

Also, it is apparent that the present chip pricing policies are restrictive and minimize the affects of normal market fluctuations in the Canadian Dollar and World Pulp Prices in terms of the increase in demand and the price of a less restrictive pricing policy. The cost of producing chips at a pulpmill range from $54.55 to $97.65 per BDU. As the price offered f.o.b sawmill demonstrates, more competition would assist sawmills to get prices for their chips which are closer to that of the pulpmills costs for production

VII. Summary and Conclusions

A. Summary of the Objectives

The introduction of debarkers and chippers in the late 1940's in B.C. resulted in larger sawmills being able to take advantage of a waste product which costs money to burn or to dispose of. The mills intended chipping to be a way to generate additional revenue. Originally, firms did not incur a significant increase in their overall costs of production. Consequently, chipping offered a way for firms to offset increasing costs of lumber production.

In Alberta, the utilization of residues is a more recent occurance. The sawmill and pulpmill industries do not have as long a history of development as in B.C. The pulpmills in Alberta do not need residue chips to produce at the same operating capacity, as the mills are allocated enough timber to be self sufficent. In B.C. the significance of the unutilized wood was evident. There were enough chips available to consider the development of a pulp industry which had pulpmills relying on supplies of wood residues from sawmills. The pulpmills had a limited supply of standing timber as a guaranteed wood source.

A previous wood chip study involved looking at the marketing aspects of chipping in Alberta which resulted in the recognition of monopsonistic competition. This study points out a concern that present chip pricing policies may have increased the potential amount chipped at the expense of reduced revenues being available to sawmills. Those in a preferred location i.e., closer to the pulpmills are not able to capture their producer surplus and instead find it transferred to the pulpmill. This can ensure the utilization of chips which would not be bought in a competitive market.

This study also provided discussion on the following:

1. The information base regarding the costs of production for the chipping operation,
2. The rate of return available for the sawmills,
3. Identification of cost constraints that specifically affected rates of return,
4. The impact of size of operation on costs of production,
5. The effect of location of mill on rates of return,
6. Transportation costs, the cost of wood chips to the producers of pulp,
7. The economic impact of the price policies employed by the pulpmills.

B. Results

The study determined that the extent of chipping among the various operators in Alberta was limited to thirteen firms that had a combined total of 70% of Alberta's lumber production. There were various reasons why the other firms did not have the same impact on the production of lumber and did not chip.

In the study the costs of production, i.e., initial and annual costs were calculated. Economic efficiency by determining the net present value, profitability-ratio and internal rates of return of the firm was evaluated. When comparing the three methods, similar conclusions were made regarding the firm's ability to chip. For simplicity, the internal rate of return method was recognized as being most acceptable when determining a firm's relative ability to chip. When defining the economic efficiency of the firm, the sensitivity analysis evaluated the differences in three rates of return and four price changes. As the price of chips improved, the economic efficiency of the firm, as evaluated by the IRR, NPV, and P/R ratios improved.

Conclusions in the Cost-Price-Firm Analysis were that high annual or initial costs were due to inappropriate equipment, type of maintenance, or the mill layout. Where a high CRF prevailed, high variable costs of production were most likely due to a lack of available timber which resulted in the high costs per unit of output.

The size of operation also had a role in determining returns. When a firm had a lower than average price for chips, the ability to reduce costs by having more production per unit of output, i.e., above average CRF, helped in achieving an adequate rate of return. The cost constraints involved in chipping may be resolved by achieving an adequate level of production. This points to the possibility that economies of scale in chipping exist. Although it was not possible to discuss scale directly from the data calculated, the implications of size were evident with the larger firms being more profitable. The firms that had better rates of return had high chip recoveries and lower per unit costs. Firms 3, 4, 6, 9 and 12, for example, achieved adequate returns under all three Cost Cases. The number of negative results i.e., Firms 1,5,10 and 13 suggest that in the short run profit maximization is not the only motive for chipping some output maximization is also evident.

When determining costs to the firm, two accounting methods were employed, to evaluate the affect of the two types of cost methods for the debarkers. In the first situation, purchasing a debarker reduced saw maintenance. Eventually, if chipping was undertaken by the mill, due to the joint nature of production for chips and lumber, some of the cost of the debarker would have to be allocated to the chipping operation (Accounting Method 2). Accounting Method 1 allocated the full expense to the chipping operation. By defining costs such that all initial costs would be incurred by the firm, the potential rate of return would be reduced accordingly. A firm not chipping could determine the potential rate of return based on another sawmill's costs with a choice of two cost methods.

One difficulty encountered in the study involved determining the costs of production (initial and annual) so they would accurately reflect industry costs at the time of the survey (July, 1981). Determining certain costs from the data was difficult. As opposed to the model the study was set up to consider, some firms tended to allocate specific costs such as depreciation differently.

A firm may not perceive these rates of return due to differences in the allocation of specific costs. It appeared that some firms were doing well in their chipping operation. In such cases operators considered the initial costs as being a sunk cost. Economic viability was thought of in terms of the ability to cover the variable costs of production only. With changes in the prices of lumber firm behaviour would seem to be set towards reinvesting high annual profits during high lumber price years i.e., into chipping equipment. This study determined rates of return included with fixed costs as well as variable costs. By including initial costs, the calculated rates of return on the investment were lower than firms perceived.

Different ways existed in approaching the price sensitivity analysis. Certain prices changes were chosen which resulted in differences in the rates of return for the firm. In contrast to price increases that would be needed by a firm Chapter 6 discussed the price changes that would be allowable in the pricing formula under market conditions. These changes were not sufficient to provide for the necessary increases required by firms 1 [illegible] 10 and 13 for achieving adequate rates of return.

During the survey, various operators mentioned that the price of chips did not reflect the actual cost to the pulpmill. This argument considered residues as if they were equivalent to chips produced by the pulpmill. This would suggest some logging costs should be included in chipping costs for sawmills.

In this analysis, some logging costs were assumed for the pulpmill, as the demand for output chips were a major input to production. When producing chips, the logging cost was a necessary production cost. Conversely, for the sawmill, no logging costs were assumed as the opportunity cost of producing chips involved only a burning or disposable cost. Sawmill operators who felt a logging cost should be included which would demonstrate the need for a higher price for chips for the sawmill may try to get as high a price as possible to offset their own high production costs.

For a major buyer of chips in the province, buying from the sawmills was about 50% less than the cost of the pulpmill producing them. As pointed out, although only a portion of the chips produced by the pulpmills were sawmill residues, logging costs were also included for this portion.[78] At the same time there are distinctive differences in the level of demand for chips, as both pulpmills buy different amounts. They are located far enough apart that their timber sheds do not overlap, which would result in competition for the chips along the timber sheds fringe. The price set by a price discriminating monopsonist were indicated to be lower than the price that would be available without discrimination in a more competitive market. The low prices

[78] This study was only set up to compare the cost of chipping between a sawmill and pulpmill for sawmill residues.

offered that are below production costs of a pulpmill are partly a reflection of monopsonistic power and partly due to the reduced opportunity cost of residue chips (i.e., not including logging costs).

C. Conclusions

The possibility that not all chips were being utilized efficiently and that prices offered were insufficient for a firm to achieve an adequate rate of return was researched. A total of 118,400 BDU's per year were determined as being available based on a .62BDU/Mfbm (CRF). This could be broken down such that 41,000 BDU's would be provided by the 13 firms presently chipping and the remaining 77,400 BDU's would be supplied by the 12 firms that did not presently chip. The economic availability of the entire total of 118,400 BDU's is questionable. The present pulpmills do not have any additional supply of wood available from their FMA which increases the potential for shortages of wood in the future with the development of new operations and the potential of increased demand by the 2 pulpmills.[79]

Of the potential sawmill residues created by all 25 sawmills based on a .62BDU/Mfbm CRF, approximately 25% are

[79] Based on an A.A.C. of 795,000 BDU's and a present level of utilization of 598,000 BDU's for pulping and 200,000 BDU's as converted to lumber production leaves no additional supplies available.

not being utilized. This was significantly lower than previous studies determined. A study by Styan (1977) determined that up to 50% of the potential chips were not being utilized.

A higher price may assist firms to meet their fixed costs of production as four firms were incurring a loss. These firms were in some cases incurring significant annual and initial costs per BDU which could be lowered by increasing the production of lumber output or chip production per output of lumber (CRF).

The economic potential of increasing the CRF of the firms presently chipping has to be determined since with the possibility of expansion for both of the pulpmills and the addition of new developments, there may be an increased demand for cheap sawmill residues. The significance of alternative sources for chips such as CRF improvements by sawmills presently chipping or chipping by sawmills that do not presently chip may increase with expansion of the industry if policies were directed at promoting residue utilization.

The study did not determine the amount of investment required by the individual firms presently chipping to make improvements in their Chip Recovery. The chipping potential of the firms not chipping is also questionable due to the type of operation, size of operation, attitude, and length of experience. The economic potential of the 77,400 BDU's (from the 12 firms presently not chipping) probably could not involve individual firms considering chipping because of the costs involved. Present demand is such that the pulpmills do not require additional chips.

The pulpmills were saving as much as 50% per unit of chips compared to their costs of production. This assumed that all the chips that the pulpmill bought were of uniform quality and would not affect the resulting quality of pulp. In the presence of monopolistic competition, the single buyer of a resource would pay significantly less than the competitive or monopolistic market. In considering movements in the price of the Canadian dollar and American pulp prices, with the present prices determined by a formula the pulpmill sets, possible price movements for chips would not be significant enough for the firms which require a higher price.

D Policy Implications

A conflict arises when consideration is given to utilization or the promotion of residue utilization in the forest industries development in Alberta. The promotion of higher residue utilization may result in discrepancies in the pricing of the resource, returns available to the sawmill, and the amount utilized by the pulpmill as opposed to B.C. Alberta has always considered the need to guarantee a sufficient supply of wood to the pulpmills. In B.C. sawmill residues are considered as being permanent sources of wood. It is questionably whether such a policy has affected residue utilization. Without the development of a pulp industry, residue utilization would not be a consideration for sawmills. Alberta's sawmill industry is much smaller than B.C.'s. It may not be correct to suggest that Alberta follow B.C.'s scheme, and therefore not allocate 100% of a pulpmill's needs through their FMA.

The price required for the development of an industry in Alberta which is relatively small may be significant and it may be difficult to encourage utilization of this resource.

Increases in the demand of the industry for residues is available through the development of the Berland Fox Creek and Brazeau areas. If new developments are allocated sufficient sources for wood on their FMA that they do not need chips from outside sources i.e. sawmill residues, the current situation of 25% of sawmill residues not being utilized is likely to continue.

The impact of present policies on the development of the sawmill and pulpmill industry creates a conflict between pulpwood and residues for pulp. A policy that promotes higher residue utilization may only conflict with the higher priority of promoting large industry development, which has traditionally been provided enough wood so firms do not need sawmill residues. Residues are only utilized when they are a cheaper alternate source for wood fibre. The promotion of higher residue utilization may result in distortions in the pricing of the resource, returns available to the sawmill and the amount utilized by the pulpmill.

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Appendix A

spruce
pine
fir

alberta forest products association

11710 kingsway avenue, edmonton, alberta T5G 0X5
telephone (403) - 452-2841

May 28, 1981
Circular #76-81

To All AFPA Members

To Whom it May Concern

The bearer Alex MacDonald of 11443 - 77th Avenue, Edmonton is preparing his Master of Science Thesis at the University of Alberta in the Faculty of Agriculture and Forestry. He has chosen a subject which may develop some useful information for the sawmilling industry in the province. He will attempt to model wood chip residue utilization from the point of the producing firm and relate to their productive and transportation costs, also to analyze the buying and selling relationship [illegible] the pulp mills and sawmills. He wishes to sample some 27 producing mills in the province, [illegible] currently producing chips, some not.

Following a lengthy discussion we had whereby he outlined the purpose of his project, I have advised him that I would write a letter to our membership. I suggested to him that some of the information he is after would be considered as confidential by some members, however, whatever cooperation you can provide him would be useful for his assembly of a study. It appears his approach does not [illegible] [illegible] done for this region and could be useful.

Yours very truly,

[illegible]

Arden A. Rytz
[illegible]

[illegible]

[illegible] 1981

Dear Sir:

This project is being undertaken as a graduate thesis in the Department of Rural Economy, University of Alberta in co-operation with the Alberta Forest Service and with the support of the Alberta Forest Products Association (A.F.P.A.).

The purpose of the study is to look at present and potential chip utilization, including an investigation of production and transportation costs. Your cooperation in providing some of this information, as outlined in the attached survey form, is sought. All information provided will be held in strict confidence. Particulars regarding your firm will be aggregated with all other firms surveyed to insure that individual firm results cannot be publicly determined.

You probably have already received a letter from Arden Rytz, A.F.P.A. An outline and explanation of the kind of data being sought is enclosed. I will be contacting you within two or three weeks for a personal interview. You are one of twenty-seven firms being contacted.

[illegible] endeavor [illegible]

Yours sincerely,

[illegible]

APM/gd
Enclosure

June 16, 19[illegible]

Dear Sir:

I have undertaken a project as a graduate student of the Department of Rural Economy, University of Alberta, in cooperation with the Alberta Forest Service and with the support os the Alberta Forest Products Association (A.F.P.A.)

The purpose of the study is to look at the present and potential chip utilization, including a determination of production and transportion costs. Although the study is directed at looking at sawmills in Alberta I would like to discuss with a representative of your firm how it utilizes the chips that are bought from sawmills. Your firm is an integral part of the residue utilizing industry and consequently I hope your firm my provide some interesting insight into what and how chips are processed. Any information that you may provide to me would be held in the strictest confidence.

You probably have already received a letter from Arden Rytz, (A.F.P.A.), informing you of the project. I will probably be in your area [illegible] days [illegible] I will call [illegible] days [illegible]

[illegible]

Yours truly,

[illegible]

June 16, 1981

Dear Sir:

I hoped by now that you would have received my letter dated June 8, 1981. The purpose of the study was to model chip utilization and investigate production and transportation costs. In the previous letter I mentioned my desire for a personnel interview with a company representative. The information I required was listed on the survey as well as an explanation of how the aggregated data would be treated. Hopefully I will be in your area in the next ten days to two weeks. I will call [illegible] days in advance [illegible] [illegible] Thank you.

Yours [illegible]

[illegible] MacDonald

Appendix B

explanations are intended to inform you of what I would like to ask in a personal interview.

1) Total production of lumber (FBM).

2) Average number of shifts per year.

3a) Annual chip output (BDU).

3b) What is your chip recovery factor on a BDU/MFBM basis?

4) What kind of chipping equipment do you use?

a) Make
b) Type
c) Year purchased
d) Age when bought
e) Purchase cost and expected salvage value after N years

5) What are the fixed costs of the following on a yearly basis

a) Property taxes
b) Insurance
c) Depreciation
d) Interest on Average Investment

6) What are the variable costs of production on a yearly basis as follows

a) Labor (c[illegible])
Chipper
Debarker
Total

b) Power
Chipper
Debarker
Total

c) Maintenance and repairs (parts and other supplies)
Chipper
Debarker
Total

7) Who do you sell your chips to?

8) What price do you receive (FOB Sawmill)?

9) Do you use all the residues for chipping? If not, what do you do with them? i.e What percent is burned/disposed of. Indicate in BDUs how large this potential source of chips is.

10) If you use the railway system to transport your chips, what is the

Average number of BDU/load
Rail miles to pulpmill
Rate in cents/BDU
Total amount shipped/year
Name of railway company

11) If you use the trucking system to transport your chips, what is the . . .

Average number of BDU/load
Distance to pulpmill
Loading and unloading costs
Total amount shipped/year
Name of the trucking firm

[illegible] Outline the problems [illegible] existing [illegible]

GENERAL INFORMATION

[illegible] (yearly basis)

[illegible] Diagramatically show how your sawmill [illegible] explain [illegible] are created and [illegible]

SAWMILL OPERATIONS WITHOUT CHIPPING FACILITIES

*Note: These questions are intended to inform you of what I would like to ask in a personal interview.

1) Total production of lumber (FBM).

2) Average number of shifts per year

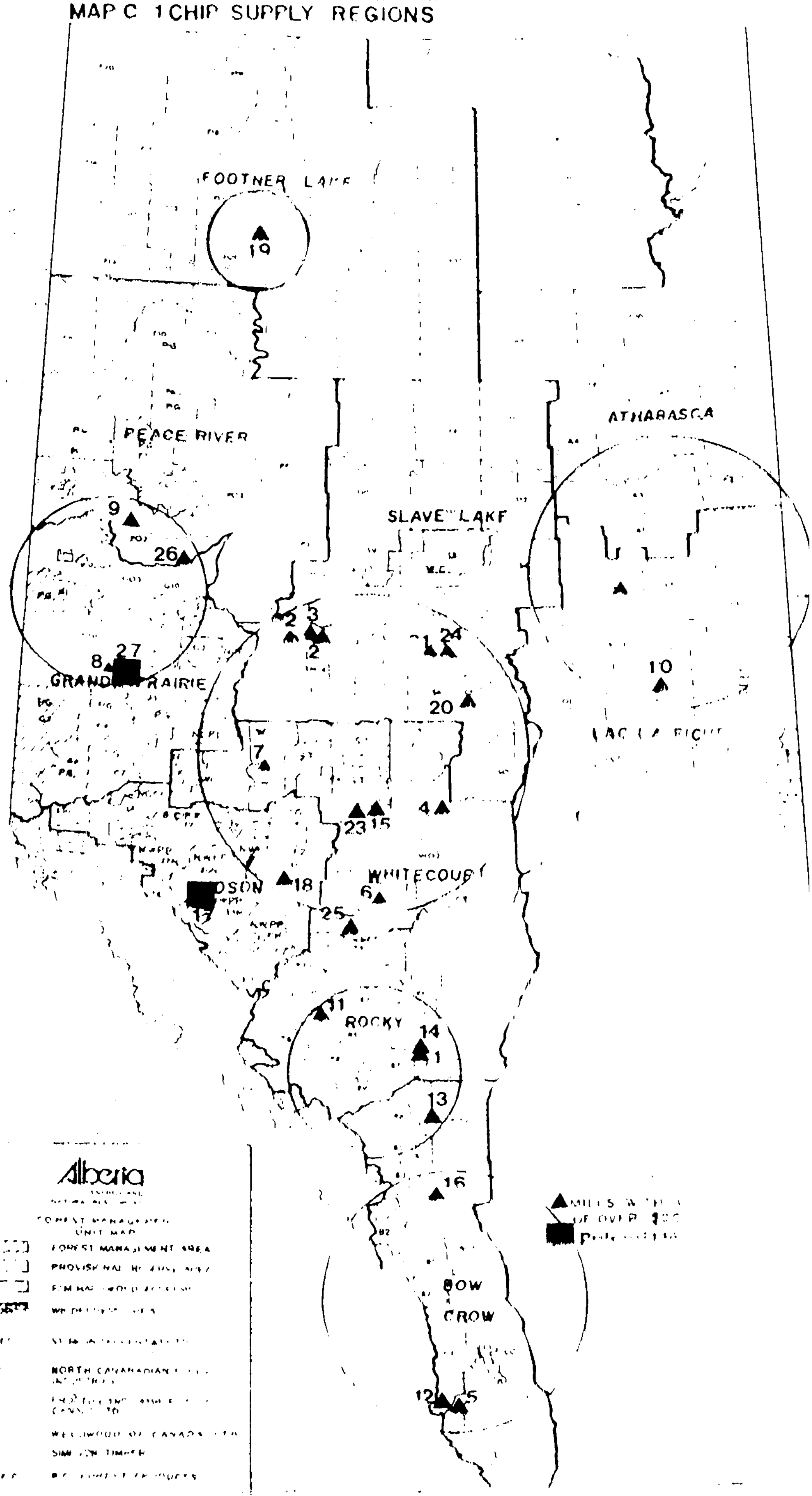
3) What do you presently do with all your residues created in the lumber process?

4) What are the constraints that [illegible] presently affect your ability to chip?

5) Explain how your sawmill is set up. (i.e. kind of equipment [illegible] and map out your sawmill and [illegible])

Appendix C

MAP C 1 CHIP SUPPLY REGIONS



List of Firms Surveyed List C-1

Forest		Yearly Lumber Production Sawmills mm fbm	Pulpmills
Rocky	1) Revelstoke Companies Ltd.	9.00	
Whitecourt	2) Bissel Brothers Lumber Ltd	12.00	
Whitecourt	3) Buchanan Lumber Ltd	23.28	
Whitecourt	4) Ziedlers Forest Ind. Ltd.	47.00	
Bow-Crow	5) Johnson Brothers Sawmills Ltd	13.00	
Whitecourt	6) L.H. Rehn Lumber Ltd.	4 00	
Whitecourt	7) Mostowich Lumber Ltd.	7 00	
GrandePrairie	8) North Canadian Forest Industries Ltd (Grande Prairie)	[illegible]85 00	
GrandePrairie	9) North Canadian Forest Industries Ltd (Hine Creek)	16 00	
Athabasca	10) Pelican Spruce Mills Ltd.	14 70	
Rocky	11) Revelstoke Companies Ltd (Harlech)	17 00	
Bow Crow	12) Revelstoke Companies Ltd (Sentinel)	15 00	
Rocky	13) Revelstoke Companies Ltd (Sundre)	14 50	
Rocky	14) Rocky Wood Preservers Ltd	4 50	
Whitecourt	15) Alberta Energy (Blue Ridge)	26 00	
Bow Crow	16) [illegible] Lake Sawmills Ltd	[illegible]	
Edson	17) St Regis (Alberta) Ltd		
Whitecourt	18) Svesberg Lumber Co. Ltd	9 00	
Footner	19) North Canadian Forest. Industries Ltd. (High Level)	[illegible]02 00	
Whitecourt	20) Urchyshyn Contracting Ltd.	22 10	
Whitecourt	21) Vanderwell Contractors Ltd	12.50	
Whitecourt	22) Wagner Lumber Ltd.	10 00	
Whitecourt	23) Western Construction and Lumber Co. (Ltd.)	50.00	
Whitecourt	24) Ziedlers Forest Industries Ltd.	12 00	
Whitecourt	25) A and A Logging	4 00	
GrandePrairie	26) Boucher Bros. Ltd.	1[illegible] 00	
[illegible]	27) Procter and G[illegible]		97 00
		[illegible]16 28	87[illegible].28

TABLE C 1

Initial Costs of Production

Firm Production/Year

Cost of Debarkers
A) Initial Cost of Debarkers
B) Accessory Costs
C) Total Cost
D) Depreciation per year

Chipper Cost
A) Initial cost of chipper
B) Motors and installation
C) Conveyors infeed
outfeed
D) Screens
E) Surge bins
F) Metal Detector
G) Vibrating Conveyor
H) Chip Blowing System
I) Storage Bins
J) TOTAL COST
K) Depreciation per year

ry Costs
A) Engineering Cost
B) Hydraulic Equipment
C) Compressor
D) Conveyors
E) Electrical

TOTAL INITIAL COSTS 1) (100)
debark 2)

Table C-1 (Continued)
Fixed and Variable Costs of Production

	100%	50%
A) Fixed Costs		
1) Property Taxes		
2) Insurance		
TOTAL COSTS A		
B) Fixed Costs		
1) Depreciation on Building		
2) Deprectiation Equipment		
TOTAL COSTS B		
C) Variable Costs		
1) Labor		
2) Power		
3) Maintenance Costs		
TOTAL COSTS C		

TOTAL FIXED COSTS A + VARIABLE COSTS C = 1) ______ (100%)

= 2) ______ (50%)

Appendix D

In calculating the (IRR) for firm 1, Case 2 and firms 1,5 and 8 for Case 3, the values for annual costs as outlined in Table D-14 could not be used when running program 3 which calculated the (IRR) without the effect of taxation. The program which was set up to force the NPV to zero (which would be the (IRR) of the investment) would not run with those values outlined by the letter A, B, or C in Table D-14, Page 150. Therefore, lower values for annual costs had to be used. The outcome was the same, the (IRR)'s calculated were less than zero.[80]

Another discrepancy that was noted involved the calculation of the P/R values. Some of these values were negative. For the non-tax calculations P/R was equal to the present value of (Gross Revenue - Annual Costs) divided by the present value of the initial costs of the investment. So where Annual Costs were greater than Gross Revenue Net Revenue would be negative.

For the tax calculations the cashflow approach was used i.e., CF=(NR - D)*(1 -t) + D. A test condition in program one (Appendix F) stated that if Cashflow was negative, assume Cashflow equaled Net Revenue. A negative Cashflow resulted if Depreciation was greater than Net Revenue. The test condition was no help where Net Revenue was negative than Cashflow would be negative. This occurred for Annual Cost increases in Case 2 and 3 where Annual Costs exceeded Gross Revenue. Therefore dividing a negative cashflow by the initial costs of the investment resulted in a negative value for (P/R) when testing for taxation.

This was the same problem encountered when calculating a value for (IRR) when a negative value for cashflow was replaced by a negative net revenue value. Where annual costs exceeded gross revenue, the resulting values for (IRR) were less than zero for Cases two or three.

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[80] In calculating the IRR of the firm (forcing the NPV to as close to zero as possible) an iterative process was followed where a maximum and a minimum value for the IRR was tested. The IRR of the firm had to be within the maximum and minimum values and forcing the NPV to zero produced the (IRR) that did this. (See further explanation and example in Appendix E, Program 3. Page 172)

Table D - 1 The Internal Rate of Return *

Firm	No Price Change			10 % Price Change		
	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3
1	0	0	0	0	0	0
2	6	6	0	9	9	0
3	17	8	3	19	13	8
4	8	10	6	9	13	10
5	0	0	0	0	0	0
6	23	20	17	27	25	22
7	3	0	0	6	3	0
8	0	0	0	0	0	0
9	28	32	27	33	36	32
10	0	0	0	0	0	0
11	8	7	0	11	11	3
12	29	24	21	32	28	27
13	0	0	0	0	0	0

* zero refers to the firm receiving an IRR less than zero. This is true of all the Tables D-1 to D-4 that have a zero.

Table D - 1 (cont'd) The Internal Rate of Return

Firm	30 % Price Change			50 % Price Change		
	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3
1	1	0	0	7	0	0
2	16	16	7	23	22	14
3	31	23	19	40	32	28
4	19	21	18	27	28	25
5	0	0	0	0	0	0
6	37	34	31	45	43	49
7	13	11	7	20	17	13
8	0	0	0	3	2	0
9	43	46	42	53	55	53
10	2	6	0	9	12	5
11	21	19	11	28	25	18
12	44	38	36	55	46	15
13	2	2	0	9	9	1

Tables D-1 to D-4 illustrate the I.R.R. for 13 firms under 3 cost cases outlined in Table D-1[illegible] and D-16 for 4 price changes. This table includes taxation. The Accounting Method is one where 100 % of [illegible] costs are attributable to the investment.

Table D-2 The Internal Rate of Return

Firm	No Price Change			10 % Price Change		
	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3
1	1	0	0	4	0	0
2	17	16	9	21	20	13
3	26	18	12	32	23	18
4	17	18	13	22	22	17
5	0	0	0	0	0	0
6	32	29	27	38	35	32
7	9	7	3	13	11	8
8	0	0	0	0	0	0
9	36	38	35	46	46	42
10	1	5	0	5	8	1
11	22	19	8	27	23	13
12	34	33	27	43	41	24
13	1	2	0	5	5	0

Table D-2(cont'd) The Internal Rate of Return

Firm	30 % Price Change			50 % Price Change		
	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3
1	12	0	0	19	6	1
2	29	28	21	36	35	29
3	42	34	29	52	44	39
4	30	31	26	36	39	34
5	2	1	0	6	5	1
6	47	45	42	57	51	53
7	21	18	15	28	26	23
8	5	4	0	11	10	0
9	70	77	67	64	68	66
10	11	15	7	18	21	14
11	37	32	22	44	40	30
12	53	43	45	65	50	55
13	11	12	1	1[illegible]	17	8

This table includes taxation and is for Accounting Method Two where 50 % of the debarker costs are included for the chipping investment

Table D-3 The Internal Rate of Return

Firm	No Price Change			10 % Price Change		
	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3
1	0	0*	0*	0	0*	0*
2	12	11	0	19	18	0
3	32	16	6	41	26	16
4	15	19	12	22	26	19
5	0	0	0*	0	0	0*
6	43	38	32	51	46	41
7	6	0	0	12	7	0
8	0	0	0*	0	0	0*
9	52	58	50	61	67	59
10	0	0	0	0	0	0
11	16	15	0	24	22	7
12	54	44	40	63	538	49
13	0	0	0	0	0	0

*As Table D 14 explains these values would have been different if they had been based on the actual annual costs defined in Table D-14. Program 3 would not run with the values specified therefore it was nessecary to readjusted to the values outlined in D 14. The IRR was still less than zero.

Table D 3 (cont'd) The Internal Rate of Return

Firm	30 % Price Change			50 % Price Change		
	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3
1	2	0*	0*	14	0*	0*
2	31	30	14	42	41	27
3	57	43	35	73	60	51
4	36	39	33	49	52	46
5	0	0	0*	0	0	0*
6	67	63	58	83	79	74
7	25	20	13	37	32	26
8	0	0	0*	6	5	0
9	79	84	77	96	102	94
10	5	12	0	17	23	9
11	38	35	22	52	47	34
12	81	69	66	99	86	83
13	5	6	0	16	18	1

This table excludes taxation and is for Accounting Method One where 100 % of the debarker costs are included.

Table D-4. The Internal Rate of Return

Firm	No Price Change Case 1	No Price Change Case 2	No Price Change Case 3	10 % Price Change Case 1	10 % Price Change Case 2	10 % Price Change Case 3
1	2	0*	0*	9	0*	0*
2	32	31	17	40	38	25
3	49	34	24	58	44	35
4	33	34	24	41	42	33
5	0	0	0*	0	0	0*
6	60	55	49	69	64	59
7	19	14	7	26	21	15
8	0	0	0*	0	0	0*
9	73	75	67	84	85	78
10	-3	9	0	9	16	1
11	42	36	16	51	44	25
12	68	58	54	78	67	64
13	3	4	0	10	10	0

* As table D 14 explains these values would have been different than they were calculated if they had been based on the actual levels of annual costs defined in Table D-14. There was no difference as to the outcome of the results the IRR was still <0

Table D 4(cont'd) The Internal Rate of Return

Firm	30 % Price Change Case 1	30 % Price Change Case 2	30 % Price Change Case 3	50 % Price Change Case 1	50 % Price Change Case 2	50 % Price Change Case 3
1	23	0*	0*	35	12*	8*
2	54	52	40	66	65	53
3	77	62	54	94	81	73
4	56	57	48	71	72	63
5	3	0	0*	13	10	1*
6	87	83	77	105	100	95
7	39	35	29	52	48	43
8	10	9	0*	22	20	3*
9	104	106	98	124	126	118
10	22	28	14	34	39	27
11	68	59	41	85	73	56
12	98	86	83	118	103	102
13	22	23	3	33	33	16

This table excludes taxation and is for Accounting Method Two where 50 % of the debarker costs are included

Table D-5 Profitability Ratio 0 % Discount Rate

Firm	No Price Change					
	Case 1		Case 2		Case 3	
1	0.45	0.45	-0.13	-0.13	0.46	-0.46
2	1.20	1.40	1.18	1.36	0.77	0.77
3	1.57	2.14	1.27	1.54	1.09	1.17
4	1.25	1.49	1.32	1.63	1.19	1.37
5	0.13	0.13	0.12	0.12	0.15	0.15
6	1.78	2.57	1.69	2.37	1.57	2.14
7	1.09	1.17	0.98	0.98	0.74	0.74
8	0.36	0.36	0.32	0.32	1.09	1.09
9	1.98	2.97	2.11	3.22	1.94	2.88
10	0.58	0.58	0.79	0.79	0.33	0.33
11	1.24	1.53	1.20	1.48	0.98	0.98
12	2.03	3.04	1.82	2.64	1.73	2.47
13	0.62	0.62	0.70	0.70	0.12	0.12

Tables D 5 to D 7 are set up to illustrate the difference in the Profitability Ratio for 4 price changes and 3 cost cases with the tax/nontax ratios side by side. The Profitability Ratios include 100 % [illegible]

Table D-5(cont'd) Profitability Ratio 0 % Discount Rate

Firm	10% Price Change					
	Case 1		Case 2		Case 3	
1	0.65	0.65	0.06	0.06	0.27	0.27
2	1.32	1.63	1.30	1.59	1.00	1.00
3	1.75	2.50	1.45	1.89	1.26	1.53
4	1.38	1.76	1.45	1.90	1.32	1.64
5	0.26	0.26	0.25	0.25	0.03	0.03
6	1.96	2.93	1.86	2.73	1.75	2.49
7	1.20	1.40	1.11	1.21	0.97	0.97
8	0.53	0.53	0.48	0.48	0.22	0.92
9	2.19	3.37	2.31	3.62	2.14	3.28
10	0.77	0.77	0.99	0.99	0.52	0.52
11	1.41	1.81	1.37	1.73	1.11	1.23
12	2.23	3.46	2.00	3.01	1.92	2.84
3	0.80	0.80	0.88	0.80	0.30	0.30

Table D.5(cont'd) Profitability Ratio 0 % Discount Rate

Firm	30 % Price Change					
	Case 1		Case 2		Case 3	
1	1.02	1.05	0.44	0.44	0.11	0.11
2	1.55	2.10	1.53	2.06	1.23	1.47
3	2.10	3.20	1.80	2.60	1.62	2.23
4	1.65	2.30	1.71	2.43	1.58	2.17
5	0.52	0.52	0.50	0.50	0.22	0.22
6	2.32	3.65	2.22	3.45	2.11	3.21
7	1.43	1.87	1.24	1.67	1.22	1.43
8	0.86	0.96	0.82	0.82	0.59	0.59
9	2.59	4.18	2.71	4.43	2.55	4.02
10	1.08	1.16	1.19	1.39	0.91	0.91
11	1.69	2.39	1.62	2.23	1.36	1.73
12	2.65	4.20	2.37	3.73	2.30	3.60
13	1.08	1.1[illegible]	1.12	1.24	0.66	0.66

Table D·5 Profitability Ratio 0% Discount Rate

Firm	50 % Price Change					
	Case 1		Case 2		Case 3	
1	1.22	1.45	0.81	0.81	0.49	0.49
2	1.78	2.55	1.75	2.51	1.46	1.92
3	2.45	3.91	2.15	3.31	1.97	2.94
4	1.92	2.84	1.98	2.96	1.85	2.70
5	0.79	0.79	0.75	0.75	0.48	0.48
6	2.68	4.36	2.58	4.16	2.47	3.93
7	1.66	2.33	1.57	2.14	1.45	1.90
8	1.10	1.20	1.08	1.15	0.26	0.26
9	2.99	1.99	3.12	5.24	2.25	1.90
10	1.28	1.55	1.38	1.77	1.15	1.30
11	1.98	2.36	1.87	2.74	1.62	2.23
12	3.06	5.12	2.73	1.45	2.6[illegible]	1.3[illegible]
13	1.26	[illegible].52	1.30	1.6[illegible]	1.0[illegible]	1.[illegible]

Table D.6 Profitability Ratio 5 % Discount Rate

	No Price Change					
[illegible]	Case 1		Case 2		Case 3	
1	0.39	0.39	0.11	0.11	0.40	0.40
2	1.04	1.21	1.02	1.18	0.66	0.66
3	1.36	1.86	1.10	1.32	0.94	1.02
4	1.08	1.22	1.14	1.41	1.03	1.19
5	0.11	0.11	0.10	0.10	0.13	0.13
6	1.55	2.23	1.46	2.05	1.36	1.85
7	0.94	1.01	0.85	0.95	0.61	0.64
8	0.32	0.32	0.28	0.28	0.94	0.94
9	1.72	2.5[illegible]	1.83	2.79	1.68	2.19
10	0.50	0.50	0.69	0.69	0.28	0.28
11	1.09	1.[illegible]	1.07	1.28	0.84	0.[illegible]4
12	1.75	2.64	1.58	[illegible]93	1.50	2.11
13	[illegible]	[illegible]	0.[illegible]0	[illegible]	0.[illegible]0	

Table D.8 (cont'd) Profitability Ratio 5 % Discount Rate

Firm	10 % Price Change					
	Case 1		Case 2		Case 3	
1	0.56	0.56	0.05	0.05	0.23	0.23
2	1.14	1.42	1.12	1.38	0.87	0.87
3	1.51	2.16	1.25	1.64	1.09	1.32
4	1.20	1.53	1.25	1.64	1.14	1.42
5	0.22	0.22	0.21	0.21	0.02	0.02
6	1.70	2.54	1.61	2.36	1.51	2.16
7	1.04	1.21	0.96	1.05	0.84	0.84
8	0.46	0.46	0.42	0.42	0.80	0.80
9	1.89	2.92	2.00	3.13	1.85	2.81
10	0.67	0.67	0.26	0.86	0.45	0.45
11	1.22	[illegible]	1.18	1.50	0.96	1.06
12	[illegible]	2.00	1.73	2.60	1.66	[illegible]
13	[illegible]	0.60	[illegible]	0.76	0.26	[illegible]

Table [illegible] (cont'd) Profitability Ratio 5 % Discount Rate

20 % Price Change

[illegible]	Case 1		Case 2		Case 3	
1	0.89	0.91	0.38	0.38	0.09	0.09
2	1.34	1.82	1.33	1.78	1.07	1.27
3	1.82	2.77	1.56	2.25	1.40	1.93
4	1.43	1.29	1.48	2.10	1.37	1.88
5	0.45	0.45	0.43	0.43	0.19	0.19
6	2.01	2.16	1.92	2.98	1.82	2.78
7	1.24	1.62	1.16	1.45	1.05	1.24
8	0.75	0.75	0.71	0.71	0.51	0.51
9	2.24	3.62	2.35	3.83	2.20	3.54
10	0.94	1.01	1.03	1.19	0.79	0.79
11	1.47	2.07	1.40	1.94	1.18	1.50
12	2.29	2.72	2.05	3.22	1.99	3.12
13	0.93	[illegible]	0.97	1.07	0.57	0.57

Table D-6(cont d) Profitability Ratio 5 % Discount Rate

Firm	50 % Price Change					
	Case 1		Case 2		Case 3	
1	1.06	1.25	0.70	0.70	0.42	0.42
2	1.54	2.21	1.52	2.17	1.26	1.66
3	2.13	3.38	1.86	2.86	1.71	2.55
4	1.66	2.46	1.71	2.56	1.60	2.34
5	0.68	0.68	0.65	0.65	0.41	0.41
6	2.3[illegible]	3.78	2.24	3.61	2.13	3.40
7	1.44	2.02	1.36	1.85	1.25	1.64
8	0.95	1.04	0.93	1.00	0.22	0.22
9	2.59	4.32	2.70	4.53	2.55	4.24
10	1.11	1.35	1.20	1.53	1.00	1.13
11	1.[illegible]	2.57	1.62	2.37	1.40	1.93
12	2.65	4.44	2.36	3.86	2.32	3.77
13	1.09	1.31	1.12	1.38	0.87	0.88

See explanations at bottom of Table D 5 (no price change)

Table D-7 Profitability Ratio 10 % Discount Rate

Firm	No Price Change					
	Case 1		Case 2		Case 3	
1	0.78	0.80	0.33	0.33	0.08	0.08
2	1.18	1.59	1.16	1.56	0.94	1.11
3	1.59	2.43	1.36	1.97	1.23	1.69
4	1.25	1.74	1.30	1.84	1.20	1.64
5	0.40	0.40	0.38	0.38	0.17	0.17
6	1.76	2.76	1.69	2.61	1.60	2.44
7	1.09	1.41	1.01	1.27	0.92	1.09
8	0.66	0.66	0.62	0.62	0.45	0.45
9	1.96	3.17	2.06	3.36	1.93	3.10
10	0.82	0.88	0.90	1.05	0.69	0.69
11	1.28	1.81	1.23	1.69	1.03	1.31
12	2.01	3.25	1.79	2.83	1.74	2.73
13	0.82	0.88	0.85	0.94	0.50	0.50

See explanation on Table D-5 (no price change)

Table D-7(cont'd) Profitability Ratio 10% Discount Rate

Firm	10 % Price Change					
	Case 1		Case 2		Case 3	
1	0.93	1.10	0.62	0.62	0.37	0.37
2	1.35	1.93	1.33	1.90	1.11	1.45
3	1.86	2.96	1.63	2.51	1.49	2.23
4	1.46	2.15	1.50	2.24	1.40	2.04
5	0.60	0.60	0.57	0.57	0.36	0.36
6	2.03	3.31	1.96	3.16	1.87	2.98
7	1.26	1.77	1.19	1.62	1.10	1.44
8	0.83	0.91	0.82	0.87	0.19	0.12
9	2.27	3.78	2.36	3.97	2.24	3.71
10	0.97	1.18	1.05	1.34	0.87	0.99
11	1.50	2.25	1.42	2.07	1.22	1.69
12	2.32	3.84	2.07	3.38	2.03	3.30
13	0.95	1.15	0.98	1.21	0.77	0.7[illegible]

[illegible]

Table D-7(cont'd) Profitability Ratio 10 % Discount Rate

Firm	30 % Price Change					
	Case 1		Case 2		Case 3	
1	0.34	0.34	-0.10	-0.10	-0.35	-0.35
2	0.91	1.06	0.89	1.03	0.58	0.58
3	1.19	1.62	0.96	1.17	0.82	0.89
4	0.94	1.13	1.00	1.24	0.90	1.04
5	0.10	0.10	0.09	0.09	0.11	0.11
6	1.35	1.95	1.28	1.80	1.19	1.62
7	0.82	0.89	0.74	0.74	0.56	0.56
8	0.28	0.28	0.24	0.24	0.83	0.83
9	1.50	2.25	1.60	2.44	1.47	2.18
10	0.44	0.44	0.60	0.60	0.25	0.25
11	0.96	1.16	0.94	1.12	0.74	0.74
12	1.53	2.31	1.38	2.00	1.31	1.87
13	0.47	0.47	0.53	0.53	0.09	0.09

*** Explanations [illegible]

Table D-7(cont'd): Profitability Ratio 10% Discount Rate

Firm	50 % Price Change					
	Case 1		Case 2		Case 3	
1	0.49	0.49	0.04	0.04	0.20	0.20
2	1.00	1.24	0.98	1.21	0.76	0.76
3	1.32	1.89	1.10	1.44	0.96	1.16
4	1.05	1.34	1.10	1.44	1.00	1.24
5	0.20	0.20	0.19	0.19	0.02	0.02
6	1.49	2.22	1.41	2.07	1.32	1.89
7	0.91	1.06	0.84	0.84	0.74	0.74
8	0.40	0.40	0.37	0.37	0.70	0.70
9	1.66	2.56	1.75	2.74	1.62	2.49
10	0.58	0.58	0.75	0.75	0.40	0.40
11	1.07	1.38	1.04	1.31	0.84	0.93
12	1.69	2.62	1.52	2.28	1.46	2.16
13	0.60	0.60	0.66	0.66	0.23	0.23

[illegible]

Table D-8 Net Present Value at a 0 % Discount Rate

Firm	No Price Change			10 % Price Change		
	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3
1	395107	860107	1110170	251557	-716557	-966557
2	71819	64306	83755	113819	106306	121
3	589104	278574	89039	771104	460574	271039
4	568703	745970	437918	881078	1058345	750293
5	1356298	1440298	1884548	1151099	1235099	1679349
6	2065421	1803366	1494961	2537021	2274966	1966561
7	46324	-11265	140755	109048	57090	-15308
8	-300131	-322061	-987146	-221381	-243311	-908396
9	3212152	3617932	3067872	3871177	4276957	3726897
10	253908	-124449	403369	136909	-7449	286369
11	174782	182817	-18969	270081	278116	85814
12	1248613	1154758	986651	1502990	1409136	1241028
13	374218	296658	863618	198043	120483	687443

Table D-8(cont'd) Net Present Value at a 0% Discount Rate

Firm	30 % Price Change			50 % Price Change		
	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3
1	17771	429457	679457	161595	141808	391808
2	197819	190306	84121	278219	270706	164521
3	1135604	825074	635539	1500104	1189574	1000039
4	1505825	1683092	1375040	2130577	2307845	1999792
5	740699	-824699	1268949	330299	-414299	-858548
6	2480219	3218164	2909759	4425219	4163164	3854759
7	234496	182538	117793	359944	307986	243241
8	63881	85811	750896	46809	35844	-593396
9	5189227	5595002	5044947	6509797	6915577	6365577
10	48545	113275	-52369	165345	230275	90815
11	460679	468714	276412	651278	659313	467010
12	2011750	1917896	1749788	2520510	2426655	2258548
13	77155	115935	-335093	253668	292448	8968

This table includes taxation. These tables D-8 to D-13 are set up to consider 3 discount rates and 4 price changes and include and exclude taxation where specified. Compare affect of taxation by comparing D-8 to D-9. NPV was only evaluated for Accounting Method One (100% costs)

Table D.9 Net Present Value at a 0 % Discount Rate

Firm	No Price Change			10 % Price Change		
	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3
1	395107	860107	1100170	-251557	716557	-966557
2	143638	128614	-83755	227639	212614	244
3	1178209	557149	178079	1542209	921149	542079
4	1137407	1491942	875838	1762157	2116692	1500587
5	1356295	1440295	1884549	1151099	1235099	1679345
6	4130844	3606734	298992	5074044	4549934	3933124
7	92649	-11265	140755	218097	114182	-15307
8	-300131	-322061	-987146	-221381	-243311	-908396
9	6424312	7235867	7135752	7742362	8553917	7453802
10	253909	124449	403369	136909	-7449	286369
11	349565	365635	-18969	540163	556233	171628
12	2497226	2309514	1973739	3005986	28118274	2485499
13	374218	296658	863618	198043	120483	687443

Table D.9(cont'd) Net Present Value at a 0% Discount Rate

Firm	30 % Price Change			50 % Price Change		
	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3
1	35542	429457	679457	323187	141808	391808
2	395639	380614	168244	556443	541418	329048
3	2271208	1650148	1271079	3000207	2379148	2000078
4	3011655	3366190	2750087	4261155	4615690	3999585
5	740699	-824696	1268949	-330299	-414299	-858548
6	6960444	6436334	5819524	8850444	8326334	7709524
7	468993	365078	235588	719889	615974	486484
8	-63881	-85811	750896	93618	71688	-593396
9	10378462	11190017	10089902	13019607	13831162	12731047
10	-97090	226550	52369	331090	460550	181630
11	921360	937430	552825	1302556	1318626	934021
12	4023501	3835789	3503014	5041021	4853309	4520534
13	154306	231866	335093	507329	584889	17929

This table does not include taxation. An explanation of the table is given at the bottom of Table D.8

Table D.10 Net Present Value at a 5 % Discount Rate

Firm	No Price Change			10 % Price Change		
	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3
1	438808	846818	-1063290	314507	722515	-938990
2	14100	7595	120612	50467	43962	47982
3	371791	102903	61214	529385	260497	96379
4	182022	329886	63143	452507	600371	333628
5	1382676	-1466676	1851352	-1204994	1288994	-1673670
6	1435609	1208696	941648	1843968	1617054	1350007
7	-32524	-82392	-194516	21788	-23201	-85891
8	-323202	-342190	-918088	-255012	-274001	-849898
9	2343632	2694997	2218700	2914281	3265646	2789349
10	300078	187979	-429945	-198768	-86669	-328185
11	62403	56487	-118240	144922	139006	-27508
12	917292	811495	673515	1137557	1031760	893780
13	455319	-308160	879090	302769	235610	725540

Table D.10(cont'd) Net Present Value at 5% Discount Rate

Firm	30 % Price Change			50 % Price Change		
	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3
1	-81295	473915	690390	43242	224839	441314
2	123203	116698	24752	192821	186316	94371
3	845005	576117	411999	1160626	891738	727620
4	993475	1141339	874597	1534449	1682312	1415570
5	849628	-933628	1318304	-494263	-578263	-962938
6	2660683	2433769	2166721	3478958	3252045	2984997
7	130414	85424	29361	239039	194049	137986
8	-118632	-137622	-713519	-22785	-32280	-577139
9	1055581	1406942	3930649	5199063	5550428	5074131
10	-38183	17866	125565	63127	119176	-1581
11	309961	304045	137530	475000	469084	302569
12	1578092	1472295	1334316	2018627	1912830	1774851
13	64174	30894	421441	88367	121946	[illegible]

This table includes taxation. An explanation [illegible] is given at the bottom of Table D.9

Table D-11 Net Present Value at a 5 % Discount Rate

Firm	No Price Change			10 % Price Change		
	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3
1	-438808	846815	1063290	-314507	-722515	938990
2	76287	63277	-120613	149022	136012	47877
3	881891	344117	15881	1197078	659304	331068
4	674454	975813	442328	1215423	1516782	983298
5	-1382675	-1466675	1851349	1204994	1288994	-1673668
6	3224039	2770214	2236121	4040754	3586930	3052835
7	7587	-82392	-194517	116212	26232	-85892
8	-323202	-342191	9180886	-255012	-274001	-849897
9	5125015	5827738	4875152	6266312	6969035	6016448
10	300078	187980	429945	198768	-86670	-328186
11	213744	214786	-118242	378783	379824	46795
12	1998456	1811388	1530821	2438990	2251922	1971357
13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table D-11(cont'd) Net present value at 5% Discount Rate

Firm	30 % Price Change			50 % Price Change		
	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3
1	81295	473764	690238	183161	224839	441314
2	294493	281483	97592	433734	420723	236833
3	1828317	1290543	962307	2459555	1921781	1593546
4	2297360	2598718	2065236	3379297	3680656	3147172
5	-849628	-933628	1318304	-494264	-578263	-962939
6	5674184	5220357	4686263	7310728	6856905	6322810
7	333451	243483	131357	550712	460733	348608
8	118632	137622	713518	17744	1244	-577139
9	9548904	9251628	8299039	10835864	11538588	10586002
10	3850	115949	-125566	206470	318569	77053
11	708860	709901	376873	1038937	1039978	706950
12	[illegible]	3312985	2852421	[illegible]	[illegible]	[illegible]
13	2327	-69486	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

Table D-12 Net Present Value at a 10 % Discount Rate

Firm	No Price Change			10 % Price Change		
	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3
1	473917	836002	1025541	365084	727168	916708
2	-32273	-37968	-150224	-430	-6126	-86631
3	197195	38235	-181933	335180	99749	43948
4	128650	-4410	-237963	108181	232421	-1133
5	1403868	1487868	1824681	1248295	1332295	1669107
6	929600	730920	497100	1287148	1088468	854648
7	-95873	139535	-237710	-48318	-87710	142600
8	-341737	358363	-862604	-282032	-298658	-802899
9	1645836	1953482	1536449	2145483	2453129	2036095
10	337172	239021	450487	248467	150316	-361782
11	-27886	-45010	197997	44365	27241	118555
12	651098	535706	421932	843957	728565	614791
13	520478	161675	[illegible]	[illegible]	[illegible]	[illegible]

Table D-12(cont'd) Net Present Value at a 10% Discount Rate

Firm	30 % Price Change			50 % Price Change		
	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3
1	160888	509633	699173	51846	291549	481089
2	63254	57559	22946	124210	118515	38010
3	611530	376098	232400	887879	652448	508750
4	581839	706078	472526	1055501	1179741	946188
5	937145	1021145	1357958	-625996	709996	1046809
6	2002242	1803563	1569743	2718704	2520024	2286204
7	46791	7399	-41687	141900	102508	53421
8	162621	179248	-683489	78700	87013	-564078
9	3144775	1452418	2035388	1145979	1453625	1036591
10	107863	58787	184373	-19158	29916	-75816
11	188869	171744	25918	233373	316249	170452
12	1229678	1114286	1000512	15430	[illegible]	[illegible]
[illegible]	17826	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

Table D.13 Net Present Value at a 10% Discount Rate

	No Price Change			10% Price Change		
	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3
1	473917	896002	1025541	365084	-727168	916708
2	22716	10785	-150224	85861	74470	86631
3	643826	172965	181933	919796	448934	161539
4	302513	561148	237963	776172	1034808	567703
5	1403868	1487868	1824678	1248295	1332295	1669107
6	2495505	2098148	1630510	3210598	2813241	2345601
7	-60752	139535	-237710	34356	87710	142600
8	-341737	358363	-862603	282032	-298658	802898
9	4081146	4696431	3862371	5080437	5695723	4861662
10	-337172	239021	-450487	248468	150317	-361782
11	104625	93591	-197999	249128	238095	118555
12	1597739	1411188	1172571	1983459	1796908	1358290
13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table D.13 (cont'd) Net Present Value at a 10% Discount Rate

	30% Price Change			50% Price Change		
	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3
1	147417	509501	699041	70613	291421	480960
2	213232	201840	10830	335147	323756	162746
3	1472492	1001631	714237	2025190	1554328	1266934
4	1723487	1982124	1515021	2670805	2929440	2462336
5	937145	1021145	1357957	-625997	709997	1046809
6	1640789	1243430	[illegible]75791	[illegible]073707	[illegible]676350	[illegible]208710
7	224575	145791	47617	414794	336010	237836
8	-162622	179248	683488	-43212	59839	564078
9	[illegible]079017	7694304	6860242	[illegible]081422	[illegible]696708	[illegible]862648
10	71059	2709	184374	106349	294500	3965
11	538135	527102	235511	327143	816109	521518
12	[illegible]754895	2568343	2329727	[illegible]	[illegible]	[illegible]
13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

This table [illegible]

Table D.4 The Initial and Annual Costs Used To Calculate the Firms Economic Efficiency

Firm	Initial Costs Case 1	Initial Costs Case 2	Initial Costs Case 3
1	720982	760982	760952
2	358600	358600	358600
3	1031425	1031425	1031425
4	2314825	2356825	2356825
5	1553000	1637000	1637000
6	[illegible]631161	[illegible]631161	2631161
7	541657	541657	541657
8	472169	472169	472169
9	[illegible]264508	[illegible]264508	[illegible]264508
10	598200	598200	598200
11	663246	743246	743246
12	1222089	1405001	1405001
13	979000	979000	9790[illegible]

Firm	Annual Costs, Accounting Method # 1: Case 1	Accounting Method # 1: Case 2	Accounting Method # 1: Case 3	Accounting Method # 2: Case 1	Accounting Method # 2: Case 2	Accounting Method # 2: Case 3
1	222035	307035	357035	167354	258405	298000
2	67552	70557	113031	46401	50382	79752
3	286873	411085	486899	226061	339897	404707
4	559053	479746	602967	423015	383961	534000
5	371059	371059	459909	269043	269043	34670[illegible]
6	[illegible]34718	[illegible]39540	762902	[illegible]94157	488887	598711
7	124034	144817	170715	99200	116078	136001
8	123092	127478	260495	98270	103238	249675
9	[illegible]99345	[illegible]37034	757057	192348	153506	548506
10	165141	139249	195033	121160	98354	150354
11	178634	156220	233141	128124	106738	1979[illegible]0
12	273656	224616	352483	213947	236524	3110[illegible]
13	[illegible]31528	216016	[illegible]22408	173186	160712	[illegible]

The corresponding values that were used to calculate the IRR without taxation i.e., program three, used the following values instead of the ones in the table; / 272,000, B- 80,000 [illegible] [illegible],478 [illegible] The [illegible] in Chapter [illegible] ted [illegible] with th[illegible]

Table D.15

Percent Change in Price Yielding a 0, 5 or 10% Internal Rate of Return (I.R.R.)
Accounting Method Two

	0 % (I.R.R.)			5 % (I.R.R.)			10 % (I.R.R.)		
Item	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3
1	+27	+59	+77	+43	+76	+94	+59	+94	+111
2	21	15	+6	4	3	+10	+23	+12	+37
3	32	15	+5	-24	7	+4	14	+3	+13
4	18	24	-14	-7	12	2	+5	+1	+10
5	+66	+7	+92	+90	+95	116	114	121	143
6	44	38	32	35	30	23	26	21	14
7	7	+1	+11	+3	+14	+25	+20	+28	+39
8	+38	+41	124	+56	+60	143	+76	+79	164
9	49	55	47	-41	47	39	33	39	31
10	+21	+10	+34	+38	+27	+50	+54	+43	+67
11	18	19	1	-8	68	+13	+4	+6	+26
12	49	15	39	42	37	31	34	28	22
[illegible]	+1	[illegible]	+49	+38	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible] Irrigation

Percent Change in Price Yielding a 0, 5 or 10% Internal Rate of Return (I.R.R.)
Accounting Method Two

	0 % (I.R.R.)			5 % (I.R.R.)			10 % (I.R.R.)		
Item	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3	Case 1	Case 2	Case 3
1	1	+33	+47	+11	+47	+51	+25	+51	75
2	39	36	19	28	26	8	-17	15	+3
3	45	29	20	37	22	13	-29	14	5
4	36	38	26	26	29	17	-16	18	6
5	+25	+29	+48	+44	+49	+68	+64	+70	+89
6	55	50	44	48	43	37	40	35	+29
7	23	16	9	12	5	+3	+1	+7	+15
8	+13	+16	+10	+29	+32	125	+45	+48	141
9	61	62	55	54	55	48	47	49	41
10	-4	13	+9	+10	+6	+23	+25	+15	38
11	39	41	17	32	31	7	23	21	+3
12	58	6	47	-51	18	-40	44	40	32
[illegible]	[illegible]	4	26	+10	[illegible]	[illegible]	+25	[illegible]	[illegible]

[illegible] Irrigation

Table D.1? Range of Initial Costs for Size Class 1

Item	Low	Average	High
Debarker	50000		50000
Chipper	25000		75000
Chipper Motor [illegible]	5000		15000
Conveyors	25000		75000
Screen	10000		30000
Surge Bin	0		20000
Metal Detector Vibrating Conveyor		[illegible]	
Chip Blowing Sys	60000		90000
Storage Bin(s)	60000		90000
Sub-total	245000		1055000
Accessory Cost	69000		422000
Building Cost	45000		235000
Total	[illegible]		[illegible]
[illegible]		9?652?	

Range of Initial [illegible] of Size [illegible]

Item	Low	[illegible]	High
Debarker	87500		154541
Chipper	50000		180000
Chipper M[illegible]	12500		45000
Conveyors	50000		180000
Screen	[illegible]		[illegible]
Surge Bin		[illegible]	
Metal Detector Vibrating Con[illegible]	?0000		[illegible]
Chip Blowing S[illegible]			
Storage Bin(s)	120000		260000
Sub total	810000		961541
Accessory Cost	324000		784616
Building [illegible]	[illegible]		[illegible]
Total			

Table D-18

Range of Annual Costs for Size Class 1

	Case 1		Case 2		Case 3	
	Low	High	Low	High	Low	High
Property/ Taxes	3,000	10,000	3,000	42,000	3,000	42,000
Insurance	4,000	8,700	8,000	67,000	8,000	67,000
Labor	41,000	114,000	41,000	114,000	41,000	114,000
Power	45,000	85,000	18,000	88,000	80,000	176,000
Mainten.	72,000	170,000	56,000	170,000	56,000	170,000
Total	165.000	437,700	126,000	481,000	188,000	569,000
Average	255,327		288,888		365,656	

Range of Annual Costs for Size Class 2

	Case 1		Case 2		Case 3	
	Low	High	Low	High	Low	High
Property/ Taxes	6,000	15,000	6,000	25,000	6,000	25,000
Insurance	8,000	17.000	12,000	50,000	12,000	50,000
Labor	107,000	249,000	107,000	253,000	107,000	253,000
Power	83,000	123,000	83,000	123,000	161,000	326,000
Mainten.	61,000	259,000	41,000	259,000	41,000	259,000
Total	265,000	663,700	254.000	710,000	327.000	913,000
Average	516,693		482,734		618,852	

Table D-19

What Combinations of Initial and Annual Costs are Available

Initial Costs	Annual Costs Case 1	Annual Costs Case 2	Annual Costs Case 3
Size Class # 1			
Case 1			
459,000	(1)165,000	126,000	188,000
459,000	255,327	(2)288,888	(3)365,656
459,000	437,700	481,000	(4)569,000
Case 2			
1,712,000	(1)165,000	126,000	188,000
1,712,000	255,327	(2)288,888	(3)365,656
1,712,000	437,700	481,000	(4)569,000
Case 3			
976,521	(1)165,000	126,000	188,000
976,521	255,327	(2)288,888	(3)365,656
976,521	437,700	481,000	(4)569,000
Size Class # 2			
Case 1			
1,384,000	(1)265,000	254,000	327,000
1,384,000	516,693	(2)482,734	(3)618,852
1,384,000	663,000	710,000	(4)913,000
Case 2			
3,376,157	265,000	254,000	327,000
3,376,157	(1)516,693	(2)482,734	(3)618,852
3,376,157	663,000	710,000	(4)913,000
Case 3			
2,358,145	(1)265,000	254,000	327,000
2,358,145	516,693	(2)482,734	(3)618,852
2,358,145	663,000	710,000	(4)913,000

Numbered Annual Costs are those selected to be combined with the corresponding level of Initial Costs.

Table D-20 Size Class #1. Price for Chips ($26.11)

	Q of chips	Initial Costs	Annual Costs	IRR *	Price Needed for a IRR 0%	5%	10%
case1	6,000	459,000	165,000	0	$42.80	$47.54	$52.56
	6,000	459,000	288,000	0	63.45	68.19	73.21
	6,000	459,000	365,656	0	76.24	80.98	86.00
	6,000	459,000	569,000	0	110.13	114.87	119.90
case2	14,420	976,521	165,000	1%	24.99	29.18	33.63
	14,420	976,521	288,888	0	33.58	37.77	42.22
	14,420	976,521	365,656	0	38.90	43.10	47.54
	14,420	1,712,000	569,000	0	53.00	57.20	61.64
case3	21,600	1,712,000	165,000	2%	24.16	29.21	34.56
	21,600	1,712,000	288.888	0	30.06	35.11	40.46
	21,600	1,712,000	365.656	0	33.72	38.77	44.12
	21,600	1,712,000	569,000	0	43.40	44.38	53.80

Summary of Costs

	Initial Costs	Annual Costs 1	2	3	4	Min. Annual Costs	Lumber product.	Gross Revenue
case 1	15.30	27.50	48.14	60.94	94.83	10.81/BDU	9.6mmfbm	$156,660
case 2	13.52	11.43	20.00	25.32	39.40	12.59/BDU	23.2mmfbm	$376,500
case 3	15.85	7.64	13.37	[illegible].92	26.34	10.26/BDU	34.8mmfbm	$548,310

* IRR at a price of $26.11/BDU

Table D-21 Size Class #1 Price for Chips ($37.42)

	Q of chips	Initial Costs	Annual Costs	IRR *	Price Needed for a IRR 0%	5%	10%
case 1	6,000	459,000	165,000	0	$42.80	$47.54	$52.56
	6,000	459,000	288,000	0	63.45	68.19	73.21
	6,000	459,000	365,656	0	76.24	80.98	86.00
	6,000	459,000	569,000	0	110.13	114.87	119.90
case 2	14,420	976,521	165,000	14%	24.99	29.18	33.63
	14,420	976,521	288,888	4.5%	33.58	37.77	42.22
	14,420	976,521	365,656	0	38.90	43.10	47.54
	14,420	976,521	569,000	0	53.00	57.20	61.64
case 3	21,600	1,712,000	165,000	12.5%	24.16	29.21	34.56
	21,600	1,712,000	288,888	7.0%	30.06	35.11	40.46
	21,600	1,712,000	365,656	3.5%	33.72	38.77	44.12
	21,600	1,712,000	569,000	0	43.10	44.38	52.80

Summary of Costs

	Initial Costs	Annual Costs 1	2	3	4	Min. Annual Costs	Lumber product	Gross Revenue
case 1	15.30	27.50	48.14	60.94	94.83	32.12/BDU	9.6mmfbm	$224.520
case 2	13.52	11.43	20.00	25.32	39.40	23.90/BDU	23.2mmfbm	$539.596
case 3	15.95	7.64	13.37	16.92	26.34	21.57/BDU	34.[illegible]mmfbm	$810.51[illegible]

* IRR at a price of $37.42/BDU

Table D-22 Size Class #2 Price for Chips ($26.11)

	Q of chips	Initial Costs	Annual Costs	IRR *	Price Needed for a IRR 0%	5%	10%
case1	27,650	1,384,000	265,000	10%	$19.59	$22.70	$25.98
	27,650	1,384,000	482,734	0	27.47	30.57	33.86
	27,650	1,384,000	618,852	0	32.39	35.49	38.78
	27,650	1,348,000	913,000	0	43.03	46.13	49.42
case2	62,142	2,358,145	265,000	27%	11.85	14.20	16.70
	62,142	2,358,145	482,734	21%	15.36	17.71	20.20
	62,142	2,358,145	618,852	17%	17.55	19.90	22.39
	62,142	2,358,145	913,000	8%	22.28	24.63	27.12
case3	101,000	3,376,157	265,000	35%	9.31	11.38	13.58
	101,000	3,376,157	482,734	31%	11.47	13.54	15.73
	101,000	3,376,157	618,852	28%	12.81	14.89	17.08
	101,000	3,376,157	913,000	23%	15.73	16.13	[illegible]

Summary of Costs

Initial Costs	Annual Costs 1	2	3	4	Min. Annual Costs	Lumber product	Gross Revenue
case 1							
10.01	9.58	17.46	22.38	33.02	16.01/BDU	44.59mfbm	$721,94[illegible]
case 2							
7.52	4.26	7.77	9.96	14.69	18.53 BDU	100.2mfbm	$1,622,527
case 3							
6.68	2.62	4.77	6.12	9.03	19.13 BDU	162.6mfbm	$2,62[illegible]

* IRR at a price of $26.11 BDU

Table D-23 Size Class #2 Price for Chips ($37.42)

	Q of chips	Initial Costs	Annual Costs	IRR *	Price Needed for a IRR 0%	5%	10%
case 1	27,650	1,384,000	265,000	26%	$19.59	$22.70	$25.98
	27,650	1,384,000	482,734	15%	27.47	30.57	33.86
	27,650	1,384,000	618,852	8%	32.39	35.49	38.78
	27,650	1,348,000	913,000	0	43.03	46.13	49.42
case 2	62,142	2,358,145	265,000	45%	11.85	14.20	16.70
	62,142	2,358,145	482,734	40%	15.36	17.71	20.20
	62,142	2,358,145	618,852	36%	17.55	19.90	22.39
	62,142	2,358,145	913,000	29%	22.28	24.63	27.12
case3	101,000	3,376,157	265,000	57%	9.31	11.38	13.58
	101,000	3,376,157	482,734	52%	11.47	13.54	15.73
	101,000	3,376,157	618,852	49%	12.81	14.89	17.08
	101,000	3,376,157	913,000	44%	15.73	16.13	19.99

Summary of Costs

	Initial Costs	Annual Costs 1	2	3	4	Min. Annual Costs	Lumber product.	Gross Revenue
case 1	10.01	9.58	17.46	22.38	33.02	27.41/BDU	44.59mfbm	$1034663
case 2	7.52	4.26	7.77	9.96	14.69	29.84/BDU	100.2mmfbm	$2325353
case 3	6.68	2.62	4.77	6.12	9.03	30.74/BDU	162.6mmfbm	$3779420

* IRR at a Price of $37.42/BDU

Table D-24

Present Value of One Dollar per Year for 5 Years at i%

1%	2%	3%	4%	5%
4.8535	4.7134	4.5797	4.4518	4.3295
6%	7%	8%	9%	10%
4.2123	4.1002	3.9927	3.8896	3.7908
11%	12%	13%	14%	15%
3.6959	3.6048	3.5172	3.4331	3.3522
16%	17%	18%	19%	20%
3.2743	3.1993	3.1272	3.0576	2.9906
21%	22%	23%	24%	25%
2.9260	2.8636	2.8035	2.7454	2.6893
26%	27%	28%	29%	30%
2.6351	2.5827	2.5320	2.4830	2.4356
31%	32%	33%	34%	35%
2.3897	2.3452	2.3021	2.2604	2.2203
36%	37%	38%	39%	40%
2.1807	2.1427	2.1058	2.0699	2.0352
41%	42%	43%	44%	45%
2.0014	1.9686	1.9367	1.9057	1.8755
46%	47%	48%	49%	50%
1.8462	1.8177	1.7899	1.7629	1.7366

Formula: 1/i − (1/i(1+i)**n)

This formula gives the same result as;

= CF1/1+i)**1 + CF2/((1+i)**2.. .CF5/((1+i)**5

where: CF1=CF2=CF3=CF4=CF5 is equal annual cashflow.

Appendix E

```
C     THE UTILIZATION OF WOOD CHIPS(PROGRAM 1)
C
C
C PROGRAMED BY C.P. WOYTOWICH  and  ALEX MAC DONALD
C
      DIMENSION NRR(15,4,3), TTCOST(15,4,3), PP(15,4,3)
     1          NCOST(15,2)
      DIMENSION CFFLW(15,2,3), S(15,2,3), PCHIP(15),
     1          QCHIP(15), ACOST(15,4)
      DIMENSION DEP(15,4), TRATE(15), DFACT(15,3), SS(15,4),
     1          ARR(15,4)
      DIMENSION NRBDU(15,4), INCOST(15,2), GREV(15),
     1          NTREV(15,4), X(15,4)
      DIMENSION Y(15,4), CSHFLW(15,4), IRR(15,2), Z(15,3,4),
     1          NPV(15,3,4)
      DIMENSION CBDU(15,4), BENE(15,3,4)  BENFF(15,2,3),
     1          ZZ(15,2,3)
      REAL NRR, PP, NCOST, PCHIP, NRBDU, INCOST, NTREV, IRR
     1    NPV,
C  ENTER N = NUMBER OF FIRMS FOR WHICH THERE IS DATA (MAX
C  OF. 15) The  ariables that are dimensioned above will be
C  explained as the variables are manipulated
      N = 13
C
C  READ INITIAL DATA PCHIP,QCHIP,ACOST,TRATE,DFACT AND
C  INCOST PCHIP is the price of chips as found in the survey
C  for 13 firms. QCHIP is the quantity of chips that were
C  produced by the 13 firms.ACOST is the annual costs of
C  operations for the 13 firms.TRATE is the tax rate of 50%
C  DFACT is the discount rate that was used to evaluate the
C  NPV or the profitability ratio of the firm. This study
C  evaluates 3 discount rates 0,5, and 10%.INCOST is the
C  initial costs of the investment. The study evaluated two
C  kinds of initial costs where 100% and 50% of the initial
C  costs of the debarker were included. DEP is the
C  depreciation method that was used to calculate the
C  cashflow of the investment.There were 2 dep. methods
C  evaluated in the study.Depreciation Method one include
C  100% of the debarker depreciation costs while Method 2
C  corresponds to 50% of the depreciation costs being
C  included in depreciation. Originally the study was set up
C  to evaluate 4 kinds of but in the analysis only two of
C  these methods were considered.
      READ (5,10) (PCHIP(I),I=1,N)
 10   FORMAT (1X, 15F10.2)
      READ (5,20) (QCHIP(I),I=1,N)
 20   FORMAT (1X, 15F10.0)
      DO 30 J = 1, 2
        READ (5,10) (ACOST(I,J),I=1,N)
 30   CONTINUE
      DO 40 J = 1, 4
        READ (5,10) (DEP(I,J),I=1,N)
 40   CONTINUE
      READ (5,10) (TRATE(I),I=1,N)
```

```
      DO 60 J = 1, 3
        READ (5,50) (DEACT(I  J),I=1,N)
50      FORMAT (1X, 15F10.4)
60    CONTINUE
C
      DO 80 J = 1, 2
        READ (5,70) (INCOST(I J),I=1 N)
70      FORMAT (1X, 15F10.2)
80    CONTINUE
C
C  WRITE TABLES OF VALUES FOR EACH VARIBLE AND FIRM
C
C
      WRITE (6,90) (PCHIP(I),I=1,N)
90    FORMAT (3X, ' PCHIP - ', 1X, 8(2X,F10.2)
     1        7(2X,F10.2))
      WRITE (6,100) (QCHIP(I),I=1 N)
100   FORMAT (1X, ' QCHIP -   1X  8(2X,F10.0)
     1        7(F10.0,2X))
      DO 120 J = 1, 2
        WRITE (6,110) J, (ACOST(I J),I=1,N)
110     FORMAT (1X, ' ACOST    1X  I1.    =
     1        7(2X,F10.2))
120   CONTINUE
      DO 140 J = 1, 4
        WRITE (6,130) J, (DEP(I,  I   ))
130     FORMAT (3X, ' DEP     I1
     1        7(2X,F10.2))
140   CONTINUE
      WRITE (6,150) (TRATE(I),I=1,N)
150   FORMAT (3X    TRATE -      8(2X
      DO 170 J = 1, 3
        WRITE (6,160) J, (DEACT(I
160     FORMAT (3X    DEACT  ,  I1                    10.4
     1        2X, 7(2X F10  ))
170   CONTINUE
      DO 190 J = 1, 2
        WRITE (6,180) J, (INCOST(I J)  I=1 N)
180     FORMAT (1X, 'INCOST    I1            8
     1        7(2X,F10.2))
190   CONTINUE
C
C  CALCULATE NET AND GROSS REVENUE,X AND Y GREV is the gross
C  revenue of the investment. NTREV is the net revenue of
C  the investment Net revenue wascalculated for two kin
C  annual costs ie, j=2 where j=1 corresponds to annual
C  costs 100% of the debarker costs being  included in
C  annual costs. When j=2 50% of the debarker
C  included in the annual costs
      DO 210 I = 1, N
        GREV(I) = PCHIP(I) * QCHIP(I)
        DO 200 J = 1  2
          NTREV(I                ACOST
          IF    1
```

```
          IF (J .GT  1) JC = 3
          X(I,JC) = NTREV(I,J)   DEP(I,JC)
          X(I,JC + 1) = NTREV(I,J) - DEP(I JC + 1)
          Y(I,JC) = X(I,JC) * TRATE(I)
C  CSHFLW is CSHFLW=(NR-DEP)(1-t)+DEP.This is the cashflow
C  method defined in chapter 3.For GREV,13 values are
C  evaluated. For NET REVENUE(NTREV) two sets of values are
C  stored in J=1 and J=2 where J stands for the 2 sets of
C  values of annual costs which outline the two accounting
C  methods where 100% and 50% of the debarker costs are
C  attributed to the chipping operation. DEP ,depreciation
C  is set up to evaluate four types of depreciation.
C  Therefore the counter of JC tests for the four values of
C  depreciation that were originally for the study.For
C  depreciation JC=1 and JC=3 Accounting Method one is
C  considered(100% debarker costs).For JC=2 and JC=4
C  Accounting Method two is considered(50% debarker costs)
C
          Y(I,JC + 1) = X(I,JC + 1) * TRATE(I)
          CSHFLW(I,JC) = Y(I,JC) + DEP(I,JC)
          CSHFLW(I,JC + 1) = Y(I,JC + 1) + DEP(I,JC + 1)
          IF (Y(I,JC) .LT  0) CSHFLW(I,JC) = NTREV(I,J)
          IF (Y(I,JC + 1) .LT  0) CSHFLW(I,JC + 1) = NTREV
     1    I,J)
C  These two conditions test for JC = 1 to ...
C  method one to four where if cashflow ...
C     hflow is ...
200      CONTINUE
210    CONTINUE
       WRITE (6,220) (GRE (I) I 1,N)
220    FORMAT ( X    GREV
       DO 240 J = 1, 2
         WRITE (6,230) J, (NTREV(I
230      FORMAT (1X, ' NTREV
                  ...  F12.2))
240    CONTINUE
       DO 280 J = 1, 4
         WRITE (6,250) J, (Y(I,J) I 1 N)
250      FORMAT (2X, '  Y  ', I1 ...
     1            7(2X,F12.2))
         WRITE (6,260) J, (Y(I,J) I 1 N)
260      FORMAT (2X, '  Y  ', I1, ...
     1            7(2X,F12.2))
         WRITE (6,270) J, (CSHFLW(I    N)
270      FORMAT (1X, ' CSHFLW     ...
     1            7(2X,F12.2))
280     CONTINUE
C   This next section calculates the payback period of the
C   investment.The corresponding values for payback were
C   evaluated in Table D 24,the Internal rate of return of
C   the investment.CSHFLW has K=4 values stored in the array
C   CSHFLW. These four values correspond to the four methods
C   of depreciation. Testing the condition for K .GT 2 mea
C   ...
```

```
C   the numerator and for K=3 and 4 initial costs 2 will be
C   used as the numerator  Initial costs 1 corresponds to
C   Accounting Method one s costs where 100% of the debarker
C   costs were attributable to the chipping operation.Initia
C   costs 2 corresponds to Accounting Method two's costs
C   where 50% of the debarker costs were attributable to th
C   chipping operation
        DO 300 I = 1, N
          DO 290 K = 1, 4
            JC = 1
            IF (K .GT. 2) JC = 2
            IRR(I,
290       CONTINUE
300     CONTINUE
        DO 320 J = 1, 4
          WRITE (6,310) J,
310       FORMAT (1X, ' IRR
     1
3         CONTINUE
C   This next section calculates the Net Present Value for
C   firms I-13,for three discount rates of 0,5 and 10
C   percent J=1 to 3 for four methods of depreciation broke
C   down to evaluate the two accounting methods as follows:
C   K=1 and 2 is for Accounting Method one where 100% of
C   debarker costs are attributed to the chipping operation
C   K=3 and 4 is for Accounting Method two where 50% of
C   debarker where attributed to the chipping operation
C   was observed when calculating the IRR in the previous
C   section the test condition    is .GT. 2 sets JC=2 from
C   JC=1.JC=1 is for Accounting Method one(100% of the
C   debarker costs).JC=2 is for Accounting Method two(50% of
C   the debarker costs) Initial costs one is subtracted from
C   the Z(I,J,K) factor when K=1 and K=2 ie includes 100% of
C   debarker costs  For K=3 and 4 initial Initial costs 2
C   subtracted from the Z(I,J,K) factor which is for
C   Accounting method two where 50% of debarker costs are
C   attributed to the operation. BENE is the profitability
C   ratio as defined in the discussion of chapter ?. BENE is
C   the discounted cashflow divided by the initial costs of
C   the investment for two Accounting Methods one and two.
C   Before when K=1 or 2 the initial costs = 1 is evaluated
C   which is the 100% cost method  Where K = 3 or 4 the
C   initial costs = 2 is evaluated which is for 50% of the
C   costs of the debarker.BENE is evaluated for three discount
C   rates of 0,5 and 10%.Because one is using CSHFLW in the
C   calculations BENE shows the effect of
C   considers the 4 depreciation methods
C   stated previously
C   methods were analysed
        DO 350 I = 1
          DO 340 J = 1
            DO 330 K =
              Z(I,
```

```
            IF (K .GT. 2) JC = 2
            NPV(I,J,K) - Z(I,J,K) - INCOST(I,JC)
            BENE(I,J,K) - Z(I,J,K) / INCOST(I,JC)
330       CONTINUE
340     CONTINUE
350   CONTINUE
      DO 400 J = 1, 3
        DO 390 K = 1, 4
          WRITE (6,360) J, K, (Z(L,J,K),L=1,N)
360       FORMAT (1X, ' Z  ', I1, 1X, I1, ' =
     1           8(1X,F12.2), /, 7(1X,F12.2))
          WRITE (6,370) J, K, (NPV(L,J,K),L=1,N)
370       FORMAT (1X, 'NPV ', I1, 1X, I1, ' =
     1           8(1X,F12.2), /, 7(1X,F12.2))
          WRITE (6,380) J, K, (BENE(L,J,K),L=1,N)
380       FORMAT (1X, 'BENE ', I1, 1X, I1, ' =
     1           8(1X,F12.2), /, 7(1X,F12.2))
390     CONTINUE
4     CONTINUE
C  This section evaluates the profitability ratio without
C  the effect of taxation being included in the
C  calculations. For this ratio the effect of the 4 kinds of
C  depreciation are not evaluated instead only the 2
C  Accounting Methods are evaluated where J=1 corresponds
C  Accounting Method method one and J=2 corresponds to
C  Accounting Method two. K=1 to 3 corresponds to the
C  discount rates of 0, 5 and 10%
      DO 430 I = 1, N
        DO 420 J = 1, 2
          DO 410 K = 1, 3
            ZZ(I,J,K) = DFACT(I,K) * NREV(I,J)
            BENEF(I,J,K) = ZZ(I,J,K) / INCOST(I,J)
410       CONTINUE
420     CONTINUE
4     CONTINUE
C  NCOST is the initial costs divided by 2 for two kinds of
C  initial costs where JC=1 is for Accounting Method one and
C  JC=2 is for Accounting Method two.NCOST is used to
C  calculate the average investment.For the study average
C  investment was not used because it was not as reliable a
C  form of evaluating the return on an investment since
C  discount rates are not taken into taken and the average
C  investment lead to rates of return that were higher than
C  the IRR rates which considered more realistic of a firms
C  rate of return because the method considers the initial
C  costs of the investment and evaluates three discount
C  rates. NRBDU + CBDU will equal the price of one BDU of
C  chips so that NRBDU shows the net revenue per BDU and
C  CBDU shows what maximum total costs could be based on the
C  price of chips. SS(I,J) + S(I,JC,K) + DEP(I,J)
C  =NRR(I,J,K) which when divided by the QCHIP(I) will equal
C  PP(I,J,K) which is the price required by the firm to
C  yield a 0, 5 or 10% rate of return ie K=3 and is for the
C  ...
```

```
      ts are considered
      DO 460 I = 1, N
        DO 450 J = 1, 4
          JC = 1
          IF (J .GT. 2) JC = 2
          NCOST(I,JC) = INCOST(I,JC) / 2.
          ARR(I,J) = CSHFLW(I,J) / NCOST(I,JC)
          NRBDU(I,JC) = NTREV(I,JC) / QCHIP(I)
          CBDU(I,JC) = PCHIP(I) - NRBDU(I,JC)
          SS(I,J) = DEP(I,J) / TRATE(I)
          DO 440 K = 1, 3
            CFFLW(I,JC,K) = INCOST(I,JC) / DFACT(I,K)
            S(I,JC,K) = CFFLW(I,JC,K) / TRATE(I)
            NRR(I,J,K) = S(I,JC,K) + SS(I,J) + DEP(I,J)
            TTCOST(I,J,K) = NRR(I,J,K) + ACOST(I,JC)
            PP(I,J [illegible]
440       CONTINUE
450     CONTINUE
460   CONTINUE
      WRITE (6,470) J, (NCOST( [illegible]
470   FORMAT (1X, 'NCOST', I1, [illegible] 8(2X,F12.2),
     1        7(2X,F12.2))
      WRITE (6,480) J, (NRBDU(I, [illegible]
480   FORMAT (1X, ' NRBDU ', I1, [illegible] 8(2X,F12.2), /,
     1        7(2X,F12.2))
      WRITE (6,490) J, (CBDU(I, [illegible]
[illegible] FORMAT (1X, ' CBDU ', I1, [illegible] 8(2X,F12.2), /,
     1        7(2X,F12.2))
        540 K = 1, 3
        WRITE (6,500) J, K, (CFFLW(L,J,K), L=1,N)
[illegible]   FORMAT (1X, 'CFFLW ', I1, 1X, I1, ' = ', 8(2X,F12.2),
     1          /, 7(2X,F12.2))
        WRITE (6,510) J, K, (S(L,J,K),L=1,N)
[illegible]   FORMAT (1X, ' S ', I1, 1X, I1, [illegible] 8(2X,F12.2)
     1          /, 7(2X,F12.2))
        WRITE (6,520) J, K, (ZZ(L,J, [illegible] N)
[illegible]   FORMAT (1X, ' ZZ ', I1, 1X, I1, ' = ' [illegible]
     1          /, 7(2X,F12.2))
        WRITE (6,530) J, K [illegible]
530     FORMAT (1X, 'BENEE , I [illegible]
     1  [illegible]

540   CONTINUE
550   CONTINUE
        620 J = 1, 4
        WRITE (6,560) J, (SS(I,J),I=1,N)
[illegible]   FORMAT (1X, ' SS ', I1, ' = ', 8(1X,F12.2),
     1          7(1X,F12.2))
        WRITE (6,570) J, [illegible]
[illegible]   FORMAT (1X, ' ARR ', I1 [illegible] 8(2X,F12 [illegible]
     1          7(2X,F12.2))
        DO 610 K = 1, 3
          WRITE (6,580) J, K, (NRR(L,J,K), L=1,N)
[illegible]     FORMAT (1X, 'NRR ', I1, 1X, I1, ' = '
     1          8(1X,F12.2), 7(1X,F12.2))
```

```
      WRITE (6,590) J, K, (TTCOST(L,J,K),L=1,N)
590   FORMAT (1X, 'TTCOST', I1, 1X, I1, '= ',
     1        8(1X,F12.2), /, 7(1X,F12.2))
      WRITE (6,600) J, K, (PP(L,J,K),L=1,N)
600   FORMAT (1X, '   PP ', I1, 1X, I1, ' = ',
     1        8(2X,F12.2), /, 7(2X,F12.2))
610     CONTINUE
620   CONTINUE
      STOP
      END
```

```
C   PROGRAM TO ANALYZE ECONOMIC DATA
C   Program two which calculated the Present value of the
C   investment.
C
C
C    PROGRAM BY ALEX MAC DONALD
        DIMENSION ACOST(15,2), GREV(15,6), NCOST(15,2),
      1           VNT(6,9)
        DIMENSION PVN(15,2,6,6,9), PVNR(15,2,6,9)
        DIMENSION NNT(15,2,6), NTT(15,2,6)
        REAL PVN, PVNR, NNT, NCOST, NTT
C   ENTER N=NUMBER OF FIRMS FOR WHICH THERE IS DATA(15 is
C   MAX)
C
        N = 13
C
C    READ INITIAL DATA GREV,NCOST,ACOST AND VNT
C
        DO 20 J = 1, 6
          READ (5,10) (GREV(I,J),I=1,N)
10        FORMAT (1X, 15F10.2)
20      CONTINUE
        DO 40 J = 1, 2
          READ (5,30) (NCOST(I,J),I=1,N)
30        FORMAT (1X, 15F10.2)
40      CONTINUE
        DO 60 J = 1, 2
          READ (5,50) (ACOST(I,J),I=1,N)
50        FORMAT (1X, 15F10.2)
60      CONTINUE
        DO 80 J = 1, 9
          READ (5,70) (VNT(I,J),I=1,6)
70        FORMAT (1X, 6F10.4)
80      CONTINUE
C
        DO 100 J = 1, 6
          WRITE (6,90) J, (GREV(I,J),I=1,N)
90        FORMAT (3X, ' GREV ', I1, '= ', 8(2X,F10.2),
      1           /7(2X,F10.2))
100     CONTINUE
        DO 120 J = 1, 2
          WRITE (6,110) J, (NCOST(I,J),I=1,N)
110       FORMAT (1X, ' NCOST ', I1, ' = ', 8(2X,F10.2), /,
      1           7(2X,F10.2))
120     CONTINUE
        DO 140 J = 1, 2
          WRITE (6,130) J, (ACOST(I,J),I=1,N)
130       FORMAT (1X, ' ACOST ', I1, ' = ', 8(2X,F10.2), /,
      1           7(2X,F10.2))
140     CONTINUE
        DO 160 J = 1, 9
          WRITE (6,150) J, (VNT(I,J),I=1,6)
150       FORMAT (1X, ' VNT ', I1, '  =  ', 8(2X,F10.4))
160     CONTINUE
```

```
C
C    CALCULATE PRESENT VALUE NET BENEFITS
C
C   In this section we calculate the NPV without the effect
C   of taxation being considered. In Program one we
C   considered NPV by considering the effect of taxation.In
C   program two taxation is not considered.NTT corresponds to
C   the initial cost of the investment in year 0 as such
C   initial costs are evaluated as a negative number.I=N
C   corresponds to the 13 firms in the sample space and K=6
C   coresponds to the 6 price changes of 0% to 50%. The
C   counter JC=1 or JC=2 corresponds to the two kinds of
C   initial costs where when JC=1 100% of the debarker costs
C   were part of the initial costs of the investment and
C   where JC=2 50% of the initial costs were considered.These
C   two values for initial costs are stored in J=1 and J=2
C   for the array NTT(I,J,K). NTT = GREV - ACOST is the net
C   revenue of the investment and is calualated for I=N (13
C   firms),J=1or2 which corresponds to the two kinds of costs
C   for debarkers 100% and 50% and K=6 which is for the 6
C   prices that were consider where K=1 corrresponds to a 0%
C   price increase and K=6 corresponds to a 50% price
C   increase. PVN(I,J,K,L,M) is an array that calculates the
C   present value of the net revenue from the end of year1
C   to year 5, to year 0 ie,L=2 to 6 corresponds to year one
C   to five for the net revenue of the investment and L=1
C   corresponds to the initial costs at year zero. NTT is
C   divided by VNT to calculate PVN when L=1 corresponds to
C   year zero. Why would one want to divide the initial cost
C   by a discount rate since initial costs are already at
C   year zero? The answer is that this manipulation is
C   necessary to store initial costs in array PVN.VNT is
C   equal to 1.0 therefore initial costs do not change in
C   anyway but they are stored in the same array as net
C   revenue which means that all values of PVN L=1 to L=6 can
C   be added together to get PVNR the present value of the
C   investment. Therefore the initial costs and the net
C   revenue are added together since they have been both
C   equated to year zero. The array PVNR(I,J,K,M) is the
C   array that is used to store the summation of net revenue
C   and initial costs which is the present value of the
C   investment.
      DO 190 I = 1, N
        JC = 1
        DO 180 J = 1, 2
          IF (J .GT. 1) JC = 2
          DO 170 K = 1, 6
            NTT(I,J,K) = -NCOST(I,JC)
170       CONTINUE
180     CONTINUE
190   CONTINUE
      DO 220 I = 1, N
        JC = 1
        DO 210 J = 1, 2
```

```
            IF (J .GT. 1) JC = 2
            DO 200 K = 1, 6
              NNT(I,J,K) = GREV(I,K) - ACOST(I,JC)
200         CONTINUE
210       CONTINUE
220     CONTINUE
C
        DO 270 I = 1, N
          DO 260 M = 1, 9
            DO 250 L = 2, 6
              DO 240 J = 1, 2
                DO 230 K = 1, 6
                  PVN(I,J,K,L,M) = NNT(I,J,K) / VNT(L,M)
230             CONTINUE
240           CONTINUE
250         CONTINUE
260       CONTINUE
270     CONTINUE
C
        L = 1
        DO 310 I = 1, N
          DO 300 M = 1, 9
            DO 290 J = 1, 2
              DO 280 K = 1, 6
                PVN(I,J,K,L,M) = NTT(I,J,K) / VNT(L,M)
280           CONTINUE
290         CONTINUE
300       CONTINUE
310     CONTINUE
C
        DO 360 I = 1, N
          DO 350 J = 1, 2
            DO 340 K = 1, 6
              DO 330 M = 1, 9
                PVNR(I,J,K,M) = 0.0
                DO 320 L = 1, 6
                  PVNR(I,J,K,M) = PVNR(I,J,K,M) + PVN(I,J,K,L,
     1            M)
320             CONTINUE
330           CONTINUE
340         CONTINUE
350       CONTINUE
360     CONTINUE
C
        DO 400 J = 1, 2
          DO 390 K = 1, 6
            DO 380 M = 1, 9
              WRITE (6,370) J, K, M, (PVNR(I,J,K,M),I=1,N)
370           FORMAT (1X, 'PVNR ', 3I1, ' = ', 8(1X,F12.2), /,
     1               7(1X,F12.2))
380         CONTINUE
390       CONTINUE
400     CONTINUE
        STOP
```

END

```
C   PROGRAM THREE by ALEX MACDONALD
C
      DIMENSION AC(15,2), GREV(15,6), C(15,2), MAXR(15,2,6)
      DIMENSION NPV(15,2,6), NT(15,2,6), Y(15,2,6),
     1          Z(15,2,6)
      DIMENSION MINR(15,2,6), R(15,2,6), X(15,2,6),
     1          D(15,2,6)
      REAL NPV, NT, MINR, MAXR
C  ENTER N=NUMBER OF FIRMS FOR WHICH THERE IS DATA(15 is
C  MAX)
      N = 13
C
C       READ INITIAL DATA GREV,C,AC
C  GREV is the gross revenue of the investment for the 13
C  firms analyzed .NCOST is the initial costs of the
C  investment which are set up and discussed in Chapter 4
C  for 2 sets of of initial costs accounting for both 100%
C  and 50% of the debarker costs.ACOST is the annual costs
C  of the investment and like the initial costs considered
C  two costing methods for 100% and 50% of the debarker
C  costs.VNT evaluated 9 discount rates.VNT equals 9 values
C  which correspond to J=9 for 0,1,3,5,7,10,12,15 and 20%.
C  I=1 to 6 corresponds to I= 1/(1+i)**n where n=6 is the
C  present value from year 0; n=1 to n=6 the present value
C  at the end of year five.
       DO 20 J = 1, 6
         READ (5,10) (GREV(I,J),I=1,N)
10       FORMAT (1X, F10.2)
20     CONTINUE
       DO 40 J = 1, 2
         READ (5,30) (C(I,J),I=1,N)
30       FORMAT (1X, F10.2)
40     CONTINUE
       DO 60 J = 1, 2
         READ (5,50) (AC(I,J),I=1,N)
50       FORMAT (1X, F10.2)
60     CONTINUE
C
       DO 80 J = 1, 6
         WRITE (6,70) J, (GREV(I,J),I=1,N)
70       FORMAT (3X, ' GREV ', I1, '= ', 8(2X,F10.2), /,
     1          7(2X,F10.2))
80     CONTINUE
       DO 100 J = 1, 2
         WRITE (6,90) J, (C(I,J),I=1,N)
90       FORMAT (1X, ' C    ', I1, '=    ', 8(2X,F10.2), /,
     1          7(2X,F10.2))
100    CONTINUE
       DO 120 J = 1, 2
         WRITE (6,110) J, (AC(I,J),I=1,N)
110      FORMAT (1X, ' AC    ', I1, '=    ', 8(2X,F10.2), /,
     1          7(2X,F10.2))
120    CONTINUE
C  This section calculates the IRR of the project by forcing
```

```
C  the NPV to become as close as possible to zero.This
C  involves an iterative process where a maximum and a
C  minimum value for R has been stated ie,MINR=-2.0 and
C  MAXR=4.0 which correspond to -200% and 400%. Therefore
C  the first value for R(I,J,K) would be 100% .Therefore NT
C  which is the Net Revenue is evaluated at a 100% discount
C  rate.Once adjusted for the discount rate the present
C  value of NT is subtracted from the initial cost of the
C  investment C(I,JC) if NT-- C is greater than or less than
C  zero then the rate of discount R(I,J,K) is changed.If the
C  NPV ie NT - C is less than -100.0 then the discount rate
C  has to be lowered by reducing the value of maximum
C  R(I,J,K) from 4.0 to the value for R(I,J,K) which is
C  1.0.In which case when Rmax and Rmin are added together
C  to calculate R(I,J,K) the new value for R would be -2 + 1
C  which equals -.5.If NPV is greater than 100 then the
C  discount rate being applied to NT - C is not big enough
C  which means that the minr value has to be increased so
C  that the resulting R value will be higher ie, Minr would
C  be set to the R(I,J,K) value which was 1.0 therefore
C  R(I,J,K) would be 4 + 1 =5/2 which equals 2.5.Eventually
C  it would be possible to calculate a value for R(I,J,K)
C  which would get NPV within 100 of zero. This value for R
C  would be the IRR of the project where the revenues are
C  equated to the costs of the investment.
C     CALCULATE NET PRESENT VALUES AND I.R.R
      DO 150 I = 1, N
        JC = 1
        DO 140 J = 1, 2
          IF (J .GT. 1) JC = 2
          DO 130 K = 1, 6
            NT(I,J,K) = GREV(I,K) - AC(I,JC)
130       CONTINUE
140     CONTINUE
150   CONTINUE
      I = 1
      WHILE(I.LE.N)DO
      JC = 1
      J = 1
      WHILE(J.LE.2)DO
      IF (J .GT. 1) JC = 2
      K = 1
      WHILE(K.LE.6)DO
      MINR(I,J,K) = -2.0
      MAXR(I,J,K) = 4.0
      NPV(I,J,K) = -100.1
      IJK = 0
      WHILE(NPV(I,J,K).LT.-100.0.OR.NPV(I,J,K).GT.100.0)DO
      R(I,J,K) = (MINR(I,J,K) + MAXR(I,J,K)) / 2
      D(I,J,K) = (1 - (1/((1 + (R(I,J,K) + 0.0000000001))**
     15)))
      X(I,J,K) = (D(I,J,K)/(R(I,J,K) + 0.0000000001))
      Y(I,J,K) = (NT(I,J,K)*X(I,J,K))
      Z(I,J,K) = (C(I,JC))
```

```
      NPV(I,J,K) = Y(I,J,K) - Z(I,J,K)
      IF (NPV(I,J,K) .LT. - 100.0) MAXR(I,J,K) = R(I,J,K)
      IF (NPV(I,J,K) .GT. 100.0) MINR(I,J,K) = R(I,J,K)
C
      IJK = IJK + 1
      IF (IJK .GT. 50) PRINT, 'NPV', NPV(I,J,K)
      END WHILE
      PRINT, 'R', R(I,J,K)
      K = K + 1
      END WHILE
      J = J + 1
C
      END WHILE
      I = I + 1
C
      END WHILE
      DO 180 J = 1, 2
        DO 170 K = 1, 6
          WRITE (6,160) I, J, K, (R(I,J,K),I=1,N)
160       FORMAT (1X, 'R    ', 3I1, ' = ', 13(1X,F5.2))
170     CONTINUE
180   CONTINUE
      STOP
      END
```

Appendix F

Company: Bradson Machinery Ltd. 1196 Pipeline Road Port Coquitlam B.C. V3B 4S1, Canada.
Kind of equipment; Debarkers (cost includes motors)
Size and Type and Cost; 28" debarker ring mounted
- $115,505, f.o.b. Vancouver. B.C. not including taxes.
36" - 8 arm debarker (Heavy Duty Model)
$132,805, f.o.b. Vancouver.
Companies using Bradson Debarkers;
Revelstoke (Sentinel) - 28" Bradson Debarker
Revelstoke (Sundre) - 28" Bradson Debarker
Spray Lake Sawmills - 36" Bradson Debarker

Company: Brunette Machine Works Limited No. 5 Capilano Way, New Westmininster B.C. V31 5G3, Canada.
Kind of equipment; Debarkers (including motors)
Size and Type and Cost; Brunette 24" ring log Debarker
2 models available MK 5, $160,000; MK 6, $195,000, F.O.B. Vancouver, not including taxes.
Brunette 32", ring log debarker 2 models, available MK 4, $180,000; MK 6, $260,000, F.O.B. Vancouver. not including taxes.
Companies using Brunette Debarkers;
N.C.F.P. Hines Creek - 32" MK 6
Ziedlers Slave Lake - 32" MK 6

Company: CAE Machinery Ltd. 3550 Loughheed Highway Vancouver B.C. V5M 2A3
Kind of equipment; Chippers and Rotary Chip Screens
Kind and Type and Cost; Chippers;
48" 6 knives-horizantal feed $37,000
54" 8 knives-horizantal feed $47,000
62" 10 knives-horizantal feed $50,000
62" 10 knives-horizantal feed $48,000
65" 8 knives-gravity feed $57,000
69" 8 knives-gravity feed $60,000;

Screens; Model 65 $20,000.
Companies using CAE Equipment,
NCFP, Hines Creek - CAE screen, Model 65.
NCFP High Level - 69" chipper.
Revelstoke Sundre - 54" chipper.
Alberta Energy - 69" chipper
Western Construction - 62" disc chipper - Horz, feed

Company: Kockums Industries Limited. 13050-88th Avenue Surrey B.C. V3W 3Y4.
Kind of equipment; Debarkers (cost is including motors)
Size and Type and Cost; Cambio 18" max. diameter,

- $152,471,F.O.B.Vancouver, not including tax.
  Cambio 30" max. diameter 30",$262,633.F.O.B.
  Vancouver, not including tax.

Companies using the debarker;
Erith and Tie - Cambio 26".(not made anymore)
N.C.F.P.Grande Prairie - 224" debarkers
(cost not available)
N.C.F.P. High Level - 1 - 18" debarker
- 1 - 24" debarker
- 1 - 30" debarker
Alberta Energy - 3 - 18" debarker
- 1 - 24" debarker
- 1 - 30" debarker
Svesberg - 1 24" debarker

Company: Lumber Systems Ltd. 14291 Burrows Rd.
Richmond B.C. V6V 1V9
Kind of equipment; Forano Chip Screens,Forano Chippers.
L.S.I. log debarkers,vibrating conveyors.
Size and Type and Cost;Forano Chip Screens(cost
not including install.,including motors)
CS-27 16 unit capacity, $9000.00
CS-2822 unit capacity,$12,000.00
Forano Chippers(cost not including installation,
without motor)
Model 48 8" diameter(max input) 6 knives,$18,000
Model 56 10" diameter(max input) 5 knives,$24,000
Model 58 10" diameter(max input) 6 knives,$28,000
LSI log debarkders(cost not incl install.)
Model 18", $145,000
Model 30", $195,000
Vibrating Conveyor,300',$5,000-$10.000 installed
Companies using L.S.I. equipment;
Buchanan - 1 - 24" Ring debarker(L.S.I.)
- 1 56" Forano chipper
Erith and Tie - 1 - Forano chipper Model 48
- 1 - Forano chip screen
N.C.F.P. High Level 1 - Forano chipper
(model not specified)
Spray Lakes - 1 - Model 58 - chipper
- 1 - Forano chip screen
Ziedlers Slave Lake - 2 CS 78 Forano
- chip screens.

Company: Peerless Page Industries Ltd. 2829 Norland
Ave, Burnaby,B.C. Canada V5B 3A9.
Kind of equipment;Storage Bins - Wood residues
Size and Type;Rapid Discharge,complete cleaning,
- 14 unit - BDU's
- 20 unit - BDU's
- 21 unit - BDU's

- 30 unit - BDU's.
- 62 unit - BDU's
- 94 unit - BDU's
- 126 unit - BDU's

Cost - $1000.00 per 1 BDU and $500.00 per 1 BDU for installation and set up.

Companies using Peerless Storage Bins:

- Buchanan - 1 - 40 BDU unit,
- N.C.F.P. Grande Prairie 2 - 30 BDU units,
- N.C.F.P. Hines Creek 2 - 126 BDU units,
- N.C.F.P. High Level - 2 - 126 BDU units,
- Revelstoke Sundre - 2 - 30 BDU units.
- Alberta Energy - 1 - 126 - BDU unit
- Svesberg - 2 - 20 BDU units,
- Spray Lakes - 2 - 20 BDU units,
- Western Construction Ltd. - 1 94 BDU unit
- Ziedlers Slave Lake 2 30 BDU units

Company: Precision Chipper Corporation, Turner Mill Equipment Ltd., 188 West 6th Ave. Vancouver, B.C. V5Y 1K6.

Kind of equipment; 38" - 4 knives, 48" - 3 or 6 knives, 58" - 3 or 6 knives. Gravity Feed, Bottom Discharge (without motor).

Max. Utilization: 38" - 20" slab, 9" roundwood,
48" 24" slab, 11" roundwood,
58" 30" slab, 15" roundwood.

Cost: (not incl. install.) 38" - $16,000 (f.o.b Van.)
48" - $20,000 (f.o.b Van.)
58" - $24,700 (f.o.b Van.)

Companies using Precision Chippers:

Ziedlers Barrhead - 54" Top Discharge, (similar to 58")
N.C.F.P. Grande Prairie 54" Top Discharge, (similar to 58")
- 75" Bottom Discharge
N.C.F.P. Hines Creek 48" Top Discharge.

Company: Radar Canada Ltd./Pacific Division P.O. Box 65567 Postal Station F Vancouver B.C. Canada, V5N 5K5.

Kind of equipment; As an engineering firm the equipment is built to customer's specifications. Therefore the kind of equipment utilized in designing a blowing system is based on what the customer has budgeted.

Use in Alberta; All firms with a peerless chip loading system utilize the pneumatic blowing system designed by Radar which includes;

Buchanan; N.C.F.P. Grande Prairie and Hines Creek and High Level: Revelstoke Sundre; Alberta Energy, Svesberg; Spray Lake Sawmills; Western Construction.

Ziedlers Slave Lake.

Company: Valone Kone Canada Ltd. 467 Mountain Highway, North Vancouver, B.C. V7J 2L3.
Kindof equipment; Debarkers
Size and type and cost;(not including motors
or installation)-VK 20K Debarking Machine,
$92,000,f.o.b.,Vancouver.
-VK 26T High speed debarker,
$125,000,f.o.b.,Vancouver.
-VK 32T Debarker Machine,
$168,000,f.o.b.,Vancouver.
Companies using the debarkers;
Ziedlers - Barrhead - VK 20K
- VK 26T
Western Construction- VK 20K
- VK 32T

Appendix G

This section outlines in detail Table 5.4 and 5.5, Page 55-56. This is supplementary to the discussion showing the differences between the three cost cases and was introduced in tabular form previously in chapter 5. Refer to Table 5.4 or 5.5, which shows the affects of changes in economic efficiency as proposed by the (IRR), (NPV) and (P/R) methods.

For firm 1 (Case 2), property taxes and insurance costs were increased from a total of ($7,750 to $30,000). These changes for Case 2 were taken from documented survey information provided by the firm. The result was an annual cost increase of 54% under (Accounting Method 2).[81] Therefore, the (IRR) was less. With an increase in power costs for Case 3, annual costs increased 78% for (Accounting Method 2). This resulted in a further reduction in the (IRR).

For firm 2 (Case 2), property taxes and insurance were increased from a total of ($4,400 to $21,000) while power costs were reduced from ($19,742 to $6,000) per year. These changes for Case 2 were taken from documented survey information. The result was that annual costs increased 9% for Accounting Method 2 and consequently the (IRR) decreased slightly. With higher power costs for Case 3 72% for Accounting 2 resulting in a reduction in the (IRR).

For firm 3, property taxes were increased 200% ($15,000 to $42,000), insurance costs increased 10 times ($5,253 to $53,330), and maintenance costs increased 65% ($78,000 to $127,000). These changes for Case 2 were taken directly from survey information that was provided by the firm. This resulted in annual costs increasing 50% for (Accounting Method 2). Under the cost assumptions of Case 2, the (IRR) was reduced. The additional power costs of Case 3 resulted in annual costs increasing 79% for (Accounting Method 2). This resulted in a further reduction to the (IRR), (NPV).

For firm 4, initial costs were increased 5.5% (Accounting Method 2) with an additional expense of $30,000 for storage bins. Maintenance costs were reduced from $205,000 to $125,468 which resulted in a decrease of 9% in annual costs for Accounting Method 2. These changes for Case 2 were taken directly from survey information that was provided by the firm. Due to the increase in initial costs though the (IRR) increased slightly. The increase in power costs for Case 3 resulted in annual costs going up 26% for (Accounting Method 2). This reduced the (IRR).

For firm 5, initial costs were increased 7.0% (Accounting Method 2), with an additional expense of $60,000 being included for storage bins. The assumption is that since firm 4 and 5 are very similar operations since firm 4

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[81] Comparisions between cases regarding % changes in annual costs for Case 2 and 3 are in relation to Case 1. The changes in annual costs which are accounted for in Case 2 and 3 are only for Accounting Method 2 because the assumption is that as in the Cost-Price-Firm Analysis that only Accounting Method 2 was necessary for the analysis.

had an expense of $150,000 for bins that firm 5 should incur a similiar expense. With no changes in annual costs for Case 2, the slight increase in initial costs resulted in a reduction in the (IRR), which was already less than zero. For Case 3, with a doubling of power costs, annual costs increased 29% for (Accounting Method 2). Therefore there was a reduction in the (IRR).

For firm 6, property taxes were increased 4 times ($6500 to $25000), insurance costs increased 350% ($14,000 to $50,000). These changes for Case 2 were taken directly from survey information that was provided by the firm. Labor costs were also increased $50,000. Two extra men were added to the operation of the chippers. This resulted in annual costs increasing 24% for (Accounting Method 2). Therefore, for case 2 the (IRR) was slightly less. With power costs increased in case 3 annual costs were 52% higher for (Accounting Method 2), resulting in a further reduction in the (IRR).

For firm 7, taxes increased 400% ($5000 to $20,000), and insurance costs increased 8 times ($3000 to $25000). These changes for Case 2 were taken directly from survey information that was provided by the firm. Labor costs were decreased 32% ($50,669 to $34,528). The manpower requirements for operation of the chipper system were reduced by one man. In Case 2 annual costs increased 17% for (Accounting Method 2), which reduced the (IRR). In case 3, with additional power costs, annual costs increased 37% for (Accounting Method 2). This resulted in further reductions to the (IRR).

For firm 8, (case 2), property taxes were increased 4 times ($4,500 to $18,000), while power costs were reduced 36% ($25,900 to $16,800). These changes for case 2 were taken directly from survey information that was provided by the firm. Therefore, for case 2 annual costs increased 5% for (Accounting Method 2) resulting in a slight decrease in the (IRR). For Case 3 the increased power costs resulted in annual costs increasing over 100% for (Accounting Method 2) which resulted in signficant reduction in the (IRR).

For firm 9, (Case 2), power costs were reduced by 36% ($163,036 to $106,050) and maintenance costs were reduced 40% ($259,325 to $154,000). These changes for case 2 were taken directly from survey information that was provided by the firm. Therefore, under Case 2 annual costs were 8% less for (Accounting Method 2). This resulted in a higher (IRR). For Case 3 power costs increased 100%, which resulted in an increase to annual costs of 32% for (Accounting Method 2). This resulted in a reduction to the (IRR).

For firm 10 (Case 2) power costs were reduced 38% ($40,392 to $25,000), and maintenance costs were reduced 17% ($72,500 to $62,000). These changes for Case 2 were taken directly from survey information that was provided by the firm. This resulted in Case 2's annual costs decreasing 19% for (Accounting Method 2), which lead to a higher (IRR). In Case 3, with an increase in power costs, annual costs increased 24% for (Accounting Method 2). This resulted in a reduction in the (IRR).

For firm 11, an additional cost for storage bins of $80,000 increased initial costs. The increase was 20% for (Accounting Method 2). This change was necessary to see what effect the additional cost would have on the firm's rate of return. An expense for bins was not originally included in the calculations.

In Case 2 property taxes were increased six times ($8000 to $49,000), insurance costs were increased 3 times ($3887 to $11,500), power costs were lowered from ($41,860 to $6800) and maintenance costs were reduced 50% ($74,790 to $39,000). These changes for Case 2 were taken directly from survey information that was provided by the firm. Therefore, annual costs increased 17% for (Accounting Method 2), which reduced the (IRR). In Case 3, with the additional power costs, annual costs increased 55% for (Accounting Method 2), which resulted in a further decrease in the (IRR).

For firm 12, total initial costs were increased 20% for Accounting Method 1 to reflect an additional expense for depreciation on building. This was done after further comparisons were made between firms of a similar size which indicated the firm had depreciation on building expenses that were indicative of size.

For Case 2, property taxes were reduced 50% ($15,000 to $7500), insurance costs were tripled ($6415 to $17,500), labor costs were increased 20% ($107,520 to $124,800) and maintenance costs were reduced by one third ($61,000 to $41,000). The result was that annual costs were similar to Case 1. These changes for Case 2 were taken directly from survey information that was provided by the firm. Since both annual and initial costs increased the (IRR) decreased. For Case 3 with the increase in power costs annual costs were 45% higher for (Accounting Method 2). This resulted in a further reduction to the (IRR).

For Firm 13, property taxes were increased ($10,000 to $40,000), insurance costs were increased ($5438 to $28,000), power costs were reduced ($64,000 to $18,000), and maintenance costs were reduced ($78,000 to $56,000). These changes for Case 2 were taken directly from survey information that was provided by the firm. This resulted in annual costs decreasing 7% for (Accounting Method 2) which caused a slight increase in the (IRR). For Case 3, with the increase in power costs annual costs increased 60% for (Accounting Method 2) which resulted in a decrease in the (IRR).