

FINANCE FOR SILVICULTURE

IN

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By

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Abstract

Government funding for silviculture in British Columbia has expanded recently, but remains well short of the level recommended by many foresters. This thesis contains a proposal to replace government funding with investment from capital markets. It describes the funding mechanism, analyzes the implications to government, and introduces a method of distributing investment funds through a system of competitive bidding between forest management companies. In return for their participation, investors and forest companies would both receive equity in future timber production. The thesis concludes that at a cost of foregoing 50% of its future stumpage revenue, government might replace its current spending on intensive forest management with a funding level from capital markets of \$500 million to \$800 million per year.

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Many people on British Columbia's roads have a keen interest in some aspect of forestry. I wish to thank these people for their generosity in offering a lift and conversation on my many trips hitchhiking about the province.

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G.O.

CHAPTER ONE

INTRODUCTION

This thesis discusses a means of financing intensive silviculture in British Columbia. It proposes that capital for the undertaking be attracted nationally or internationally, rather than being provided by British Columbia society. It is reasoned that certain arms-length investors are more suited to provide an ample, steady stream of investment capital for forestry than is the provincial government.

Forest management requires four types of input: land, capital¹, expertise, and coordination. This thesis describes an organization in which government would contribute land and coordinate the enterprise, investors would contribute capital, and forest companies would contribute their expertise. There would be some overlap of contributions. The thesis seeks to describe a means of sharing the benefits of forest production among the three contributors in such a way that the benefits anticipated by each would provide an incentive appropriate to that contributor's particular needs and desires. The hope is that each will consider himself better off than he is under present management arrangements.

Sources

Literature consulted is cited in an attached bibliography. The main research for this thesis, however, was conducted through an extensive series of interviews. The scope of these interviews was broad, including meetings over an hour in length on six occasions with Ministry of Forests staff, many interviews with foresters in industry, and meetings with lawyers and influential individuals in the investment community. The financial discussions were supplemented by the writer's personal experience of five years in the investment business.

¹ Some readers might consider labour inputs, however for the sake of this list it is assumed that labour is purchased with capital.

In addition, extensive personal correspondence was exchanged with foresters, economists, and financiers across Canada and in the U.S. and New Zealand. Relevant published works of some correspondents are cited in the bibliography.

Organization of the Thesis

It is recommended that the reader begin with Chapter Six. This will allow Chapters Three through Five to be approached with some scattered curiosity and understanding.

Following this introduction, Chapter Two presents background silvicultural statistics for British Columbia, and a conceptual discussion of alternative financing techniques.

The main body of the thesis is contained in Chapters Three, Four, and Five. These three chapters discuss the involvement of investors, government, and forest companies in the proposed financing arrangement. The discussion develops in a logical sequence in that some terminology employed in the latter sections is defined in earlier sections. If readers wish to approach these sections out of order they may benefit by referring to Appendix K, 'Glossary'.

Chapter Six, 'Discussion', consists largely of points raised in interviews during the development of the thesis. These points are pertinent to an appraisal of the overall infrastructure, but are of too specialized a nature to be incorporated in those chapters. Chapter Seven presents a summary and conclusion which discusses the implications and viability of implementing this proposal.

A number of Appendices containing technical information pertinent to an informed reading of the thesis follow the body of the text. The first three appendices support the discussion of investor participation. Appendix A presents a summary of the results of an empirical analysis by the author of the financial benefits of forest products certificates. Appendix B.1 discusses real lumber price gains, while B.2 presents Canadian bond yields and inflation rates for the past 72

years. Appendix C discusses interest rate hedger participation in the investment certificate.

Appendix D discusses silviculture. It contains: (D.1) a description of cultural treatments for the information of those readers unfamiliar with forestry, (D.2) an estimation of silviculture worker productivity and costs, and (D.3) a rough quantification of growth responses which may be expected in British Columbia.

Appendices E and F deal with forest products. Appendix E gives a short table of conversion factors for logs, lumber, chips, and pulp, while Appendix F presents a logical method of equating volume with value. Some silvicultural treatments serve mostly to increase forest volume (eg. fertilization) while others have a small effect on volume production but instead increase the merchantable value of a forest stand (eg. spacing and pruning). The framework in Appendix F presents a common basis for analyzing the two types of forest management response.

Appendix G demonstrates how the market prices of a series of issued wood certificates may be used to guide the decisions of forest managers. This is an alternative to using discount rates for forest management decision-making. Technical analysis pertinent to forest company involvement in the scheme is contained in Appendix H.

Finally, Appendix K is a glossary to the thesis. The contractual infrastructure which is described in this thesis requires the creation of a number of entities which do not presently exist. These have been given appropriate names and are collected, with definitions, in Appendix K. Also included are references to the pages in the text where these terms are used.

General Comment

This thesis presents an interwoven set of very specific recommendations. It is expected that very few, if any, readers will agree with the entire set. There may be some readers who agree with none at all. This thesis is not presented to form a consensus but rather is presented as a full set of preliminary recommendations by one individual. It was felt in presenting this innovative proposal that a broad set of specific suggestions would be preferable to a general theoretical discussion. By being specific, this thesis may, even if not accepted for implementation, stimulate discussion of many points relevant to forest management in British Columbia.

CHAPTER TWO

BACKGROUND

The Ministry of Forests and Lands defines two types of silviculture: basic and intensive. Basic silviculture is the set of treatments (site preparation, planting, brush control) required to restock recently denuded land to a free-growing state. Intensive silviculture is the set of further treatments which serve to guide forest growth from the juvenile stage to harvest age². Intensive treatments vary with the volume and quality of growth desired. Brief descriptions of silvicultural treatments are presented in Appendix D.1. The tables below describe the status of forest land in British Columbia in 1984, and the silvicultural activities undertaken since that time.

British Columbia Forest Status: 1984³

There are 26.2 million hectares of land potentially productive, available, and suitable for timber production in British Columbia. Of that:

3.2 million hectares are decadent (timber growing slowly or reducing due to decay).

2.0 million hectares are stagnant (extremely dense immature timber stands not expected to become merchantable without juvenile spacing).

3.6 million hectares are NSR (not sufficiently restocked). Of this total 1.2 million hectares are good and medium sites.

The Resource Analysis of 1984 pointed out that "2.9 million hectares of productive forest land (good and medium sites) are partially or completely occupied by nonforest vegetation. That total is expected to increase by 48,000 hectares per year if no proper management action is taken."

² The Ministry definition of intensive silviculture also refers to restocking the backlog of not satisfactorily restocked land.

³ Ministry of Forests, 1984

Table 1British Columbia Forest Activities Since 1984^{4 5}

<u>Resource Degradation</u>	<u>Area in Hectares</u>	
Logged:	<u>1984/85</u>	<u>1985/86</u>
Clearcut	187,023	204,504
Selective Cut	29,394	27,226
Timber Area Burned	28,606	134,998
Area Under Pest Attack	678,930	612,170
<u>Resource Enhancement</u>		
Planted	100,035	101,442
Site Rehabilitation	14,493	16,039
Conifer Release	181	1,195
Spacing	5,615	10,872
Fertilization	Ø	17
Pruning	Ø	Ø
Commercial Thin	86	196

The low level of intensive forest management relative to the rate of denudation in British Columbia is due to a number of factors. (1) There remains in some areas of the province a large inventory of mature and overmature timber which is scheduled to be harvested before the products of intensive management would be required. While some Timber Supply Areas expect supply deficits within ten years, there are remote areas of the province which do not expect 'falldown' for fifty years or more. (2) Tree growth is relatively slow in British Columbia when

⁴ Ministry of Forests, 1986, 1985

⁵ Part of the areas in Table 1 under 'Timber Area Burned' and 'Area Under Pest Attack' may fall outside the 26.2 million hectares defined as potentially productive, available, and suitable for timber production.

compared with the U.S. South, Brazil, New Zealand, and other timber producing regions of the world. Economic analysis of the benefits and costs of intensive management in British Columbia generally demonstrate that very low financial returns may be anticipated. (3) Forest management spending is a government responsibility, and government budgets are limited. Given a perceived lack of urgency to address timber supply deficits, and the lack of profitability of forestry investment, government makes forestry expenditures for social welfare purposes. Such political motivation means that forestry must compete for funding with other social welfare causes. Also, it means that the limited spending undertaken tends to be equitably distributed between regions, rather than being directed to the most productive growing sites.

Jack Walters (1984) estimated that an annual investment of \$660 million spent on the best 28% of the Crown land base would permit eventual expansion of harvest rates by 20%. Reed (1985) estimated that annual forestry expenditures of \$300 million would be required to replace current denudation. Combined federal and provincial spending on basic and intensive forest management in British Columbia has been increasing in recent years, and is currently running at approximately \$200 million per annum.

Funding

A number of approaches to provide increased funding for intensive silviculture in British Columbia have been discussed recently. Four approaches are described here, with comment as to the suitability of each.

(a) Status Quo

Opposition parties in the provincial legislature, forest management companies, forest workers unions and environmental groups all recommend that direct government spending for forest management be increased. While noting that increased silvicultural funding must come from alternate social programs, these

interest groups feel that a sacrifice should be made by present society in order to provide security and a flow of forest benefits to future generations.

An outline of the present government (federal and provincial) sources of funding for silviculture on provincial Crown land follows. The figures in parentheses refer to the funding level in 1986/87⁶.

(i) Ministry Operations Vote (administration; nursery and seed operations; \$61.2 million)

(ii) Section 88 (basic silviculture; \$66.6 million)

(iii) Small Business Enterprise Account (roads and basic silviculture; \$7.4 million)

(iv) Forest Resource Development Agreement (research and intensive silviculture; \$44 million)

(v) Forest Stand Management Fund (JobTrac: general silviculture; \$15.5 million)

Total silviculture funding in British Columbia has increased rapidly in recent years, as evidenced by the following series of figures⁷: 1983/84: \$88 million, 1984/85: \$111 million, 1985/86: \$136 million, 1986/87: \$195 million. A federal/provincial combined total of \$249 million is budgeted to be spent in the 1987/88 fiscal year.

An important question regarding government spending on forest management which rarely rises is 'how will the growth increment these expenditures are creating be distributed?'. If the status quo is maintained, and future timber is distributed as it is currently, then the direct expected return to the current government investment in silviculture may be nil, or even negative (eg. according to Ministry officials it costs \$3 to \$7 of current dollars to produce one cubic meter of wood over a rotation, however recent provincial stumpage rates have averaged \$2 per cubic meter). There are other values which government expects its management expenditures to produce, such as employment creation and tax revenue generation,

⁶ British Columbia, 1987

⁷ Op. cit.

but these other values arise from any creation of economic activity, and would exist regardless of who funded the forest management activities.

(b) Crown Corporation

Another possibility for organizing funding for intensive silviculture is through the creation of one or more Crown corporations. The various permutations of this option were thoroughly investigated by the B.C. Ministry of Forests in the autumn of 1983 and presented to Cabinet. The sketches were turned down flatly by then premier Bill Bennett. The reasons for rejection are not crucial to this analysis, it is sufficient to note that the option has been studied and was found to be unsatisfactory.

Crown corporation models for forest management exist in New Zealand, Australia, and in Canada in Quebec. Due to economic and cultural disparities, none could be transposed intact to British Columbia. For a discussion of the theoretical basis for public corporations, including a discussion of preferential treatment and profit motivation, the reader is directed to Teeguarden and Thomas' (1985) discussion of their possible role in Federal forest land management in the U.S.

An observation regarding Crown Corporations is that as political preferences oscillate from conservative to liberal and back again a point in the cycle is often reached where it is deemed expedient to privatize many of the existing public corporations. The packaging of forest management activities into a semi-autonomous corporate entity (Crown Corporation) may be the first step en route to their wholesale transfer to the private sector.

(c) Privatize Land

A fairly radical recent suggestion by University of British Columbia professor Dr. David Haley (1984) is that the best 25 to 30 percent of British Columbia's forest land be sold to private interests. Haley observes that the existing tenure system does not give forest companies the security they require to recoup

management expenditures, and believes that if the companies owned the land outright this obstacle would be removed, resulting in optimal economic management of the forest land base. Under his plan a sale mechanism which protected incumbent licensees could be devised, and the lands so transferred would be subject to legislation designed to control forest practices potentially damaging to the broader public interest.

It should be noted that stumpage is not charged on timber from private land. This privatization would imply that the government doing so would discharge forever its direct return from the land, along with its management responsibilities. That foregone return might be capitalized into the sale price, but it may be a hard sell, politically, to convince the public that the one-time revenue from such a sale would be adequate recompense for the opportunities foregone. Also, the public would likely wish guaranteed free access to the land for recreation purposes.

(d) Timber Equity

An alternative to the options discussed above is to define an equity (ownership) in timber which will exist in the future, and share that equity among those who help to create the timber. (1) Timber growing requires investment. This may be sought in the capital markets by offering an instrument which incorporates the peculiar nature of timber production with the strengths and needs of those markets. (2) Timber growth is very dependent on astute cultivation and tending. The forest management companies, in their various forms and with their various tenure types, are best suited to this role, possibly with technical support from government and private research agencies. (3) Timber requires land on which to grow. This is a government contribution, and should result in an equity share proportionate to the fertility of a particular site. (4) There are risks, both physical (losses to fire and pests) and financial (market fluctuations) to be considered while the timber is under production, and to be recognized in the equity distribution.

This thesis presents the results of an investigation into the structure and implications of financing intensive silviculture through the distribution of equity rights to future timber. The main concerns in developing this proposal were (i) that investors be attracted at the lowest possible rate of return, (ii) that incentives be created for conscientious forest management by industry, and (iii) that the risk exposure of government be minimized.

Concern (i) would be addressed through ensuring investment security and liquidity, and by carefully defining the 'Wood Unit' which would be sold to investors. The second concern resulted in the description of a competitive bidding process through which forest companies might draw silvicultural funding to their tenured areas. Concern (iii) was dealt with through a clear definition of 'stumpage', and by a proposal to establish two Reserves, one a cash deposit account and the other comprised of standing timber inventory. The writer feels that the primary concerns have been well addressed, although peripheral concerns remain.

CHAPTER THREE

INVESTORS

All securities must offer a potential yield in order to be attractive to capital markets. The appropriate yield of any particular security may be analyzed through an inspection of (i) the prevailing and anticipated risk-free returns available in the market, (ii) the expected duration of the investment, and (iii) the perceived risk of holding that particular security. The risk of holding may be divided into two components: liquidity and security.

It would be desirable to attract investor participation in forest management at the lowest possible rate of return. This would be accomplished by offering a very secure, totally liquid investment opportunity.

Security

Obligations issued and guaranteed by politically stable governments are presently considered the most secure type of investment asset available in the market. It is therefore proposed that the investment instrument should be issued by government, rather than by individual forest companies. Pension fund managers with whom this investment concept was discussed were strongly in favor of government issuance.

Liquidity

Liquidity may be created through two alternative techniques. One possibility is that the government could offer investors the opportunity to redeem their holdings at any time, or at periodic intervals. The two problems with this technique are: (i) difficulties may be encountered in determining the periodic value of the asset, and (ii) a flood of redemptions in any one period could put a strain on government credit and reserves.

The other way to create liquidity is to permit the asset to be freely transferable, and to provide for transfer through the facilities of an over-the-counter market or through a Stock Exchange. A Stock Exchange listing is the technique recommended and fully discussed in this paper.

Duration

The time from investment to realized return (harvest) in forestry is generally very long. Tree growth, from planting to final harvest, requires anywhere from fifty years to eighty years or more in British Columbia. Such long time periods are beyond the contemplation of ordinary capital markets. Currently, a long term investment has a duration of twenty or twenty-five years. This paper defines a 'Unit Rotation' as a period of twenty-five years. It is proposed that investors be sold an opportunity to participate in forest management on a Unit Rotation (UR) basis; they would provide funds today in return for a payout at the end of the Unit Rotation. It will require two or more UR's to actually manage a typical forest stand through one physical rotation.

Types of Investors

By definition, a Unit Rotation opportunity would be sold to long term investors. These investors would gain maximum benefit from participation, as explained later, if they hold a large portfolio of non-forestry assets. Large, long term, diversified investors may be sought in the form of pension funds, insurance trusts, corporate conglomerates, and possibly foreign governments without adequate timber resources of their own. Some smaller individual investors and speculators may also be attracted, depending on their individual perceptions of future supply/demand balances in the forestry sector.

Size of the Capital Market

Aware of the inflation hedge and diversification aspects of forest holdings, European pension funds have been investing in forestry for many years. In North

American pension funds have traditionally minimized the real asset component of their portfolios. The inflationary decade of the 1970's altered this perception however, and forestry investments are rapidly gaining acceptance here. Tarver (1982) says that forest syndicate managers in the U.S. who market forest land participation to pension funds currently recommend that 5% of a fund's assets be placed in forestry.

Canadian pension funds control \$220 billion in assets⁸. Five percent of this figure suggests that over \$10 billion would be available domestically for forestry investment if the correct opportunity were offered. The assets of foreign investment entities are several orders of magnitude larger.

Type of Participation

Forest product markets are cyclic in nature, responding to housing demand and other consumption variables in the economic cycle. The forest owner (in British Columbia the Crown) would wish to maintain harvesting flexibility in order to maximize its return from these cycles. Trees are wonderful assets in that they may be stored on the stump, increasing in volume, during periods of unfavorable prices. To maintain flexibility, the government should offer an investment contract providing for the delivery of dollars, rather than physical products, at the end of a Unit Rotation.

The specific government obligation associated with the investment contract might be varied from year to year, but the contract issued to arms-length investors in any given year (the supposition here is of annual issuance) should be standardized, an identical opportunity being offered to all investors. This is as opposed to marketing different types of participation for different regions of the province, or for investment on lands managed under different tenure types. A standardized annual contract would minimize the marketing and administration costs associated with

⁸ Trusteed pension funds controlled \$121.5 billion in the third quarter of 1986. This represents 55% of total public and private pension assets in Canada. -- Statistics Canada, 1987.

issuance, and facilitate the transferability (liquidity) of the contract once it is listed for Stock Exchange trading.

Investors supplying forest management capital might participate in the wood value their investment helps to create in one of two ways. They might share in growth as (a) a percentage of the actual growth increment which is created, or (b) a fixed volume of growth, with the forest manager absorbing any difference (positive or negative) between realized growth and the volume obliged. Sharing actual growth on a percentage basis is not advisable since then:

(1) The investor's expected return would be a share of an uncertain future volume and quality of timber. He would want to be compensated for this uncertainty in the form of higher expected returns.

(2) The investor would wish input into the decision of how the forest is managed and protected, encroaching on the autonomy of the forest manager.

(3) Detailed growth response records would be required. This would place an added cost on the investment infrastructure.

It is therefore recommended that investor participation be on a fixed volume basis. The Crown would experience economies through being able to pool risks and record-keeping on a provincial (or Timber Supply Area) basis. A major benefit of this method of dividing the increment is that it provides a strong incentive for the forest manager to manage well. Using the investor's capital, he will benefit on a one-to-one ratio with all growth in excess of the fixed obligation.

Stumpage vs. Products

The invested funds would promote forest growth, creating stumpage value.⁹

⁹ Stumpage is the net value of standing timber. It is classically defined as the gross value of products which may be produced from timber, less the costs of harvest, transport, and manufacture.

Common sense would therefore suggest that the investor return be expressed as a certain quantity of stumpage. This is not feasible for a number of reasons:

(1) Stumpage values vary widely by region and timber type. It would be impossible to describe an 'average' stumpage for British Columbia. Contracts promising stumpage value would therefore need to be site specific, an impediment to both ease of issuance and contract liquidity.

(2) Stumpage values are negotiated in British Columbia rather than being determined by open bidding. The recent countervail duty case with the U.S. has alerted most potential investors to the fact that stumpage rates may be artificially low in British Columbia. It is unlikely that investors would be willing to base their future returns on such a factor.

Investors would likely wish their return to be based on a type of timber equity for which free market prices are readily available. Stumpage is out of the question. Logs might be considered, however domestic log prices are protected at an artificially low level by log export restrictions. It is therefore recommended that the investor return be based on the prices of manufactured products (specified lumber grades, chips and pulp, plywood, newsprint or paper) as they leave the mill or at some major distribution point such as f.o.b. Vancouver Harbour. This type of equity contract would create conversion complications for the forest manager but greatly increase its acceptance by investors.

The Wood Unit

The stream of rationalization to this point may be summarized in the following statement: ***the government would sell to investors a freely transferrable obligation representing the delivery in twenty-five years time of the cash value of a specified mix of manufactured forest products.*** This contract is here called a 'Wood Unit'. Since the principal manufactured forest product (highest value per unit

volume of fibre) is lumber, and since lumber trades in Mbf units¹⁰, it is recommended that the Wood Unit be expressed in Mbf units¹¹.

Pension funds and other large investors may purchase the Wood Units in multiples of thousands of Mbf, but for the sake of divisibility, and small investor participation, it would be preferable to denominate the Wood Unit as representing one Mbf. It should then trade in the \$100 range, comparable with listed corporate stock prices.

The Wood Unit should prove to be an important addition to the set of assets available for inclusion in investment portfolios. Wood as a commodity is relatively bulky and heavy for its dollar value. The Wood Unit would facilitate the holding of wood in a portable, transferable, store-of-value form. As such it would compete with gold bullion and other real assets in providing investors with an inflation hedge and cyclic price diversification.

Lumber and plywood futures are presently available to investors through the facilities of the Chicago Merchantile and Montreal Exchanges. These contracts are for durations of three months to a year. There does not exist anywhere in the world a vehicle for investor participation in forest products as a long term commodity holding. The cost of storing lumber is very high in relation to the value represented. The only route currently available is through direct, site specific investment in forest land enhancement. The Wood Unit would therefore create its own market niche.

Comparison of the Wood Unit with Gold

Gold bullion is held by investors for its status as an inflation hedge, its security as a value of last resort, and its historic record of cultural acceptance.

¹⁰ An Mbf is one thousand board feet. One board foot measures one foot by one foot by one inch.

¹¹ Refer to Appendix E for log, lumber, and pulp conversion factors.

Recently, it has become popular among gold investors to hold bank issued demand certificates rather than the physical commodity. Gold dealers estimate that 60% of bullion trading in Canada occurs in certificate form. Purchase of a certificate saves the investor a 'refining charge' and, if outside the Toronto area, saves him a shipping charge as well. However the bank charges a storage fee (approximately 1/2% per annum) to the certificate holder. Certificates are non-transferable without a lawyer's affidavit, but if lost can be cancelled and replaced by the bank, upon payment of a fee.

The government issued Wood Unit should be regarded by investors as being at least as secure as bank issued gold certificates. The Wood Unit would be transferable, and would not require the payment of a storage fee. It may also pay an implicit dividend. It should therefore, depending on relative price expectations, be very attractive to the gold-holding segment of investment portfolios.

1986 Study

A study was undertaken by Olivotto (1986) to investigate the return that a Wood Unit should offer in order to attract a capital flow. The study employed Portfolio Theory^{1 2} to analyze changes in wood product prices (logs, lumber, pulp, newsprint) and stock market prices (Standard and Poor 500 Composite Index (S&P)), as compared with interest rates (U.S. Government Bonds) and the inflation rate (PPI), during the period 1960 to 1984 inclusive. The theory on which that analysis was based, and the results of the analysis, are presented in Appendix A.

The prices of three hypothetical Wood Units were considered, formed as weighted combinations of individual product prices, as follows:

$$W1 = 25\% \text{ LOGS} + 25\% \text{ LUM} + 25\% \text{ PULP} + 25\% \text{ NEWS}$$

$$W2 = 50\% \text{ LUM} + 50\% \text{ PULP}$$

^{1 2} Markowitz, 1959; Sharpe, 1970

$$W3 = 50\% \text{ LUM} + 35\% \text{ PULP} + 15\% \text{ NEWS}^{13}$$

Computer analysis¹⁴ was then performed to inspect the historic attractiveness of each hypothetical Wood Unit to the market. Portfolios combining each Wood Unit with stock and bond holdings were compared with portfolios consisting of stocks and bonds alone. It was found that W1 required a dividend of 2% to be an attractive holding during the period, while W2 and W3 required dividends of 2.5%.

Bond yields averaged 7.3% and the S&P averaged 8.9% per year (dividends plus capital gains) during the 1960 to 1984 period. The Wood Units were found to be attractive at 2% to 2.5% for two main reasons:

(1) Price Appreciation: Forest product prices rose 5.4% (pulp) to 8.1% (logs) per year during the period. This resulted in average annual gains of 5.7% to 6.2% for the Wood Units. These increases were .8% to 1.3% greater than the inflation rate (4.9%).

Historically, forest product prices have risen faster than the inflation rate. The graph in Appendix B.1 illustrates that lumber prices have increased 1.7% per annum in real terms, on average, since the year 1800. Recent price histories for pulp and paper products are illustrated in Appendix F.2.

(2) Zero Beta: Changes in wood product prices were found to be not correlated with changes in stock market prices. The lack of correlation ($\beta=0$) means that there is no *systematic* risk to a Wood Unit holder; Wood Units should be attractive to investors at an expected rate of return equal to, or lower than, the risk-free market rate.

The lack of correlation demonstrated by the study of the 1960 to 1984 period was verified by inspecting changes in log prices relative to changes in the

¹³ W3 roughly parallels the current composition of primary forest product exports, by value, from British Columbia.

¹⁴ White, 1978

Dow Jones Industrial Average over the 75 year period 1910 to 1984. This analysis produced a beta of $-.08$.

It has been suggested that the quality of lumber (or fibre) represented by the annual Wood Unit issue be varied from year to year. Appendix F illustrates that recently the prices of various grades of lumber have appreciated at different rates. In particular, the price of a lumber mix which might be produced from high-grade logs has been rising 1% to 2% per annum faster than the price of commodity-grade lumber. Investor expectations regarding future price increases of the Wood Unit will depend on the product mix which is represented.

A matrix of correlations between price changes of the four forest products studied is presented following the 'beta' discussion in Appendix A. Changes in lumber prices are not well correlated with changes in pulp prices. Investors seeking stability may prefer a Wood Unit which combines lumber with pulp, while speculators may prefer only lumber or only pulp. The product mix represented by the Wood Unit issued in any given year should reflect investor sentiment at that time.

Pricing the Wood Unit

Currently, government bonds trade in the market at a rate of return of approximately 9%, of which 5% is inflation expectation and 4% is expected real return. To attract investment capital, the Wood Unit (a government issued obligation, with $\beta=0$) should offer a comparable return. By example, if commodity grade lumber prices are \$250 per Mbf, and expected to increase in real terms by 1.3% per annum, the return necessary to attract Wood Unit holders would consist of the inflation expectation (5%), anticipated real gains in the price of wood (1.3%), and an expected compound rate of increase to maturity adequate to match the 9% risk-free market rate of return. A Wood Unit without dividends would tend to sell at a discount to current cash prices for the product mix represented. Its price would be computed by compounding current prices at their expected rate of

increase for twenty five years, and discounting that figure to the present at the required market rate of return.

example (i): commodity grade

\$250 compounded at 6.3% = \$1151

\$1151 discounted at 9% = \$133

example (ii): premium grade

\$360 compounded at 6.9%¹⁵ = \$1909

\$1909 discounted at 9% = \$220

All returns would be in the form of capital gains realizeable in the market at any time. In example (i) an investment of \$133 would be expected to grow to \$250, inflation adjusted, plus match any real wood price gains which occur in the interim.

A comparison of bond and Wood Unit price responses to changes in interest and inflation rates is included in Appendix C.

Legal Considerations

The Pension Benefits Standards Act regulates the investment activities of pension funds. It was inspected for limitations with respect to pension fund investment in the Wood Units. It appears that no problem would be encountered; all indebtedness of, or guaranteed by, . . . a province of Canada are qualifying investments under the Regulations attached to this Act.

Legislation would need to be written governing the listing of the Wood Unit on a Stock Exchange. The Vancouver Stock Exchange is approved to trade commodity futures contracts, although none are listed at this time. The Wood Unit is not however a commodity futures contract. A futures contract is an agreement between two parties regarding the price which will be paid at a future date for

¹⁵ Reflects higher price gain expectations; refer to Appendix F.

delivery of a quantity of products. No dollars are exchanged when a futures agreement is struck, although both parties place a surety deposit with the Exchange. The Wood Unit is quite different in that it would represent a fully paid obligation for future value delivery. In this sense it is more like a bond than a commodity contract.

The Wood Unit is an entirely new type of financial contract, and would likely require the writing of a new Act permitting its existence and defining the rights and obligations associated with its issuance.

Tax Treatment

The Federal government is very supportive of forestry development in Canada, and has over time created many special tax arrangements to support forestry activity. Two years ago, early in the development of this thesis, various tax incentives were contemplated, some modelled on the 'flow-through share' treatment of mining exploration expenditure.

It has since been decided that this proposed infrastructure should be able to stand on its own, without special tax support. The only tax request is a reasonable one; that the investor return from holding the Wood Unit be treated as a capital gain rather than as ordinary income. The tax on this gain would be payable either when sale through the Stock Exchange occurs, or on redemption at the end of the Unit Rotation.

Stock Exchange Trading

A Stock Exchange listing does not in itself guarantee liquidity. In addition to the long term purchasers to whom the initial Wood Unit issue would be sold, a viable market must involve the participation of hedgers and speculators. Some such participants are identified in the following list.

(1) The study of the 1960 to 1984 period showed that forest product prices were much better correlated than stock prices to the inflation rate:

$$\rho_{W1,INFL} = .4; \quad \rho_{S\&P,INFL} = -.2$$

Periods of high inflationary expectations should attract secondary market purchasers to the Wood Unit.

(2) Examples in Appendix C demonstrate that, if real interest rates and wood prices remain constant, the Wood Unit price should not change in response to changes in the inflation rate. This fact should attract hedgers interested in inflation protection.

(3) Appendix C demonstrates how interest rate hedgers would use the Wood Unit. These hedgers, by taking a long position in Wood Units and a corresponding short position in lumber (or pulp?) futures, would profit from a fall in interest rates while being unaffected by changes in wood product prices.¹⁶ The sensitivity of this hedge position (percentage profit per dollar invested) is a function of the remaining term to maturity. Long term Wood Units have the highest sensitivity. Interest rate hedgers would therefore concentrate their activities on newly issued Wood Units, aiding market liquidity for the first few years.

(4) Forest product consumers such as publishers and builders may use the Wood Unit to hedge expected consumption needs. These hedgers may be expected to mainly take long positions in Wood Units nearing maturity.

(5) Forest product companies might use short positions in Wood Units to raise capital for the construction and expansion of processing facilities. These short positions, spread over a series of annual Wood Unit issues, might be retired by production from the improved facilities as each Wood Unit issue matures.

¹⁶ An opposite position would hedge against increases in interest rates.

(6) Forest companies holding Management Contracts may purchase Wood Units at cyclic lows. By turning a Unit in for cancellation the company would receive a refund of its H&M deposit plus 4 m³ of stumpage-free timber equity.

(7) International arbitragers and speculators may be expected to participate in Wood Unit trading once the market has developed a sizeable outstanding float.

CHAPTER FOUR

GOVERNMENT

The provincial government, in the name of the Crown, owns 95% of British Columbia's forest land. It also owns all the timber growing and to be grown on that land, and the fish, wildlife, water, minerals and other natural resources which that land produces. Government provides licences to individuals and companies to reap commercial benefits from the use of the land and from the exploitation of its resources. In return the government collects rents and royalties. It is part of government's social responsibility to ensure that the rents and royalties collected are adequate compensation for the values removed and for the alternate social uses foregone.

This chapter of the thesis analyzes the obligations which government would have to assume under this financing proposal. The analysis is based on the assumption that government wishes to realize the full economic rent produced by timber management. The chapter goes on to describe two 'reserves' which would be required to implement the investment scheme.

The previous section suggested that investment funds for forest management would best be attracted by offering the value of a fixed volume of forest products to be delivered at a future date. Assuming this would be acceptable, the government needs to consider (i) the application of the funds to the land, and (ii) the future conversion of stumpage into products. For both these requirements the government would need to rely on the involvement of industrial forest companies. It would wish to do so on a basis which permits those companies a sufficient level of profitability while allowing government to collect the true value from the use of its land resource and the exploitation of its timber, water, and other resources.

Capital Return

It is necessary to make clear exactly what the government would deliver to investors.

(1) The government would not deliver a cutting right.

(2) The government would not deliver the stumpage value which the investment produces.

(3) The government would not physically deliver a mix of forest products.

Instead, the government would promise to deliver a quantity of future dollars. The amount of dollars would depend on the future market value of a clearly specified mix of forest products.

It has been proposed that the investor return be expressed in Mbf's of manufactured products. Present lumber recovery rates are approximately 225 board feet per cubic meter (m^3) of log input.¹⁷ ¹⁸ Thus 4 m^3 of logs produce .9 Mbf of lumber. The conversion of logs into lumber creates residues (sawdust, shavings, and slabs) which have value as inputs to pulp and paper manufacturing. The residue from converting 4 m^3 of logs into .9 Mbf of lumber is 1.9 m^3 of solid-wood equivalent, or approximately .4 BDU's (bone dry units). The Wood Unit might be expressed as "one Mbf equivalent", meaning .9 Mbf of lumber plus .4 BDU's of residue. As already discussed, the precise product mix backing the Wood Unit should vary from year to year. For the sake of this discussion it is assumed that the raw material required to produce one Wood Unit of product is 4 m^3 of logs.

The government pledge to investors, per Wood Unit of capital raised, would therefore be to provide 4 m^3 of raw material (of minimum quality) plus the cost

¹⁷ See Appendix E for a table of conversion factors.

¹⁸ Lumber recovery varies both with sawing technique and log size, and would therefore differ between regions of the province.

of converting that material into manufactured products. To do so the government must ensure that the application of the investment funds to its forest land will provide a growth increment, in twenty-five years, of four cubic meters plus enough additional growth to provide adequate stumpage receipts to pay for conversion of the cubic meters into products.

The P/L Diagram

The implications to government of undertaking this obligation may be analyzed through use of the P/L (Profit/Loss) Diagram. Four important variables need to be defined in order to pursue the discussion:

CP = the value of the Wood Unit at maturity (equals the cash price of one Mbf of product mix at that time),

H&M = the future cost of harvesting and milling 4 m³ of logs into one Mbf equivalent of product.

Gr = the growth increment in m³ created by the investment (realized growth after twenty five years, less what would have occurred without investment),

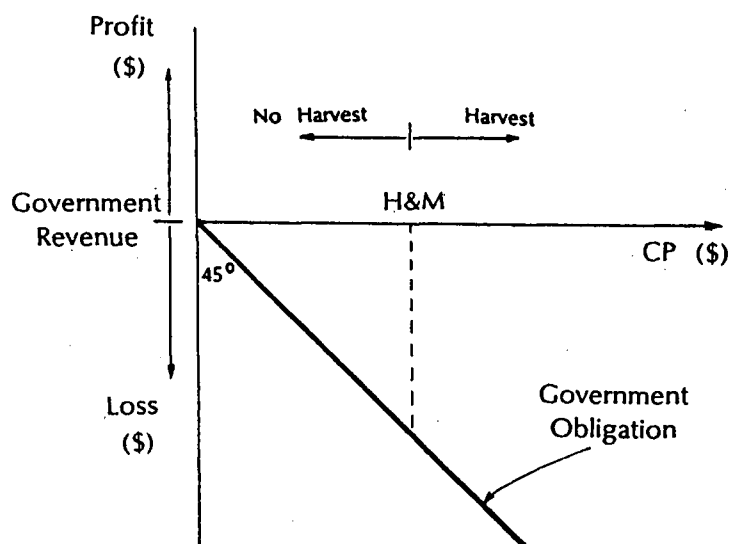
P/L = the net profit or loss to government (per Wood Unit) of inviting investor participation in forest management.

Stumpage is generally realized through the sale of standing timber; it is the economic value of the harvest potential of trees in the forest, and is classically defined as the value of manufactured products less the cost of harvesting and milling those products. The stumpage revenue from the investment may therefore be expressed as the difference between CP and H&M, multiplied by the growth which has been created. The pledge per Wood Unit to the investors, meanwhile, is to deliver the value of one CP.

Figure 1 illustrates that as CP increases, the cost to government of retiring the Wood Unit rises equally. H&M will locate somewhere on the horizontal axis. The location of H&M determines the harvest threshold.

FIGURE 1Government Pledge to Investors

Illustrated as a function of future product prices.



(1) If $CP < H\&M$ stumpage would be negative, harvest would not occur¹⁹, and government would pay investors the value CP without receiving any revenue from the forest.

(2) If $CP = H\&M$ harvest may or may not occur.

(3) If $CP > H\&M$ harvest would occur. Government would receive revenue of $CP - H\&M$ from all growth which the investment had produced, while paying investors CP for the pledged portion of the growth.

The algebraic derivation which follows incorporates growth (Gr) with stumpage ($CP - H\&M$) to arrive at the net government profit or loss (P/L) on the Wood Unit pledge:

¹⁹ Harvest decisions are here assumed to be based only on timber values, ignoring (i) other forest values, and (ii) social externalities (ie: employment creation).

Stumpage = Product Price minus Processing Cost

$$(1) \text{ Stumpage per Mbf} = CP - H\&M$$

Assuming one Mbf equals 4 m³:

$$(2) \text{ Stumpage per m}^3 = (CP - H\&M)/4$$

Multiplying by the volume present:

$$(3) \text{ Total stumpage produced} = [(CP - H\&M)/4] \cdot Gr$$

Subtracting the investor obligation:

$$(4) P/L = [(CP - H\&M)/4] \cdot Gr - CP$$

Transposing this equation into a usable format:

$$\begin{aligned} P/L &= CP \cdot Gr/4 - H\&M \cdot Gr/4 - CP \\ &= CP \cdot Gr/4 - CP - H\&M \cdot Gr/4 + H\&M - H\&M \\ &= (Gr/4 - 1) \cdot CP + (Gr/4 - 1) \cdot (-H\&M) - H\&M \\ (5) \quad &= (Gr/4 - 1) \cdot (CP - H\&M) - H\&M = mx + b \end{aligned}$$

where:

$m = (Gr/4 - 1)$ = growth in Mbf less one Mbf to investors,

$x = (CP - H\&M)$ = stumpage per Mbf, and

$b = (-H\&M)$ = cost of processing the investor obligation

Equation (5) is plotted on the P/L Diagram, Figure 2, showing a range of growth possibilities. In equation (5) 'm' is the slope of the P/L ray, 'x' is the market dependent variable, and 'b' is the harvesting threshold.

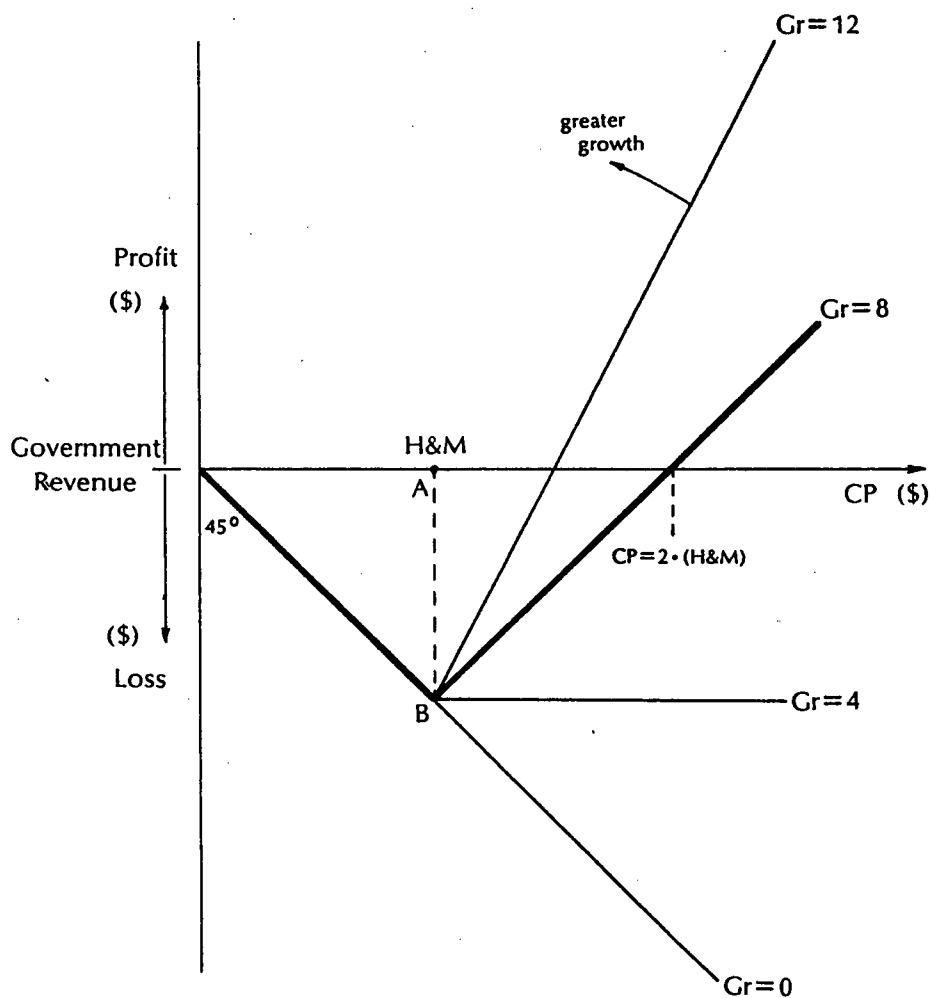
The expected P/L line for a growth projection of 8 m³, as a function of future product prices (CP), has been highlighted. In this case the future CP would need to be twice the cost of H&M in order that stumpage receipts would be sufficient to pay the cost of processing the pledged Wood Unit.

Regions of the P/L Diagram

Figure 3 shows the P/L Diagram shaded so as to highlight four distinct feasible regions. Region 1, the profit region, indicates those combinations of production and future prices which would provide government with sufficient

FIGURE 2P/L Diagram

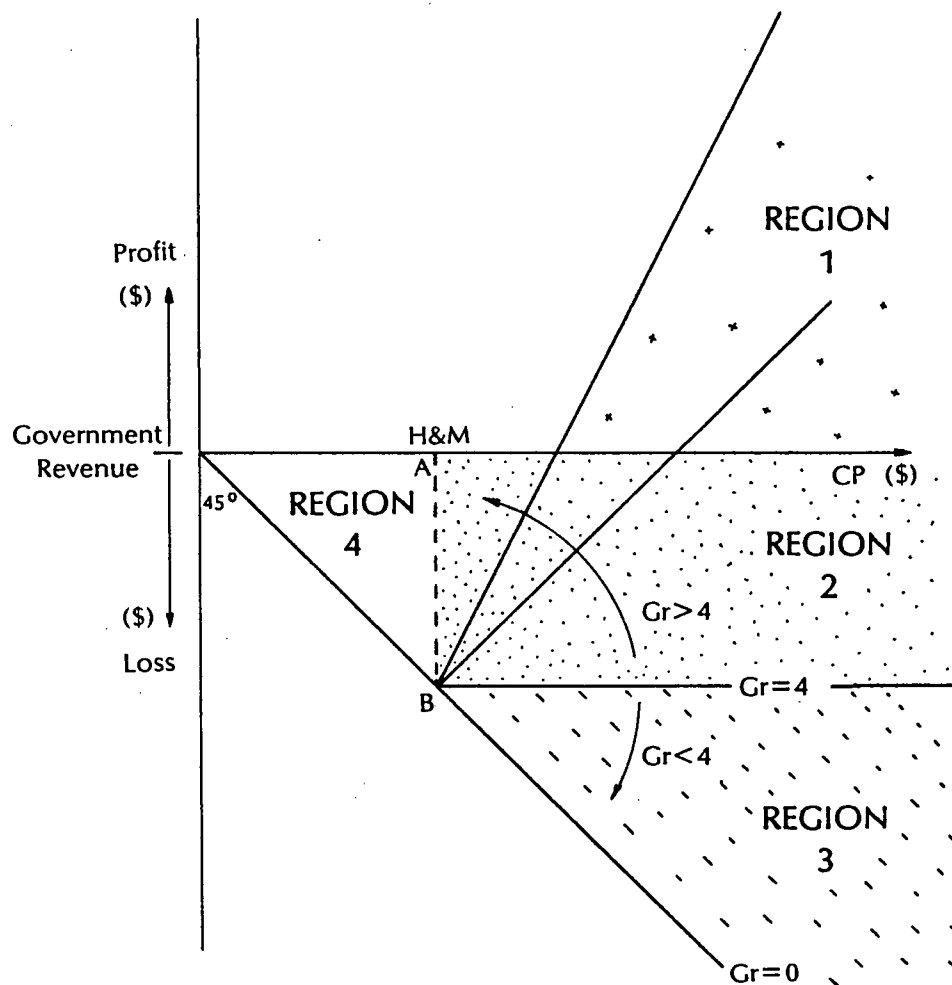
Illustrating the expected government profit or loss on Wood Unit issuance as a function of future prices and growth response.



Gr = expected growth increment = number of cubic meters in twenty five years.

FIGURE 3Regions of the P/L Diagram

Illustrating the four distinct feasible regions of the P/L Diagram.



revenue to retire the investment obligation and have some dollars left over. Region 2 represents the cost of processing the fixed (one Mbf) volume of product. It should be emphasized that Region 2 lies between two parallel horizontal lines; its magnitude is independent of price or growth considerations. Region 3 represents losses due to inadequate investment productivity. This underproduction may be due to poor management, catastrophic losses, or poor investment selection. The magnitude of this loss increases as product prices increase, since stumpage receipts would be insufficient to match the increasing value of the Wood Unit pledge.

Region 4 is actually an extension of Region 2, and would be provided for by the precautionary measures advocated for Region 2. The reader should recall that in the event the government accepts a loss by locating in Region 4 the timber remains in the forest, uncut and free of lien.

It is recommended that the government provide for the eventuality of locating in Regions 2, 3, or 4 by establishing two reserves. One would be called the Harvest and Mill Reserve, the other the Standing Green Reserve. Together they should provide the most cautious government with enough security to seriously contemplate the financing scheme described herein. Without them it would be a very speculative government indeed which would enter the scenario portrayed in Figure 2.

The Harvest and Mill Reserve

In order to provide for the future expense of harvesting and milling the volume of forest products pledged to investors the government should establish a cash reserve. This reserve would be in the form of a conservatively managed capital pool, expected to earn a market rate of return comparable to mutual fund, pension fund, and insurance trust capital pools. The Harvest and Mill Reserve would be established at the time investment funds are raised with an initial deposit calculated as the present cost of processing the volume of future products promised, discounted at the current market rate of interest over twenty-five years. Each year

the growing asset level in the Reserve would be inspected by comparing it with the then-current cost of processing, discounted at the then-current market rate of return for the number of years left until the obligation is due. Some years the asset level may be in excess, in other years it may be deficient; it would be drawn down or topped up accordingly. As an example, if \$200/Mbf is the current cost of processing, and the indicated rate of return is 8%, the initial deposit to the H&M Reserve would be \$29 per Mbf pledged²⁰. The earlier example estimated that under present market conditions investors would pay \$133 per commodity grade Wood Unit. If \$29 is placed in the Harvest and Mill Reserve, \$104 per Wood Unit pledge would be available for forest enhancement activities.

The level in the H&M Reserve would exactly equal the processing obligation when the Wood Units mature. It's existence would eliminate Region 2 from the P/L Diagram. On that diagram, it would lift point B, with its set of radiating rays, vertically to point A, as illustrated in Figure 4. This Reserve would also eliminate the possibility of locating in Region 4. If the price of the Wood Unit reflects product prices, and product prices are less than the cost of processing, there will come a time before the twenty-five years have passed when the cash level in the H&M Reserve will exceed the value of the Wood Unit. The Unit would then be purchased in the market with funds from the Reserve, cancelling the obligation.

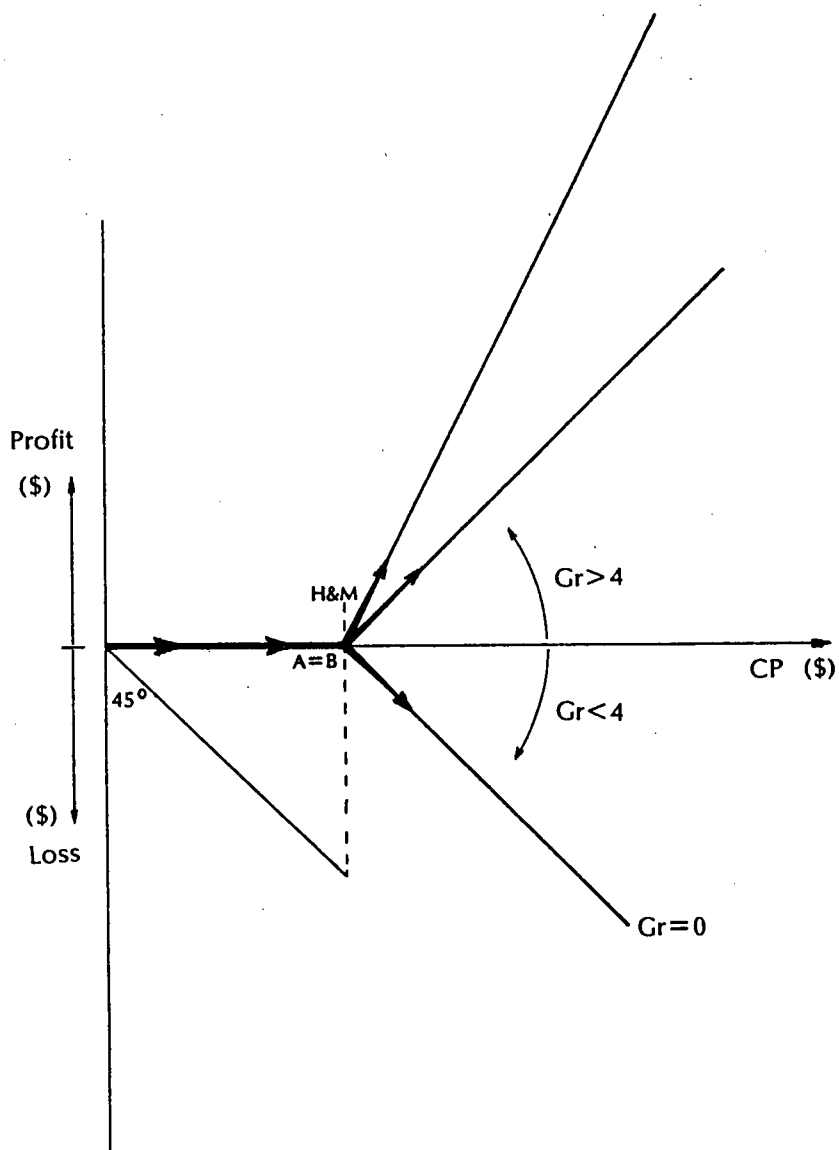
The Standing Green Reserve

Region 3 of the P/L Diagram represents the possibility that the use of the investment funds will not produce enough physical growth to provide the raw material for the investor return (eg. that an investment of \$104 will not grow 4 m³ in twenty-five years). Most foresters would consider this a remote possibility, however major insect infestations or several bad fire seasons may cause it to occur. Government may make a number of provisions for this contingency.

²⁰ Processing cost inflation is addressed in the following chapter 'Forest Companies' and in Appendix H.

FIGURE 4Amended P/L Diagram

Illustrating the effect on expected government profit/loss of the creation of a Harvest and Mill Reserve.



(1) Investment funds should be placed on the best growing sites possible, in order that the plentiful growth on some sites may be used to compensate losses on other sites.

(2) Efforts, in conjunction with industry, should be made to protect the forest. Such measures are already well established.

(3) The government should take a self-insuring view in placing its forestry investments. This means that investments should be diversified over a wide area of land, and over timber stands of varying species types and ages. To place major segments of investment in contiguous blocks of homogenous timber type is an invitation to disaster.

(4) It may be possible to re-insure the investments for catastrophic losses through the federal government. This possibility should be explored if the financing plan is considered for implementation.

(5) To self-insure, the government might set aside a quantity of cash reserves, based on its estimation of the probability of production deficiencies cross-referenced with the probability of very high future prices. The cost of establishing this reserve would be subtracted from the revenue raised by the initial sale of the Wood Units.

(6) Instead of cash reserves, the government might reserve a portion of its existing timber inventory from current harvesting. The reserved timber would be harvested in the future to replace any inadequate growth of managed stands. The opportunity cost of current revenue foregone by such reservation should be added to the consideration of the overall investment scheme.

Such timber reserves (Standing Green Reserves) should be diversified by area, perhaps located on a Regional or Timber Supply Area basis. They would not be required in a one-to-one ratio with the volumes contracted to investors; the appropriate ratio could be computed using conservative estimates of the probable extent of production deficiencies. The Standing Green (S.G.) Reserves would not need to be fixed forever to specific locations. What matters is the physical volume present in

relation to the investor volumes pledged.

If stumpage (CP - H&M) values are relatively low at the end of the Unit Rotation, insufficient growth would not be too expensive for government, since the investor return (CP) would be very nearly matched by the existing deposit level in the H&M Reserve. The real risk of underproduction is if it occurs at the same time as very high real prices (moving to the right on the P/L Diagram). The Standing Green Reserves may therefore incorporate 'economically inaccessible' timber stands, of which British Columbia has a plentiful store. The cost of accessing this timber would be affordable in the case of very high future prices, when it would be most needed. Alternatively, the Reserves might be comprised of certain described trees in a stand, with the possibility of selectively removing other (mature) trees and establishing an appropriate understory.

Forest Growth Estimation

Information regarding growth response to silvicultural treatment in British Columbia is largely unavailable; a wide range of intensive management activities have only recently been undertaken in an organized, recorded fashion. Our domestic species have been grown in Europe for a century, however, and data from Europe may be transposed to British Columbia, making adjustments for soil and climatic differences. Reliable estimates of growth response to a variety of silvicultural regimes would be needed to thoroughly appraise the viability of this investment scheme.

The earlier example suggested that the issue of commodity-grade Wood Units should provide \$104 (\$133 less \$29 H&M deposit) per 4 m³ of raw material pledged. A number of silvicultural treatments are inspected here for their growth response per \$104 invested. The appraisal is made using sample calculations based on 1985/86 provincial average costs (Appendix D.2), and yield estimates taken from published government sources (Appendix D.3). The examples are based on Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) management.

Table II
Four Yield Examples

(i) Backlog Reforestation

Cost^{2 1}: Plant (\$267 labour, \$200 seedlings), plus an average one and a half brushing and weedings (1.5 X \$375) = \$1030/ha.

Incremental Yield: 4.2 m³/ha/yr good site; 4.2 X 60%^{2 2} = 2.5 m³/ha/yr medium site.

Yield per Wood Unit = (\$104/\$1030) X 2.5 = .25 m³/ha/yr or 6.6 m³ in 25 years.

(ii) Rehabilitation

Cost: Salvage scrub and burn (\$300), prepare site (\$196), plant (\$467) = \$963/ha.

Incremental Yield: 5.8 m³/ha/yr good site; 5.8 X 60% = 3.5 m³/ha/yr medium site.

Yield per Wood Unit = (\$104/\$963) X 3.5 = .38 m³/ha/yr or 9.5 m³ in 25 years.

(iii) Conifer Release

Cost: Remove overtopping brush (\$435), spot plant (\$150) = \$585/ha.

Incremental Yield: 3.7 m³/ha/yr good site; 3.7 X 60% = 2.2 m³/ha/yr medium site.

Yield per Wood Unit = (\$104/\$585) X 2.2 = .39 m³/ha/yr or 9.8 m³ in 25 years.

(iv) Space and Fertilize^{2 3}

Cost: Space (\$575), fertilize (\$200) = \$775/ha.

Incremental Yield: 3.5 m³/ha/yr low site. (Douglas-fir SI = 21 meters at 50 years)

Yield per Wood Unit = (\$104/\$775) X 3.5 = .47 m³/ha/yr or 11.7 m³ in 25 years.

^{2 1} Average cost, British Columbia, 1985/86.

^{2 2} Figures in Appendix D.3 (good site) are reduced in examples (i), (ii), and (iii) by 40% to be indicative of medium site productivity. This is a generous reduction based on Ministry of Forests and Lands yield tables, which give top heights for coastal Douglas-fir at 50 years of age as: High site = 50 to 42 meters; Medium site = 42 to 30 meters.

^{2 3} The effects of fertilization taper off over time. This treatment however provides quality as well as volume increment, by concentrating growth on fewer stems of larger size.

These examples indicate that to the best of our current knowledge the pledge of 4 m³ may be matched with growth of from 6 m³ to 11 m³ on a medium Coastal site. These growth increments are in addition to the 8.9 m³/ha/yr or 220 m³ which would grow in an unmanaged stand. Growth rates in the central Interior (Prince George area) are less than on the Coast. The table at the end of Appendix D.3 suggests that natural growth in the Interior occurs at half the rate of the Coast. The Interior region is relatively flat compared to the mountainous Coast, however, and management is therefore less expensive on a per hectare basis. A comparison of the two regions should also consider the present value of expected lower harvest costs in the Interior.

The numbers in Table II have been verified with the Forest Service as being accurate and representative. Later examples in this thesis illustrate growth distribution assuming that there is a 50% chance of achieving a mean growth increment of 9 m³ in twenty five years or .36 m³/ha/yr, per Wood Unit of investment. This is a conservative figure for medium Coastal sites.

The Clearing House

The government would need to establish a body to administer its forest management activities under the investment program. This 'Clearing House' would maintain records of investments and monitor the corresponding Harvest and Mill Reserves and Standing Green Reserves. It would need to be aware of trends in product markets and forest growth response in order to balance new Wood Unit issues. It might also act as a market-maker for the listed Units. The Clearing House would necessarily act in close association with the Forest Service.

The Clearing House may prove to be the driving force behind whether investment funds are economically raised and efficiently spent. If structured as a private entity, profit motivations might stimulate efficient activity. Governments wish to maintain flexibility, however, and it is likely that the Clearing House would be a government agency or commission.

In order to provide checks, counsel, and democratic representation, it is recommended that the Clearing House be governed by a tribunal consisting of a representative elected by the Wood Unit holders, an appointment by government, and a forester representing Management Contract holders. The three would be employed full time managing the House; their salaries would most appropriately be paid by the organization whose interest they represent.

These interests would be different. For example, the investor representative may be interested in product quality and insurance reserves, and work against activities, such as over-issuance, which depress Wood Unit prices. The company tribune may be expected to promote efficient forest activities, such as herbicide use, to be watchful of the H&M Reserve account, and to argue against excessive brokerage commissions and social welfare expenditures. The government appointee would be most conscious of environmental and distributional considerations.

The Silviculture Fund

Revenue from the annual Wood Unit issue would be initially placed in a Silviculture Fund, from which it would be distributed over time to the land by the Clearing House. It should be emphasized that there is no urgency to this distribution; monies might be wisely held in the Fund for two or three years, earning interest, while investment projects are selected, people are trained, and a management infrastructure is set in place and tested. The benefits of taking a cautious approach should outweigh the two or three years worth of growth foregone.

Government Benefits

The government may expect a number of direct and indirect benefits from the proposed silvicultural investment scheme.

(a) Social:

- (i) Employment would be created (silviculture is very labour intensive).
- (ii) Implementation would employ legal, actuarial, computing, and professional forester services.
- (iii) Remote, economically depressed communities would benefit. They are generally located adjacent to the denuded forest lands requiring management.
- (iv) The improved raw material supply would provide industrial growth and security.
- (v) A healthy forest is a valuable strategic asset.

(b) Economic:

- (i) Stumpage receipts designed to replace the current 15% tariff on softwood lumber exports to the U.S. would remain in general revenues.
- (ii) Personal income taxes (with a 2.5 times multiplier) would recapture some of the investment.
- (iii) Corporate tax revenue may increase in the future.
- (iv) Timber growth which will bear stumpage in the future would be initiated.

CHAPTER FIVE

FOREST COMPANIES

The government of British Columbia relies heavily on forest companies to undertake the site-specific management required on their tenured lands.^{2 4} Management to date has been primarily financed through Section 88 'credits to stumpage' or direct Ministry contracts. This has resulted in the government developing a network of administrators and checkers, while the integrated companies and silvicultural contractors have developed technical expertise. A contribution of this expertise is essential to the implementation of the finance proposal described herein.

The government, as owner of the capital pool (Silviculture Fund), would need to create some incentives to attract entrepreneurial participation. The incentives should be designed so as to stimulate voluntary participation in an efficient manner. The incentives might provide corporate stability (through timber volume or price guarantees), and competitive opportunity (through the freedom to select alternate silvicultural regimes). They might be designed to promote efficient use of raw material supplies, and would necessarily promote the enhancement of those supplies. This section of the paper describes a method of corporate involvement in forest management modeled on an incentive basis.

Distribution of Silviculture Dollars

It would be desirable to place silvicultural investments into the most productive treatments and sites available, maximizing output per unit of input. Productive output from forest management is measured by both the volume and the quality of growth increment. Productive inputs are the area of land employed, dollars invested, and expertise contributed. A company wishing to attract silviculture

^{2 4} This reliance is to be continued, as evidenced by the creation, in 1986, of the first "Tree Farm Subsidiary Agreement". This agreement gives Crestbrook Forest Industries (TFL 14) the right to deal directly with all government Ministries. Replacing continual supervision, the agreement provides for a single annual audit of operations by the Forest Service, with cash or AAC penalties levied for poor performance.

dollars to its tenure would therefore need to demonstrate that its expertise, together with a specified quantity of dollars from the Fund, would produce a specified quality and volume of timber on a described area of land.

(a) Outputs: Quantity and Quality

An analysis comparing the historic prices of a range of Douglas-fir lumber grades is contained in Appendix F.1. The analysis shows that product prices tend to fluctuate together, and that the prices of superior products always exceed those of lower grade products. When lumber prices are proportionately grouped into log-sets representative of different levels of silvicultural management, it is found that prices form distinct bands relative to each other. A MEDIUM log set is defined as containing 70% dimension lumber and 30% higher grades. Average prices per cubic meter of other log sets relative to the MEDIUM (\$1.00) grade are: LOW (\$.70), HIGH (\$1.30), and PRUNED (\$1.70). It is also found that relative prices have been diverging in recent years, probably due to increasing scarcity of higher grade logs. In order to analyze the returns to different types of silvicultural management, these relative price levels, and price trends, would need to be recognized.

(b) Inputs: Land, Dollars, and Expertise

Land may be measured as to its area and calibrated as to its potential productivity in growing various tree species. The quantity of dollars available for forest management, and the cost (in terms of product pledge per dollar raised) would be known by government. The management input which is not explicitly quantifiable is the contribution of expertise by integrated companies and silvicultural contractors.

This expertise is a required component of the management plan. Some expertise may be purchased with dollars, by letting silvicultural contracts for bid. Other expertise may be attracted by an offer of a share of the growth it contributes to create. A choice between these two means of attracting participation

would be made with consideration to the present costs, ongoing responsibilities, and the desires and needs of the companies involved.

TFL's and FL's

There are two distinct types of major forest tenure in British Columbia.

A Tree Farm Licence (TFL) gives its holder the exclusive right to harvest timber from an area of land. Cutting plans and Management and Working Plans are developed on a five-year rotating basis. TFL's are for a period of twenty five years, replaceable in the tenth year with a new twenty five year licence. Most TFL's were replaced shortly after the new Forest Act was proclaimed in 1978, and are coming up for replacement in the next few years. Approximately 30% of British Columbia's timber harvest currently comes from TFL areas.

A Forest Licence (FL) gives its holder the right to cut a specified annual volume from within a Timber Supply Area (TSA). Several operators may be harvesting anywhere within the TSA at one time, although negotiations between companies have resulted in mutually agreed 'chart areas' being assigned to each. If timber growth in the TSA is seen to be less than the rate of harvest, the Allowable Annual Cut (AAC) of the TSA may be reduced by making proportionate reductions to the AAC of each operator in the TSA. An FL is granted for a period of fifteen years, replaceable after five years for an additional fifteen year period. Approximately 60% of British Columbia's harvest is cut under Forest Licences.

Forest companies may be expected to respond differently to intensive management funding, depending on whether their tenure is area or volume based. TFL holders would expect to harvest the resultant increment on their tenured lands. Forest Licence holders however have no assurance that the increment would be of benefit to themselves at harvest time. Their cutting rights may be granted elsewhere in the TSA while a competitor harvests the intensively managed stand.

Stumpage-Free Timber

Biological growth estimation is very imprecise. It is accurate enough to project a base growth level, needed to undertake the pledge to investors, but any prediction is bracketed by a wide range of best/worst case scenarios. For example, a certain treatment may be expected to produce 9 m³ in 25 years, but experience suggests that anywhere from 6 m³ to 14 m³ might actually result. The value of four cubic meters of this growth would be pledged to investors, the remainder would be available for the forest managers (government and companies) to share. There are three distinct ways in which the corporate share might be allocated:

(i) Ceiling: A company might be assigned a contract whereby all growth response in excess of a specified level is its to harvest free of stumpage payment. In the example a company may wish to specify all growth in excess of 10 m³. This type of 'ceiling' contract would provide incentive for use of management funds in such a way as to stretch volume production as much as possible above 10 m³, if stumpage prices are expected to be significant.

(ii) Window: A more conservative company may wish to specify stumpage-free growth in a certain range (eg: 8 m³ to 12 m³) and be willing to pay stumpage on the 4 m³ below and all growth above that range. This contract would have the effect of stimulating quality production; growth would be held near 12 m³ and higher value per cubic meter would be sought.

(iii) Percentage: Some companies may be willing to pay stumpage on all timber harvested in excess of the investor pledge, provided the stumpage charged is a fraction of the prevailing rate. To be roughly comparable with the contracts described above, the company might seek to pay future stumpage at only 40% of then-prevailing rates. The incentive to management of this type of contract would be a function of the magnitude of the perceived difference between expected stumpage rates and the expected actual value of the right to harvest (i.e. if stumpage rates collect full economic rent, the incentive would be minimized and

only the company's mill requirements would be considered; if stumpage rates are depressed, management would be intensified to produce more relatively low-rent timber).

These three types of contract might be mixed in many ways. The attractiveness of each to any one company would depend on that company's prediction of growth relative to the 'official' prediction accepted by government, through the Clearing House.

Management Contract: TFL

It is proposed that integrated forest companies with Tree Farm Licences be offered an opportunity to bid for Management Contracts on the following basis:

- (1) describe a forest stand or area of land within the TFL area,
- (2) describe the silvicultural activities intended to be undertaken on that area (this would be a tentative plan to final harvest),
- (3) quote the cost of this activity to the Silviculture Fund,
- (4) provide an outline of the growth response which the silviculture undertaken in the current period is expected to produce (this would be a comparison of expected yield curves of specified log quality for the managed and unmanaged stand),
- (5) based on (4), specify the Ceiling, Window, or Percentage of stumpage-free growth that is considered adequate compensation for undertaking the Management Contract,
- (6) provide a single figure quotation of the current cost of harvesting the timber from the site described, transporting it, and milling it into the products anticipated (this figure would determine the initial deposit to the Harvest and Mill Reserve),

(7) agree to maintain the Harvest and Mill Reserve at an adequate level once the initial deposit based on (6) has been made,

(8) agree to responsibly supervise and record the silvicultural activities which are undertaken (records might be kept private, but would be turned over to government if the company elected to default).

In return the company would receive:

(1) a significant share of the probable growth increment as a stumpage-free asset (when realized), and

(2) a government processing contract, to be paid at the rate of the deposit level in the H&M Reserve. This Reserve is largely under the company's influence.

Discussion of Bidding

On adjacent holdings on Vancouver Island, Macmillan Bloedel is currently managing its forests for maximum fibre production while B.C. Forest Products is performing silviculture directed at higher quality sawlog production. Funding for either type of management would be available through this 'bidding' system of distributing dollars from the Silviculture Fund.

Since dollars from the Fund are expected to be spent on physical land management, the forest company would itself pay the costs related to planning, supervising, and recording the silvicultural activities. Such costs would not be recognized in dollar terms; rather they would be compensated for with the Window, Ceiling, or Percentage of stumpage-free timber. The company would thus benefit directly from its expertise, as such expertise should produce a more efficient silvicultural organization (saving costs) and greater growth response (increasing benefits).

The company also faces costs with respect to maintaining the Harvest and Mill Reserve. While planning and supervision costs would be undertaken at the time

of initial investment, the H&M costs would be a series of small deposits (and occasional withdrawals) over the twenty five year period. The financial implications of this maintenance function are discussed in Appendix H. The discussion suggests that companies would view the maintenance cost as having a present value of \$46 per Wood Unit of investment. The effect of these costs may be reduced by considering H&M contributions as a business expense for tax purposes.

The reasons that companies should be responsible for maintaining the Harvest and Mill Reserve are twofold. First, once an initial deposit is made, the balance of the Wood Unit revenue would be spent on forest management. If further deposits were subsequently required they would need to come from the pockets of government. No provision has been made in this proposal for extra contributions from government.

Secondly, and more importantly, companies would be voluntarily reporting their current H&M costs. At the end of the Unit Rotation the level in the Reserve would be paid to the company to do the actual processing. There would be a natural tendency for these costs to be overstated, in order that the company be paid as much as possible for its processing service. This tendency would be countered somewhat by the requirement that companies pay the adjusted value of that overstatement. The tendency then would be to overstate the H&M costs initially, drawing a large contribution from the Wood Unit revenue, and then gradually 'become more efficient'. This ploy would be effective for the first few years of Wood Unit issuance, but as time goes by a balance between the tendency to report inflated costs (for new funding) and the tendency to report efficient costs (regarding maintenance of existing contracts) should develop a reasonable balance.

In the preceding chapter, 'Government', stumpage is defined as the difference between the cash price of maturing Wood Units and the cost of converting trees into products.

$$\text{Stumpage} = \text{CP} - \text{H\&M}$$

In order to minimize its future stumpage charges, there would be a strong incentive for the company to over-report its H&M costs. This would require larger interim contributions to the Reserve, but (i) those dollars would be paid back to the company at the twenty five year maturity, resulting in a profit of the difference between the real H&M cost and the quoted cost, and (ii) if $H\&M = CP$, stumpage payments on its entire harvest would be nil.^{2 5}

Another consideration respecting autonomous corporate forest management is that forests require protection from fire, insects and disease. Protection costs are minimized through conscientious management and early hazard detection. It is therefore essential that the forest company have an interest in protection, either through a share in costs or through a loss of its Ceiling or Window if that share of the timber growth is damaged.

There are some structural problems with this bidding system. Some readers might argue that it favours large companies in that their mills are more efficient and therefore their H&M costs might be quoted at a lower level. Others might point out that corporate managers eat lunch together, and the general bid level would reflect this fact. Also, 'bidding' suggests there would be losers as well as winners. This implies that some forest sites which might receive treatment under a geographic method of Fund distribution would be left untreated by the bidding method. If the bidding is effective, however, the neglected sites should mostly be those of low natural productive potential.

Appraisal of Bids

A tool was sought which would facilitate the comparison of varied silvicultural treatments, expected to produce either greater volumes or improved log quality, on a common basis. The current relative values of a representative range of

^{2 5} If $H\&M = CP$ the government would be able to draw the total investor return from the H&M Reserve.

log classes which might be produced are contained in Appendix F. It was felt early in this writing that a more detailed product comparison, along the lines of Appendix F, could form the basis for a 'Schedule of Product Equivalents'. This schedule, periodically updated by the Clearing House, would be used to appraise alternate silvicultural regimes. This method would however be administratively complicated.

Instead, the market price of the Wood Unit itself may be used as an indicator of value. Relative prices of different quality Wood Units would reflect both current cash prices and the market perception regarding future prices, all rolled into one price.

This thesis defines the 'Bud' of a Wood Unit as the difference between the issue price of the Wood Unit and the initial contribution to the H&M Reserve. This 'Bud' represents the net contribution to forest land management from the pledge of one Mbf of a specified quality of forest products. A Benefit/Cost (B/C) ratio comparing varied silvicultural regimes on an area of land may be constructed by relating the Bud value, and the expected volume increment, to the cost of initiating the regime required to produce the particular quality of product represented.

$$B/C = (Gr \text{ in } m^3) \times (Bud \text{ per } 4 m^3) / \text{Silvi Cost}$$

Examples of the calculation of this B/C ratio are contained in Appendix G.

Appraisal: The Distribution Template

The B/C ratio facilitates comparison of the total returns which may be expected from alternate silvicultural projects on a given forest site. A method of comparing stumpage-bearing volumes represented by competing corporate bids was also sought, in order that the net returns from candidate projects might be computed by government. This may be accomplished pictorially through an adaption of the P/L Diagram, as illustrated previously in Figure 4 (p.33).

The establishment of a Harvest and Mill Reserve eliminates future processing costs from the consideration of the distribution of future products created by the investment scheme. This serves to raise point B, with its set of radiating growth rays, to point A on the P/L Diagram. The amended diagram is here called a 'Distribution Template', illustrated in Figure 5.

In use, the 25 year growth increment anticipated for a candidate investment project would be sketched directly onto a Distribution Template. The location of this sketch would vary with the productivity of the particular forest site under consideration. The expected increment would likely cover a probability range rather than being a precise prediction. This range might be portrayed by a cumulative probability distribution, as illustrated in Figure 6.

The corporate Ceiling or Window bid associated with the Management Contract for the candidate project would then be drawn directly onto the prepared Distribution Template. Such completed Templates submitted by companies for competing projects on different forest sites might be compared on the basis of the magnitude of the stumpage-bearing timber volume segment, valued at the current 'Bud' value for the quality of fibre which the silviculture will produce. A completed Distribution Template is pictured in Figure 7, showing the apportionment of the expected increment to investors, government, and the forest company under a Ceiling bid of 9 m³ on a medium Coastal site.

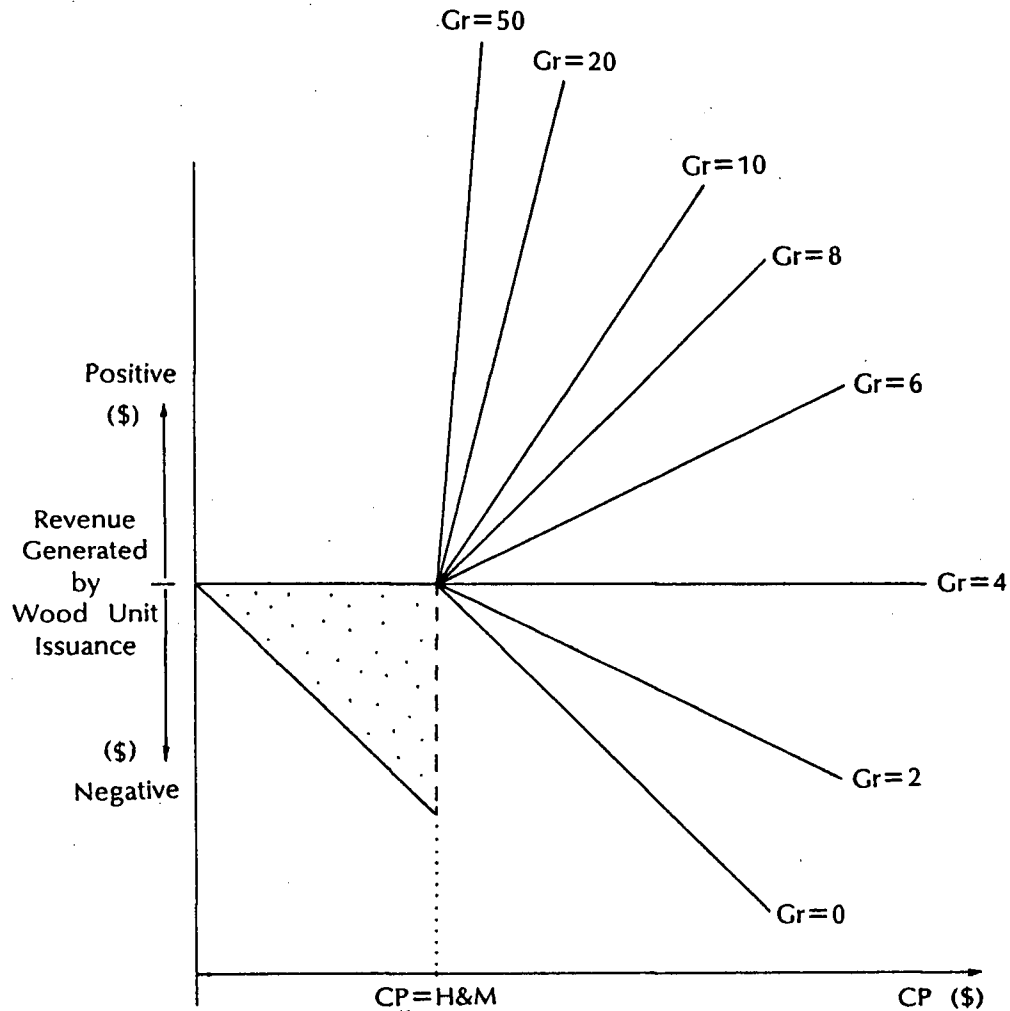
This completes the present discussion of TFL bidding.

Volume Based Licences: FL's

In public Timber Supply Areas (TSA's) outside TFL's, dollars from the Silviculture Fund would be distributed directly to the land by the government under lowest bid silvicultural contracts. The volume based licences prevalent in these areas do not permit the structuring of an incentive based on the realized productivity of particular sites. Licensees are presently awarded volume incentives (in the form of

FIGURE 5Distribution Template

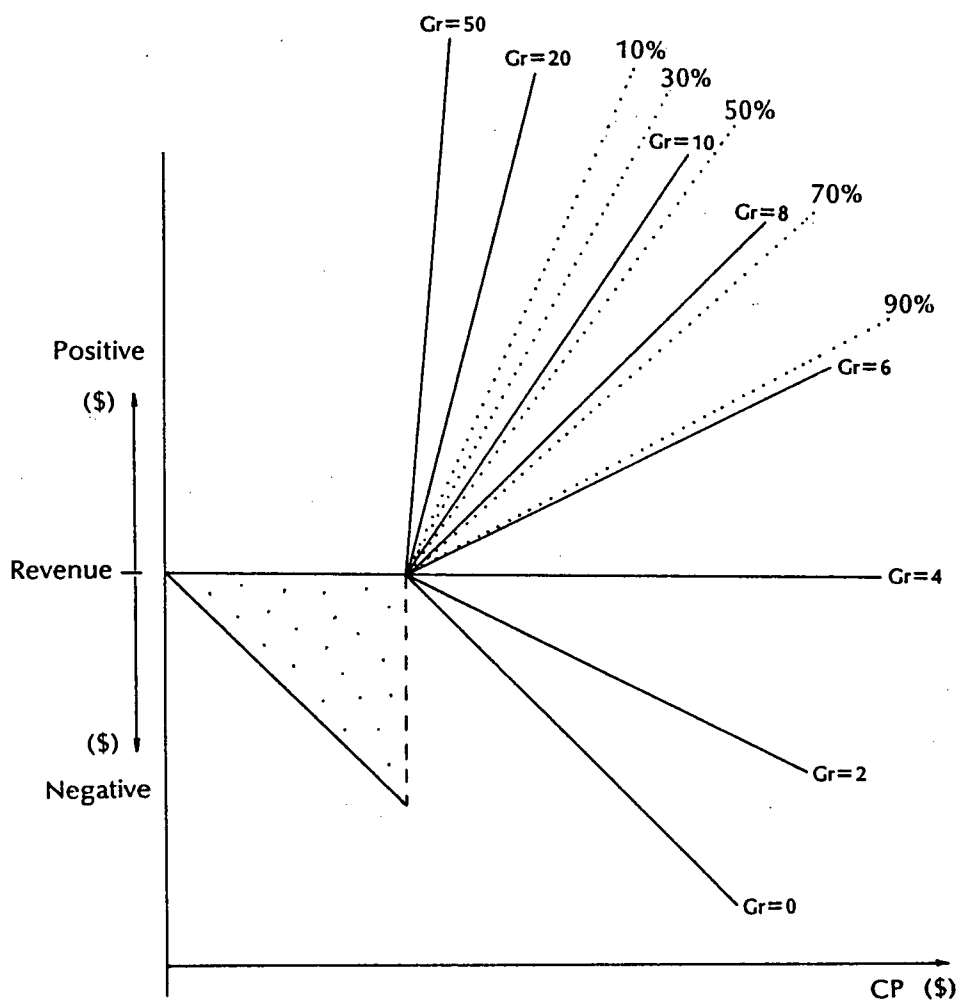
A tool for appraising forest company bids.



- the growth rays radiate from the point where $CP = H\&M$.
- the slope of each ray is $(Gr/4 - 1)$
- if $CP < H\&M$, harvest would not occur.
- the shaded quadrant represents the investor return being provided from the Harvest and Mill Reserve.

FIGURE 6Growth Probability Distribution

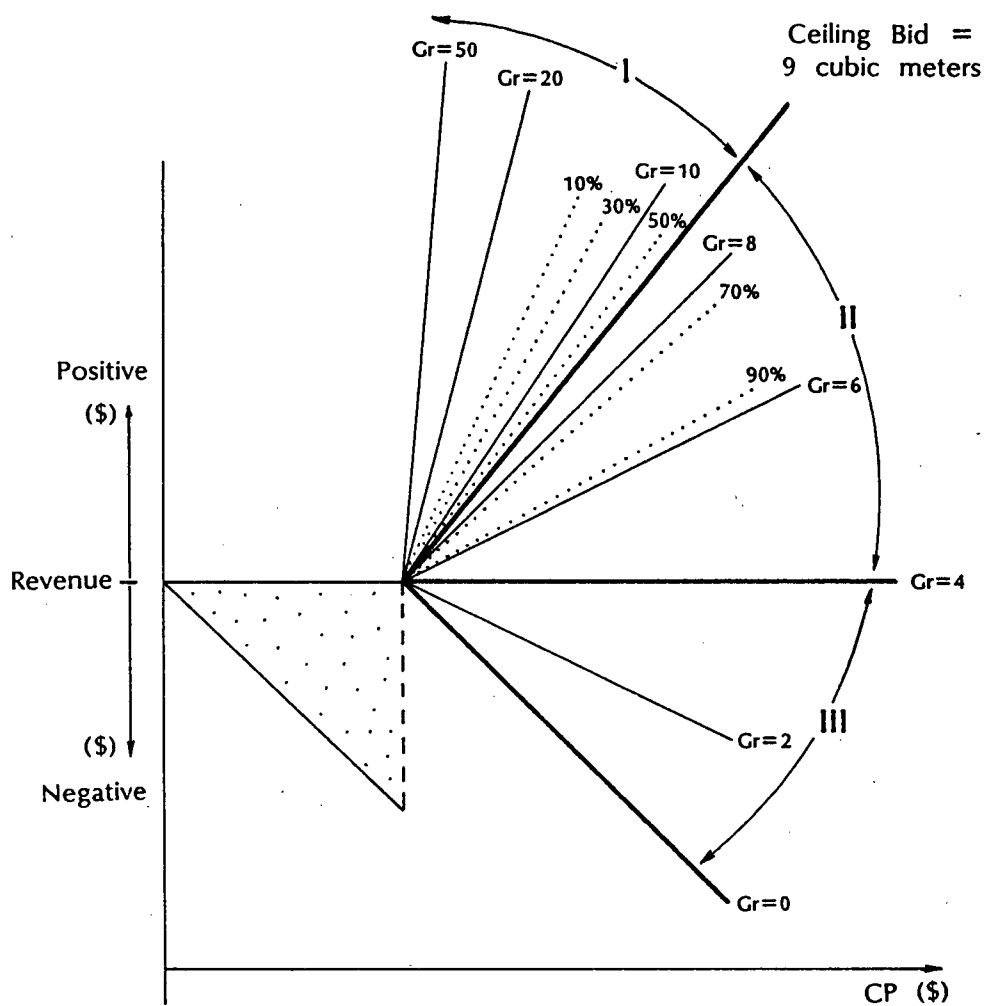
Illustrating a probability distribution of growth expectations from a specific treatment.



Percentages indicate the probability of achieving that growth level.

FIGURE 7Completed Distribution Template

Illustrating the distribution of growth expectations between government, investors, and the forest company.

Distribution:

- I : Stumpage-free timber
- II : Stumpage-bearing timber
- III : Pledged to investors

immediate increases to their AAC) for undertaking intensive silviculture, but the volume of timber to be cut under the incentives is specified by formula, not by actual stand response to the treatment undertaken.

Companies may presently earn the right to increased harvests under Section 52(a) of the Forest Act, but are expected to pay stumpage on this incentive timber as well as on timber harvested under their 'quota' of natural growth. Companies may have a stronger incentive to invest their own funds in intensive management if the rated volume increment which results is available for future harvest on a stumpage-free basis.

If Forest Licence based companies were granted stumpage-free volumes in return for management expenditures, three types of future timber volume would be harvested from Timber Supply Areas:

(a) The residual of 'nature's bounty', unmanaged natural growth harvested under the existing quota system at negotiated stumpage rates. Volumes of this type are expected to reduce steadily over time.

(b) Growth response due to investments from the Silviculture Fund. This timber would be sold competitively to the highest bidders.

(c) Growth response due to investments by individual companies. This timber would be assigned to the respective companies on a stumpage-free basis.

It may be expected that companies would exaggerate the estimates of volume response to be expected of their silvicultural activities, in order to maximize the volume of stumpage-free timber they are assigned. Within a TSA, the growth response per dollar (or per unit of work) of corporate activity would be equated with the response to Silviculture Fund investment, measured on a similar basis. Residual timber available (the difference between these two types of cut and the actual AAC of the TSA, as indicated by surveys and sample plots) would be the 'natural growth', distributed under the existing quota system.

This type of growth distribution presents several options to current operators in a TSA:

Option 1 Companies do no spending; all forest management is paid out of the Silviculture Fund. This would result over time in more and more of the TSA's timber supply being sold under competitive bidding.

Option 2 Companies rush into silviculture, spending generously; no investment would be needed from the Silviculture Fund. Over time this would result in most of the TSA cut being harvested stumpage-free, and the TSA would become a self sustaining forest production unit.

Option 3 A balance may develop between investment from the Silviculture Fund and spending by some companies. These companies would be accumulating rights to future stumpage-free timber while other companies would anticipate purchasing future supplies on the competitive market. The philosophy and price projections of individual companies would determine which stance they take.

This Forest Licence discussion is based on timber 'volume' only, no mention is made of timber 'quality'. This is because incentives are not tied to the specific sites where forest enhancement is undertaken. It is worth noting that current incentives, based on volume only, tend to favour high-volume, low-quality silvicultural activities.

Many Forest Licence holders are presently applying to convert their licences into area based Tree Farm Licences. This might be gradually accomplished by granting companies site-specific harvesting and management rights in return for silvicultural activities on those sites. A company would then be able to earn Tree Farm status by undertaking management, plus it would then be rewarded by the volume and quality responses to its activities.

To provide for physical risks, Standing Green Reserves would need to be located on a TSA basis, balanced at the Regional level. These reserves would be a

Crown asset, and are discussed in the chapter 'Government'.

Corporate Shareholders

In order for a corporation to justify management expenditures to its directors and shareholders, the resultant benefits should be quantifiable on its balance sheet. This quantification would be accomplished by performing periodic forest inventories and considering the corporate stumpage-free share of actual growth increment in light of the prevailing stumpage rate. This balance sheet entry would increase with accumulating growth, decrease with physical losses, and fluctuate with stumpage rates. It would be a real corporate asset whose value would be recognized in the market price of the shares of that corporation.

Corporate attempts to maximize this balance sheet entry should result in (i) productive silvicultural management, and (ii) an incentive to inflate current stumpage prices. Activity (ii) would be especially prevalent if the majority of the corporation's future timber supply was anticipated to be harvested on a stumpage-free basis.

Transfer of H&M Contracts

It is possible that the growth response to silvicultural activities may not meet even conservative expectations. In such a case the company holding a Management Contract would wish to walk away from its obligation, ceasing its maintenance of the Harvest and Mill Reserve. This eventuality might be provided for by a carrot and stick approach. The stick would be a loss of stumpage-free timber and the processing contract; the carrot would be the possibility of transferring the H&M maintenance duty, and corresponding government processing contract, to another forest products company.

The difficulty with such a transference is that the raw material would remain located on the tenured lands of the selling company. If the sale were accompanied by an assignment of the right to harvest a volume of timber from the seller's tenure area, transportation inefficiency would be created and existing tenure rights

would be violated. An alternative would be for the purchasing company to be granted rights to cut timber near its own mill, if that timber was available, while a stumpage differential was charged to the next timber cut by the selling company.

A different possibility would be for an individual shareholder of the forest company to be awarded an increased equity position in the company in return for undertaking the responsibility of maintaining the H&M obligation. This shareholder would likely wish the H&M costs to be stated as an average of prevailing rates, rather than continuing to be quoted by management of that particular company.

The discussion above assumes that the stumpage-free Ceiling or Window is inadequately filled with timber growth. This may be due to (i) mismanagement, (ii) initial over-estimation, (iii) catastrophic losses, or (iv) poor protection practices. Other than catastrophic losses, these causes would be principally due to corporate error, and the inadequacy would be a loss carried by that corporation. In the case of catastrophic loss, insurance might be provided by the federal level of government. In the case of all four losses the Standing Green Reserve would compensate the provincial government to the extent of its investor obligation. It is therefore clear that companies bidding for Management Contracts would incorporate a large 'buffer zone' in their Window or Ceiling bid.

Some companies may also wish to transfer H&M Contracts among themselves, in order to allow mills to specialize in certain quality Wood Units. A HIGH quality mill should be interested in purchasing the H&M rights to a distant stand if the mill's utilization capability is efficient by a factor greater than log transport costs.

Company Buys a Wood Unit

Companies holding Tree Farm Licences may wish to undertake silvicultural activity at their own expense. This would be accommodated by permitting a company to earn Wood Units by registering its silvicultural activity with the Clearing House.

The activity would be appraised for extent and intended products and divided by the going Wood Unit cost of performing that activity. A contractual deposit (no cash value) would parallel the ordinary H&M deposit, and the company would receive a government guaranteed pledge of 4 m³ stumpage-free timber, of the indicated quality, per Wood Unit valuation.

Alternatively, a company might nullify an existing H&M obligation by purchasing a Wood Unit in the market and turning it in for cancellation to government. It would receive in return a refund of the H&M deposit associated with that Wood Unit, and the 4 m³ represented would become a stumpage-free asset of the company.^{2 6}

Utility Aspect of Company Operations

This finance proposal, if implemented, would provide a measure of stability to forest company operations. Through the Management Contract, a portion of the company's manufacturing capacity would be booked (assigned guaranteed utilization) for a future period, permitting accurate, coincidental long term plans for timber supplies and processing facilities to be made. Through the process of being able to specify its own H&M costs the company is assured of adequate compensation. The right to benefit from extra value (unneeded residues, higher utilization, or higher product quality than required) might be an added attraction to the contract.

A company engaging Management Contracts on an annual basis would therefore be providing its future with a profitable, predictable stream of future capacity utilization. This would add a 'utility' component to operations, comparable with water and electrical utility companies which also make long term plans to supply a steady stream of product at 'cost plus profit'.

^{2 6} There is a conflict between this provision and the provision for government to use the H&M funds for market purchases of Wood Units if $CP < H\&M$ (ie. if stumpage is zero or negative) or if the company defaults on its Management Contract. Under such purchases the stumpage value of the 4 m³ would become a government asset.

The company would also be acting as the spending arm of a large silvicultural enterprise, undertaking a steady stream of forestry activity which might be profitably managed. Growth, partially a company asset, would begin accumulating once the activity is undertaken. These factors would tend to stabilize corporate performance from year to year. The company would thus be viewed as more conservative by the investment community, with a resultant effect on debenture yields and stock prices.

Individuals and Contractors

Individual silvicultural contractors might be offered a performance incentive through an equity participation in the stands they treat (perhaps a small percentage Ceiling). This type of incentive may be particularly effective for spacing and pruning contracts, stimulating careful selection of trees left living and careful removal of trees which are harvested.

The record keeping involved would be horrendous, however. It might be simplified by apportioning equity according to a single audit ten years after the activity was undertaken, the interim equity possibility being represented by a site-specific warrant. If the warrants were transferable, contractors would not need to wait the ten years to realize a benefit from excellent work. It should evolve that contractors who perform well would develop a reputation and be able to sell their warrants for premium prices.

CHAPTER SIX

DISCUSSION

Much of the primary research for this paper was in the form of personal interviews with people in the forest industry, the investment business, and in government. This section presents some of their concerns and observations, many of which have been incorporated in the body of the thesis.

Recent Policy Changes

Several people have asked how the recent (Parker, 1987) changes in provincial forest policy would effect this proposal. Three aspects of the new policy are relevant.

(1) Forest companies will in future rejuvenate to a satisfactory level, at their own expense, forest land which has been harvested. This is of some concern, as the targets of cost minimization and legislated stocking will not tend to initiate timber stands suitable for profitable subsequent management. The species mixture and early growth experience of forest stands largely determine their subsequent productivity.

(2) Stumpage and royalty rates have tripled. This is a fine development; it makes the offer of stumpage-free timber much more attractive.

(3) Forest Licensees will be offered a means to convert their tenures to Tree Farm status. These conversions will not necessarily proceed, as the new policy altered many tenure characteristics for TFL's, all in a negative direction.

The Tree Farm Licence is the preferred tenure type under this proposal. Area based, it permits stand specific incentives to be awarded to the managing company. These incentives are needed to stimulate quality log production and good protection practices.

Political Feasibility

Several points rose in discussion with the Ministry of Forests early in the development of this concept:

(1) The government made it very clear that it does not wish to become involved in product manufacturing.

(2) The government recognized that the Forest Act contains no provision allowing it to make the undertaking that would be required to back the Wood Unit securities.

(3) The government worried that any incremental timber which might result from intensive silviculture may be required to offset anticipated wood supply deficits. The incremental wood may be required to maintain the allowable cuts of existing licensees.

A resolution of each of these points would be necessary before this finance proposal is implementable. Each point requires agreement between the forest industry and government. The implementation of this proposal therefore hinges on the small 'p' politics between those two parties.

The two senior levels of government have been brought together recently on forestry matters by the FRDA program and the softwood lumber countervail duty case. Since many of the benefits (reduced UIC payments, increased income tax receipts) of the financing scheme would flow to the federal level, it may be expected that that level of government would provide financial assistance to implementing the scheme. This might be in the area of silvicultural research, or funding for the computer facilities which would be required to maintain records and process growth and yield data. The federal government might also contribute favourable rulings regarding the tax treatment of investor and forest company contributions to the program.

Price Risk

Recent correspondence from the Minister of Finance expressed the opinion that this proposed method of financing silviculture is too risky for government. In particular, government worries about the 'open-ended liability' of pledging the future value of forest products, without knowledge of what future prices will be.

This expressed concern ignores the growth response which the investment would create. If future prices are high, representing a large liability, the value of the corresponding inventory asset should also be high. To implement this proposal people in finance will need to be convinced that trees grow, that the silvicultural investment would serve to increase production from the existing land asset at a minimal direct cost to government, and that the risk/return ratio to government is actually lower under this proposal than under the present method of direct government expenditure for forest management.

Contractual Risk

At several meetings questioners have noted that stumpage rates in British Columbia are very low. If this is the case at maturity, most of the Wood Unit's value would come from the Harvest and Mill Reserve. Since this Reserve is established with only a quarter of the funds from Wood Unit issuance, these questioners often express a desire to invest in the Reserve rather than the Units.

The large apparent return to the H&M Reserve is due to interim contributions from forest companies. If these payments are not made the company would forfeit its Management Contract. To the company, contract default would mean:

- (1) a loss of stumpage-free timber (the whole timber increment would become stumpage-bearing), and
- (2) a loss of the processing contract (it would be sold to another party or be held by government).

If the net value to the company of (1) plus (2) above is less than the cost of maintaining the H&M Reserve, the company may at any time default. Since the company originally entered the Management Contract of its own volition, the default would be due to environmental change, principally either: (i) low forest product prices, which make operations un-economic, or (ii) poor growth response of the invested stand.

(i) Low Prices

In the case of low and expected continued low forest product prices, when the annual deposit would be most difficult to make and default likely, the market price of the Wood Unit would also be low. The maximum cost to government of the defaulted contract would be the difference between the Wood Unit market price and the existing deposit level in the Harvest and Mill Reserve. By paying this difference, the government may cancel both contracts. In doing so it re-purchases the full stumpage value of the stands under consideration.

If prices are low, say \$200 per Mbf, and expected to show no real gains in the future, the Wood Unit price would be:

$$\$200 \text{ compounded at } 5\% = \$677.$$

$$\$677 \text{ discounted at } 9\% = \$79$$

A Management Contract defaulted in this example immediately after issuance would therefore cost government $\$79 - \$29 = \$50$, and recapture the full future stumpage value of \$104 worth of recent investment. Over time, as long as the Management Contract is not in default, the deposit level in the Harvest and Mill Reserve would be growing, reducing the gap between bankruptcy price levels and the insurance level per Wood Unit.

(ii) Poor Growth

In the case of default due to poor growth response, timber supplies would be drawn when needed from the Standing Green Reserves. The cost to government

of the company's default would be the difference between the deposit level in the H&M Reserve and the cost of processing replacement timber. Or, as in the low-price default, the gap between the H&M deposit level and the Wood Unit price might be paid, cancelling both contracts and leaving the S. G. Reserve intact.

At any time after the silvicultural investment has been made there would exist a deposit in the Harvest and Mill Reserve, a growing timber increment, and a cash price for products. The relative magnitudes of these three variables would determine the limit to the government's financial risk, and determine the most appropriate choice of action in case of forest company default.

Yield to Maturity

The data in Appendix A illustrates that investors would purchase the Wood Units at a discount of approximately 50% from cash prices. The paper from which that conclusion is drawn was distributed to five different forest economists (three in the U.S.). A few criticized fine points of the analysis, but all agreed that the results are valid and believable. That paper also formed the basis of three seminars -- one at UBC, one before government, and one at the 1987 Western Forest Economists meeting. Each seminar resulted in positive feedback and enthusiastic queries as to how the findings might be beneficially employed.

To check whether this yield would be accepted in the marketplace, the concept was discussed with a pension fund manager in Vancouver who administers \$3 billion of assets. He is a hands-on trader who believes that his personal skill will produce an optimal return in any given year, and enjoys price volatility. He agreed that the Wood Unit should be attractive at a real return of approximately 3%. He also pointed out that the diversifying aspect of potential investments arises two or three times per week in board meetings.

Letters from two Americans, who each manage large timberland investment syndicates for pension funds, expressed positive feelings regarding the Wood Unit

certificate. In particular they noted that the Wood Unit represents an investment in wood only, not in land. They expect the price of wood to appreciate more rapidly than the price of land, and therefore expect the certificate to be attractive to the market at a lower rate of return than a timberland investment opportunity would be.

Marketability

There are a number of considerations, beyond simply the 'rate of return', to marketing the Wood Unit. The prime consideration is the public's lack of knowledge and understanding of timber investments, and the lack of a track record of their performance. It has been pointed out by several correspondents that this lack of knowledge may result in a hard sell. With reference to this subject several specific comments have arisen:

(1) The analysis in Appendix A would not sell the certificate. Instead, a clear description of what asset is represented, and why it would be attractive, should be packaged to fit in the first three or four paragraphs of an offering prospectus.

(2) A prospective purchaser would want an estimate of the expected value of his asset in 10, 15, or 20 years both in real and nominal dollars, under various growth and price assumptions. These projections might be compared to a 'hurdle rate', with an estimation of the probabilities of reaching or exceeding that hurdle rate.

(3) Investors may require a guaranteed price floor for their investment, a cash limit to their possible losses. Also they may want assurance that the certificates will require a premium to be paid if the government wishes to retract (buy-back) in the first five years after issuance.

(4) Stock Exchange prices of real asset proxies frequently diverge from underlying values; most closed end investment funds sell at a discount to book value. The original issue price must offer the first owner compensation for this

secondary market risk.

(5) Stock Exchange liquidity is created through the participation of market makers, hedgers and speculators. One respondent pointed out that the attraction of market makers may be expensive for government. Market makers are attracted by being offered a call on a block of stock, or by receiving a commission.

(6) The pension fund manager described earlier thought that the Wood Unit would be quite volatile once it was listed for trading, and relished the thought. This volatility would attract speculators, creating liquidity.

(7) There is a niche in the capital market for an inflation-indexed bond, but none exist. The Wood Unit might fill that niche.

(8) In planning issuance, the investment public would need to be educated to the point where a threshold minimum of investment could be raised. This minimum would be in excess of \$100 million.

Silvicultural Yield

All interviews with people in the forest industry required clarification that the return to investors would come from the increment created by intensive management, not from the entire growth of the forest. The subsequent discussion of how to measure the increment (volume vs. value) and how to apportion it to various treatments always spurred skeptical comment. There is very little publically available data regarding growth response to a range of species, sites, and treatments in British Columbia. Data would need to be adapted from European and U.S. trials, and contributed by private industry. Under the FRDA program a wide range of data collection is being initiated, but complete results from these trials will not be available for many years.

The pessimistic attitude of most correspondents regarding this aspect was quite disheartening. Instead of pointing to individual threads which might be woven

into a simple framework, however sketchy, their opinion was that here the proposal faced an insurmountable wall. The attitude of this writer is quite different. While specific, experimentally verified growth responses for all species and treatments is unavailable, it is felt that an aggregation of the experience of British Columbia's foresters would produce a very reasonable framework with which the financing scheme could be implemented. This framework needs to be strong enough to give the government confidence that growth response will be adequate to provide the investor return. The plan can then be implemented, with more accurate and specific data being collected along the way.

Most respondents felt that private forest companies have reasonable estimates of growth response on lands within their tenure jurisdictions. The design of the government/company liason should exploit this knowledge, by providing an incentive to the company to either share its actual data or to indicate the gross growth potential of different levels of silvicultural investment. The bidding process outlined in the chapter 'Forest Companies' is one way this incentive may be created.

Experimental Controls

Several foresters have worried about the logistics of establishing rigorous experimental controls (untreated areas) for every silvicultural treatment undertaken. Such a network would not be required.

Control blocks may be established for research purposes. These would remain part of the silvicultural unit; their expected production shortfall might be recognized by a proportionate reduction in unit silvicultural value. The controls would not determine the growth increment due to treatment, however. Instead, the distribution of future timber would be based on a written description, made when the treatment is undertaken, of the expected growth of the untreated stand. (This is a form of control in itself).

Inventory Structure

Several correspondents have pointed out that a majority of the silvicultural opportunities in British Columbia are respecting young stands which will not reach harvest age within twenty five years. Revenues to repay current investors would therefore need to be drawn from existing mature, untreated timber stands.

A means of partially diffusing the impediment to issuance created by the present imbalanced inventory structure may be to tentatively provide for a roll-over provision at the end of a Unit Rotation, whereby maturing portfolio holdings may be replaced with a fresh Wood Unit issue, representing a subsequent twenty five year period. Several Unit Rotations would be required for British Columbia's existing forest to be balanced. Once this occurs, the number of Wood Units retired in any given year should correspond to the harvest rate in that year.

Stumpage-Free Timber

People in the forest industry find the offer of stumpage-free timber an attractive proposition. They worry however about the tax treatment of such an asset. In particular, they worry about the taxation of valuation write-ups recorded as the book value of accumulated volumes are periodically adjusted to match rising product prices.

Some forest companies presently hold rights to stumpage-free timber through Timber Licences (Old Temporary Tenures). Timber harvested under these licences is charged royalty at fixed rates specified in Schedule A of the Forest Act instead of being charged stumpage. The value of such timber rights is not presently included on corporate balance sheets, although it may be reflected in share prices.

A resolution of the accounting and tax considerations associated with a pledge of stumpage-free timber is beyond the expertise of this writer. These matters would however need to be explicitly addressed, and described in firm contractual arrangements, before forest companies would participate in the investment scheme.

Tenure Security

The discussion in this thesis assumes that existing forest tenures are secure contracts, as described in Sections 9 to 44 of the Forest Act. Many correspondents from industry expressed a contrary opinion, often citing unresolved Indian Claims or the recent establishment of a park on South Moresby Island as examples. Many feel bitter and helpless in the face of increasing pressures to use forest land for purposes other than commercial timber production.

The Wood Unit may aid in the resolution of some land use conflicts, by acting as a tool which quantifies the value of the productive capacity of specific forest sites. The productivity of a site, expressed in terms of the market-determined Wood Unit price, might be quoted as the true opportunity cost of removing land from commercial production. This technique would especially serve to protect rich, fertile sites.

Perceived tenure security will influence a company's willingness to contribute to the investment scheme. The company may ask whether its stumpage-free rights would be affected by a reduction in its AAC, and in what order of priority the three thirds of the incremental growth would be processed. 'Trust and security' would be provided by enforceable contracts which address these points.

Legal Aspects

(a) Forest Management: Present tenure arrangements in British Columbia grant forest companies the exclusive right to cut over an area of land (Tree Farm Licence) or the right to cut a specific annual harvest within a timber supply area (Forest Licence). Many correspondents needed to be reminded that the right to cut does not necessarily imply ownership. The forest company does not actually own the wood until the logs have been scaled and the assessed stumpage paid. This distinction is important, since it gives the government, which owns all growing stock on Crown land, the ability to dispose of some of that stock's value to investors,

and the ability to firmly negotiate future charges, returns, and benefits with each forest company.

(b) Stock Exchange: Communication with the Manager of Listings at the Vancouver Stock Exchange, and with the Chairman of the B.C. Securities Commission, has indicated support for the scheme if the other participants favor it. The Vancouver Stock Exchange presently only trades shares, limited partnership units, and certain established commodity and equity options. New legislation would be required in order to list the Wood Unit.

Applicability to Private Land

A number of correspondents from industry and government have suggested that this scheme be adapted and sold to raise investment capital for the management of private forest land. One forestry consultant pointed out that firm contracts could be made with private landowners, and that the obligations they undertook could be registered against the land title. He contrasted this with the impossibility of registering a lien against Crown land, and his general perception of a poor track record of government in keeping contracts made with industry.

The investigation has not been diverted to consider financing forestry on private land for a number of reasons.

(1) The object of this investigation was to facilitate forest enhancement on a large scale. Crown land comprises 95% of British Columbia's forest land base.

(2) Investors on private land would purchase a different type of contract than the Wood Unit. They would likely be offered the opportunity to participate in actual growth, by means of a share in stumpage value. The contract would therefore be site specific, and involve the investor in the fire and pest risks of forest management.

(3) The investor would desire a higher return from his participation on private land, for two reasons. One would be to cover his higher risk due to participation in physical losses. The other reason is that private obligations are considered by the market to be somewhat less secure than government obligations.

A study by Sterling Wood (1983) investigated private timberland investment, with the objective of attracting pension funds to Vancouver Island. Although the report was favorable, the proposed investment project has not been initiated.

Private forest landowners might be able to benefit from this proposal, however. A provincial program offering standing timber insurance at reasonable prices might be developed, hedging private risks against the proposed Standing Green Reserves.

Comparison with Mining

In discussing the sale of timber equity, several correspondents pointed out that mining ventures sometimes offer a mineral (silver, gold, or oil) backing to debentures issued to raise capital for facilities construction. The backing is generally stated as a weight or volume of mineral sufficient at current market prices to offset the dollar obligation of the debenture. The contract often allows for the quantity of mineral represented to be adjusted if mineral prices change.

The method of financing described in this paper is quite different. The miner pledges a fraction of his proven, fixed ore body in return for the capital required to access the body. By contrast, trees grow. The forester is dealing with a rate of increase over time rather than with a finite, existing resource. The dollars raised through Wood Unit issuance would be used to establish or direct a procession of time. Rather than pledging an existing asset, the forester would be pledging a share in the benefits of employing his soil, moisture, and climatic resource. The debenture holder's confidence would therefore be placed in management expertise rather than in a physically existing commodity.

Limit to Issuance

Only two correspondents raised a point which has caused this writer much trepidation. The point is that there is no market-determined limit to the quantity of Wood Units which might be sold. Theoretically, an upper limit would be the entire enhanced growth potential of British Columbia.

One limit might be imposed by the availability of Standing Green Reserves. Each block of Wood Unit issuance should be matched by the establishment of a prorated S.G. Reserve area. Once a significant portion of the available mature inventory was placed in Reserves, Wood Unit issuance might slow. An ambitious issuer might however avoid this limitation by decreasing the percentage of Standing Green Reserve needed per Wood Unit issued.

Another limit might be reached through the company bidding process. As investment accumulates, high yield sites suitable for treatment would become scarce, and the Window or Ceiling bid would become an ever-larger share of total growth. In the initial stages of over-issuance this would result in bids being accepted which partially encompassed the 'natural growth', later the entire natural growth would be included in the Ceiling, and finally the Standing Green Reserves themselves might be intentionally sold, with a twenty five year lead time, by an irresponsible issuer.

An alternative to these natural limits to issuance would be to place a legislative limit, perhaps stated as a percentage of the provincial AAC. The problems with this are twofold: (i) the irresponsible issuer would likely also be overcutting the forest, and (ii) legislated limits may be easily, gradually modified.

The limit to issuance should be fully, publicly debated before this finance proposal is implemented.

CHAPTER SEVEN

CONCLUSION

This thesis has illustrated how the sale of Wood Units to investors on a Unit Rotation (25 year) basis might raise forest management capital for government. The implications to government of such a sale were analyzed through use of the P/L Diagram. It was noted that Harvest and Mill Reserves and Standing Green Reserves should be established to cover government risks under the financing plan. The thesis described how government might appraise alternative forest management activities by using a Benefit/Cost ratio based on the market price of the Wood Unit.

A Management Contract was described which provided for forest company supervision of silvicultural activities and maintenance of the Harvest and Mill Reserve. It was proposed that in return for the contract companies would receive silvicultural funding for their tenured lands, plus a Ceiling or Window of stumpage-free timber. A bidding process based on this exchange was described, as was a means of comparing bids through the use of a Distribution Template.

Implications

Today, an issue of 5 million Wood Units, representing a pledge to deliver the value of 20 million cubic meters in 25 years, should raise \$665 million (\$133/Mbf, commodity quality product represented) to \$1.1 billion (\$220/Mbf, premium quality product represented). A deposit of one quarter of this capital into the Harvest and Mill Reserve would leave a net contribution to forest management of from \$500 million to \$800 million. These figures bracket Walters (1984) estimate of the funding level required to fully manage the Crown's best forest land on an intensive basis.

The pledge of 20 million cubic meters represents a volume slightly less than 30% of the current annual harvest from Crown land. Readers should recall that in order to facilitate this proposal it would be necessary to grant stumpage-free timber

rights to forest management companies. Those rights might represent another 20% of the current harvest volume, plus cover a portion of increased rates of harvest due to future forest productivity being greater than it is presently.

Together, these figures represent 50% of the current volume of stumpage-bearing timber harvested from Crown land. Distribution of this equity share in future timber, by the means outlined in this proposal, would provide \$500 to \$800 million annually for silvicultural activity, plus provide for conscientious supervision of the forest management undertaken.

British Columbia's land base is adequate for the scale of the investment project envisioned. A minimum Wood Unit issue of \$100 to \$200 million would be necessary to ensure market liquidity. If \$200 million were raised, \$50 million would be placed in the Harvest and Mill Reserve and \$150 million would go into forest management. At \$1000 per hectare, this capital would treat 150,000 hectares. The current non-productive backlog of good and medium forest sites in British Columbia is 2.9 million hectares. Treating 150,000 hectares per year, this backlog would require twenty years to address. Meanwhile, there are many currently productive forest sites where growth might be enhanced, and logging activity releases more land each year.

Viability

Some comment should be made regarding the likelihood that this proposal will be implemented. There are reasons to believe it may go no farther than this thesis.

(1) The government has indicated that it views equity financing for forestry as too risky a proposition. This view has been formed from a cursory inspection of the concept, however, and may be modified once this document has been circulated and analyzed.

(2) Forest companies may resist the proposal, hoping that once government tires of its recent wave of forestry spending it will consider tenure security, through land privatization, as a viable alternative. Private land would allow companies to reap

the benefits of natural growth in addition to the growth due to expertise. Investment would however still be required in this case.

(3) The existing forest resource in British Columbia largely consists of an inventory of mature timber, plus areas of recently regenerated or unproductive forest land. There is relatively little land carrying stock suitable for silvicultural treatment which would be ready for harvest in twenty five years, when the returns from current Wood Unit issuance would be due.

(4) The transaction costs of issuing the Wood Unit securities have not been explicitly addressed in this thesis; it is assumed they would be approximately 3% to 5% of the revenue raised. These costs might turn out to be much higher, creating an economic impediment to implementation.

There are, however, reasons to believe this proposal may be seriously considered. The forest land of British Columbia has been neglected for years and is presently in a state which would respond well to the investment. The people of British Columbia would also respond well to the investment. No individual with whom this concept was discussed has been exposed to its entirety, and none yet have been convinced that it is workable, but every individual, to varying degrees, has expressed the sentiment that they wished or hoped it would work.

The implementation of this proposal would require new laws to be written, new types of contracts to be struck between government and industry, and an entirely new financial instrument (neither a commodity future nor a bond) to be sold to investors. It would require precise forest records to be kept, and should result in the accumulation of detailed knowledge regarding site and species potentials and silvicultural treatment responses. The expense of this knowledge accumulation, and the bother to operational foresters, should be offset by the ability of future generations to use the knowledge to manage the forest in a productive and cost-effective manner.

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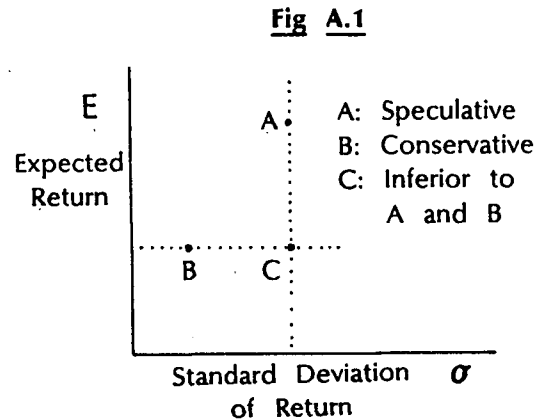
APPENDICES

APPENDIX A

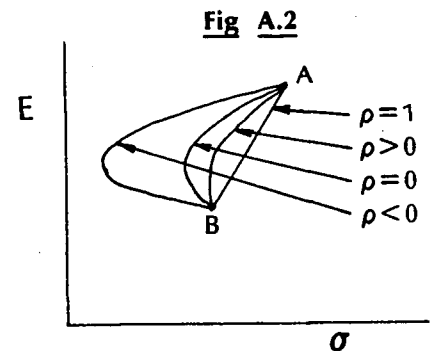
Portfolio Analysis

Theory¹

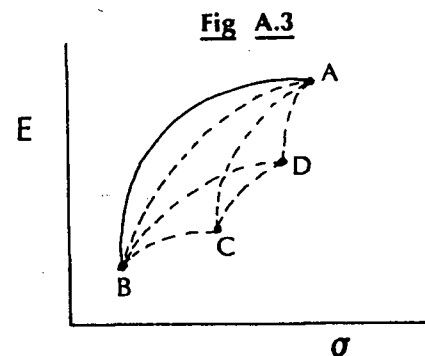
(1) Investors inspect two aspects of a security when considering its purchase: (1) they want a high return, and (2) they want the return to be stable, not risky. The tradeoff between return and risk may be expressed in a two dimensional diagram (Fig A.1) relating the expected return (E) to the standard deviation of return (σ).



(2) When securities are combined into portfolios, the E of the portfolio is the weighted average of the returns to the individual securities, but the σ of the portfolio depends on the correlation (ρ) between the returns to the individual securities. Securities with low or negative correlation (Fig A.2) may produce a portfolio with a lower σ than each individual security.



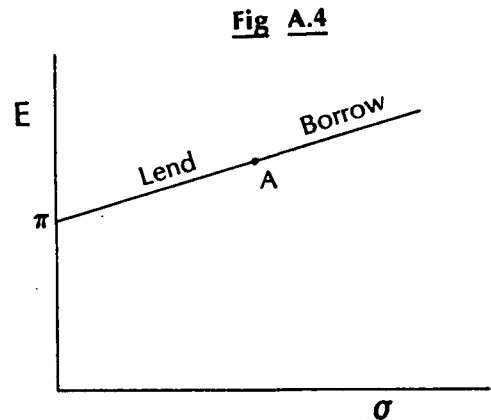
(3) When all securities available in the market are combined in all possible combinations, the upper left boundary indicated on the E - σ diagram represents the best possible portfolio combinations available in the market, as illustrated in Fig A.3. This boundary may be determined for a given set of assets with mathematical algorithms².



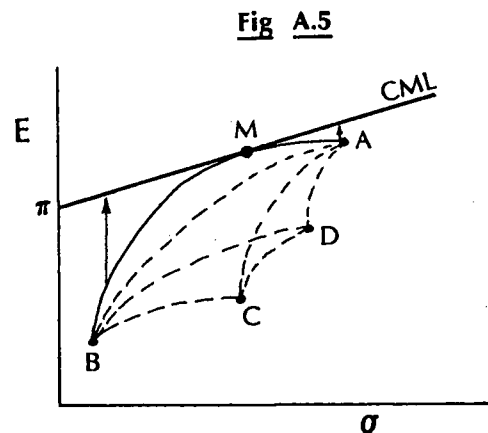
¹For a full exposition of portfolio theory the reader is referred to Sharpe, 1970.

²For a published example see Levy and Sarnat (1984).

(4) If the concept of a risk-free rate (π) of borrowing or lending is combined with the possibility of investing in a particular security (A in Fig A.4), the investor may position himself anywhere on a ray extending from the point $E=\pi$, $\sigma=0$ through the locus of that security on the E, σ diagram by either lending some of his investable funds at π or by borrowing at π to purchase more A.

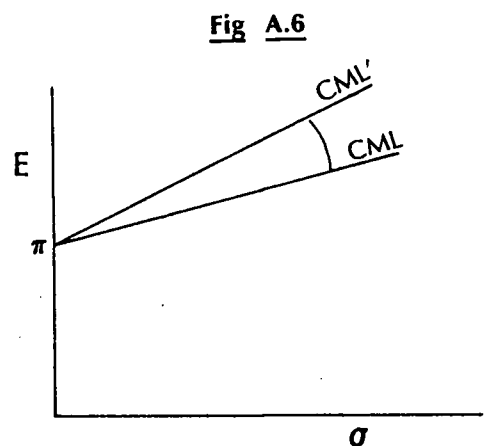


(5) When the risk-free rate from Fig A.4 is combined with the portfolio possibilities curve shown in Fig A.3, one optimal point (M) is indicated on that curve (see Fig A.5). All other points are dominated by M combined with lending or borrowing possibilities.



For empirical analysis, M is generally taken to be the Standard and Poor Index (S&P) and π is the return to long term government bonds. The ray shown in Fig A.5 from π through M is called the Capital Market Line (CML) and represents the best possible opportunities available in the market.

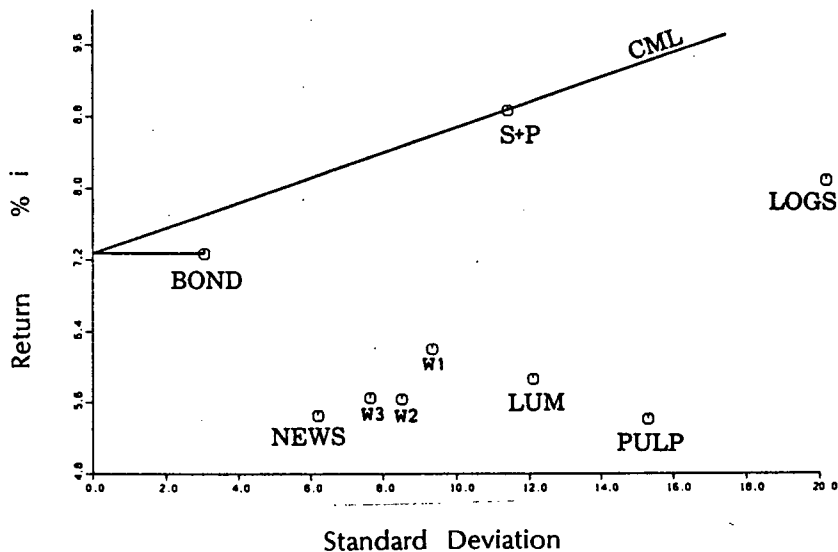
(6) When a new security is introduced to the market it will attract investment from existing holdings if it offers the opportunity to create a portfolio which locates above (or lifts) the CML in $E-\sigma$ space by an amount greater than the transaction costs of switching assets to the new security. 'Lift' is pictured in Fig A.6.



Empirical Analysis

In order to inspect the attractiveness of the Wood Unit to investors, the prices of logs, lumber, pulp, newsprint, the S&P index, and long term government bonds were collected for the 25 year period 1959 to 1984. All prices are in U.S. dollars. Annual returns were calculated as the percentage price gain from year to year, with dividends added to the S&P return. The resulting data was analyzed using the SHAZAM econometrics computer program (White, 1978), and the results plotted on an E- σ diagram (Fig A.7).

Fig A.7
Average Returns and Standard Deviation of Returns
1960 - 1984: U.S. Dollars
 Plotted on an E- σ Diagram



On Fig A.7, the location of each security is comprised of the security's average return during the period studied (vertical axis) plotted against the volatility of its return (horizontal axis). For example, log prices rose more rapidly and were more volatile than lumber prices during the period. Returns were calculated on the basis of average annual price; the standard deviations would be larger for all securities on a monthly or daily basis.

A number of hypothetical Wood Units were created as follows:

$$W1 = 25\% \text{ LOGS} + 25\% \text{ LUM} + 25\% \text{ PULP} + 25\% \text{ NEWS}$$

$$W2 = 50\% \text{ LUM} + 50\% \text{ PULP}$$

$$W3 = 50\% \text{ LUM} + 35\% \text{ PULP} + 15\% \text{ NEWS}$$

and the locii of the portfolio possibilities combining each Wood Unit with the S&P were computed and plotted on the E- σ diagram. The convexity of the resulting curves is due to the negative correlation between fluctuations in wood prices and fluctuations in stock market prices.

Fig A.8

W1, W1 + 2%

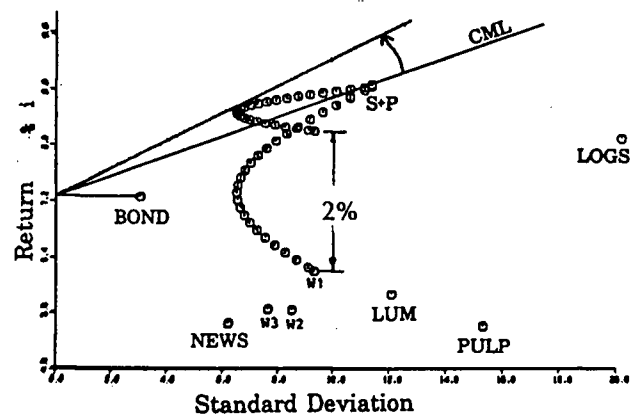


Fig A.9

W2, W2 + 2.5%

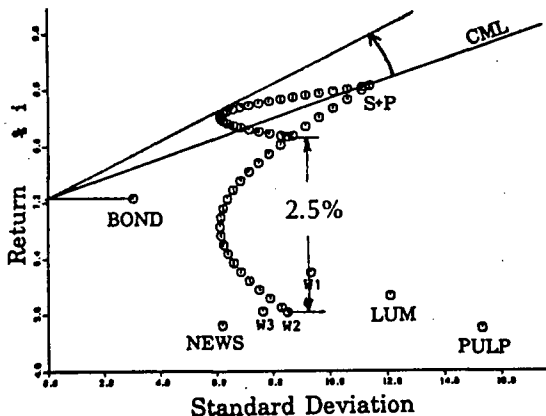
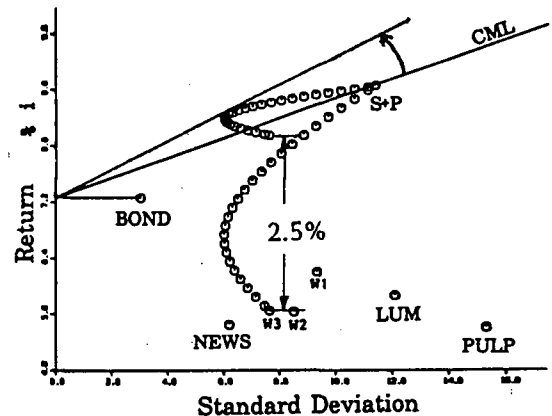


Fig A.10

W3, W3 + 2.5%



Beta

The systematic risk relative to the market of holding a particular security may be characterized with the beta coefficient (β) produced by regressing returns to the particular security against returns to the market portfolio.

$$R_i = a + \beta(R_m)$$

where: R_i = return to security i , and

R_m = return to the S&P.

An asset whose variability of return does not correlate with market fluctuations is considered risk-free by the holder of a diversified portfolio, since random fluctuations by any individual security are compensated for by overall portfolio stability. Correlated fluctuations, which would allow the whole portfolio return to shift, are considered risky. A risk-free asset has $\beta=0$, the market portfolio has $\beta=1$; an asset with beta less than zero is counterbalancing, and is therefore attractive at less than the risk-free rate. Ordinary least squares regression produced the data below:

a and β : 1960 to 1984

	a	SE_a	β	SE_β
W1	7.63	2.39	-.16	.17
W2	6.99	2.18	-.15	.15
W3	6.37	1.96	-.08	.14
BOND	7.09	.79	.02	.05

If the betas for spot prices, calculated on an average annual basis, are indicative of betas for Wood Units, the Wood Units should attract capital at a rate of return less than or equal to the risk-free market rate. The betas from the 1960 - 1984 study are negative, and not statistically different from zero.

Forest Products Intercorrelations 1960 to 1984

LOGS	1.0			
LUM	.56	1.0		
PULP	.33	-.24	1.0	
NEWS	.18	-.08	.80	1.0
	LOGS	LUM	PULP	NEWS

Portfolio Analysis: Data Summary
1960 - 1984

<u>Symbol</u>	<u>Mean Return</u>	<u>St. Dev.</u>	<u>Corr. with S&P</u>
S&P	8.9 %	11.4	1.00
BOND	7.3 %	3.0	-.07
LUM	5.9 %	12.1	.33
PULP	5.4 %	15.3	-.48
NEWS	5.4 %	6.2	-.33
LOGS	8.1 %	20.2	-.09
W1	6.2 %	9.3	-.20
W2	5.6 %	8.5	-.20
W3	5.7 %	7.6	-.10

Data Summary: 1910 - 1984

	<u>Return</u>	<u>St. Dev.</u>	<u>Correlation</u>
Dow Jones Industrial Average:	6.26	23.1	
Douglas-fir Log Prices:	5.91	16.1	-.12

Data: Inflation Rate and Annual Returns: 1960 - 1984

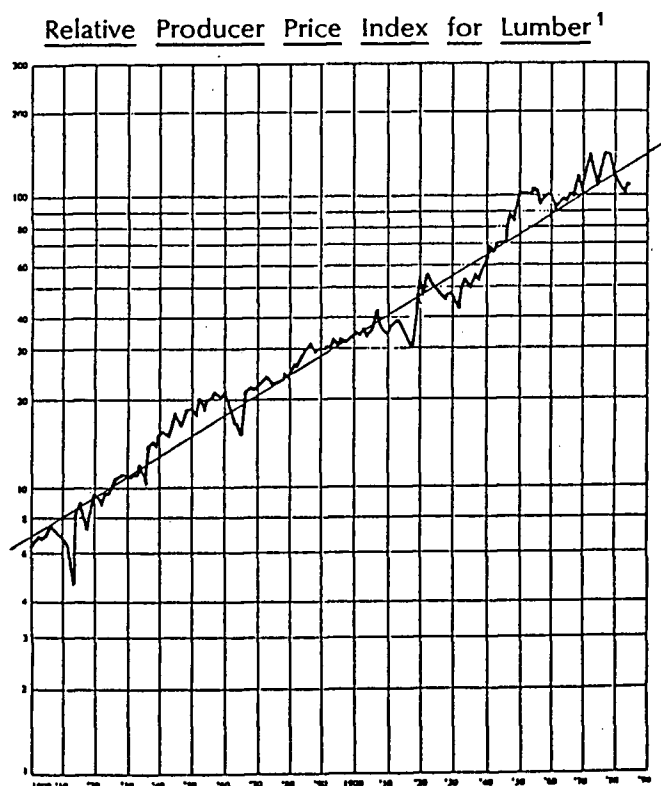
<u>Year</u>	<u>Inflation</u>	<u>Logs</u>	<u>Lumber</u>	<u>Pulp</u>	<u>News</u>	<u>W1</u>	<u>W2</u>	<u>W3</u>	<u>S&P</u>	<u>Bond</u>
1960.	1.8	1.2	-6.1	-0.6	0.0	-1.4	-3.3	-3.3	2.1	4.0
1961.	0.9	-1.5	-5.4	-7.1	0.0	-3.5	-6.2	-5.2	18.7	3.9
1962.	1.9	-0.2	2.3	-1.4	0.0	0.2	0.4	0.7	-1.5	3.9
1963.	1.4	1.9	2.2	-2.8	0.0	0.3	-0.3	0.1	14.7	4.0
1964.	1.5	1.7	1.1	5.0	0.0	2.0	3.1	2.3	20.5	4.1
1965.	2.3	5.9	0.0	2.7	0.0	2.2	1.4	1.0	10.9	4.2
1966.	3.2	3.2	5.4	-1.3	2.2	2.4	2.0	2.6	-0.5	4.7
1967.	3.0	6.0	2.0	1.4	2.9	3.1	1.7	1.9	9.7	4.9
1968.	4.3	19.0	21.0	-3.3	0.7	9.3	8.8	9.4	13.4	5.3
1969.	5.2	20.4	11.6	0.0	3.5	8.9	5.8	6.3	2.8	6.1
1970.	5.4	-9.5	-16.3	13.8	3.4	-2.2	-1.3	-2.8	-12.7	6.6
1971.	4.9	1.0	25.7	-6.1	3.9	6.1	9.8	11.3	22.9	5.7
1972.	4.2	5.4	18.3	1.3	4.4	7.4	9.8	10.3	16.1	6.0
1973.	5.8	81.2	27.4	27.4	8.5	36.1	27.4	24.5	-0.6	7.1
1974.	8.8	4.8	-1.4	55.0	21.8	20.0	26.8	21.8	-19.0	8.1
1975.	9.3	-6.5	-4.7	20.0	17.9	6.7	7.6	7.3	6.8	8.2
1976.	5.2	20.3	23.4	0.0	8.2	13.0	11.7	12.9	24.1	7.9
1977.	5.9	11.3	19.8	-6.2	7.9	8.2	6.8	8.9	4.3	7.7
1978.	7.4	10.8	16.5	-11.8	4.0	4.9	2.4	4.7	3.4	8.5
1979.	8.6	52.7	9.8	26.0	12.8	25.3	17.9	15.9	12.4	9.3
1980.	9.2	-0.6	-9.2	21.4	12.5	6.0	6.1	4.8	20.4	11.4
1981.	9.6	-12.7	-0.6	3.0	11.9	0.4	1.2	2.5	10.4	13.7
1982.	6.0	-6.8	-6.1	-7.6	1.6	-4.7	-6.9	-5.5	3.6	12.9
1983.	3.8	-10.2	14.9	-11.8	-2.4	-2.4	1.5	2.9	31.3	11.3
1984.	3.8	4.1	-4.3	18.2	10.5	7.1	7.0	5.8	7.1	12.0

APPENDIX B.1

Real Lumber Price Gains

The chart below, on logarithmic scale, shows a consistent rising real lumber price trend averaging 1.7% per year. The U.S. Forest Service expects real annual price gains for softwood lumber of 2% to 2.5% until the year 2030, due to steadily increasing demand and relatively fixed supplies (Haynes and Adams, 1985). Skeptics, however, point out that the demand for lumber is elastic, and expect that supply restrictions will cause substitution rather than continued rapid price escalation. These skeptics estimate future price rises in the order of 1% or less per annum.

Based on the 1960 - 1984 study, this thesis assumes a base case investor expectation of 1.3% annual real price gains, with a range of from .5% for low grade lumber to 1.9% for premium quality product.



¹ Relative Index derived by dividing the Actual Price Index by the All Commodities Price Index (1967 = 100). U.S. Department of Agriculture (1985).

APPENDIX B.2

Real Returns, Canada, 1914 - 1986

Nominal, inflation, and real returns to Government of Canada long term bonds were computed on an annual basis, and are presented below as averages per decade.

	Real Rate of Return	Rate of Inflation ¹	Nominal Rate of Return ²
1914 - 1920	-3.04	11.21	8.17
1921 - 1930	7.03	-2.38	4.65
1931 - 1940	5.18	-1.28	3.90
1941 - 1950	-1.66	3.97	2.31
1951 - 1960	1.52	2.36	3.88
1961 - 1970	3.21	2.71	5.92
1971 - 1980	0.88	8.03	8.91
1981 - 1986	5.24	7.18	12.42
1914 - 1986	2.35	3.50	5.85

This thesis employs a base-case real interest rate of 4%. This rate is supported by numerous authors³ and is the interest rate employed by the U.S. Forest Service in appraising forestry projects.

The rate of 4% is used to arrive at an approximation of what investors would pay per Wood Unit. The implications of changes in this rate are discussed in Appendix C.

¹ Average annual increase in the Canadian Consumer Price Index, Statistics Canada, 1987.

² Average annual yield on Government of Canada long-term bonds, Bank of Canada, 1987.

³ Manning, 1977; Foster, 1979; Row et al, 1981; Fitzsimons, 1986.

APPENDIX C

Hedgers

Interest rate, inflation, and product price hedgers may be expected to join long term investors in Wood Unit trading. The Wood Unit price will react differently than bond prices to changes in interest rates. The type of reaction will depend on whether the inflation or real component of the nominal interest rate changes, as illustrated below.

Example

The base case in this thesis assumes that interest rates are 9% (5% inflation, 4% real) and that wood prices are expected to appreciate at 1.3% per annum in excess of the inflation rate. If the spot price of wood is \$250 per Mbf, the Wood Unit would be priced at \$133. Meanwhile, a twenty five year government bond with a \$9 coupon would be priced at \$100. Consider the individual effects of changes to the inflation and real components of the nominal interest rate:

(i) Inflation drops by 2%

$$(\text{inflation } (3\%) + \text{real } (4\%) = \text{nominal } (7\%))$$

$$\text{Bond price} = \$123 \qquad \text{Wood Unit price} = \$132$$

(ii) Inflation increases by 2%

$$(\text{inflation } (7\%) + \text{real } (4\%) = \text{nominal } (11\%))$$

$$\text{Bond price} = \$83 \qquad \text{Wood Unit price} = \$135$$

(iii) Real rate drops by 2%

$$(\text{inflation } (5\%) + \text{real } (2\%) = \text{nominal } (7\%))$$

$$\text{Bond price} = \$123 \qquad \text{Wood Unit price} = \$212$$

(iv) Real rate increases by 2%

$$(\text{inflation } (5\%) + \text{real } (6\%) = \text{nominal } (11\%))$$

$$\text{Bond price} = \$83 \qquad \text{Wood Unit price} = \$85$$

If inflation rates change the Wood Unit price will be barely affected, since the change in the expected future value of the security nearly exactly offsets the change in the purchasing power of inflated future dollars. If real interest rates change, however, the price of the Wood Unit will be more responsive than bond prices.

The other factor influencing the Wood Unit price will be the spot price of the wood mix represented. If interest rates remain unchanged, Wood Unit prices should move in a dampened fashion in proportion to spot prices.

These factors suggest several strategies for hedgers:

(1) An investor worried about inflation but satisfied with current real interest rates and confident in wood price projections might purchase Wood Units to counter some of the inflation exposure of his other holdings.

(2) An investor anticipating changes in real interest rates might take a long or short position in Wood Units, long if interest rates are expected to decrease and short if rates are expected to increase.

(3) The investor in (2) might hedge his position by taking an opposite position in short term lumber futures. The hedge ratio, or volume of Wood Units relative to the volume of lumber futures, would be determined by the individual investor.

Term to Maturity

For the above investor, the responsiveness of the price of the Wood Unit to changes in real interest rates is mostly a function of the remaining period to maturity. When the Wood Unit is first issued it will fluctuate widely with interest rates; as it approaches maturity the fluctuations will become limited.

Example

This example illustrates numerically the effect of the remaining term to maturity. Assume the cash price of the product mix is \$250 per Mbf and that two Wood Unit series exist.

WUa: 24 years to maturity = \$137 at 4%; \$171 at 3%

WUb: 8 years to maturity = \$204 at 4%; \$220 at 3%

If the real interest rate falls from 4% to 3%, the profit to a Wood Unit holder would be:

WUa: profit = 25%

WUb: profit = 8%

An interest rate hedger would be attracted to the more highly leveraged opportunity, WUa in this example. Such hedgers should provide a demand for, and liquid trading in, newly issued Wood Units.

APPENDIX D.1

Silviculture: Techniques

The techniques used to enhance (i.e. to garden) the forest are referred to as silviculture (from the Latin sylvan: the woods). Silvicultural techniques employed in British Columbia include the following:

Site Preparation

In 1986 the major treatment was burning (60%). 20,000 hectares were mechanically treated by windrowing, scarifying, or mounding. These latter treatments expose the mineral soil below the duff, much like ploughing a farm.

Planting

This is a labour intensive process which presently absorbs 80% of the Ministry of Forests and Lands' silviculture budget. Work is performed by lowest contractor bid and is quality checked by MoF&L personnel.

Brushing and Weeding / Conifer Release

As young trees grow after planting they are sometimes outpaced by wild shrubs and deciduous trees. Weeding is the process of freeing the conifers. This process may be undertaken manually or with herbicides.

Spacing

In this process workers are sent through the woods with power saws to thin the forest, removing some of the trees (usually the weaker ones) to allow those remaining more air, light, and room to grow. The cut wood is generally left on the ground but may be removed if one is careful not to damage the remaining timber.

Fertilization

The addition of nutrients (especially nitrogen) has been shown to greatly improve growth rates of certain species on low-fertility sites. The fertilizer may be spread by hand, from light planes, or by helicopter.

Pruning

The lower branches of selected crop trees may be removed in successive 'lifts'. This provides for the production of clear wood on the pruned portion of the tree stem. The benefits of pruning are maximized if the crop tree is permitted to grow for a long time subsequent to treatment.

APPENDIX D.2Silviculture: Productivity and Costs

<u>Productivity</u> ¹	<u>Treatment</u>	<u>Average Cost</u> ² 1985/86, \$/ha
	<u>Labour and Support</u>	
400 - 1500 seedlings per person day	Planting	\$267 ³
.7 - 2 hectares per person day	Brush and Weed	\$375
.5 - 1.5 hectares per person day	Conifer Release	\$435
.3 - 1 hectare per person day	Spacing	\$575
40 - 75 trees per person day	Pruning	n/a
30 - 75 hectares per person day	Surveys	\$6
	<u>Machines and Operators</u>	
.5 - 2 hectares per hour	Site Preparation	\$196
15 - 30 hectares per hour	Fertilization (Aerial)	\$169



¹ Source: personal communication with contractors. The wide ranges reflect the diversity of forest sites in British Columbia.

² Source: Ministry of Forests Annual Report, 1985/86

³ Excludes cost of seedlings

APPENDIX D.3

Silviculture Yield

The three examples below are taken from the Ministry of Forests and Lands' Policy Manual, TIM 002 Annex 'A'. They show sample calculations for productivity gains due to treatment of representative good sites on Vancouver Island (FIZ B).⁴

(1) Backlog Reforestation: Plant site and brush and weed to free growing state: yield = $4.2 \text{ m}^3/\text{ha}/\text{year}$.

(2) Rehabilitation: Salvage existing scrub and burn site, prepare site and plant: yield = $5.8 \text{ m}^3/\text{ha}/\text{year}$.

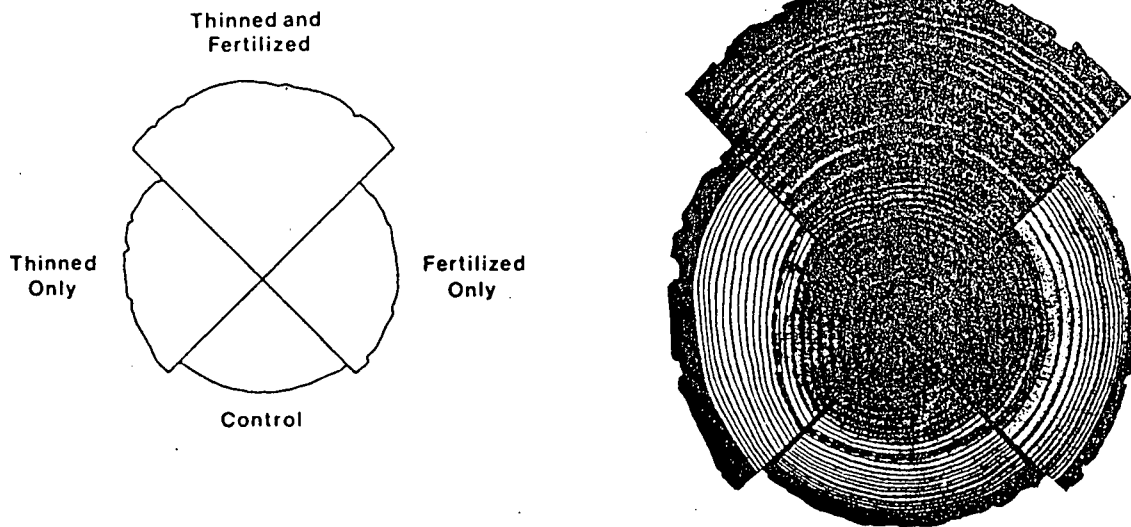
(3) Conifer Release: On an NSR site, remove the overtopping alder and fill in spots with planting: yield = $3.7 \text{ m}^3/\text{ha}/\text{year}$.

Preliminary data (12 years) from an experiment by the Canadian Forestry Service (Barclay and Brix, 1985) on a low site (D-fir site index 21 m at 50 years) at Shawnigan Lake show that a moderate level of spacing and fertilization (30%, 224 kg N/ha) increased net volume increment by $3.5 \text{ m}^3/\text{ha}/\text{year}$ over control stands. This growth was added to fewer stems of larger size, increasing merchantable volume growth by $4.7 \text{ m}^3/\text{ha}/\text{year}$.

Pruning does not increase volume production; it may in fact reduce the rate of growth if live branches are removed. The benefit of pruning is that it increases the value of subsequent growth of the tree. The reader is referred to Appendix F for a discussion of the relative merit of clear vs. knotty wood production.⁵

⁴ These sample yields are offered under Section 52 (a) of the Forest Act as incentive increases to licensees' annual cuts in return for reforestation activities. They may be considered conservative as only two licensees have earned increases in the eight years that this section has been in force.

⁵ Smith, 1987, gives a good review of pruning in B.C.



The illustration above is taken from the cover of Barclay and Brix, 1985, 12 year growth response. Trends in ring width and bark thicknesses are both worthy of note.

Natural Growth

The table below presents 'close utilization less decay' volumes per hectare of trees 12.5 cm and greater dbh in unmanaged stands on medium sites. ⁶

	<u>Volume (m³/ha) / Mean Annual Increment (m³/ha/yr)</u>			
	<u>25 yrs</u>	<u>50 yrs</u>	<u>75 yrs</u>	<u>100 yrs</u>
<u>Coast</u>				
(Douglas-fir, FIZ ⁷ C Bruce SI 45.8)	33 / 1.1	294 / 5.9	624 / 8.3	892 / 8.9
<u>Interior</u>				
(Lodgepole Pine, FIZ ⁷ H Goudie SI 19.8)	12 / .4	113 / 2.3	248 / 3.3	371 / 3.7

⁶ Source: Ministry of Forests, Planning and Inventory Branch, 1986.

⁷ FIZ: Forest Inventory Zone.

APPENDIX E

Table of Conversion Factors

Units

Logs : m³ (cubic meters)

Lumber : Mbf (thousand board feet)

Chips : BDU (bone dry unit)

Pulp : tonne (metric ton)

Conversion

m³ = 36 cu ft (solid wood)

BDU = 5000 lb

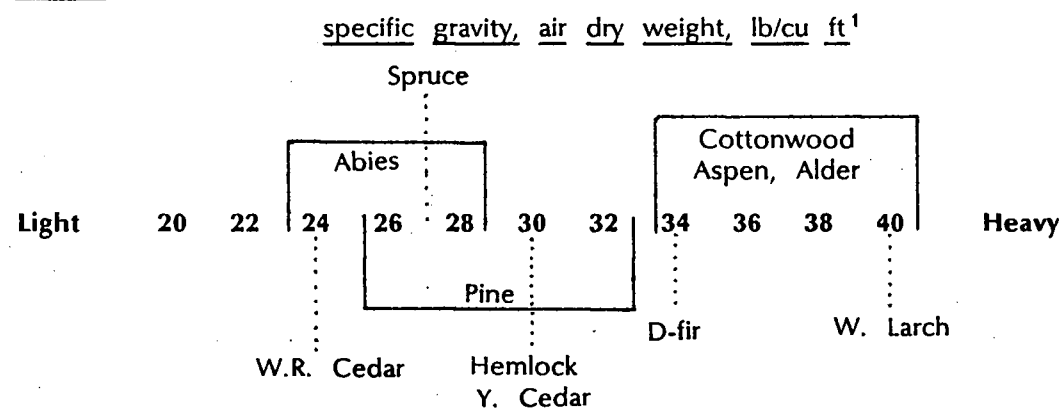
tonne = 2200 lb

bd ft = 12" X 12" X 1"

m³ (log) = 225 bd ft (lumber) + .1 BDU (chips)

BDU (chips) = 1 tonne (B.K. Pulp) + lignin slurry

Species



4 m³ = 144 cu ft = 4000 lbs SPF or 5000 lbs D-fir.

Logging truck: highway = 50 m³ ±; woods = 90 m³ ±.

3/4 ton pickup truck, heavy load = one Mbf.

Railway car = 130 Mbf of lumber or 80 tonnes of pulp.

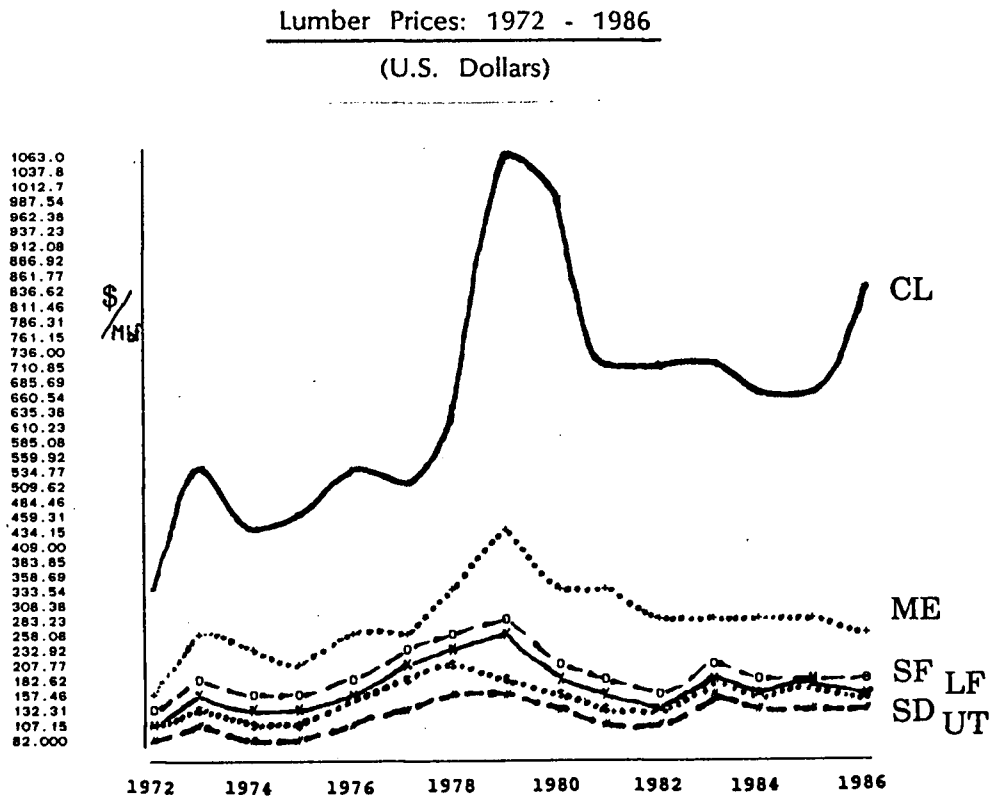
¹Source: Mullins and McKnight, 1981.

APPENDIX F.1

Wood Quality

Different silvicultural regimes would be expected to produce quite different log-sets. The value of a log may be measured by the highest quality set of lumber products which may be economically produced from that log. The object of this appendix is to illustrate a system whereby the production of pulpwood or utility grade sawlogs may be compared with high quality saw or veneer logs.

Prices per Mbf for a set of Douglas-fir lumber grades in U.S. dollars, ranging from utility to clears, were collected and are plotted below. It should be noted that the price lines never cross; an inferior grade is always worth less than or equal to a superior lumber grade.

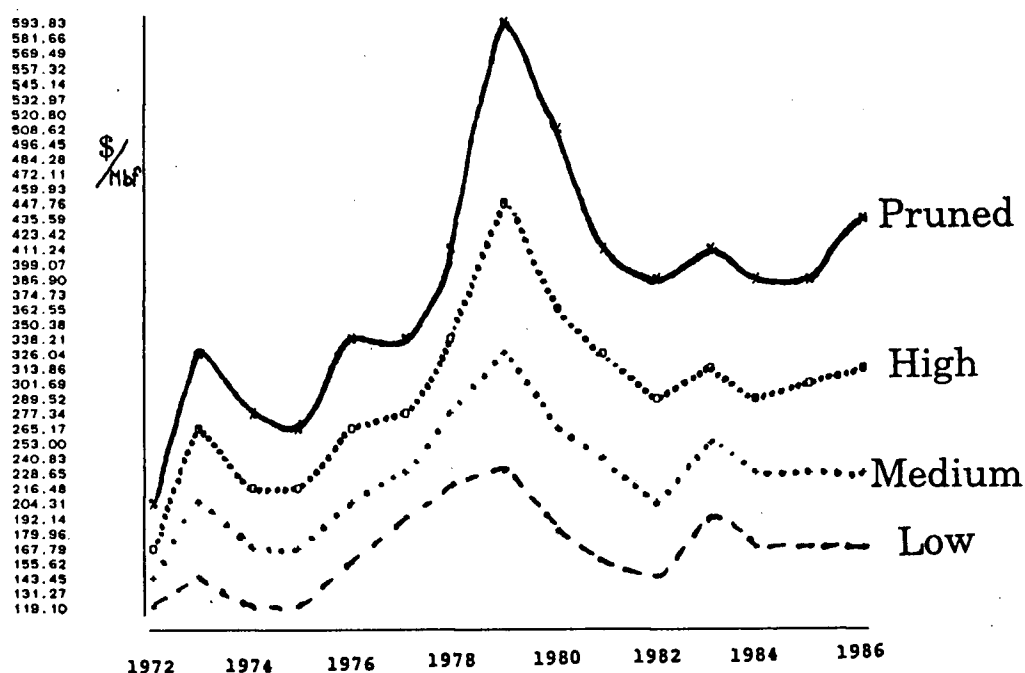


- CL = Clears: 2 1/2 X 6 & Wdr, #2 Clear, 15% #3
- ME = Timbers: 6 X 12 & WDR, #1 Merch, 15% #2
- SF = Structural L F: 2 X 4, #1 & Btr, Random 10/20'
- LF = Light Framing: 2 X 4, Std & Btr, Random 8/20'
- SD = Studs: 2 X 4 - 8' PET, Stud Grade
- UT = Utility: 2 X 4, Random 8/20'

Source: Random Lengths Yearbook, 1986.

Four types of logs, representative of different intensities of silviculture, were defined as weighted combinations of specified grades of lumber. The LOW mix might be representative of material from unmanaged or minimally managed second growth timber stands. At the other extreme, the PRUNED mix is a conservative adaption of New Zealand figures (Park, 1985) which suggest 45% clear recovery from their pruned stands.

Prices of Lumber Mixes: 1972 - 1986
(U.S. Dollars)



(Dim = Average of light framing, structural framing, and stud.)

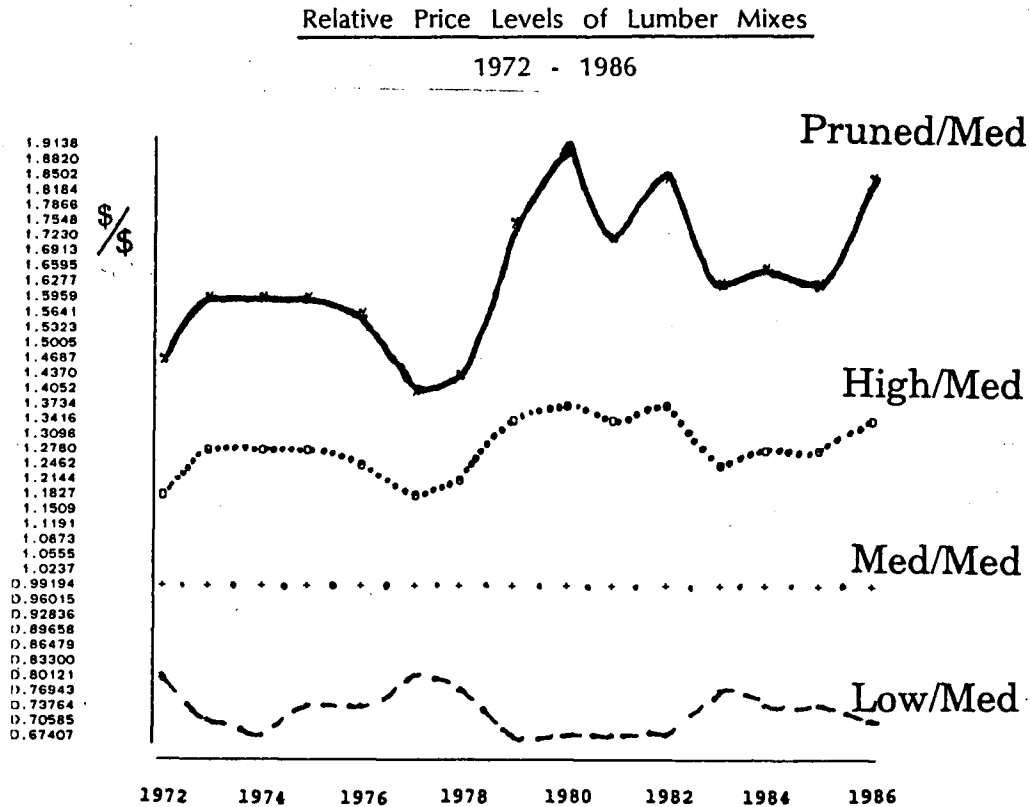
LOW = 30% Utility + 70% Dim

MEDIUM = 10% Utility + 60% Dim + 25% Merch + 5% Clear

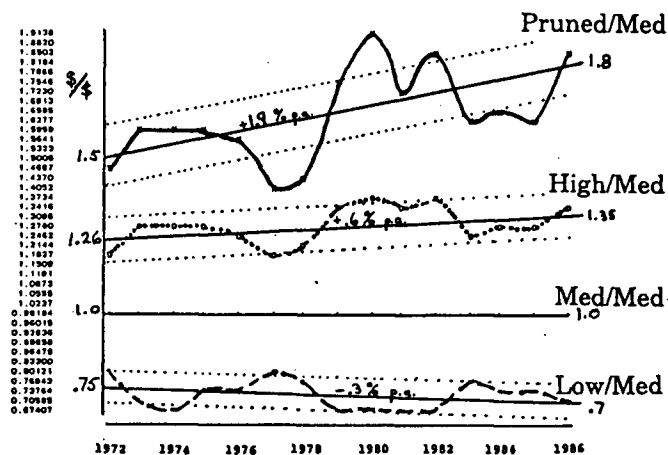
HIGH = 45% Dim + 40% Merch + 15% Clear

PRUNED = 35% Dim + 30% Merch + 35% Clear

To inspect relative price movements, prices were expressed as a ratio to the Medium grade-set by dividing the prices of other mixes for each year by that year's price of the Medium mix. The price of each grade-set forms a distinct belt relative to the Medium grade mix for the 15 year period portrayed.



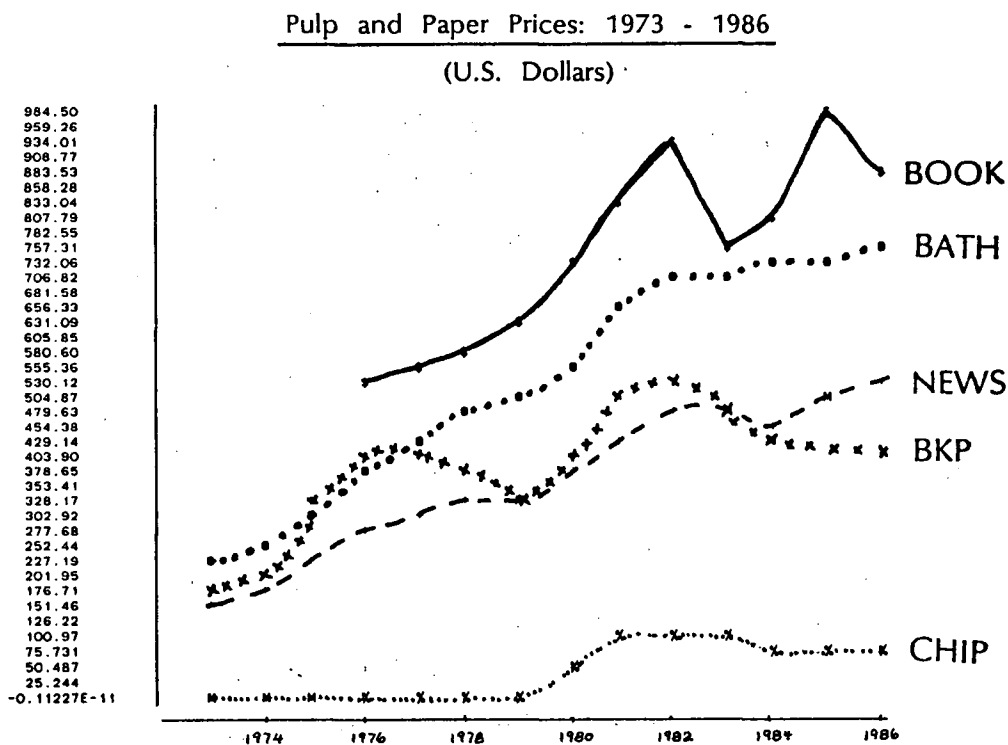
It is interesting to note the divergence of the trendlines. The price of the Pruned set has appreciated 1.9% per annum faster than the price of the Medium set over the past 15 years. The chart below presents best-fit regression lines bracketed by dotted lines two standard deviations either side of the trendline.



APPENDIX F.2Pulp and Paper Prices

For the reader's reference, the chart below presents historic prices for a range of pulp and paper products in U.S. dollars. Some of the lines cross because they represent different products rather than different grades of the same product, as is the case with lumber. A lumber grade rule is based on a sequential ordering of quality classes. A Paper Grade Rule, if one were to be created, would be descriptive rather than ordered, with each paper selected being representative of different fibre requirements.

It is interesting to note the stability of tissue (BATH) prices. Tissue is characterized by a very direct contact between mills and retail customers. Its price therefore fluctuates minimally in response to business cycles.



Source: Miller Freeman, 1986.

APPENDIX G

Wood Unit Guiding Silviculture

This Appendix contains two examples which together illustrate how the market price of the Wood Units would guide choices between alternate silvicultural regimes. The first example illustrates the theory of comparison; the second example illustrates the application of the theory to a practical situation.

It is necessary to speak about the net dollar value per Wood Unit which would go directly into forest management. This dollar value is here termed the 'Bud' of the Wood Unit, and is calculated as the difference between the issue price of the Wood Unit and the initial contribution to the H&M Reserve required to process the product mix specified.

$$\text{Bud} = \text{WU} - \text{H\&M}_0$$

where:

Bud = net contribution to land management,

WU = revenue from sale of one Wood Unit, and

H&M₀ = cost of initial deposit to the H&M Reserve.

EXAMPLE 1: Derivation

Data in Appendix F.1 illustrates that today the price of a HIGH product mix exceeds that of a LOW product mix by a ratio of 1.3 to .7. It also shows that recently the HIGH price has been rising 1% per annum relative to LOW. If investors expect the price divergence to continue, and current product prices are used, the HIGH Wood Unit might sell in the market for \$182 while the LOW Wood Unit sold at \$77:

HIGH: Cash price = \$325; product prices = + 1.5% p.a.; WU = \$182

LOW: Cash price = \$175; product prices = + .5% p.a.; WU = \$77

where: $\$325/\$175 = 1.3/.7$

The cost of processing would likely be different for HIGH and LOW products. If $H\&M(\text{high}) = \$300$ and $H\&M(\text{low}) = \$160$, and the H&M Reserve is earning 8%, then the required initial deposits to the Harvest and Mill Reserve would be $H\&M_O(\text{high}) = \$44$ and $H\&M_O(\text{low}) = \$23$, and the Bud's are:

	WU	-	$H\&M_O$	=	Bud
HIGH	\$182	-	\$44	=	\$138
LOW	\$77	-	\$23	=	\$54

In this example LOW management should produce 138/54 times as much timber volume increment per dollar spent on silviculture.

EXAMPLE 2: Application

The forest manager is considering a 20 year old timber stand for management under different regimes.

Option 0: Do nothing. The unmanaged stand is expected to average growth of 4 $\text{m}^3/\text{ha}/\text{yr}$ of LOW quality wood.

Option 1: Treat the stand with a heavy dose of fertilizer (\$400). Plan to harvest pulpwood in 15 years. Expected increment due to treatment = 3 $\text{m}^3/\text{ha}/\text{yr}$ (higher at first, lower later, 3 is average).

Option 2: Space (\$575), fertilize (\$200), prune 300 stems per hectare (\$600): total cost = \$1375. Harvest in 40 years. Expected yield is only 1 $\text{m}^3/\text{ha}/\text{yr}$ greater than an unmanaged stand, but all growth is of better quality. The increment in this case is 5 $\text{m}^3/\text{ha}/\text{yr}$ of HIGH quality product less the value of 4 $\text{m}^3/\text{ha}/\text{yr}$ of LOW product.

A Benefit/Cost Ratio (B/C) may be formed to compare the options. The cost associated with management is the expense of initiating the particular silvicultural regime. The benefit is the growth which will be produced, valued at present by the current Bud value for the quality of product expected. (eg: $B/C = (25 \text{ years} \times \text{mean annual increment}) \times (\text{Bud per } 4 \text{ m}^3) / \text{Silvi Cost}$)

$$B/C = (Gr \times Bud/4) / \text{Silvi Cost}$$

where:

Gr = expected volume at 25 years, and

Bud = Wood Unit price less H&M deposit.

Benefit: Option 0: $(25 \times 4) \times (\$54/4) = \1350

Benefit: Option 1: $(25 \times 3) \times (\$54/4) = \1013

Benefit: Option 2: $[(25 \times 5) \times (\$138/4)] - [(25 \times 4) \times (\$54/4)] = \$4313 - \$1350 = \$2963$

Costs: Option 0 = \$0, Option 1 = \$400, Option 2 = \$1375

Benefit/Cost Ratios:

$$B/C \text{ Option 1} = \$1013/\$400 = 2.53$$

$$B/C \text{ Option 2} = \$2963/\$1375 = 2.16$$

Option 0 represents an asset already owned and accounted for by government. In this example the current value of the 'natural growth', realizable through the sale of Wood Units, is \$1350.

The B/C ratio indicates that Option 1 would be preferred to Option 2. The government may prefer Option 2 however, since it involves three times as much economic activity per hectare of land.

This B/C ratio is different from that produced by discount rate analysis. The discounters rely on chosen interest rates and future values to form a benefit/cost ratio. The B/C ratio formed in this example is constructed with current market determined prices. The only estimation required is that of forest growth, which lies within the principal realm of the forest manager.

Appendix H

Harvest and Mill Reserve

The Harvest and Mill Reserve is established to provide for the future conversion of growth increment into products specified in the issued Wood Units. It would be a cash deposit account, intended to equal the cost of processing at the end of one Unit Rotation. It has been suggested that the Reserve be established with a portion of the proceeds of Wood Unit issuance, and be thereafter maintained to maturity by the forest company holding a Management Contract.

At any time the Reserve may be characterized with an 'indicated interest rate' (%I), calculated as the rate at which the existing deposit level should grow for the remaining term to maturity to equal the current H&M quote. If this rate was actually earned by Reserve assets, and the H&M quote did not inflate, the Reserve would exactly provide for future needs, and no maintenance contributions would be required. If not, the contribution by a forest company holding a Management Contract, in any given year, would be:

$$\text{Co contribution} = \text{level in Reserve} (\%I + \% \Delta \text{H\&M} + \text{mkt rate})$$

where:

%I = indicated interest rate, computed as the rate at which the existing H&M deposit level should grow for the remaining period to maturity to equal the current H&M quote.

% Δ H&M = percentage change in the H&M quote as compared with the quote of the previous year.

mkt rate = rate of return actually earned by the Reserve assets over the preceeding year.

For example, if a conservative %I of 8% were chosen, and the H&M quote was \$200 per Mbf, the indicated deposit to the Harvest and Mill Reserve would be \$29.20. If over the following year the Reserve earned the market rate (9%) and

processing costs rose with general inflation (5%), the deposit level at the end of the year would be \$31.83 and the H&M quote would be \$210. The indicated interest rate (%I) would then be 8.17% (\$31.83 compounded at 8.17% for 24 years = \$210). A deposit by the forest company of \$1.29, raising the deposit level to \$33.12, would drop %I back to 8%.

%I is an indicator of the safety of a particular Reserve. It represents the annual liability to the company, to the extent that it exceeds the difference between realized Reserve earnings and the rate of processing cost inflation.

A 'zero' level for %I would be the rate at which market rates are expected to exceed processing cost inflation. At %I₀, the zero level, expected annual deposits would be nil.

$$\text{ie: } \%I_0 + \% \Delta H\&M - \text{mkt rate} = 0$$

$$\text{or: } \%I_0 = \text{mkt rate} - \% \Delta H\&M$$

In the example, where market rates are 9% and %ΔH&M is 5%, %I₀ = 9% - 5% = 4%. An indicated rate of 4% on an H&M quote of \$200 would suggest a deposit level of \$75 (\$75 compounded at 4% for 25 years = \$200). Under these expectations, \$75 should be deposited in the Reserve. The company holding a Management Contract might choose to add \$46 to the \$29 deposit instead of anticipating a series of annual deposits. Given these expectations, \$46 is the present value of undertaking the H&M obligation.

The forest company would be contributing to the finance plan a pledge to cover processing cost inflation, to the extent of %I less market returns. It would be in effect borrowing capital at an interest rate of [(%ΔH&M - mkt rate) + %I] to make this contribution. This borrowing rate would be reduced by (i) controlling cost inflation, (ii) ensuring that H&M Reserve assets are productively employed, and (iii) periodic extra contributions to the Reserve. A Reserve with a large deposit level (low %I) would be less expensive to maintain.

APPENDIX K

Glossary

B/C Ratio a benefit/cost ratio relating the current value of growth expectations to the current cost of silvicultural activities.

page: 49, 105

Bidding: the process which directs dispersals from the Silviculture Fund to TFL's.

page: 45 to 53

Bud: the share of investor funds which are actually spent on forest management, calculated as the difference between Wood Unit revenue and the corresponding deposit to the H&M Reserve.

page: 49, 103

Ceiling: the level above which all growth is a stumpage-free return to the company.

page: 44, 48, 50, 57

Clearing House: the agency which coordinates silvicultural investment with Wood Unit issuance.

page: 38, 57

Distribution Template: a pictorial representation of the distribution of expected growth between investors, government, and forest management companies.

page: 49 to 53

Growth:

(i) nature's bounty: existing timber inventory past juvenile age.

(ii) total growth: the twenty five year growth expectation of any specific stand.

(iii) natural growth: that future growth which would occur on the site if left in an unmanaged state.

(iv) investor pledge: four cubic meters per Wood Unit of investment.

(v) expertise share: total growth less natural growth and the investor pledge.

page: 36, 44, 63, 66, 96

H&M Contract: a sub-contract of the Management Contract.

page: 46, 56, 106

H&M Reserve: a cash deposit account established to provide for the future processing of the products pledged to investors.

page: 32, 45, 47, 50, 56, 62, 106

Management Contract: a comprehensive agreement between government and integrated companies with area-based tenures regarding silvicultural activity and future processing responsibility.

page: 45, 62, 57, 106

P/L Diagram: a graphical representation of government stumpage eventualities under a range of future price and growth response possibilities.

page: 27 to 32

Silviculture Fund: a government account, created by the revenue from Wood Unit sales, from which disbursements for site-specific silvicultural activity would be made.

page: 39, 54

Standing Green Reserve: mature or near-mature timber volume reserved from current harvesting to be held as insurance against catastrophic loss of invested stands.

page: 33, 55, 63

Stumpage: defined as the difference between the price of maturing Wood Units and the corresponding deposit level in the H&M Reserve.

page: 16, 28, 40, 47, 54

Stumpage-free Timber: an incentive to forest company participation.

page: 44, 50, 58, 68

Unit Rotation: a period of twenty five years.

page: 14, 47, 68

Window: a specified part of future harvest which would be a stumpage-free return to the forest company.

page: 44, 48, 50, 57

Wood Unit: the contract sold by government to investors, representing the delivery in twenty five years time of the cash value of a specified mix of forest products.

page: 16, 20, 26, 49, 57, 69, 85