THE DIFFICULTY IN IDENTIFYING A SUBSIDY IN THE USE OF A NATURAL RESOURCE: CANADIAN LUMBER IMPORTS

by

Brian Craig Harkleroad

A thesis submitted in partial fulfillment
of the requirements for the degree

of

Master of Science

in

Applied Economics

MONTANA STATE UNIVERSITY
Bozeman, Montana

March 1989

APPROVAL

of a thesis submitted by

Brian Craig Harkleroad

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

Date	Chairperson, Graduate Committee

Approved for the Major Department

Date	Head, Major Department

Approved for the College of Graduate Studies

Date	Graduate Dean

STATEMENT OF PERMISSION TO USE

In presenting this thesis in partial fulfillment of the requirements for a master's degree at Montana State University, I agree that the Library shall make it available to borrowers under rules of the Library. Brief quotations from this thesis are allowable without special permission, provided that accurate acknowledgment of source is made.

Permission for extensive quotation from or reproduction of this thesis may be granted by my major professor, or in his absence, by the Dean of Libraries when, in the opinion of either, the proposed use of the material is for scholarly purposes. Any copying or use of the material in this thesis for financial gain shall not be allowed without my written permission.

Signature _____

Date _____

ACKNOWLEDGMENTS

I would like to thank my major professor, Dr. Ronald Johnson, for his time and patience during the writing of this thesis. I would also like to thank Dr. Jeffrey LaFrance for his help in my understanding of the empirical sections of this thesis and his comments and encouragement throughout the course of my graduate work. My thanks are also extended to Dr. Clyde Greer for his comments and work on my thesis committee.

I would like to express my appreciation to Linda McGillen and Charles Stigers of The Montana Power Company for their respective editing and calculus skills.

Finally, I would like to thank my family for their continual support and encouragement throughout the course of my graduate schooling.

TABLE OF CONTENTS

	Page
APPROVAL	ii
STATEMENT OF PERMISSION TO USE	iii
ACKNOWLEDGMENTS	iv
TABLE OF CONTENTS	v
LIST OF TABLES	vii
LIST OF FIGURES	viii
ABSTRACT	ix
CHAPTER:	
1. INTRODUCTION	1
The Definition of a Subsidy	2
History and Background	4
Outline of Chapters	7
End Notes	9
2. NATURAL RESOURCES AND THE DIFFICULTY IN IDENTIFYING A SUBSIDY	10
Theory of the Mine	10
Reduction in Costs	16
Constrained Harvests and a Reduction in Costs	22
Steady State Model	28
Maximum Sustained Yield	29
Reduction in Harvest Costs	33
Theory of the Mine with a Steady State	34
Conclusion	37
End Notes	39

TABLE OF CONTENTS-Continued

	Page
3. CANADIAN STUMPAGE PRICE SYSTEMS AS COUNTERVAILABLE SUBSIDIES	40
Background	41
History of Harvest Regulation	42
Material Injury	47
Stumpage Price Setting Systems as the Cause of Material Injury	50
Allowable Cut as the Driving Force of Supply	52
Empirical Analysis of the Canadian Lumber Market	55
Review of Previous Studies	55
Model Development and Methodology	56
Results and Discussion	59
Conclusion	66
End Notes	67
4. CONCLUSION	68
REFERENCES CITED	71

LIST OF TABLES

Table		Page
1.	Lumber Production in British Columbia and Canadian Total.....	43
2.	Description of Variables and Sources of the Data.....	58
3.	OLS Estimated Coefficients for Regression Equations.....	62
4.	IV Estimated Coefficients for Regression Equations.....	64

LIST OF FIGURES

Figure		Page
1.	Price Time Path for the Theory of the Mine.....	15
2.	Quantity Time Path for the Theory of the Mine....	15
3.	Price Time Path for the Theory of the Mine with a Reduction in Costs.....	17
4.	Quantity Time Path for the Theory of the Mine with a Reduction in Costs.....	17
5.	Price Time Path for a Two-Country Model.....	20
6.	Price Time Path for a Two-Country Model with a Reduction in Costs to the Low Cost Country.....	20
7.	The Effect of a Constraint on the Quantity Time Path in the Theory of the Mine.....	24
8.	The Effect of a Constraint on the Price Time Path in the Theory of the Mine.....	24
9.	Quantity Time Path for the Theory of the Mine with a Harvest Constraint and a Per Unit Payment.	26
10.	Maximization of Sustainable Yield.....	31
11.	Long Run Timber Quantity Time Path with the Combined Theory of the Mine and Steady State System.....	36

ABSTRACT

Canadian stumpage price subsidies are claimed to be the cause of injury to the U.S. lumber industry. Legislative action has been taken which will impose a 15% export tax on Canadian lumber. This study examines the difficulty of identifying such a subsidy in the case of Canadian lumber imports, and more importantly, the difficulty of identifying subsidies in the use of natural resources as a whole. This is done through examination of resource depletion in the theory of the mine and the steady state timber management system. A model of the Canadian lumber market is then proposed. Examination of this model rejects the hypothesis that stumpage price systems are subsidies which injure the U.S. lumber industry.

CHAPTER 1

INTRODUCTION

The conventional approach to international trade argues that a subsidy to producers in the exporting country will benefit consumers but harm producers in the importing country. Despite the potential net welfare gains to the importing country, harm to domestic producers is often the motivating force behind protectionist legislation. Under the U.S. Fair Trade Act (1979), however, evidence of material injury to domestic producers must be provided before countervailing duties can be imposed against the exporter. The motivating factor in determining material injury by the U.S. International Trade Commission (ITC) is a decline in the domestic price traceable to the subsidy.

Most research into this area employs the use of static analysis to determine injury to domestic producers. In the case of an exhaustible resource, however, static analysis results in serious shortcomings. For this reason, a simple model of resource extraction over time is employed. Using such a model, for one example, it will be shown that a subsidy can have the usual effect of lowering the price, but resource owners in the importing country can, at the same time, experience a wealth increase. This contrasts with the accepted conventions of material injury. The basic reason is that a subsidy will result in more rapid extraction, and hence, depletion, of the stock in the exporting country. In turn, the present value of the

resource stock in the importing country can increase. The complexities that can arise are further demonstrated with reference to the recent imposition of tariffs on Canadian lumber imported into the United States. In particular, it will be shown that the imposition of tariffs on Canadian lumber were not correctly justified.

To develop and further clarify the above arguments, the material in this chapter describes the definition of a subsidy and the concept of material injury as used by the ITC. Also, background information pertaining to the ITC's actions against Canadian lumber imports is provided.

The Definition of a Subsidy

A subsidy is defined as economic assistance from an outside third party to either a buyer or a seller in a transaction. Greenwald, in the Encyclopedia of Economics, states that a subsidy "generally allows a buyer to receive a good or service for less expense than would otherwise have been necessary" (Greenwald, 1986, p. 905). He summarizes that a subsidy can affect both the equilibrium quantity and the price in transactions of a specified good, and it generally encourages the transaction because it alters the price or cost of a good or service to the subsidy recipient to encourage output and reduce the selling price.

The U.S. Congress defines a subsidy in a similar manner. It states that a subsidy include but not be limited to:

A. The provision of capital, loans, or loan guarantees on terms inconsistent with commercial considerations.
B. The provision of goods or services at preferential rates.
C. The grant of funds or forgiveness of debt to cover operating losses sustained by a specific industry.
D. The assumption of any costs or expenses of manufacture, production or distribution (U.S. Congress, House, 1979, pp. 177-178).

While such assistance to producers in an exporting country may harm domestic producers, the mere existence of a subsidy does not imply that countervailing duties will be imposed. First, the subsidy must be shown to cause material injury to the domestic industry; just its presence does not mean that material injury has occurred. The critical issue is whether the subsidy affects the output of the final product and the price charged by the producers. Once material injury to the domestic industry is proved, a countervailing duty equal to the net subsidy can be applied.

Congress defines material injury as "harm which is not inconsequential, immaterial or unimportant" (U.S. Congress, House, 1979, p. 178). Determination of material injury falls on the Commerce Department, specifically the ITC, which takes into consideration not only the total volume of imports but also any increase in volume in either absolute terms or relative to production or consumption in the United States. In determining the impact on price, Congress instructs the ITC to consider whether price undercutting of the imported product has occurred and if the effect of the imports has significantly depressed prices or prevented price increases.

In summary, a subsidy that is subject to countervailing duties must cause a decrease in the price of the product and must cause

material injury. It is this definition that will be examined when considering the application of countervailing duties on a natural resource.

History and Background

The issue of "unfair" subsidies in international trade has been debated for quite some time. While some industries have been concerned with the problem of imports for decades, the United States lumber industry has only recently focused attention on foreign imports and legislative protection for domestic interests.

In May 1982, Senator Robert Packwood (R-Ore.) convinced the ITC to conduct a preliminary investigation into the matter of subsidized lumber imports from Canada based on concern from lumber mill operators in the Northwest who claimed they were being put out of business by a flood of Canadian lumber imports (U.S. Department of Commerce, 1986). The hearings investigated possible lumber subsidies by various Canadian provincial governments and agencies, but no recommendations were made, and no legislative action was taken.

As a result of information obtained in the investigation, however, U.S. lumber producers, known as the Coalition for Fair Canadian Lumber Imports, filed a petition in October, 1982, for countervailing duties on Canadian softwood lumber imports.[1] The basis for the petition was that Canadian federal and provincial governments were assuming a cost of production of the Canadian lumber industry and consequently, harming the United States lumber industry (Luckert, 1984). The petition alleged Canadian federal and provincial

governments "are providing subsidies on the production of softwood lumber that is imported into the United States" (Coalition for Fair Lumber Imports, 1986a, p. 1). It also alleged that the U.S. softwood lumber industry was being materially injured because of the subsidized imports.

The subsidies identified in the petition included Canadian stumpage programs which include transportation subsidies, grants and low or interest-free loans. However, the emphasis of the petition was focused on the setting of stumpage prices. The summary of the petition stated that

> . . . the major subsidy at issue is the sale of softwood stumpage (the right to harvest softwood timber) to lumber companies by the provincial governments at preferential rates. The provinces sell softwood stumpage at rates that are administratively set and are far lower than competitive prices for comparable stumpage (Coalition for Fair Lumber Imports, 1986a, p. 6).

The petition claimed that "by charging less than the market value, the Canadian provincial governments substantially, and artificially lower Canadian producers' cost of production" (Coalition for Fair Lumber Imports, 1986a, p. 23). Therefore, the subsidy identified is the selling of stumpage rights below fair market value. The subsidy is assumed to have lowered the cost of lumber production and increased supply to the U.S. The petition called for the ITC to impose countervailing duties on Canadian lumber imports.

In May 1983, the ITC declared that although some programs (such as loans and grants) provided by the Canadian governments did confer subsidies, they were of such small effect as to be de-minimus. That is, they caused no harm to the United States lumber industry. The ITC

also declared that stumpage price programs alleged to be subsidies were not "provided to a specific enterprise or industry or group of enterprises" (Federal Register, 1983, p. 24159)(sometimes referred to as the general availability/specificity test) as required by the Fair Trade Act; therefore, no countervailing duties were imposed.

Continued pressure by the United States lumber industry led to a request from the United States Trade Representative for an update of the 1983 ITC findings in March 1985. The ITC filed an update of its previous report in October 1985. Although the report made no recommendations, the Coalition for Fair Lumber Imports felt it had a strong enough case to file a petition for countervailing duties.[2] Filed in May 1986, this petition alleged that Canadian lumber imports were causing material injury by reason of subsidies. The petition further strengthened the case of the general availability/specificity test with new and updated arguments. It was argued that although the subsidies were not provided specifically to the Canadian lumber industry (the subsidies were allegedly provided to the pulp and paper industries as well), the effect was to benefit mainly the Canadian lumber industry which, in turn, caused harm to the United States lumber industry.

Based on the new information presented in the petition, the ITC determined in July 1986, "that an industry in the United States is materially injured by reason of imports from Canada of softwood lumber, rough dressed or worked" (U.S. International Trade Commission, 1986, p. 1). It also stated that these products are alleged to be subsidized by the Government of Canada.

Finally, in December 1986, the Coalition for Fair Lumber Imports, through the United States Trade Representative, agreed to withdraw its petition upon the imposition of a 15% tax enforced by the Canadian governments on lumber exports to the United States. The export charge is to remain in effect until the provincial governments increase their stumpage fees by the same amount (U.S. Department of Commerce, 1987).

Outline of Chapters

This thesis examines not only the difficulty of identifying a subsidy in the case of lumber imports from Canada, but just as important, the ambiguity in identifying a subsidy in the use and depletion of natural resources as a whole. Chapter 2 examines the difficulty in identifying a subsidy for natural resources in general, and relates it to the case of Canadian lumber imports. The first section compares depletion of a stock of a nonrenewable resource, as in the theory of the mine, to the depletion of a stock of old growth timber. Implications are derived by treating subsidies as a reduction in costs. Subsidies are then discussed in a steady state forest management system where the old growth stock of timber has been depleted. The subsidies covered include a reduction in costs and harvesting at maximum sustained yield. Subsidies are examined in the long run supply of lumber when the theory of the mine and the steady state system are combined.

Chapter 3 examines the specific issue of Canadian stumpage price systems as countervailable subsidies as claimed by the Coalition for Fair Lumber Imports and the arguments used by the Coalition for Fair

Lumber Imports are presented. The institutional arrangements pertaining to the setting of stumpage prices are discussed, and the argument that Canadian stumpage prices are the driving force of lumber supply is examined.

A closely related argument, examined in Chapter 3, is one which claims that if the timber supply is determined administratively, then no subsidy occurs. An empirical study of this proposal is undertaken, and a hypothesis of exogenous harvest levels is tested. The question of whether the stumpage price setting systems or the annual allowable cuts are the driving force in the determination of supply is discussed in relation to the subsidy and material injury claim.

Finally, Chapter 4 presents conclusions from the results of this study and discusses the implications of countervailing duties in the question of stumpage price subsidies of Canadian lumber imports. It restates the difficulty in identifying a subsidy in regard to natural resources and summarizes the arguments in the specific issue of stumpage price setting and subsidies.

End Notes

1. The Coalition for Fair Canadian Lumber Imports represented a group of United States softwood lumber manufacturers and associations representing United States lumber manufacturers. The organization is now defunct (U.S. Department of Commerce, 1986).

2. The Coalition for Fair Lumber Imports is the new representative of the manufacturers and associations. The manufacturers and producers represented include mostly smaller mills and lumber companies. Many of the major manufacturers in terms of size are not listed in the Coalition membership.

CHAPTER 2

NATURAL RESOURCES AND THE DIFFICULTY IN IDENTIFYING A SUBSIDY

This chapter shows the problems of identifying the existence of a subsidy in a natural resource setting such as the depletion of a stock of old growth timber. The theory of the mine is applied to the depletion of the old growth stock with the effects of a traditional cost reducing subsidy examined. Also examined is the effect of a subsidy when there is a constraint on the amount harvested in each time period. A steady state model wherein growth equals harvests is also developed. The steady state model allows examination of a subsidy in the form of a regulation of harvests at maximum sustainable yield. Subsidies are discussed in relation to their traditional and legislative definitions. The analysis shows the difficulty in identifying a subsidy in a dynamic setting.

Theory of the Mine

This section introduces the theory of the mine as a management system for the depletion of non-renewable, old growth timber reserves. Once the theory of the mine is set up, the effects of a traditional subsidy, in the form of reduced costs, are examined. The reduction in costs is then combined with a constraint on the quantity harvested as is currently practiced in most public forest management situations.

Using the model, time profiles for price and quantity are derived. The introduction of a subsidy will alter the profiles and yield implications that are at odds with the traditional view of how subsidies affect resource allocation.

The theory of the mine examines the optimal depletion of a non-renewable resource over a period of time. While the resources usually considered are oil, natural gas, and mineral deposits, old growth timber reserves also can be examined in the theory of the mine. Here, the basic assumption is that old growth timber is a non-renewable resource. Treating old growth timber as a non-renewable resource is commonplace. Lyon and Sedjo (1983), for example, have explored mining of timber stands for the economically optimal drawdown of existing old growth stands. Mining of the forest is defined as harvests of timber that decrease the inventory of timber as well as the cutting of timber on submarginal lands (Lyon, 1981).

Old growth timber is previously unmanaged, unharvested, or virgin timber that is no longer adding volume to the stand. It is often composed of trees 300 to 400 years old, that grow slowly, if at all. In many cases, the stand loses volume because of disease and decay, and in this context, old growth stands can be considered non-renewable. Once a stand is harvested, it would take several hundred years for it to return to its old growth state. According to The Congressional Quarterly (1983, p. 139), "The economic models that we all live by will not allow [newly planted] trees to grow 300 to 400 years." Therefore, the harvest of old growth timber is similar to

the extraction of a mineral from a mine when examining the price and quantity time paths.

Early works on the theory of the mine, such as Gray (1914), examine the rate of extraction of a stock of reserves for a firm in a competitive industry. The assumed objective of the firm is to maximize profits over time. The general result is that marginal rent, or the price minus the marginal cost of extraction, rises at the market rate of interest throughout the extraction period. Quantity extracted decreases throughout the extraction period.

Hotelling (1931) and Herfindahl (1967) show that a social planner or government maximizing social welfare will reach the same optimal solution of decreasing quantity and increasing price as a competitive industry. These models contain several simplifying assumptions including a stable downward sloping demand curve which is known by all participants in the market and a finite stock of the resource which is known by the producers. The resource stock is homogeneous, and costs are constant throughout the extraction, although the assumption of rising costs can be included without changing the basic conclusions of the model. For each time period, social welfare is defined as the sum of the producer and the consumer surplus up to the quantity extracted.

The optimal quantity harvested maximizes social welfare throughout the depletion of the stock (Hartwick and Olewiler, 1986, pp. 499-501); that is,

$$(2.1) \qquad \text{Max} \int_0^T e^{-rt}\left[B(q(t)) - cq(t)\right]dt$$

$$\text{Subject to: } dS/dt = -q(t) \text{ and } \int_0^T q(t)dt \leq S_0,$$

where B(q(t)) is the area under the demand curve up to q(t), c is the cost of harvesting per unit, and q(t) is the quantity of timber harvested in time, t; r is the interest rate and S_0 is the total stock of old growth timber to be harvested. The constraint assumes that the sum of harvests over all time periods is equal to the total stock of the old growth.

The Hamiltonian for this optimization problem is

$$(2.2) \qquad H(t) = e^{-rt}\left[B(q(t)) - cq(t)\right] - \psi(t)q(t),$$

where $\psi(t)$ is the co-state variable or shadow price representing the marginal value of the stock of timber. Necessary conditions for this model are

$$(2.3) \qquad \partial H/\partial q(t) = e^{-rt}[p(t) - c] - \psi(t) = 0$$

$$(2.4) \qquad -\partial H/\partial S = d\psi/dt = 0$$

$$(2.5) \qquad \partial H/\partial \psi = \partial S/\partial t = -q(t).$$

$$(2.6) \qquad H(T_0) = e^{-rTo}\ [B(q(T_0)) - cq(T_0)] - \psi(T_0) * q(T_0) = 0.$$

Condition 2.3 is the optimality condition for the Hamiltonian and must hold at each point in time. Condition 2.4 states that the change in the co-state variable over time is equal to the negative of the change in the Hamiltonian with respect to the change in the stock. Condition 2.5 shows the change in the stock over time equal to minus the harvest rate, with S given initially as $S(t_0) = S_0$. In this model Condition 2.6 states that the resource will be extracted until its marginal social benefit with respect to time is just zero. Combining 2.3 and 2.6 gives $B(q(T_0))/q(T_0) = p(T_0)$. That is, average consumer benefit

equals marginal consumer benefit, which occurs at $q(T_o) = 0$, i.e. the choke price. Then $\psi(T_o) = [p(0) - c]e^{-rTo}$.

The terminal condition for this problem requires that price in the final time period be equal to the choke price or the backstop price. The choke price is the price at which no one is willing to buy more of the resource with the assumed demand. If price in the final period is less than the choke price, the producer can always gain by delaying harvests and extending the depletion time.

From condition 2.3, the co-state variable is equal to the discounted value of the marginal rent, $\psi(t) = [p(t) - c]e^{-rt}$. For this problem, the co-state variable is a constant because $-\partial H/\partial S = 0$. This gives the result that so long as the stock is being extracted, the present value of the rent at different points in time must be the same; that is

$$(2.7) \qquad (P_t - c)e^{-rt} = (P_T - c)e^{-rT},$$

where P_t and P_T are the prices in time periods, t and T, respectively. Beyond the terminal time period, T_o (i.e., $t > T_o$), we have $(p_t - c)e^{-rt} < \psi_o$, where $\psi = [p(0) - c]e^{-rTo}$ is the shadow price of the stock. As quantity extracted decreases over time, the price rises. The optimization problem yields an increasing price over time such that marginal rent, R(t), from harvest grows at the rate of interest as shown in Figure 1. (Figure 2. shows the quantity time path for the theory of the mine). That is, "if each year is to have some production, no year can be more attractive to an owner of a [resource] than another, for if it were, he and all his brethren would

Figure 1. Price Time Path for the Theory of the Mine.

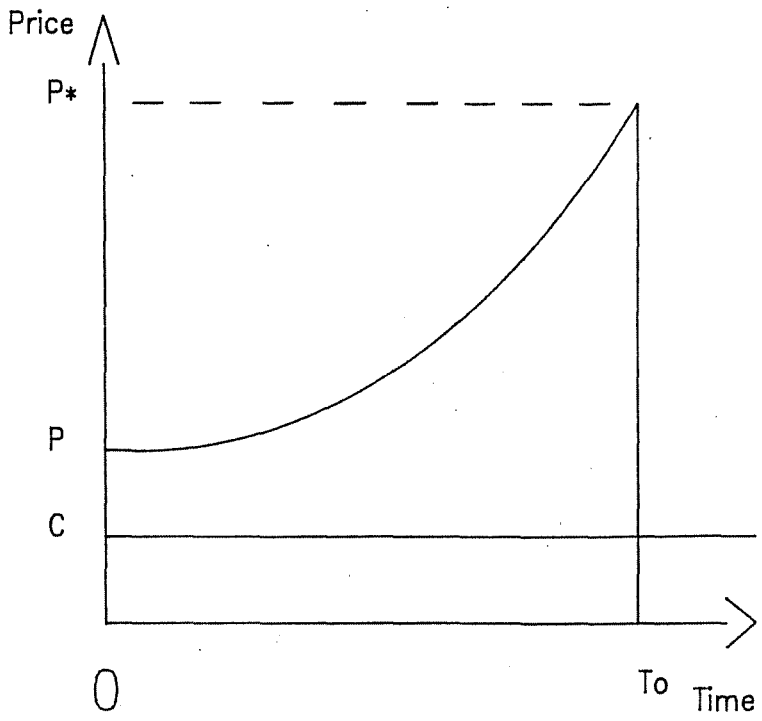
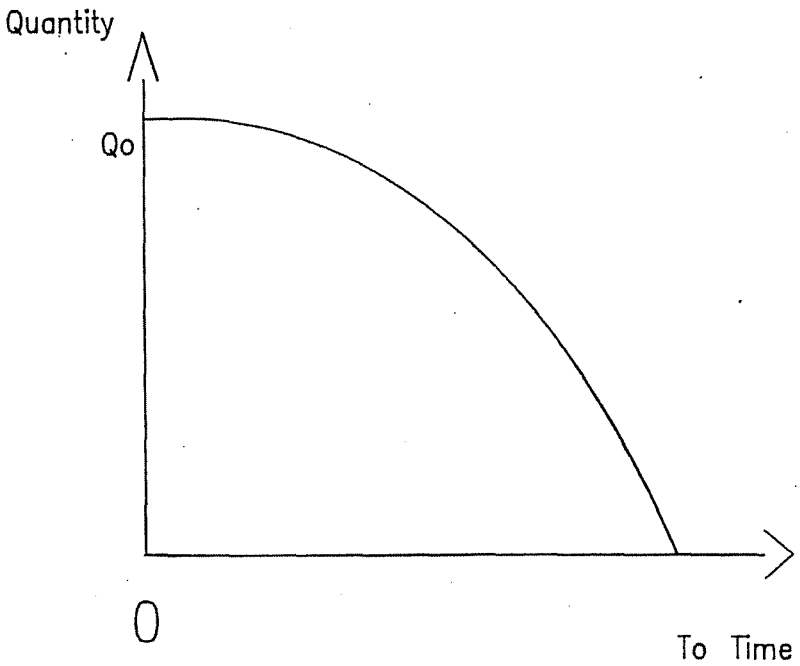


Figure 2. Quantity Time Path for the Theory of the Mine.



shift production to that year" (Herfindahl, 1967, p. 65). Quantity harvested decreases until T_0 where the old growth stock is depleted as shown in Figure 2.

Reduction in Costs

The effect of a reduction in harvest costs on the price and output paths of a competitive industry shows the effects of a subsidy on a resource stock in a dynamic setting. The assumption here is that the government subsidizes production by paying the firms a certain amount based on each unit harvested. Equation (2.7) can be rewritten to account for the payment as

$$(2.8) \qquad [P_t - (c - ss)]e^{-rt} = [P_T - (c - ss)]e^{-rT} ,$$

where ss represents the reduction in costs for each unit harvested. The payment reduces the costs paid by the firms for each unit sold, which, in turn, alters the quantity and price paths. The decreased costs of production due to the per unit payments are shown as C_s in Figure 3.

With the decrease in harvesting costs, the requirements that marginal rent rise at the rate of interest and that all of the old growth stock be depleted must still hold. To physically deplete the old growth stock at the instant P* is reached, the initial price must be reduced from P_0 to P_s. The price path, P_0-W, shown by the dashed line in Figure 3. and the quantity path, Q_0-W, in Figure 4. are followed if the original initial price is kept. Rent, in this case, is now larger in the initial period because of the subsidized harvest

Figure 3. Price Time Path for the Theory of the Mine with a Reduction in Costs.

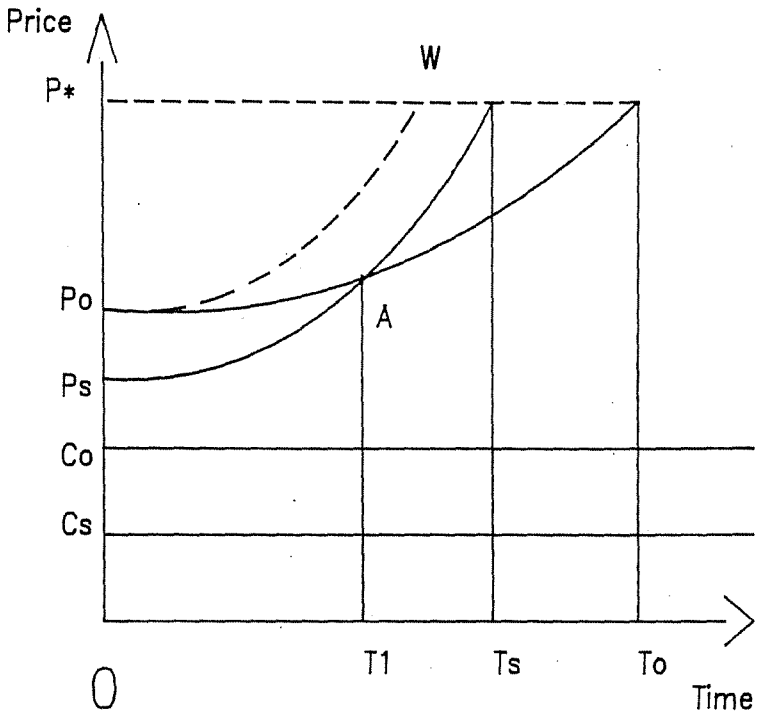
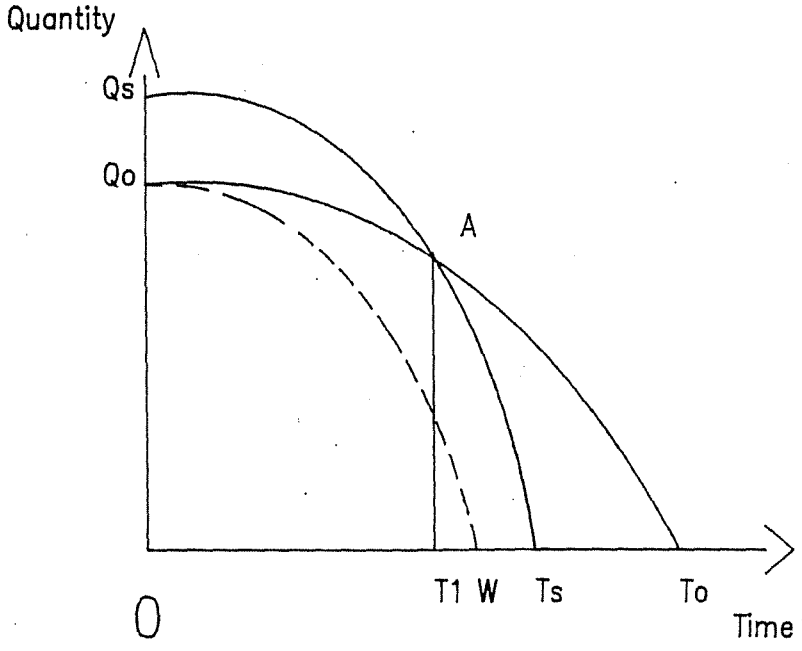


Figure 4. Quantity Time Path for the Theory of the Mine with a Reduction in Costs.



costs, but it must still rise at the interest rate. Given the new price path, however, the choke price is reached before the resource stock is exhausted. Therefore, the initial price must be reduced from P_0 to P_S to meet the stated conditions. The corresponding harvest time is reduced from T_0 to T_S.

In a static framework, the payment from the government appears to be a subsidy because initially more trees are harvested with a reduction in harvest costs. By reducing the harvest cost, the government assumes a cost of a factor of production. This provides a higher quantity of timber at a lower price in the early years of harvest.

In a dynamic framework, however, a reduction in costs cannot be considered a subsidy throughout the entire depletion period. From the initial time period to T_1 the quantity harvested is greater and the price is less than in the case with no reduction in costs. The increase in the total quantity supplied during the early period is area Q_S-A-Q_0. The time period from T_1 to the depletion of the old growth, however, shows quantity to be less and price to be greater than the case with no cost reduction. The quantity harvested during that period is reduced by area A-T_0-T_S, where A-T_0-T_S is exactly equal to Q_S-Q_0-A.

The major implication in the dynamic framework is that the traditional definition of a subsidy does not apply throughout the depletion of the old growth timber. In such a case, the quantity of timber harvested is less and the price is greater than the case without a government payment in the later time periods.[1]

Before countervailing duties can be imposed against a subsidizing country, material injury to the domestic producers must be proved. However, within the framework of the theory of the mine, a country with lower costs that subsidizes production may actually benefit the producers in the United States. As will be shown, a subsidy can increase the present value of the timber stock in the U.S.; the owners of the timber stock are made better off, and the material injury argument no longer holds. This outcome may well apply to Canadian lumber imports, particularly since it is claimed that even in the absence of a subsidy the cost of harvesting the vast amounts of Canadian old growth timber is less than the cost of harvesting timber in the U.S.

To demonstrate the possibility that a subsidy can increase the wealth of resource owners in the importing country, a two country model is used where both countries have stocks of old growth timber and where the costs in country A are lower than the costs in country B. The difference in costs could be due to any number of factors, such as the accessibility of the old growth, the historical differences in harvesting the old growth stocks, or the transportation costs to markets. Both countries face constant costs; that is, each stock within itself is of uniform quality. Also, assume that there are no trade barriers between the two countries and that the market structure is competitive. This relationship is shown in Figure 5. (Figure 6. shows the two-country model with a reduction in costs.) The optimal harvest plan follows Hartwick and Olewiler's (1986, pp. 72-74) example of extraction with deposits of differing quality.

Figure 5. Price Time Path for a Two-Country Model.

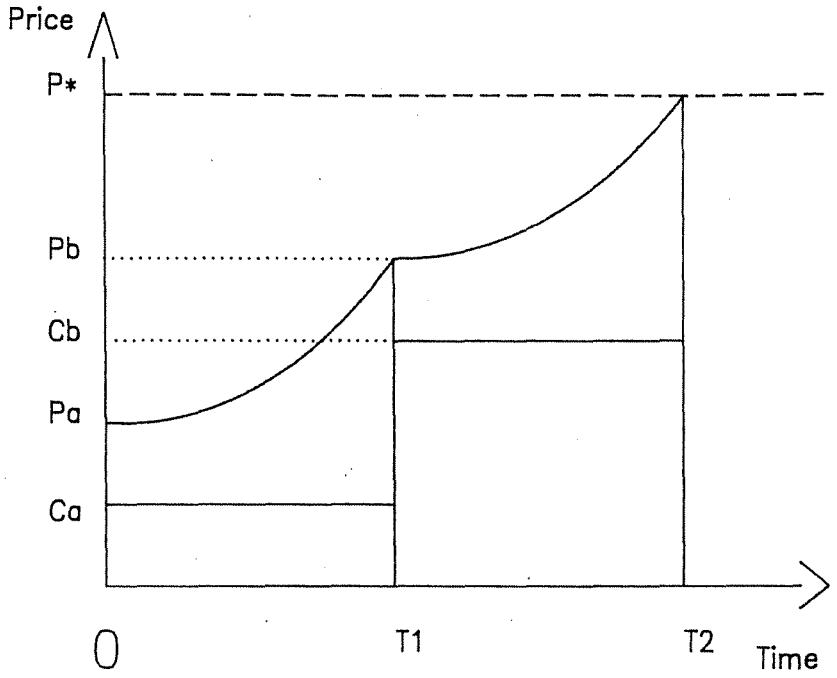
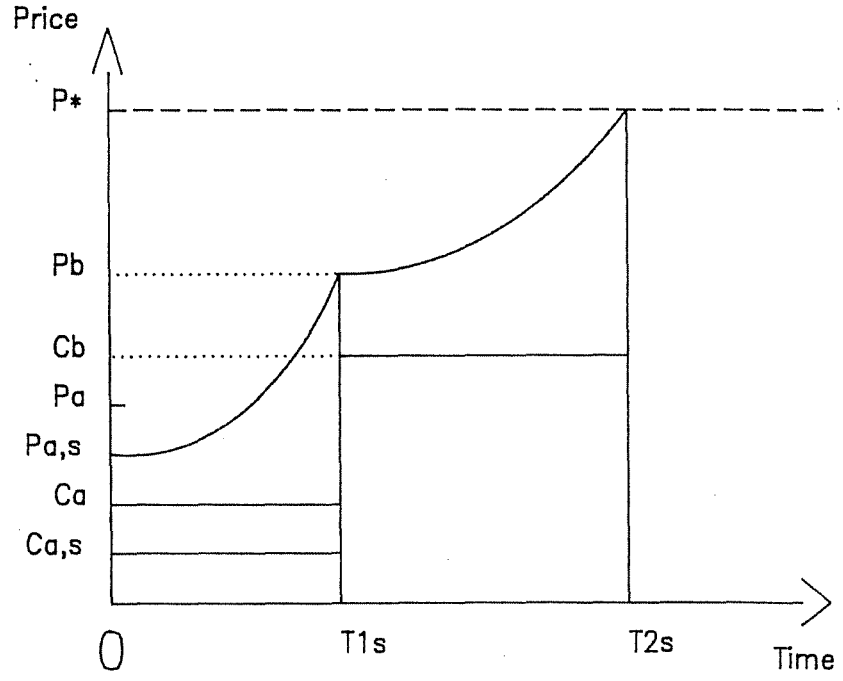


Figure 6. Price Time Path for a Two-Country Model with a Reduction in Costs to the Low Cost Country.



Optimization calls for the lower cost resource to be extracted first. Thus, harvests for country A start at T_0 and marginal rent, $P(t) - C_a$, grows at a rate equal to the rate of interest. Country A continues to harvest until T_1 where the stock of country A is depleted. At T_1, country B can begin harvesting and its marginal rent, $P(t) - C_b$, continues to rise at the rate of interest. Harvests continue until T_2 where the choke price, P*, is reached, and the stock of B is depleted. All of the old growth stock in both countries is depleted at that time. The initial price, P_a, is obtained by working backward from the time when both stocks are depleted.

If the government of country A made a "per unit" payment to decrease the harvesting costs of stock A, the time period for the depletion of stock A would be reduced. This relationship is shown in Figure 6. Note, however, that P_b is still the initial price required for the producers in country B to remain indifferent between harvesting times and for the rental value to rise at the rate of interest. Therefore, P_b is still the choke price for the depletion of Stock A, regardless of the decrease in the harvesting costs of stock A. If country A retains the initial price, P_a, then with a decrease in costs, and the requirement that the marginal rental value rise at the rate of interest, the price would reach P_b before the stock of A is depleted. This does not meet the necessary condition that the stock is depleted when the choke price, P_b, for country A is met. Consequently, the initial price, P_a, must be reduced to $P_{a,s}$ for this to occur. The depletion time for stock A is reduced from T_1 to T_{1s}.

The price path for stock B remains the same except that it now starts at T_{1s} instead of T_1, and the final depletion time is reduced from T_2 to T_{2s}. The result is an increase in the present value of stock B. The reason for this outcome is that receipts from the harvests can be invested in alternative assets earlier than in the non-subsidy case. Thus, the owners of the stock in country B are actually better off with the subsidy payment to stock A producers by the government of country A.

This analysis illustrates an important point. What is commonly considered a subsidy to the producers of one country does not necessarily materially injure the producers in another country, and may actually help the producers in the second country. While this case does not cause material injury, a subsidy can materially injure producers in another country if higher cost producers are subsidized. In this setting, a cost reduction causes harvests of the higher cost timber stock to begin earlier and the present value of the lower cost stock decreases. A reduction in harvest costs is only one aspect of the effects of a subsidy in the theory of the mine. The next section shows that other factors also can have the same effect as a subsidy.

Constrained Harvests and a Reduction in Costs

This section utilizes the theory of the mine with a harvest constraint to show the effects of an imposed government harvest program on the price and quantity profiles. First, the effects of a harvest constraint will be shown. Then, along with a harvest constraint, a reduction in costs will be applied to further emphasize

the discrepancies in the traditional definition of a subsidy and to illustrate the effects in a dynamic framework.

A constraint on harvests may be instituted because the government wishes to maintain a given level of production over a specific period of time. For example, many timber management programs profess to support an even flow management objective to preserve a timber supply for future generations. Such harvest constraints alter the price and quantity time paths as well as the depletion time for the old growth timber stock. This section illustrates that both the price and quantity paths change if a harvest constraint is imposed on the rate of depletion of an old growth timber stock.

With a harvest constraint, Equation 2.1 becomes

$$(2.9) \qquad \text{Max} \int_0^T e^{-rT}[B(q(t)) - cq(t)]dt$$

$$\text{Subject to: } \partial S/\partial t = -q(t), \int_0^T q(t)dt \leq S_0 \text{ and } q(t) \leq \bar{q}.$$

The last constraint, $q(t) \leq \bar{q}$, converts the previous control problem into a problem of bounded control (Kamien and Schwartz, 1981, pp. 170-179).

Figure 7. shows that the quantity harvested under the constraint, $\bar{Q}$, is less than the unconstrained harvest until T_c (Figure 8. shows the price path). At T_c, constrained harvests become greater than the unconstrained level. After T_1, output decreases from its constant level until the stock becomes depleted at T_2.

The total quantity harvested under the unconstrained solution at T_c is exactly equal to the quantity harvested at T_1 under the constrained solution. In other words, the quantity, Q_o-A-T_c-O,

Figure 7. The Effect of a Constraint on the Quantity Time Path in the Theory of the Mine.

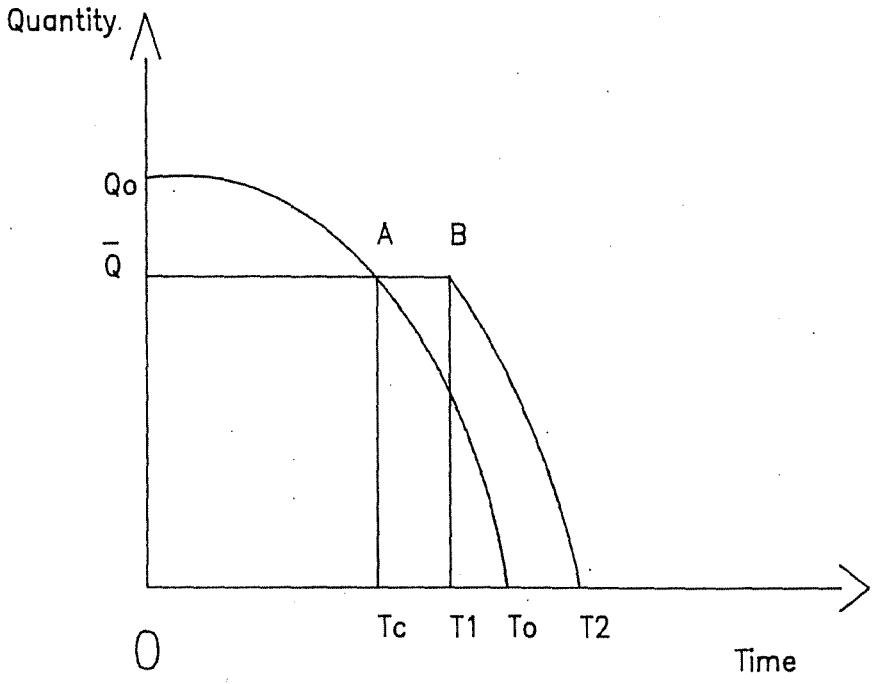
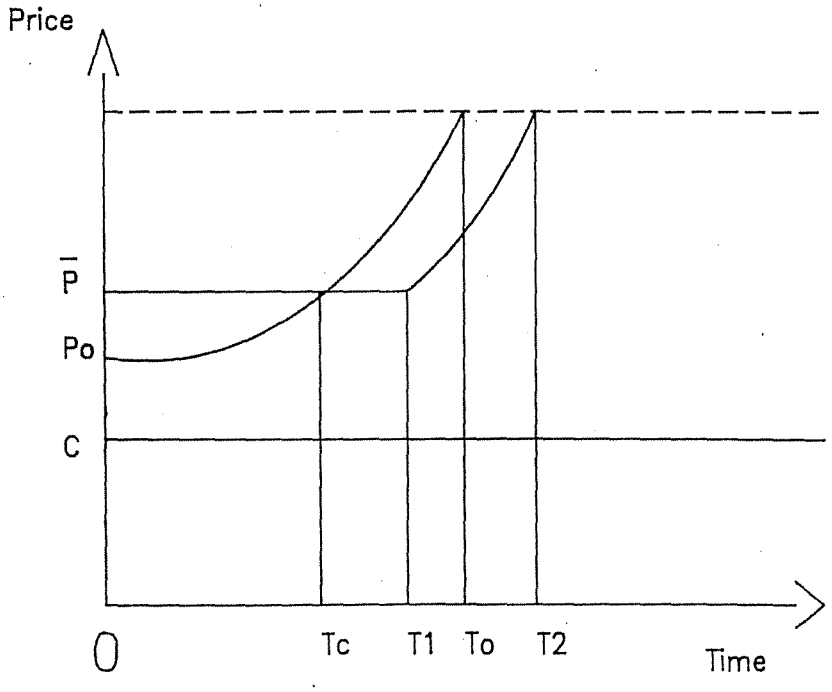


Figure 8. The Effect of a Constraint on the Price Time Path in the Theory of the Mine.



harvested under the unconstrained solution is exactly equal to the quantity, $\bar{Q}-B-T_1-0$, harvested under the constrained solution.

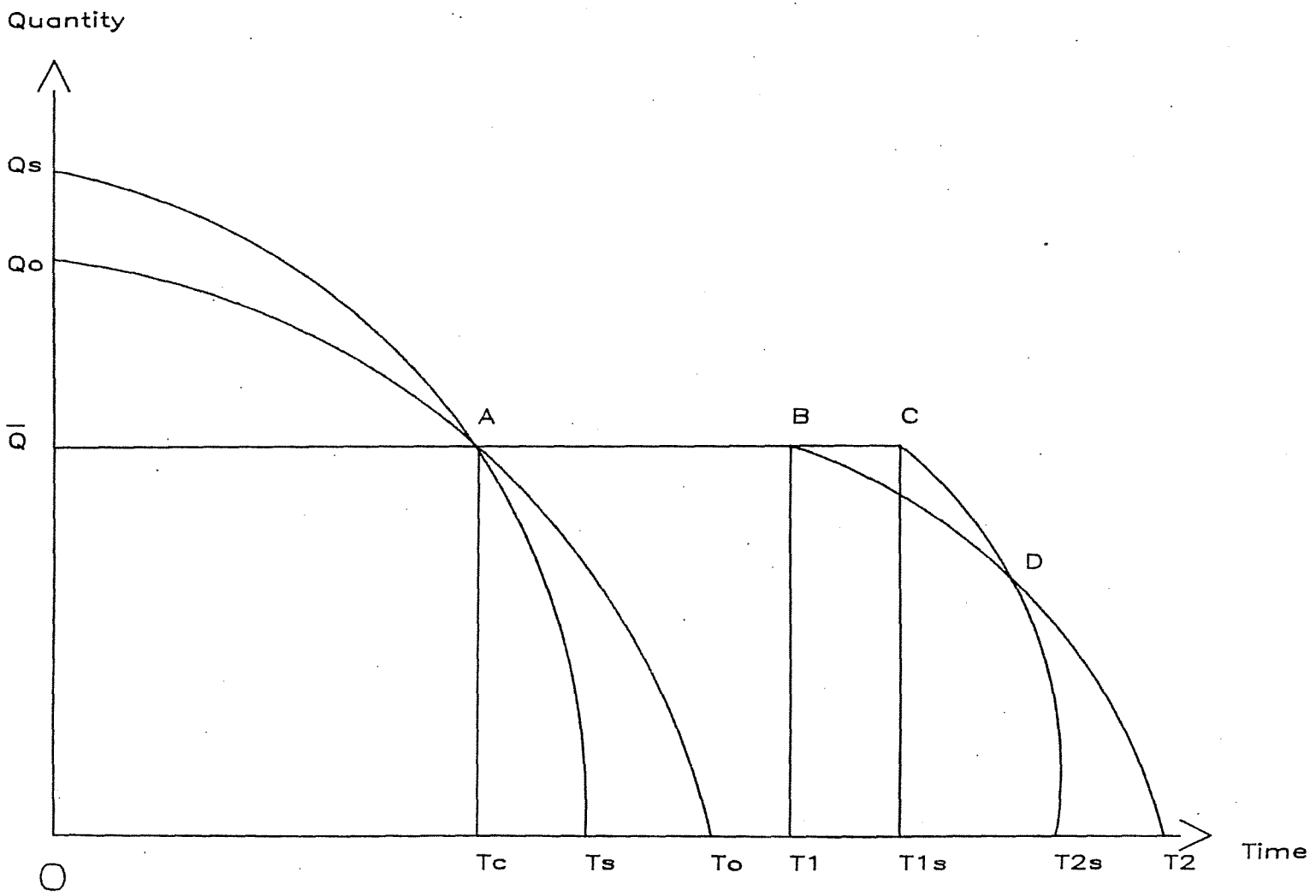
Figure 8. shows the price time path which has an initial constrained price, $\bar{P}$, greater than the unconstrained price until T_c. Price is less than the unconstrained price from T_c until the depletion of the timber stock. At T_1, the constraint is no longer binding, and price rises such that marginal rent rises at the interest rate until the choke price is reached, and the stock is depleted at T_2.

The general result is that when a constraint is imposed, the quantity harvested is less and the price is greater than the unconstrained harvest case from the initial time period to T_c. The quantity not harvested in this period, due to the constraint, is $Q_0-A-\bar{Q}$. Consequently, quantity harvested is greater and the price is less than the unconstrained harvest from T_c to T_2. The quantity increase during this period is $A-B-T_2-T_0$ which is equal to the quantity, $Q_0-A-\bar{Q}$.

Importantly, when a policy, traditionally defined as a subsidy, is applied to a situation where a constraint on harvests exists, there may be no effect on immediate harvests. With a cost reduction via a "per-unit" payment, the time paths are only partially altered. Figure 9. shows a combined harvest constraint and cost reduction and the effects on the quantity time path.

The effects on price can be deduced by examining the quantity paths. The cost reduction causes marginal rent to increase from $(P_t - c)$ to $[P_t - (c - ss)]$ which, in turn, causes the harvest constraint to hold for a longer period of time. Producers can

Figure 9. Quantity Time Path for the Theory of the Mine with a Harvest Constraint and a Per Unit Payment.



maximize present value by continuing harvests at the constrained level and take advantage of the larger rent created by the "per-unit" payment cost reduction. The time, at which the harvest constraint is no longer binding, goes from T_1 to T_{1s} where $T_{1s} > T_1$, and the total quantity harvested, Q_s-A-T_s-0 and $\bar{Q}$-C-T_{2s}-0, are identical and $T_{1s} > T_1$ (the horizontal axis of Figure 9. is exaggerated to accommodate the number of time paths).

The harvest constraint dominates the initial time periods, and there is no change in the initial time periods with a subsidy when compared to the harvest constraint alone. However, the cost reduction causes a diversion of the quantity time paths beyond T_1. Prices will, at first, be lower, then become higher in comparison to the constrained harvest alone when the paths cross at D.

The major implication of the combination of the cost reduction and the harvest constraint is, again, that the traditional definition of a subsidy does not hold for all periods. Importantly, with the presence of a harvest constraint a subsidy will have no effect on price in the initial periods. Thus, the mere presence of a subsidy cannot be used to infer that price has fallen and that material injury has occurred. This point will play an important role in the analysis offered in Chapter 3.

Another implication is the transfer of rents from the government to the timber producers. If the harvests are constrained, the cost reduction is not passed on to decrease the price of the final product. Assuming the rights to harvest timber are well defined, the rents provided by the payment are captured by the timber producers and lost

by the owners of the timber, the government. The selling price is independent of a cost reduction with a harvest constraint in the initial periods, and given the assumptions of the model the payments will not be passed along in the form of a lower selling price. The reduction in costs becomes a transfer to the timber producers.

Steady State Model

This section examines the definition of a subsidy in the context of a steady state model. The effects of harvests at a biological maximum, such as the culmination of mean annual increment, as well as the effects of a reduction in harvest costs are discussed with regard to subsidies. The steady state model is then combined with the theory of the mine to discuss a long-range model of timber supply and to examine the effects of policies in the context of subsidies.

Once the old growth timber stock has been depleted, the harvest of timber can approach a steady state, assuming the quantity of forest lands is unchanged. Initially, it is assumed that the objective of the government is to maximize the net present value of its forest land from present and future harvests. That assumption is relaxed when subsidies are introduced. There are other benefits from forests besides timber, such as wildlife and recreation, but this study will focus on timber production. In this context, the present value of current and future harvests is expressed as (Hartwick and Olewiler, 1986, pp. 356-358)

$$(2.10) \qquad W = (P - c)V(t)e^{-rt} + (P - c)V(t)e^{-2rt} + \ldots ,$$

where W is the value of the forest land, (P - c) represents price minus harvesting costs, V(t) is the wood volume at the time of harvest, and r is the interest rate. In this expression, marginal harvest costs are constant. By use of the geometric series rule, Equation 2.10 can be rewritten as

$$(2.11) \qquad W = (P - c)V(t)/(e^{rt} - 1).$$

The change in the value of the forest can be obtained by taking the first derivative of W with respect to t, the rotation age. Setting the first derivative equal to zero and rearranging terms, yields

$$(2.12) \qquad V'(t) = rV(t) + rV(t)/(e^{rt} - 1)$$

where $1/(e^{rt} - 1)$ is equal to $e^{-rt}/(1 - e^{-rt})$. Equation 2.12 is known as the Faustman Formula and states that the optimal rotation age is determined by setting the change in volume equal to the opportunity cost of delaying current harvests plus the opportunity cost of delaying future harvests. It is noticed that (P - c) cancels out from both sides of the equation, which implies that prices and costs have no effect when determining the rotation age in this case.

Maximum Sustained Yield

Now that a model for the rotation age is defined, the effects of harvests at maximum sustained yield and the effects of subsidies can be discussed. Samuelson (1976, p. 476) defines maximum sustained yield as follows.

> Cut down trees to make way for new trees when they are past their best growth rates. Follow a planting, thinning and cutting cycle so the resulting (net?) lumber output, over repeated cycles, ... will be as large as possible.

Maximizing sustained yield is equivalent to timing harvests to occur at the culmination of mean annual increment. This relationship is shown in Figure 10. as T_{max}, where current annual increment, (CAI), and mean annual increment, (MAI), intersect. Current annual increment is the marginal growth of the forest, $V'(t)$. Mean annual increment is the average growth of the forest, $V(t)/t$. Maximum or culmination of mean annual increment occurs at T_{max}.

This can be shown in Equation 2.12 by letting the interest rate approach zero from above. Using l'Hospital's rule and taking the limit as r approaches zero, yields

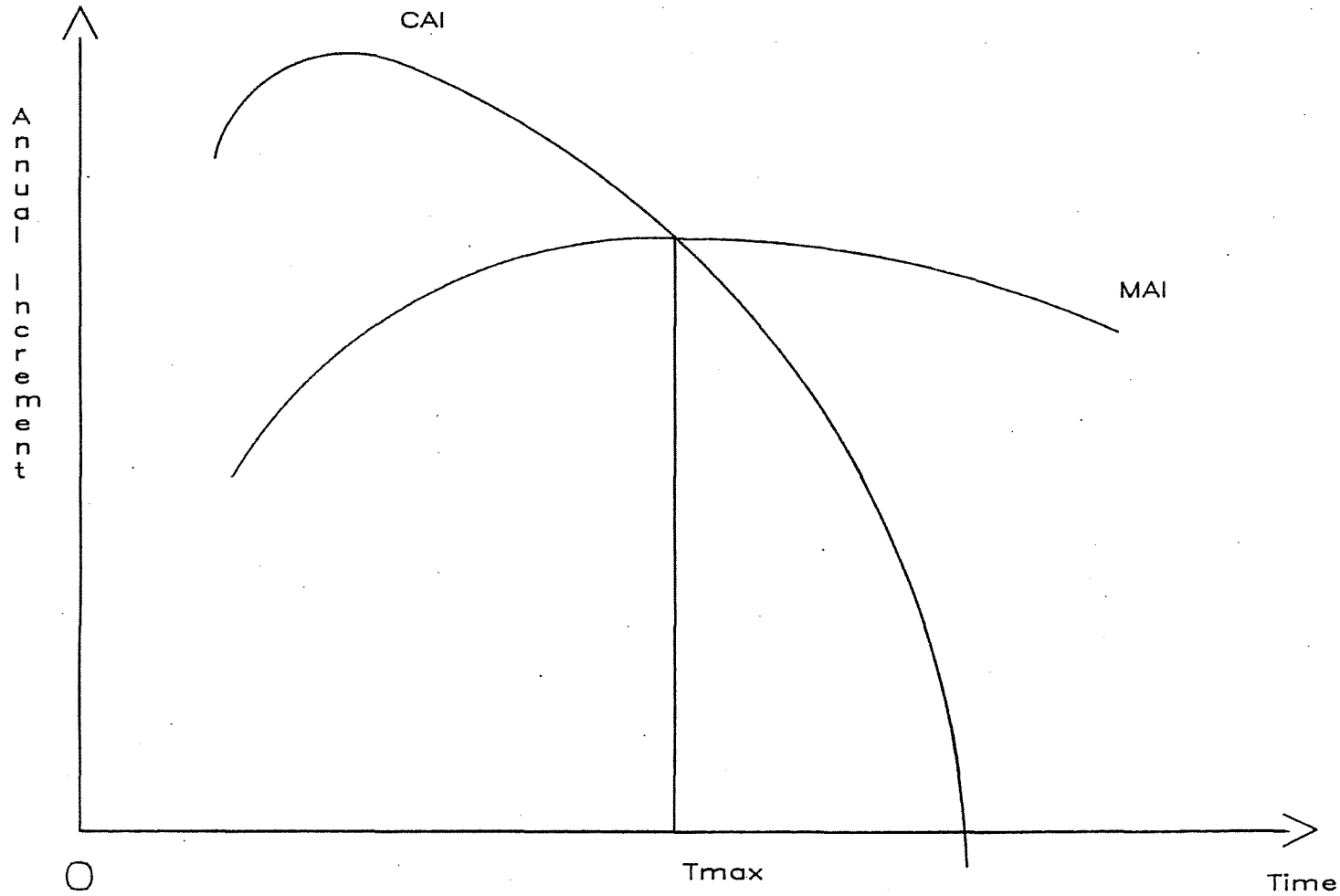
$$V'(t) = V(t)/t. \tag{2.13}$$

Equation 2.13 states that marginal growth equals average growth. The economically determined optimal rotation age would equal the maximum sustained yield rotation age only when the interest rate is equal to zero. In reality, interest rates are not equal to zero. As the interest rate increases, the rotation age decreases, and steady state harvest volumes decrease. Rearranging terms in Equation 2.12 yields

$$V'(t) - e^{-rt}V'(t) = rV(t). \tag{2.14}$$

Taking the total derivative with respect to t and r, and solving for dt/dr results in

Figure 10. Maximization of Sustainable Yield.



$$(2.15) \qquad dt/dr = \frac{V(t) - te^{-rt}V'(t)}{[V''(t) - rV'(t)](1 - e^{-rt})} .$$

The denominator of 2.15 is negative as a result of the second-order condition. Solving equation 2.14 for V(t) and substituting into the numerator in equation 2.15 and rearranging terms yields

$$(2.16) \qquad dt/dr = \frac{V'(t)(1 - e^{-rt} - rte^{-rt})/r}{[V''(t) - rV'(t)](1 - e^{-rt})} .$$

The expression within the parentheses of the numerator can be rewritten as $(1 - (1 + rt)/e^{rt})$. For all $t > 0$ and $r > 0$ this term must be positive. Since $V'(t)$ is also positive the numerator is positive and dt/dr is negative.

Any positive interest rate causes the rotation age to be to the left of T_{max} in Figure 10. A timber management program that sets harvests according to the biological rule of maximum sustained yield acts as a subsidy in the steady state. Harvests at maximum sustained yield are greater than the harvests determined with a positive interest rate. Although there are no explicit cash payments or reductions in costs, the management policy of maximizing sustained yield results in harvests greater than those that would occur without the policy. If a government adheres to a policy of maximizing sustainable yield on its own lands, it is indirectly subsidizing users by increasing the amount available. Yet, it is easy to overlook such an indirect subsidy.

Reduction in Harvest Costs

Another way to look at the difficulty in determining the effect of a subsidy within a steady state framework is to examine the impact of a reduction in harvest costs. Here it is assumed that a payment from the government to private owners of timber lands is provided at the time the stand is harvested.

To obtain any effects from a reduction in costs, Equation 2.10, with constant marginal harvest costs, must be rewritten as

$$(2.17) \quad W = [pV(t) - c]e^{-rt} + [pV(t) - c]e^{-2rt} + \ldots$$
$$= [pV(t) - c]/(e^{rt} - 1).$$

Total harvest costs are now independent of volume. Recall that if Equation 2.10 is used, then (P - c) cancels out, and a change in harvests costs has no effect on harvest or rotation age. Equation 2.17 relaxes the proportionality assumption and allows for a change in costs to alter the optimal rotation age.

Johansson and Lofgren (1985) and Clark (1976) show that $dt/dc > 0$, i.e., an increase in harvest costs increases rotation age. Therefore, a decrease in costs will generally decrease rotation age. However, as illustrated below, the steady state harvest may either increase or decrease.

Maximizing W in Equation 2.17 with respect to t yields

$$(2.18) \quad V'(t) = r[V(t) - c/p] + r[V(t) - c/p]/(e^{rt} - 1).$$

Using the procedure outlined above for taking the limit as r approaches zero yields

(2.19) $V'(t^*) = V(t^*)/t^* - c/pt^*,$

where t^* is the optimal rotation age. As can be seen, equation 2.19 does not yield the usual culmination of mean annual increment as the optimal rotation age when r is zero. Rather, it states that marginal growth is less than average growth and, therefore, harvests are to the right of T_{max} in Figure 10. Recall that culmination of mean annual increment occurs at T_{max}.

Accordingly, a decrease in rotation age does not necessarily decrease annual increment because t^* may be to the right or left of T_{max} in Figure 10. The effect of a decrease in costs on the steady state yield is ambiguous in this model.

For all practical purposes, however, rotation age is generally to the left of T_{max}. Berck (1979) has shown that financial maturity of forests is reached before the culmination of mean annual increment. This would indicate that harvests occur to the left of T_{max} in Figure 10. A decrease in harvest costs would decrease rotation age which, for most practical cases, decreases the steady state total harvest. Here, the subsidy has the perverse effect of actually decreasing the amount supplied.

Theory of the Mine with a Steady State

The theory of the mine can now be combined with the steady state model to discuss subsidies in the long run supply of timber. Lyon (1981) proposes the use of the theory of the mine to examine the time path of the price of timber, where at least, in part, an existing

forest is being mined. Lyon and Sedjo (1983) further extend the optimal depletion of the old growth timber stock and examine optimal harvest levels during and after completion of the transition, and a steady state system exists. The combination of the depletion period and approach to a steady state constitutes the long run supply response. Here, the objective function is assumed to be the maximization of the discounted value of producer and consumer surplus.

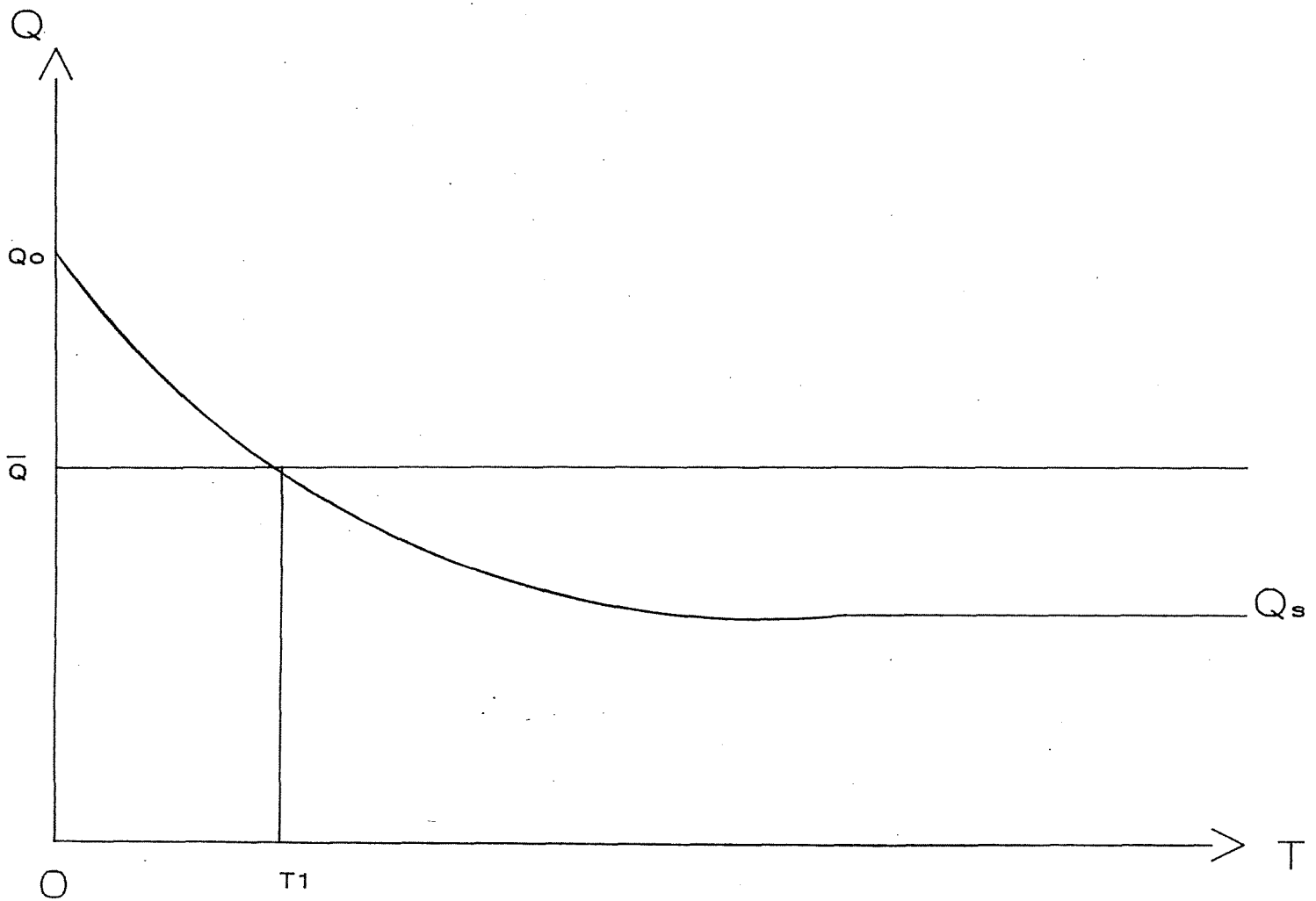
The quantity time path suggested by Lyon and Sedjo is represented in Figure 11. by the curve labeled Q_0Q_s. Harvests at Q_0 are high in the initial periods as the old growth timber stock is mined. Harvest quantity declines in the later time periods and eventually approaches a steady state level.

The inclusion of a fixed harvest, such as maximum sustained yield, is shown as $\bar{Q}$. The maximum sustained yield harvest level is below that of the long-run supply in the initial periods. At T_1, the paths cross, and the maximum sustained yield harvests are greater than the harvests along the path Q_0Q_s.

A reduction in harvest costs with maximum sustained yield has no effect on quantity harvested, $\bar{Q}$. But with the harvest level constrained at $\bar{Q}$, the question of whether a subsidy exists focuses on whether the harvests occur before or after T_1.

If the harvests occur before T_1, the quantity is less than the long-run supply path and greater after that point. This fits neither the traditional nor legislative definitions of a subsidy. If the harvests occur after T_1, the quantity is greater than the long-run supply and is consistent with the traditional and legal definition of

Figure 11. Long Run Timber Quantity Time Path with the Combined Theory of the Mine and Steady State System.



a subsidy. In both periods, the same governmental policy was in effect; yet, in one period there is no subsidy and in the other, a subsidy is present.

This example, again, shows the difficulty of identifying a subsidy in a dynamic model. The major factor in this case depends on whether harvests occur before or after T_1. Without knowledge of where the Q_0Q_S path is relative to $\bar{Q}$, it is impossible to determine whether a subsidy is taking place, and such knowledge is costly to obtain.

Conclusion

This chapter showed the ambiguity in identifying a subsidy in a natural resource case. The harvest of old growth timber was then compared with the depletion of a non renewable resource stock as in the theory of the mine and the difficulty in defining a subsidy was discussed. Within the theory of the mine, the quantity and price effects with a payment that reduces harvest costs and a constraint on harvests were examined. It was shown to be difficult to identify a subsidy in these cases. A subsidy to the producers of one country was shown not to cause injury to the domestic producers of another country if the exporting country's costs are lower than the domestic producer's costs. In this case, the domestic producers are actually made better off because the present value of their stock increases.

Next, the difficulty of identifying a subsidy in a steady state model was discussed. The steady state model was proposed as a likely management system after the old growth stock is depleted. The effects

of a reduction in costs and maintaining harvests at maximum sustained yield as countervailable subsidies were examined.

Finally, this chapter combined the theory of the mine and the steady state system to outline the long run supply response of timber. The effects of a reduction in costs and harvests at maximum sustained yield were discussed in the context of a subsidy. Again, a subsidy was shown to be difficult to identify.

A general conclusion that emerges is that the determination of whether a subsidy exists depends on the time at which the harvests take place. Information needed to determine the presence of a subsidy includes the amount of the stock remaining and an idea of the rate of depletion and the implied rental value of the resource stock. A determination of a subsidy cannot be made without this information.

The main purpose of this chapter has been to set the foundation for the study of Canadian timber subsidies on imports to the United States. The next chapter examines the specific issue of Canadian lumber import subsidies from the standpoint of charging a below-market stumpage price in the presence of a harvest constraint.

End Notes

1. A reduction in costs in the form of a government payment results in an efficiency loss in the traditional economic sense. Total social welfare is less than that in the case with no cost reduction.

CHAPTER 3

CANADIAN STUMPAGE PRICE SYSTEMS AS COUNTERVAILABLE SUBSIDIES

The purpose of this chapter is to apply the concepts developed in Chapter 2 and empirically examine the hypothesis that stumpage price is the driving force of the supply of lumber in Canada. As noted in Chapter 1, lumber producers in the United States have argued that low stumpage prices in Canada constitute a countervailable subsidy under the Fair Trade Act of 1979. In addition, the issue of setting annual allowable cuts in Canada as countervailable subsidies will be raised.

This chapter begins with background information on harvests and harvest regulation as they relate to the supply of timber in Canada. Next is a detailed discussion of the material injury clause of the Fair Trade Act of 1979. Given the institutional setting, the arguments for countervailing duties as presented by the Coalition for Fair Lumber Imports for stumpage pricing systems as the cause of material injury are reexamined. Then, an argument that states that the setting of the annual allowable cut determines lumber supply independent of stumpage price is presented. Finally, an empirical model is developed that distinguishes whether stumpage or the annual cut is the main determinant in the supply of Canadian lumber.

Background

Over 92% of the total forest acreage in Canada is owned by the provincial and federal governments (U.S. Department of Commerce, 1986). Of the productive forest land, 72% falls within the boundaries of British Columbia, Alberta, Ontario, and Quebec. There are three major timber producing zones in Canada: Coastal British Columbia, Interior British Columbia and Alberta, and Eastern Canada. While the composition of timber stands in Interior British Columbia, Alberta, and Eastern Canada is mostly spruce, pine, and fir, the old growth timber stands in Coastal British Columbia are predominantly hemlock and Douglas-fir. Harvests in Canada have followed the pattern of harvests in the U.S., i.e., the more accessible stands were cut first and tracts with higher extraction costs left until now. While the government owns the land, harvesting is carried out by privately owned firms.

Timber harvesting is financially important in British Columbia and accounts for 68% of the lumber exports to the United States (Tarr, 1983). In addition, it is one of the four provinces listed specifically in the countervailing duty petition and its policy is the most detailed and comprehensive of the major exporting provinces. For these reasons, the policies and history of British Columbia's timber harvesting are chosen for the analysis of this study.

History of Harvest Regulation

The history of harvest regulation in British Columbia provides important insights into the supply of Canadian lumber. Of utmost importance was the adoption in 1945 of a policy of sustained yield (Government of British Columbia, 1984). The goal was a systematic reduction of the old growth timber with annual allowable cuts designed to achieve a long run sustainable yield. This was to be accomplished through application of the Hanzlick Formula (Pearse, 1976), which can be expressed in its simplest form as

$$(3.1)\quad \text{Allowable Annual Cut} = \frac{\text{Volume of Mature Timber}}{\text{Number of Years in Rotation Age}} + \text{Mean Annual Increment of Immature Stands over the Planned Rotation Age.}$$

Despite a purported adherence to an even flow harvest policy, harvests, as shown in Table 1., increased considerably over time.[1] These increases, were, in part, the result of changes in the timber utilization standards which were used in the sustained yield calculations (Government of British Columbia, 1984). The Hanzlick Formula philosophy remained in effect until new legislation was passed in 1979.

The 1979 British Columbia legislation called for a more integrated approach with consideration of resource values in determining rates of harvest. The new management philosophy, termed "timber supply analysis," replaced the Hanzlick yield regulation calculation. The new approach provides "an opportunity to assess a number of proposed options, rather than limiting the planning process

Table 1. Lumber Production in British Columbia and Canadian Total.

Year	Lumber Production $1000m^3$	
	British Columbia	Canada Total
1950	8280	15465
1960	12518	18907
1970	18067	26588
1971	21090	30027
1972	22431	33000
1973	24597	36644
1974	20628	32124
1975	17569	27305
1976	25075	36822
1977	28378	41633
1978	29570	44887
1979	30357	46700
1980	28207	44995
1981	24547	40217
1982	23406	37452
1983	30777	48666

Source: Government of Canada. Selected Forestry Statistics, Canada, 1985.

to an examination of a single option" (Government of British Columbia, 1984, p. 46). The single option mentioned is adherence to the Hanzlick formula.

Under the new legislation, the chief forester determines the allowable cut for a five-year period on each of the 32 timber sale areas and the tree farm licenses. Considerations include the rate of timber production that may be sustained in the area, the short- and long-term implications in alternative rates of harvests, the requirements of established and proposed processing facilities, and finally, the economic and social objectives of the Crown as expressed by the Minister (Government of British Columbia, 1979).

The volume of timber harvested during any one year of the five-year cut control period cannot be greater than 150% or less than 50% of the yearly allotment of the allowable cut. Additionally, the volume of timber harvested during the five-year cut control period cannot be greater that 110% or less than 90% of the five-year annual allowable cut.[2] Violations of harvests greater than the restrictions result in payments to the Crown of double the stumpage rate for that volume over the maximum allowed. Violations of harvests less than the restrictions in the calendar year case result in the volumes not being carried forward to the five-year cut. If the volume is short in the five-year period, it will not be carried through to the next five-year period. The cut controls as specified in the contract are strictly regulated.

The majority of the timber harvested in British Columbia is priced through the Rothery[3] Residual Value Method System as outlined

in sections 81 to 84 of the Forest Act (Government of British Columbia, 1979). Stumpage prices are determined through appraisals which are conducted on an annual basis. In this system, an end product selling price is first calculated, then milling costs and a profit allowance are deducted from the selling price to determine the stumpage price (U.S. International Trade Commission, 1985).

The formula used to determine the stumpage price throughout Canada (Government of British Columbia, 1986a, p. 5.1-1, and 1986b p. 1-2) is

$$(3.2)\quad \text{Stumpage Rate} = \frac{\text{Selling Price}}{1 + \text{Profit \& Risk}} - \text{Operating Cost}$$

Calculated are two selling prices: one for the coastal region of British Columbia and one for the interior region. On the coast, prices by tree species are determined from a monthly survey of sales based on a three-month average. In the interior region, the selling price is based on a combination of prices for lumber, stud, and wood chips over a three-month average (U.S. International Trade Commission, 1985).

Timber dues are generally adjusted monthly. "The adjustments moderate for the buyer both the potential for profit in rising markets and losses in falling markets" (U.S. International Trade Commission, 1985, p. 52). The selling price is recalculated on a monthly basis if the three-month Average Market Value increases more than $1.00 on the coast or $5.00 in the interior from the last Average Market Value. Similarly, operating costs, which include road building, are based on

schedules designed from surveys that show the average cost of the typical firm.

Profit and risk allowances include allowances for market risk, cull and breakage, investment risks, the risk of chance, and a basic profit allowance. Profit and risk is a decimal fraction ranging from 0.11 to 0.22 on the coast and 0.12 to 0.27 in the interior region.

Finally, a minimum stumpage price is set for which timber is sold. This ranges from 6 to 8 % of the Average Market Value on the coast to 3 % of the selling price of lumber, chips and pulpwood in the interior. The purpose behind the minimum stumpage rate is that "each species in a stand of trees is assumed to have intrinsic value and, consequently, a minimum rate of stumpage is charged regardless of the indicated rate in the appraisal" (Government of British Columbia, 1986b, p. 3-8). The rate charged is the "upset stumpage" which is the greater value of the indicated stumpage from the formula or the minimum stumpage value.

A review of the institutions of stumpage price setting seems to support the allegation that prices are administratively set. That is, stumpage prices appear to be exogenously determined. Moreover, there are lags in determining prices due to the inclusion of the three-month average for selling prices. However, even if stumpage prices are administratively set, it does not necessarily follow that price is the driving force in the supply of Canadian lumber and thus, the cause of material injury to the U.S. lumber industry.

Material Injury

The material injury clause in the Fair Trade Act of 1979 specifies that a countervailing duty equal to the amount of the net subsidy shall be imposed if the ITC determines that an industry of the United States is materially injured or is threatened with material injury because of the subsidy. The ITC is instructed to consider any significant increase in the volume of imports and/or any price undercutting and decreases in prices or prevention of price increases (U.S. Congress, House, 1979). In addition, the impact on domestic producers, including any actual or potential decline in market share, profits, productivity, return on investments and utilization of capital in the U.S. industry is to be considered. Other considerations include actual and potential negative effects on cash flow, inventories, employment, wages, growth, and investment (U.S. Congress, House, 1979).

The U.S. Federal Trade Commission states that "a United States industry can be injured only if the alleged subsidy increases the quantity of imports coming into the United States" (U.S. Department of Commerce, 1986, p. 18). This increase in quantity will lead to a decrease in the price of the commodity.

The Fair Trade Act also states that "if a domestic industry's lost sales are not traceable to an alleged subsidy, then no injury 'by reason of' such imports should be found" (U.S. Department of Commerce, 1986, p. 2). The Act concludes that a causal link between the subsidy and injury must be established before the determination of material

injury can be made. In other words, "any harm to the domestic industry resulting from factors not attributable to the subsidy should not be the basis for a finding of injury within the meaning of the countervailing duty statute" (U.S. Department of Commerce, 1986, p. 9). This last requirement is critical in the current argument for applying countervailing duties on Canadian lumber imports because it must be proved that the system for setting stumpage prices in Canada increases the quantity of lumber imported through a specific causal link.

Goetz et al. (1986) address the general issues for determining the applicability of countervailing duties. They identify two approaches in dealing with imports. The first is termed the "deterrence approach," in which the government imposes a cost on foreign firms which accept subsidies. Because this cost is designed to outweigh the benefits of a subsidy, the foreign firms are deterred from accepting a subsidy. The important aspect of this approach is that subsidy benefits are commonly treated as reductions in operating costs. Therefore, Goetz et al. claim this approach makes countervailing duties easy to implement because the causal link between the subsidy benefit and the injury need never be examined.

This method is similar to that used by the Coalition for Fair Lumber Imports, although Canadian firms will obviously not be deterred from using the stumpage price system which is identified in the petition. Since the governments in Canada own most of the forest land, lumber producers are forced to acquire stumpage through the systems operated by the government.

The benefits in this case are treated as a reduction of operating costs from the allegedly "less than fair market value" stumpage prices. The petition implies that since stumpage prices are below market value, the quantity of lumber produced is greater than it would be with fair market value stumpage prices. The petition, however, does not look at the possibility that changes in the allowable cut have caused the increase in harvests.

The second method identified by Goetz et al. is the "neutralization approach." In this case, a countervailing duty is placed only on the relevant part of the subsidy which induces firms to alter their behavior in the American market. This approach establishes a need to identify the causal link from the subsidy and to countervail only that part of the subsidy which actually causes material injury. Goetz et al. conclude that countervailing duties should only be imposed when the alleged subsidy has been proved to cause the material injury, and at that point, the duty can only be imposed on the effects of the identified subsidy. Consequently, the causal link between the subsidy and the actual damage must be shown.

In the case of lumber imports from Canada, it must be established that the stumpage price system is, indeed, the means by which the subsidy is provided and that it is directly related to the 27% of the average price of imported Canadian lumber that is alleged in the petition to be the amount of the material injury.

Stumpage Price Setting Systems as the Cause of Material Injury

The petition filed by the Coalition for Fair Lumber Imports claims that "subsidized Canadian softwood lumber imports are materially injuring U.S. softwood lumber manufacturers" (Coalition for Fair Lumber Imports, 1986a, p. 95). The alleged cause is "severe overproduction," i.e., timber price subsidies which result in a surge of Canadian lumber exports (Coalition for Fair Lumber Imports, 1986a, p. 104).

The petition cites a causal link between the practice of "unfairly subsidized" stumpage prices and material injury. The programs allegedly result in Canadian producers receiving their raw materials at "grossly deflated prices."

> The provinces administratively set the price of stumpage at very low levels, encouraging overproduction. More timber can be harvested at a profit despite low and/or depressed lumber prices because the harvesters are not charged a market price for the timber, a major cost input (Coalition for Fair Lumber Imports, 1986a, p. 99).

The implied causal link is that if stumpage prices are low, then the quantity produced is greater than it would be without the reduction in costs. The petition further states that in Canada's nonmarket system, the price of stumpage is set to assure that huge quantities of timber are harvested regardless of demand (Coalition for Fair Lumber Imports, 1986a, p. 100).

The material injury outlined in the petition begins with the stumpage subsidies preventing lumber price increases in the market for lumber. It is claimed that the lumber market is cyclical in nature

and follows the business cycle. According to that argument, high lumber prices are necessary during economic expansions for the lumber industry to remain healthy during recessions. The petition claims, "Lumber prices in the current economic expansion have not increased at anywhere near the levels of increase in past economic expansions" (Coalition for Fair Lumber Imports, 1986a, p. 97). The allegedly subsidized Canadian lumber imports have "deprived domestic producers of the price increases they could reasonably expect during a time of record demand," and have reduced sales and profits of the domestic industry, and therefore, "are causing material injury within the meaning of the countervailing duty law" (Coalition for Fair Lumber Imports, 1986a, p. 99).

A second argument of material injury alleged by the petition is the closing and idling of U.S. lumber mills and a decrease in the utilization of those that remain in operation. The number of lumber producing establishments from 1978 to 1984 "fell from 3,493 to 2,856, a net loss of 637 mills and a decline of 18.2%" (Coalition for Fair Lumber Imports, 1986a, p. 113). Although the mills were "modern and efficient," they closed because of depressed prices (Coalition for Fair Lumber Imports, 1986a, p. 115). The petition also claims a 5.2% drop in utilization of mill capacity from 1983 to 1985. Another form of material injury claimed is a decrease in the U.S. share of the market for lumber from 72.4% in 1978 to 66.8% in 1985 (Coalition for Fair Lumber Imports, 1986a).

The final argument cited in the petition is the decreased profitability of U.S. firms and a reduction in employment in the U.S.

industry. Profits are shown to be half as much as those in the last economic expansion, and employment in the industry dropped 22% from 1978 to 1984 (Coalition for Fair Lumber Imports, 1986a). The cause of the damage again is alleged to be "the shift of production north of the border caused by Canadian subsidies" (Coalition for Fair Lumber Imports, 1986a, p. 121). In terms of the Fair Trade Act, the petition claims that subsidized stumpage prices increase the quantity of lumber produced. In turn, the prevention of a lumber price increase closes U.S. mills, decreases the utilization of those remaining mills, decreases the U.S. market share, and reduces employment.

The conclusion of the section on material injury in the petition states that "Canadian timber subsidies are the primary cause of the problems facing the U.S. lumber industry" (Coalition for Fair Lumber Imports, 1986a, p. 124). Basically, this argument claims that the quantity of lumber supplied is solely or mainly driven by the price of stumpage.

> In short, because profit maximization and efficient resource allocation are not the goals--rather the goal is increased employment in the forest products industry--the quantity of lumber supplied in Canada is significantly determined by the stumpage subsidy" (Coalition for Fair Lumber Imports, 1986a, p. 100).

Other factors that might determine lumber supply were considered insignificant.

Allowable Cut as the Driving Force of Supply

An alternative hypothesis to stumpage prices as the driving force of lumber supply was proposed in a study by the Federal Trade

Commission (FTC) (U.S. Department of Commerce, 1986). The FTC proposes that since the level of harvests are administratively set, stumpage prices have no effect on the quantity of lumber supplied. The FTC states that "Canadian stumpage fee systems do not injure the United States lumber industry" (U.S. Department of Commerce, 1986, p. 30). The conclusion is based on the assumption that harvest levels are administratively determined and that undercharging stumpage fees does not result in a greater quantity of logs harvested than if a fair market value were charged for stumpage rights. The argument is based on a study by Tarr (1983).

Tarr identifies three essential features of the Canadian timber market. The first is that the Canadian provinces administratively determine which acreage to allot and when to allocate the licenses for harvesting. The second feature is that the right to cut timber (stumpage rights) is also determined by an administrative process. The final essential feature is that stumpage prices are generally determined by the Rothery Residual Value Method System, i.e., stumpage prices in Canada are not determined by a market system. Tarr then concludes that

> Employing microeconomic theory, however, it follows from the three facts above that any benefits that tree harvesters capture from below market stumpage fees are not passed along to the lumber mills in the form of lower prices for logs and consequently also do not result in lower lumber prices (Tarr, 1983, p. 3).

Tarr summarizes that the quantity supplied is determined by the amount of acreage cut and the rights to cut timber are administratively set indicating that harvests are exogenously determined. "Most importantly, the method by which stumpage prices

are determined does not influence the quantity of trees the Provinces make available for cutting" (Tarr, 1983, p. 4).

Tarr also states that since stumpage prices and quantity cut are administratively determined, the stumpage prices have no effect on the quantity of trees made available. Furthermore, the price at which the logs sell is independent of the stumpage fee system.

A reduction in stumpage prices with an exogenously determined supply only affects how much of the economic rents are collected by the government. A shift up or down in the demand for logs translates into a shift up or down in the price of logs. The area of rent disposition also increases or decreases. "Rents, however, are not necessarily a cost that must be passed along in determining price" (Tarr, 1983, p. 11), i.e., the return from harvesting is a price-determined rent and not a price-determining cost.

Tarr summarizes that the final product price determines the amount of rents captured by tree harvesters if stumpage fees are set too low. But in terms of subsidies, the level at which stumpage fees are set only determines the level of rents captured by the government and the amount that accrues to the tree harvesters; they do not affect the price of the final product. In terms of the arguments presented earlier on subsidies and material injury, Tarr states that regardless of the stumpage price, the quantity supplied and the product price are not changed and do not cause material injury. Consequently, Tarr concludes that the programs for setting stumpage prices in Canada do not confer a countervailable subsidy.

Empirical Analysis of the Canadian Lumber Market

The purpose of this section is to develop a simple model of the supply and demand for Canadian lumber which can then be used to test two related hypotheses. First, are annual harvests, and hence lumber production, administratively set and therefore exogenous as argued by Tarr? Second, even if annual harvest rates are not administratively set, does the stumpage price have a significant effect on the supply of Canadian lumber? The results of these tests can then be used to compare conclusions reached by the Coalition for Fair Lumber Imports and the Federal Trade Commission. It is assumed that the economic structure of Canadian lumber can be represented by a system of simultaneous linear equations.

Review of Previous Studies

Relatively few studies model the market for lumber despite its importance in both the United States and Canada. Adams and Haynes (1980) developed an empirical model of the North American softwood lumber, stumpage and plywood markets with an emphasis on the United States, and they found that the demand for lumber is determined by housing activity and product price. Stumpage supply is determined by the annual allowable cut (for public timber), stumpage price, product price, non-stumpage costs and the inventory of timber.

Manning (1983) made the first attempt to specifically model the Canadian market, and he found the Canadian price of lumber to be insignificant in the demand determination. However, this finding is not consistent with economic theory. Manning also found that demand

in the United States for Canadian lumber is determined by price and housing activity, whereas Canadian demand is determined by the growth of the economy, U.S. demand, and construction wages.

Singh and Nautiyal (1986) developed a model based on Manning's study, and they also found the Canadian price of lumber to be insignificant. Per capita income was found to be the most important factor determining demand in Canada, but they neglected to express output in per capita terms and did not include population as an explanatory variable. This leads to questions of the validity of per capita income as the major variable explaining demand in their model. However, housing starts were found to be the most important factor in the U.S. demand for Canadian lumber.

Both the Manning and the Singh-Nautiyal studies treat Canadian lumber as a perfect substitute for U.S. lumber. If this is the case, however, the supply of U.S. lumber must affect the demand for Canadian lumber, and neither study controls for that effect. Attempts to use this type of model resulted in the supply of United States timber having a positive effect on the demand for Canadian lumber, which is inconsistent with economic theory.

Model Development and Methodology

The model used to explain the Canadian market in this study is an aggregate model of supply and demand for Canadian lumber where Canadian and U.S. lumber are treated as imperfect substitutes. This model was chosen due to statements that Canadian and U.S. softwood lumber differ in certain characteristics. Canadian lumber is

predominantly spruce-pine-fir, whereas much of the building lumber from the southern U.S. is yellow pine. This argument stems from the U.S. International Trade Commission (1986) which calls for further investigation of species differences. The Coalition for Fair Lumber Imports (1986a, and 1986b), however, denies that species or quality differences explain the increase in Canadian imports. Regardless, there seems to be enough evidence in species preferability to warrant the assumption of imperfect substitutes.

The model consists of three simultaneous equations. The price of lumber in Canada, the quantity of lumber produced in Canada and the price of stumpage are endogenous. The equations are

$$(3.3)\quad PNDXCR = \alpha_1 - \beta_1 LUMC + \beta_2 NDXUSR + \beta_3 HSLAG + \beta_4 HSC$$

$$(3.4)\quad LUMC = \alpha_2 + \beta_5 PNDXCR - \beta_6 WGSRC - \beta_7 RPSTMP + \beta_8 TREND$$

$$(3.5)\quad RPSTMP = \alpha_3 + \beta_9 PNDXCR - \beta_{10} WGSRC + \beta_{11} TREND.$$

The source and description of all variables is shown in Table 2. The model was considered with theoretical expectations about the market for Canadian lumber as shown by the signs on the coefficients in Equations 3.3, 3.4, and 3.5. Data were collected on all of the variables in question, and coefficients were estimated econometrically. Finally, the estimated coefficients were tested and evaluated in accordance with economic, statistical and econometric criteria.

Several problems were encountered in the data collection, especially in selecting aggregate prices and obtaining a measure of allowable cut. British Columbia was the only province with published

Table 2. Description of Variables and Sources of the Data.

Variable	Description and Source of Information
PNDXCR	"Industry Selling Price Index" for sawmills and planing, divided by GNPC, Statistics Canada (various issues).
GNPC	"GNP Deflator" for Canada, International Financial Statistics Yearbook, "Yearbook, 1986"
LUMC	"Lumber Production of the Sawmill and Planing Mill Industry by Province," 10,000m^3, Canada Yearbook (various issues).
HSLAG	"New Housing Units Started and Authorized," in the U.S. Lagged one year, in millions. Economic Report of the President (February 1986).
HSC	"Dwelling Units Started and Completed by Type of Financing and Region," total started, Canada, in millions. Canada Yearbook (various issues).
NDXUSR	"Selected Timber Products-Wholesale Price Indexes," all lumber divided by GNPUS. Statistical Abstract of the United States (various issues).
GNPUS	"Implicit Price Deflator for GNP," Economic Report of the President (February 1986).
WGSRC	"Average Weekly Salary, Earnings, by Industrial Division," Forestry, divided by GNPC. Canada Yearbook (various issues).
TREND	Year minus 1957.
RPSTMP	"Stumpage Prices in British Columbia," divided by GNPC, Ministry of Forests, Annual Report (various issues).

records of the annual allowable cut on a provincial basis. The data, however, were incomplete and inconsistent and could not be used in the model. A trend variable was included to account for changes in the allowable cut. Price indexes for lumber were used for both the U.S. and Canadian lumber, because aggregate data on actual product prices were not available. Finally, the quantity of both hardwood and softwood lumber was used because it was not consistently possible to separate softwood lumber production to 1958.

Annual data from 1958 to 1984 were used; 1984 was the most recent year that observations on all variables, excluding the annual allowable cut, were available. The same was true of the international financial data prior to 1958.

Results and Discussion

With the development of a model of the market for Canadian lumber, a simple test is used to examine the proposed hypotheses. Thurman (1986) suggests that the endogeneity tests proposed by Wu (1973) and Hausman (1978) have a natural application when determining price or quantity endogeneity in demand functions. In the current case, it is the endogeneity of quantity supplied that is tested. Tarr (1983) and the FTC state that since the quantity supplied is predetermined, no subsidy occurs. If this is the case, price clears the market and absorbs current demand shocks. If the quantity supplied is truly predetermined, then ordinary least squares can be used to calculate a consistent estimator of the coefficients of the demand price; otherwise, ordinary least squares leads to inconsistent estimators.

For this study, the demand equation is estimated by two different methods: ordinary least squares (OLS) and an instrumental variables (IV) estimator. These are performed on the price dependent or inverse demand equation to determine the endogeneity of quantity supplied. Thurman (1986) also performs the test on the endogeneity of price in the quantity dependent equation, but this is not necessary for the scope of this study.[5]

The Wu-Hausman test then "exploits the inconsistency of OLS, but the consistency of IV, under the alternative hypothesis" (Thurman, 1986, p. 639). It measures the distance between the OLS and the IV estimator of the coefficient of quantity supplied. The construction of the test is as follows.

The coefficient on quantity supplied is b, where $\hat{b}$ is the OLS estimator and b^* is the IV estimator in the same demand specification. The IV method of estimation used is two-stage least squares. The difference between the the two estimates is

$$(3.6) \quad d = \hat{b} - b^*.$$

The Wu-Hausman test statistic is defined as

$$(3.7) \quad S = (\hat{b} - b^*)'[\hat{V}(d)]^{-1}(\hat{b} - b^*)$$

assuming that $\hat{V}(d)$ is a consistent estimator of Var(d), then S is asymptotically chi-square. Therefore, a large value of S rejects predetermined quantity. If the test statistic is small, then the distance between estimators is small, and predetermined quantity cannot be rejected.

An inverse demand function is initially theorized with price as the dependent variable to compare the coefficients on quantity through OLS and IV as suggested by Thurman. Thurman states that market structures which predetermine quantity allow regression estimates of demand where quantity is an independent variable. This is the reasoning behind the use of a price dependent inverse demand function. A supply equation, as well as an equation for the determination of stumpage prices, also is estimated.

Column (1) of Table 3. shows the OLS results of the demand equation where product price (PNDXCR) is a function of quantity (LUMC), U.S. product price (NDXUSR), lagged U.S. housing starts (HSLAG), and Canadian housing starts (HSC). Column (2) presents the supply equation where quantity is a function of Canadian product price (PNDXCR), wages in Canada (WGSRC), stumpage price (RPSTMP), and an estimate of the changes in the allowable cut (TREND). Column (3) presents the stumpage price in Canada as a function of the Canadian product price, wages and trend.

The results in Table 3. Column (1) reveal that all right-hand side coefficients are statistically significant at the five percent level as shown by the reported t-ratios. Lumber price and quantity of lumber demanded are negatively correlated. Canadian lumber price, housing starts in Canada, housing starts in the United States, and the price of lumber in the United States are positively correlated. The tests for auto-correlation indicate that rho is not significantly different than zero. The adjusted R^2 values suggest that the specification fits the data fairly well, and the elasticity at the

Table 3. OLS Estimated Coefficients for Regression Equations.

	(1)	(2)	(3)
Dependent Variable	PNDXCR	LUMC	RPSTMP
OLS COEFFICIENT			
Intercept	0.31389 (5.60)	19072 (1.20)	-1.0696 (0.27)
LUMC	-0.000010542 (6.20)		
NDXUSR	0.70259 (6.21)		
HSLAG	0.00000012573 (3.28)		
HSC	0.0000005133 (2.48)		
PNDXCR		19046 (1.53)	18.243 (8.43)
WGSRC		-66.699 (0.99)	-0.06046 (2.72)
RPSTMP		-404.63 (0.72)	
TREND		1777.1 (3.01)	0.5558 (2.84)
R-SQUARED	0.88	0.89	0.79
Durbin Watson	1.85	1.46	1.46

a. Data from 1958 to 1984.
b. t-ratios in parenthesis below estimates.

means is 0.40, indicating that quantity demanded is not very responsive to changes in price.

Incomes in both the United States and Canada, which were thought to be important in the demand for Canadian lumber, also were tested but were found to be insignificant. Converting to per capita measures did not alter that conclusion. Also, the wholesale price index was used as an alternative deflator but yielded no better results than those reported.

Lagged housing starts in the United States appear in the reported equation although the a-priori specification calls for current housing starts in the United States. Current housing starts were tested but found to be insignificant. Since the influence of the United States building industry was considered to be too important in the demand for lumber to be excluded, a lag was tested and the results are reported. This could possibly be explained by the time it takes for the United States demand to be translated across the border due to trade restrictions or distance to markets.

Table 4. shows the same equations estimated by two-stage least squares. Quantity is endogenous in Column (1), product price and stumpage price are endogenous in Column (2), and product price is endogenous in Column (3).

Under the null hypothesis in the endogeneity test, the quantity of lumber supplied is administratively set and, therefore, predetermined. Under this hypothesis, the difference between the ordinary least squares and the two-stage estimates (reported in Table 4.) of the coefficient on LUMC should be small. The test statistic

Table 4. IV Estimated Coefficients for Regression Equations.

	(1)	(2)	(3)
Dependent Variable	PNDXCR	LUMC	RPSTMP[a]
2SLS COEFFICIENT			
Intercept	0.30588 (5.28)	12126 (1.27)	0.20431 (0.06)
LUMC	-0.000012545 (6.41)		
NDXUSR	0.81041 (6.44)		
HSLAG	0.00000010934 (2.72)		
HSC	0.00000045089 (2.09)		
PNDXCR		34713 (2.04)	19.021 (7.19)
WGSRC		-130.86 (1.61)	-0.068508 (3.14)
RPSTMP		-1049.9 (1.30)	
TREND		2343.8 (3.27)	0.61046 (3.22)
R-SQUARED	0.8724	0.8822	0.7181
Durbin Watson	1.78	1.55	0.94

a. No correction was made for auto-correlation in the error term.
b. Data from 1958 to 1984.
c. t-ratios in parenthesis below estimates.

is 4.26, and the critical value is 3.84. Thus, the assumption of an exogenously determined lumber supply is rejected. Moreover, the two-stage estimate of the supply equation shows that increases in lumber prices have a positive effect on the supply of lumber.

While the above results reject the notion that lumber supply is administratively set independent of lumber price, it does not follow that stumpage prices are the driving force of supply and therefore the cause of material injury. Recall that timber is harvested under long term contracts and supply can change in response to the price of lumber independent of stumpage price. The terms of the timber contract allow such flexibility. It is only in the long run that harvest rate constraints are binding on the firms undertaking the harvest. Accordingly, it is important to consider the effect of changes in stumpage price on the supply function and how stumpage prices have changed over time.

The supply equation reported in column (2) of Table 4. indicates that stumpage price is insignificant, which rejects the hypothesis of stumpage price as the driving force. Trend, which is an approximation for the increase in the annual allowable cut over time, is not only significant, but appears to be the driving force of supply. The other explanatory variables in the supply equation are in accordance with economic theory, although wages are insignificant.

The above result indicating that lower stumpage prices are not the driving force behind recent increases in the supply of Canadian lumber is further supported by the results in column (3). There, stumpage price is shown to be a function of output price, wages, and a

trend variable. The results show that stumpage price has been increasing over time. Thus, increases in the allowable cut appear to be the driving force behind increases in the quantity supplied, and not lower stumpage prices.

Conclusion

The major implication derived from the empirical analysis is that stumpage price does not influence the quantity of lumber supplied in Canada. This result rejects the Coalition for Fair Lumber Imports' claim that stumpage price is the driving force of lumber supply and, therefore, the cause of material injury under the terms of the 1979 Fair Trade Act. The specific causal link between stumpage prices and the material injury is rejected; therefore, a determination of material injury by subsidized stumpage prices also is rejected.[6] Material injury by uneconomical increases in the annual allowable cut over time cannot be rejected, however. Changes in the allowable cut could have the effect of a subsidy. From the analysis in Chapter 2, the allowable cut could be set at a level above that of the depletion path dictated by economic theory. This would result in a greater quantity harvested at a lower price, in accordance with the material injury criteria. However, the limitations of using trend as a variable for the allowable cut and not knowing the point on the depletion path makes the determination of such a subsidy impossible at this time.

End Notes

1. A regression run using ordinary least squares yielded the following results:

   $$\text{Lumber Production}(t) = \underset{(9.76)}{13551} + \underset{(13.95)}{1187.2}\ \text{TREND}$$

   $$R^2 = 0.89$$

   This indicates that harvests have substantially increased over time.

2. Taken from a cutting contract, Government of British Columbia.

3. Rothery is the name given to the specific residual value method system used in British Columbia.

4. Phone conversation with Jim Bullen, Assistant Chief Forester, British Columbia Ministry of Forests, on October 8, 1986.

5. The issue at hand is the endogeneity of quantity as presented by Tarr (1983). If price is exogenous, then quantity supplied shifts with changes in demand.

6. These results agree with the conclusions reached by Kalt (1987), whose study was concurrent with this one.

CHAPTER 4

CONCLUSION

Chapter 1 provided a brief overview of the problem in question, the identification of Canadian lumber import subsidies and the ambiguity of identifying a subsidy in the depletion of natural resources. Specifically, the problem addressed is the overproduction of softwood lumber from Canada caused by alleged stumpage price subsidies to Canadian producers.

In this study, a subsidy is defined as economic aid which decreases the output price and increases the quantity produced. However, before countervailing duties can be imposed, the defined subsidy must cause material injury to the affected particular U.S industry. Therefore, material injury to the lumber producers in the U.S. must be proved before trade restrictions can be imposed on Canadian lumber imports.

A brief legislative history of the situation showed that initial federal studies were against the imposition of trade restrictions on lumber imports. Later studies, however, when combined with protectionist pressure from lumber-producing areas in the U.S. found that injury was being caused. With the increased probability of trade sanctions, the Canadian Federal Government agreed to an export tax on lumber bound for the U.S. as long as further threats of lumber trade restrictions were dropped (U.S. Department of Commerce, 1987).

Although the agreement did not stop all investigations into the matter, it did quell further U.S. legislative sanctions.

Chapter 2 examined the ambiguity of defining a subsidy in the case of a natural resource. The theory of the mine was used to illustrate the depletion of a stock of old growth timber, and the optimal depletion of a resource stock in a competitive industry was outlined. Here, the quantity produced was shown to decrease over time while the output price increased.

Effects of a traditional subsidy, such as a reduction in costs, were shown to alter the price and quantity time paths, so that the traditional definition of a subsidy did not hold throughout the depletion period. In fact, the quantity harvested was less and price greater than in the case without a reduction in costs during some parts of the depletion period. A two-country model, utilizing the theory of the mine, showed that a subsidy given to the lower cost producing country actually benefited the higher cost producers of the other country.

An indirect form of subsidy examined was a constraint on the amount of the annual allowable harvest. This type of constraint is commonly used in forest management and results in sustained yield, even flow harvests. The harvest constraint was shown to decrease output and increase prices in the initial periods, but in later periods maximum sustained yield management results in an increase in harvest levels beyond that called for by financial optimization.

Chapter 3 focused on the issue of stumpage price as the driving force of Canadian lumber supply, and therefore, the cause of

material injury to the U.S. lumber industry. Material injury was further defined in the context of the Fair Trade Act in terms of the volume of imports, the effects on prices, and the impact on the domestic producers. The Act clearly requires that injury to the domestic industry be proved and that a specific causal link from the identified subsidy be shown.

The analysis presented shows that the identification of a subsidy in a natural resource case is problematic due to the dynamic nature of resource use. Consequently, traditionally measured welfare effects due to the subsidies may prove to be incorrect.

The argument that subsidized stumpage prices drive the supply of lumber from Canada and cause material injury was tested using data on lumber production in British Columbia. Following rejection of that hypothesis, an alternative argument was proposed stating that the determination of the annual allowable cut is the driving force of the supply of lumber. The empirical results support the latter hypothesis and suggest that material injury through uneconomical harvest rates, such as the setting of the annual harvest at too high a level, remains a possibility.

REFERENCES CITED

Adams, Darius M., and Richard W. Haynes. "The 1980 Softwood Timber Assessment Model: Structure, Projections, and Policy Simulations." Forest Science Monograph 22, Bethesda, MD: Society of American Foresters, 1980.

Berck, Peter. "The Economics of Timber: A Renewable Resource in the Long Run." The Bell Journal of Economics 10 (Autumn 1979): 447-462.

Campbell, Harry F. "The Effect of Capital Intensity on the Optimal Rate of Extraction of a Mineral Deposit." Canadian Journal of Economics 13 (May 1980): 349-356.

Clark, Colin W. Mathematical Bioeconomics. New York: John Wiley and Sons, 1976.

Coalition for Fair Lumber Imports. Petition for the Imposition of Countervailing Duties Pursuant to the Tariff Act of 1930, As Amended. Washington, D.C., May 19, 1986a.

Coalition for Fair Lumber Imports. Lumber Fact Book. Washington, D.C., June 1986b.

Congressional Quarterly, Inc. The Battle for Natural Resources. Washington, D.C.: Author, 1983.

Federal Register "Final Negative Countervailing Duty Determinations; Certain Softwood Products From Canada." Vol. 48, No. 105. 1983, May 31.

Goetz, Charles J., Lloyd Granet, and Warren F. Schwartz. "The Meaning of 'Subsidy' and 'Injury' in the Countervailing Duty Law." International Review of Law and Economics 6 (June 1986): 17-32.

Government of British Columbia. Forest Act. Victoria, B.C.: Queens Press, 1979.

Government of British Columbia. Ministry of Forests. Resources Planning Manual. Chapter 3. Victoria, B.C.: Queens Press, 1984.

Government of British Columbia. Ministry of Forests. Interior End-Product Appraisal Manual. Victoria, B.C.: Queens Press, 1986a.

Government of British Columbia. Ministry of Forests. Coast Log-Based Appraisal Manual. Victoria, B.C.: Queens Press, 1986b.

Government of Canada. Canadian Forestry Service, Economics Branch. Selected Forestry Statistics. Ottawa, Ontario: Minister of Supply and Services, 1985.

Gray, L.C. "Rent Under the Assumption of Exhaustibility." Quarterly Journal of Economics 28 (1914): 466-489.

Greenwald, Douglas. Encyclopedia of Economics. New York: McGraw Hill Book Co., 1982.

Hartwick, John M., and Nancy D. Olewiler. The Economics of Natural Resource Use. New York: Harper and Row, Publishers, Inc., 1986.

Hausman, Jerry A. "Specification Tests in Econometrics." Econometrica 46 (November 1978): 1251-1271.

Herfindahl, Orris C. "Depletion and Economic Theory." In Exhaustive Resources and Taxation, pp. 63-90. By Mason Gaffney. Madison, WI: University of Wisconsin Press, 1967.

Hotelling, H. "The Economics of Natural Resources." Journal of Political Economy 39 (1931): 137-145.

Johansson, Per-Olav, and Karl-Gustaf Lofgren. The Economics of Forestry and Natural Resources. West Sussex, Great Britain: Basil Blackwell Ltd., 1985.

Judge, G.G., and J.D. Wallace. "Estimation of Spatial Price Equilibrium Models." Journal of Farm Economics 40 (November 1958): 801-820.

Kalt, Joseph P. The Political Economy of Protectionism: Tariffs and Retaliation in the Timber Industry. Cambridge: John F. Kennedy School of Government, Harvard University, Energy & Environmental Policy Center, March 1987, E-87-03.

Kamien, Morton I., and Nancy L. Schwartz. Dynamic Optimization: The Calculus of Variations in Optimal Control in Economics and Management. New York: North Holland, Inc., 1981.

Luckert, Martin K. "A Synopsis of Collected Proceedings of the Countervailing Duty Case Relating to Certain Forest Products from Canada." University of British Columbia, Vancouver, B.C., June 1984.

Lyon, Kenneth S. "Mining of the Forest and the Time Path of the Price of Timber." Journal of Environmental Economics and Management 8 (1981): 330-344.

Lyon, Kenneth S., and Roger A. Sedjo. "An Optimal Control Theory Model to Estimate the Regional Long-Term Supply of Timber." Forest Science 29 (1983): 798-812.

Manning, Glen H. "The Canadian Softwood Industry: A Model." Canadian Journal of Forest Research 5 (1983): 345-351.

Pearse, Peter H. Timber Rights and Forest Policy in British Columbia: Report of the Royal Commission on Forest Resources. Victoria, B.C.: Queens Press, 1976.

Samuelson, Paul A. "Economics of Forestry in an Evolving Society." Economic Enquiry 14 (1976): 466-492.

Singh, B.K., and J.C. Nautiyal. "An Econometric Analysis of Markets for Canadian Lumber." Wood and Fiber Science: Journal of the Society of Wood Science and Technology 18 (1986): 383-396.

Tarr, David G. "Analysis of Whether Any Alleged Subsidy to Canadian Tree Harvesters Is Passed Through to Lumber Producers." 1983. In U.S. Department of Commerce. Post-Conference Brief of the Federal Trade Commission in the Matter of Certain Softwood Products from Canada Appendix, 1986.

Thurman, Walter N. "Endogeneity Testing in a Supply and Demand Framework." The Review of Economics and Statistics 68 (1986): 638-646.

U.S. Congress, House. Trade Agreements Act of 1979. Public Law 96-39, Stat. 144, 96th Congress, 1st Session, 1979.

U.S. Department of Commerce. Federal Trade Commission. Documents Related to the Canadian Softwood Lumber Agreement. January 5, 1987.

U.S. Department of Commerce. Federal Trade Commission. Post-Conference Brief of the Federal Trade Commission in the Matter of Certain Softwood Products From Canada June 12, 1986.

U.S. International Trade Commission. Softwood Lumber from Canada July 1986.

Wu, De-Min. "Alternative Tests of Independence Between Stochastic Regressors and Disturbances." Econometrica 41 (July 1973): 733-750.