

THE ECONOMIC EFFECTS OF THE FOREST RESOURCES  
CONSERVATION AND SHORTAGE RELIEF ACT  
ON TIMBER PRICES

by

Holly Linn Lippke

A professional paper submitted in partial fulfillment  
of the requirements for the degree

of

Master of Science

in

Applied Economics

MONTANA STATE UNIVERSITY  
Bozeman, Montana

January 1993

corrected ed 4/3 *HL*

APPROVAL

of a professional paper submitted by

Holly Linn Lippke

This professional paper 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.

\_\_\_\_\_  
Date

\_\_\_\_\_  
Randal R. Rucker, Chairperson

\_\_\_\_\_  
Date

\_\_\_\_\_  
Ronald N. Johnson, Committee Member

\_\_\_\_\_  
Date

\_\_\_\_\_  
Richard Stroup, Committee Member

## ACKNOWLEDGEMENTS

I would like to express my thanks to Randy Rucker for his contributions, support and critical review of this paper. I am also indebted to Ron Johnson for his valuable advice. Additional appreciation goes to my father, Bruce Lippke, for his assistance, support, patience and encouragement.

Other thanks go to Jim Hotvedt of the Washington State Department of Natural Resources, who supplied the majority of my data and many insights, and to Janet Baker of Northwest Economic Associates who gave the needed direction to begin this project.

Also gratefully acknowledged are Michael Fretwell for his continuous support and Don Clark for his consistently positive influence.

## TABLE OF CONTENTS

|   | Page |
|---|------|
| ABSTRACT .....  | vii  |
| 1. INTRODUCTION .....   | 1    |
| Background .....  | 2    |
| 2. LITERATURE REVIEW .....  | 7    |
| 3. THE MODEL .....  | 15   |
| Model Development .....   | 15   |
| Regression Model .....  | 17   |
| 4. DATA AND RESULTS .....   | 20   |
| Data .....  | 20   |
| Predictions .....   | 21   |
| Regression Results .....  | 26   |
| Estimated Marginal Implicit Prices .....  | 32   |
| 5. POLICY IMPLICATIONS, FUTURE RESEARCH POSSIBILITIES,<br>ALTERNATIVE PROPOSALS AND CONCLUSIONS ..... | 35   |
| Policy Implications .....   | 35   |
| Future Research Possibilities .....   | 37   |
| Alternative Proposals .....   | 38   |
| Conclusions .....   | 39   |
| BIBLIOGRAPHY .....  | 40   |
| APPENDICES .....  | 44   |
| Appendix A - Example of Data Available<br>from Washington State DNR .....                             | 45   |
| Appendix B - Data Specification .....   | 47   |

## LIST OF TABLES

| Table  | Page |
|--|------|
| 1. Estimates of Regression Equations Explaining<br>Implicit Price Characteristics .....  | 26   |
| 2. Estimates of Regression Equations Explaining<br>Implicit Price Characteristics Differentiating<br>Before and After Log Export Ban ..... | 30   |
| 3. Post-ban Estimates .....  | 31   |
| 4. Data Measurements .....   | 33   |

LIST OF FIGURES

| Figure  | Page |
|---|------|
| 1. Supply/Demand Model for Import<br>and Domestic Markets ..... | 6    |

ABSTRACT

In response to a new federal law, the Washington State Department of Natural Resources was required to restrict the export of unprocessed logs from state owned lands effective January 1, 1991.

Exported logs receive a greater price than domestically processed logs because of differences in quality, costs, and imperfect markets caused by regulation.

A hedonic price approach is used to estimate implicit prices of timber sales characteristics, as well as supply and demand changes, and export restrictions. It is shown that the Forest Resources Conservation and Shortage Relief Act affects the price received in both domestic and export markets. *Ceteris paribus*, domestic timber prices decline, consistent with increased supply from the restrictions, and export prices increase, consistent with reduced availability. Both grade and species are significant factors in export price premiums.

Export price premiums exist, even during a time when environmental concerns have resulted in drastic reductions in domestic timber supplies.

## CHAPTER 1

### INTRODUCTION

A long standing debate exists in the Pacific Northwest regarding timber supply. Many believe all timber harvested in the region should be processed in the region. Others believe the benefits of trade outweigh any local benefits that result from processing restrictions. There are even some who believe timber should not be cut at all. Over 20 years ago this debate resulted in a prohibition on exports of unprocessed logs from federal lands with the Foreign Assistance Act of 1968. Recently, the spotted owl has been considered an endangered species. This, along with the influence of other environmental issues, has forced large portions of the Pacific Northwest's timber lands to be reserved from timber harvest. This reduction in supply rekindled the debate and led to the Forest Resources Conservation and Shortage Relief Act of 1990. This Act forced the State of Washington to enact regulations restricting the overseas transport of unprocessed logs from Washington public lands; lands owned by the Department of Natural Resources (DNR).

The Pacific Northwest has a domestic and an export market for logs. The prices in these markets differ for several reasons. One cause of the export price premium is timber regulation. The export/domestic price differential caused by the Forest Resources Conservation and Shortage Relief Act is the focus of this paper. This is of great interest to the State of Washington because the revenues earned from timber sales by the Department of Revenue are used to support schools in the local economy. This paper analyzes DNR timber sales before and after state restrictions became effective.

It is hypothesized, that the value of DNR timber tracts and the potential revenues are affected not only by tract characteristics but also by barriers to trade. It is shown that tracts available for export have greater earning potential than those which must be domestically sold. The analysis is based on an ordinary least squares regression model. The stumpage or bid price paid for a

tract of timber is dependent upon the characteristics of the tract. Thus, a hedonic price approach, in which bid price is regressed on a number of tract characteristics, is used to determine the export price premium.

The following section gives a brief background on Washington timber policy. Chapter 2 provides a literature review outlining previous studies regarding log export policy and the export price premium. Chapter 3 outlines the model and its development. This is followed by data and results in chapter 4. The final chapter is left for policy implications, possible future research, alternative solutions and conclusions.

### Background

On October 20, 1990, federal legislation was passed restricting individual states from exporting non-processed logs from state-owned lands. This bill requires states to issue regulations controlling exports from state owned lands. As a consequence of the Forest Resources Conservation and Shortage Relief Act of 1990 (Public Law 101-382), the State of Washington enacted regulations that became effective January of 1991 banning the exportation of logs from lands managed by the State of Washington's Department of Natural Resources (DNR).

The Forest Resources Conservation and Shortage Relief Act (hereafter referred to as the Shortage Relief Act) is listed in Title IV of the Customs and Trade Act of 1990. The Act assigns responsibility to the governor to implement regulations assuring "a net increase in domestic processing of timber harvested from public lands."

Initially the Shortage Relief Act required 75% of state timber sales to be processed locally. The ban was extended to restrict 100% of state timber on October 23, 1992. The Act includes an antisubstitution clause which prohibits the purchase of export-restricted DNR timber by anyone exporting 15% or more of their average annual log consumption from their own processing facilities. Exemptions from the ban include hardwood timber, Western Red Cedar, and other timber which has been determined to be surplus to the needs of U.S.

timber manufacturing facilities by the Secretary of Agriculture or the Secretary of the Interior of the United States.<sup>1</sup>

Prior to October 23, 1992, the Shortage Relief Act required the DNR to designate sales as export restricted or as exportable. Export restricted sales were to include 75% of the total volume sold on state owned or managed lands. Restricted sales were to be proportionately distributed throughout the geographical area of public lands, and representative of the species and grade distribution of the DNR's sale program. Restrictions were to be applied on a sale by sale basis and were to cover the entire sale. That is, sales were not to be split into exportable and nonexportable parcels.

Prior to the ban, estimates show that 62% of DNR timber sales were exported.<sup>2</sup> Because the ban restricts export of entire sales, it is estimated that unrestricted, exportable logs satisfying the quality demanded by importers will account for only 15.5% of the states volume ( $.62 \times .25 = .155$ ). The majority of these exported logs are high quality Douglas fir, True fir and Hemlock.

Legislation banning log exports has been enacted largely to maintain low prices of basic forest industry raw material inputs, thereby protecting domestic processors from export competition. Support for the legislation was encouraged by small timber mills that could not compete for the declining supply of logs.<sup>3</sup> The timber supply shortfall has been created largely by increased preservation set asides.

Federal timber supply has decreased significantly in the past several years due to environmental pressures and litigation from conflicts over public land use. In 1991, timber volume sold on federal lands in Washington and Oregon was only 30.3% of the previous 4 year average (1987-1990).<sup>4</sup> Harvest decline began in 1989 when large tracts of timber were held up in litigation. Sales in 1990 increased, however, with the assistance of the Adams-Hatfield Bill that released many of these sales. By 1991 all released timber had been sold and harvests were again low. Federal harvests are now expected to

---

<sup>1</sup> Hardwood and Red Cedar account for approximately 16% of total volume on sales from January 1989 to October 1992.

<sup>2</sup> McKillop (1991).

<sup>3</sup> NEA (1989) and Butchman (1989).

<sup>4</sup> Warren (various issues).

remain low due to replanning; changes in harvest levels due to environmental concerns. Western Washington Forest Service sales have decreased from a four year average (1985-1988) of 888 million board feet (mmbf) to an average (1989-1991) of less than 440 mmbf. Sales in 1991 were only 10% of the 1985 to 1988 four year average.<sup>5</sup> DNR sales have decreased by more than 300 mmbf from previous levels due largely to spotted owl related impacts.<sup>6</sup> The amount of set asides from DNR lands is determined when an owl is identified. An "owl-circle" is then created with a 1.8 to 2.2 mile radius. Within that radius 40% must remain as owl habitat, 60% may be harvested. These requirements are enforced by state regulation to be in compliance with the Interagency Scientific Committee (ISC) report.

The decreased timber supply forced prices to rise increasing the incentives of Washington's log-processing mills to ban together and lobby for the Shortage Relief Act.<sup>7</sup> The Act allows greater access to low cost timber through the log export ban on state managed lands. This was not the first ban on exported logs within the state. Previous federal bans, however, were limited to federal lands and have been in place for more than 20 years.

Limits on log exports from the western states began in 1968 with the Foreign Assistance Act. This Act limited log exports from federal lands, United States Forest Service (USFS) and Bureau of Land Management (BLM), to a quota of 350 mmbf. In 1974 the quota was reduced to zero leaving a total ban on softwood log exports from federal lands west of the 100th meridian. Unprocessed logs from state managed lands in California and Oregon, as well as from British Columbia, have also been banned from export.

Washington is the largest log-exporting state, accounting for about half of all log exports.<sup>8</sup> Of the log exports from the Pacific Northwest region, most go to East Asia, primarily to Japan and Korea.<sup>9</sup> The DNR accounted for nearly 20% of Washington exports prior to the Shortage Relief Act.<sup>10</sup>

---

<sup>5</sup> Ibid.

<sup>6</sup> Ibid.

<sup>7</sup> NEA (1989) and Butchman (1989).

<sup>8</sup> Gruenfield and Flynn (1990), pages 50-51.

<sup>9</sup> Warren, various issues.

<sup>10</sup> NEA (1989) and Warren, Debra (first quarter, 1992).

DNR revenues contribute to the funding of public schools, universities, counties and forest management activities on state owned lands. Prior to the ban, approximately 62% of DNR harvest was sold for export at a premium price.<sup>11</sup> The DNR is now forced to accept the lower domestic price for the majority of its timber. It was expected that the higher price received in the export market would more than offset the lower price in the domestic market causing a decrease in DNR revenues. Thus, a decrease in revenues for school and other public facility construction was expected.

The ban of DNR logs from the export market by the Shortage Relief Act causes an increase in supply in the domestic market where these logs must be sold. The effect of the export ban by itself will be to increase domestic supply, causing a decrease in domestic log prices. In most regions, however, the increase in supply in the domestic market from DNR lands has not been sufficient to offset the decrease in US Forest Service harvest level declines. Therefore, the overall supply has decreased, causing an increase in domestic log price.

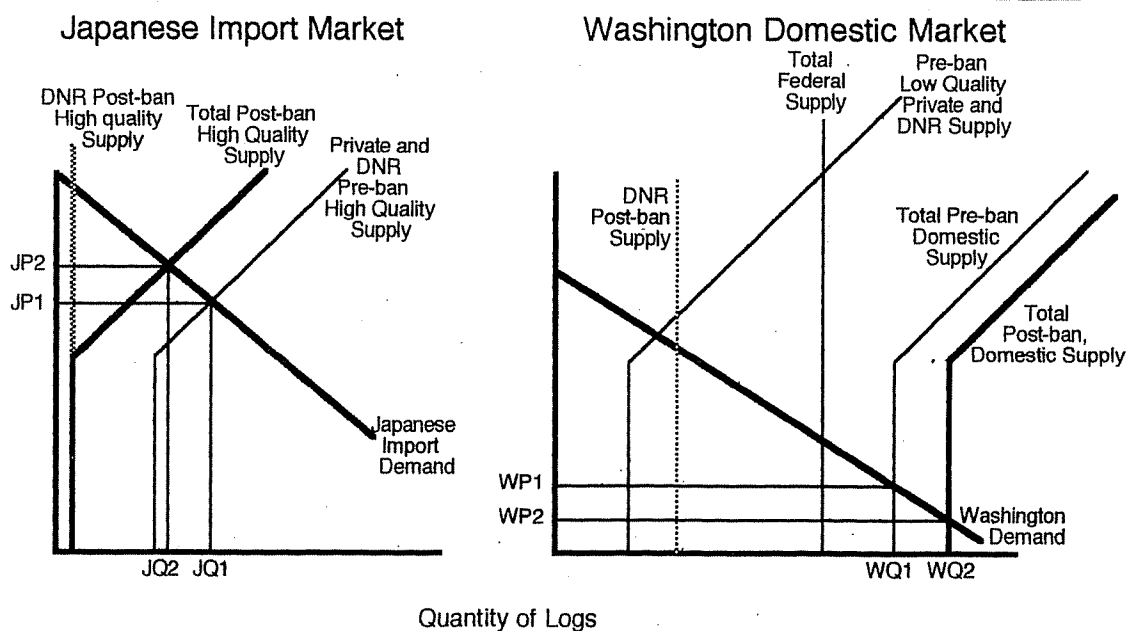
In the export market, supply has decreased as a result of the DNR export restrictions, forcing prices up. *Ceterus paribus*, the Shortage Relief Act therefore is expected to increase the difference between domestic and export prices for similar goods.

Figure 1 displays the export premium. For simplicity this figure assumes Washington to be the sole exporting region and Japan the only importer. The traded commodity is logs, which are rated as low or high quality, with high quality the only log type Japan will import. It is also assumed that Washington producers consider high and low quality as perfect substitutes. Before the Shortage Relief Act (referred to as the ban in the graph) it is assumed that all high quality DNR timber was exported. All federal timber is restricted from export. As previously determined, exports from DNR lands were approximately 15.5% of total sales during the period between January 1, 1991 and October 23, 1992. All other supply and demand factors are assumed to be constant.

---

<sup>11</sup> Department of Natural Resources, *Washington Mill Survey*, 1980, 1982, 1984, 1986, and 1988 issues, Olympia, WA.

Figure 1. Supply/Demand Model for Import and Domestic markets.



JP1 and WP1 are the pre-ban prices for Japan and Washington respectively. The ban forces the majority of DNR high quality logs to be sold in the domestic market at the new lower domestic price of WP2. The decrease in Japanese import supply forces price up in the import market to JP2. The increase of DNR sales in the domestic market after the ban causes price to decrease, widening the gap between domestic and export unprocessed log prices, thus increasing the price premium.

It must be noted, however, due to spotted owl and other environmental concerns causing declining domestic supply, domestic sales actually decreased after the ban, forcing domestic prices up.

## CHAPTER 2

### LITERATURE REVIEW

Many studies have been completed concerning restrictions on log exports. The purpose of several of these studies was to estimate the economic effects of a log export ban on Washington State owned lands. These studies typically focused on the export premium and on the effect of the ban on DNR revenues. Following is a discussion of several of these studies in chronological order.

Barney Dowdle (1980) looked at the price differentials between export and domestic logs. Dowdle believed the price differential was most likely caused by market imperfections. Market imperfections are the result of log export restrictions. The effect of federal and other state constraints is to shift much of export log demand to Washington public and private lands and to segment the export and domestic markets. The markets are insulated enough from each other to allow multiple pricing policies. A static analysis was used assuming some entity of private timber ownership has market power in the export market, thus price discrimination may exist. If export restrictions in an imperfect market exist, Dowdle concludes that fewer logs will be exported, private competitors will increase their exports and receive a higher price, and any increase in the monopolists' marginal cost will reduce domestic sale quantity before export sales. Dowdle does not attempt to legitimize the reality of a monopoly in the market nor its effects on a premium versus other possible causes.

Dowdle's examination is based on economic theory assuming a monopoly exists. It is especially interesting in several points. A monopolist in the market would set total marginal cost equal to the marginal revenue in each market. This implies that the market with the more elastic demand will have the lower price. Secondly, it may be possible to increase revenues by decreasing quantity sold if in the inelastic portion of the demand curve.

Another study, completed by Parks and Cox (1981) looked at the log and lumber market effects of a log export ban on state owned lands. They used a linear system of equations to determine the equilibrium prices of the log and lumber markets. They argue the price differential between the domestic and export log markets is attributed to the limited substitutability in the Japanese market for logs of the demanded quality and the ban on exports decreasing the availability of the logs to overseas users. Japan imports both logs and lumber from the State of Washington. Imported logs are transported to Japan to be processed into lumber in their local mills. Consequently, an increase in the price of logs due to the ban will cause an increase in the demand for Washington lumber. By simulating a 100% log export ban on DNR timber they estimated an export premium of \$85.

Sedjo and Wiseman (1983) completed one of the first empirical studies on the impact of export log restrictions from federal lands. The ratio of export market price to domestic market price was observed in three time periods; pre-restriction (1965-67), partial restriction (1969-72), and full restriction (1975-1979). A one-way analysis of variance was calculated for each. Looking at log export restrictions prior to the federal ban, they concluded that only on high quality logs were the restrictions effective. This means that there was sufficient timber on nonfederal lands to supply the low quality logs demanded in the export market, but there was not a sufficient amount of high quality logs. If an export restriction is effective, the export and domestic markets will be segmented, and prices will be higher in the export market and lower in the domestic market than the previous equilibrium. It is noted that a price differential existed even prior to any legislation restricting exports. This may have been the result of higher transportation, sorting and handling costs for exports, as well as the selection of higher quality logs within comparable grades for export.

Another study, by Flora and McGinnis (1989), estimated the export price premium prior to the enactment of the Shortage Relief Act. Their analysis applied to the Douglas fir region, including Washington and Oregon. The procedure involved extensions of existing theory, estimation of supply and demand relationships, and export supply and offshore demand interactions.

Flora and McGinnis predicted that a complete ban on log exports from state lands would cause an increase in high-grade export log price of \$150 per thousand board feet (mbf) while decreasing the domestic log price by \$50 per mbf. This is because the ban would cause a leftward shift, or decrease, in the supply of export logs, while increasing supplies to onshore purchasers.

They also predicted that the ban would cause a decrease in low grade exports; a leftward shift in supply, and an increase or rightward shift in demand as low grades are substituted for higher grades in response to the increase in the price of higher grades. This would cause little change in low-grade export log volumes and a minor increase in price.

Another study completed prior to implementation of the ban, by Flora and McGinnis (1990), examined the price and flow impacts of supply and demand for the four market sectors of onshore lumber, exported lumber, onshore logs and exported logs. This allowed the examination of the interaction between the markets and the effects of replanning, spotted owl set asides and the Shortage Relief Act. The model used included eight simultaneous equations for annual data from 1962 to 1989. It was assumed that at 1990 prices exports from the region would decline by about 450 mmbf, which is about 15% of softwood log exports from the region. Again, Washington and Oregon were used for the study region.

The effects of harvest level replanning, public lands spotted owl set asides, and the export embargo were expected to jointly increase domestic and export log prices by one-half. The export premium for logs was expected to increase as a result of the trade barrier.

It was predicted that fewer log exports would generate higher lumber exports. In log-equivalent terms each four unit decrease in log exports coincides with about a one unit increase in lumber exports. Because less total timber supply means less lumber supply available to all markets, foreign purchasers react to reduced quantities and higher prices by shopping elsewhere for both lumber and logs.

Flora, McGinnis, and Lane (1992) recently completed work defining the export premium. They suggest the export premium is composed of five components whose relative importance varies over time and market circumstances.

The first element is comparative advantage. In the mid-1960's it was claimed that Japanese trading companies bid artificially high prices on log exports in order to monopolize the market in the desired export grade. At this time, however, Japanese mills had greater product recovery from the logs, 70% versus 50% in the Pacific Northwest. As well, real wages in Japan were below those in the United States. Thus, the high bid for exports may have been due to a comparative advantage for overseas processing.

Quality is another component of the price differential. Quality is difficult to isolate when comparing export and domestic logs because of the different grading systems used. Some characteristics associated with quality are weighted differently, for example, crook and sweep are penalized greatly for export where one log may take the space of two when shipped. As well, the price differences vary for different species and grades in domestic and overseas markets.

A value added component also adds to the premium. Export logs have a higher cost for sorting, grading, handling and transportation. Flora et al. estimated this total value added differential to be \$75 per thousand board feet (mbf) in 1988 dollars.<sup>12</sup>

Continuity is another component defined by Flora et al. that adds to the price premium. Asian purchasers will pay for a stable supply agreement. Although some export logs are purchased in the spot market, the export market tends to provide more established trading relationships than the domestic market. This premium for insured supplies is greatest for high grade logs due to their scarcity. Supply continuity becomes more difficult and costly as export quality supply decreases and regulations increase.

The last noted component of the export price premium is export embargoes. Embargoes tend to cause scarcity of export purchasers' preferred species and grade. With no ban on state owned lands a \$200 per mbf export/domestic price premium was estimated for the scarcity premium in 1988 for old-growth logs, while the average export premium for all logs was \$60.<sup>13</sup> A 100% ban imposed on log exports from state lands was predicted to expand the

---

<sup>12</sup> Flora, McGinnis, and Lane, (1992) p. 7.

<sup>13</sup> Ibid, p. 9.

old growth premium to \$350 per mbf, about 100% of the domestic price. This is about \$120 per mbf for all logs, or 36% of domestic price. These figures are based on previous estimations made by Flora and McGinnis.

The study's conclusions indicate that larger export premiums occur in higher grades and that within these grades the premiums increased in the late 1980s and early 1990s. It was predicted that market cycles would also affect the premium level. An even greater premium would be expected as a result of the decrease in supply and export restrictions during a robust business atmosphere.

William McKillop of the University of California was hired as an expert witness for a Washington State lawsuit following the passage of the Shortage Relief Act. He was contracted to estimate future timber export premiums to determine the effect of the log export ban on DNR revenues. A comparable sales/transactions evidence analysis was used comparing US Forest Service and DNR sales between 1983 and 1990. Prior to 1991 there were no significant restrictions on DNR timber, even though Forest Service timber harvests restricted logs from export.

McKillop (1991) estimates substantial reductions in DNR timber sales revenue due to the Shortage Relief Act. He approximates that 62% of DNR timber has been exported in the past.

The log export premium percent was calculated for groups of comparable sales, then a weighted average export premium percent was calculated for each DNR region for each species of importance in the export market. Cut price, the price paid when the timber is harvested, was used in place of bid price because in many sales cut price is adjusted to reflect changes in prices of final products.<sup>14</sup> Washington DNR, however, does not adjust stumpage rates after timber sales.

Revenue losses were estimated for DNR lands by subtracting approximated revenues under the Shortage Relief Act from expected revenues without the Act instituted. It was assumed that DNR sales volume would not be affected due to Forest Service harvest declines, allowing DNR to sell its total

---

<sup>14</sup> Forest Service adjustment clauses allow bid price to adjust at time of harvest reflecting current market conditions.

allowable cut. The revenue estimate does, however, account for DNR sales reductions due to environmental considerations including spotted owl habitat protection.

McKillop concludes that the Shortage Relief Act causes DNR exportable logs to sell for 35% more, on weighted average basis, than comparable timber restricted from export, or \$405 per mbf for a domestic stumpage price of \$300 per mbf.

During this historical period the export/domestic cut price ratio was 2.35; 2.20 for Douglas fir alone; 1.35 for True fir; 3.34 for Western Hemlock.

In late 1991, the Washington Research Council (WRC) used previously determined high and low end estimates of the export premium to estimate DNR revenue losses. These premium estimates ranged from \$98 per mbf to \$405 per mbf. The low end was estimated by comparing stumpage prices of export restricted and unrestricted timber adjusted for quality and amount exportable within an unrestricted sale.<sup>15</sup> It is noted that this figure is lower than the long term average as a result of weak housing starts in Japan, temporarily lowering the price Japanese are willing to pay for raw logs. The high estimate is based on the study by McKillop.<sup>16</sup> DNR sales volume was estimated at 675 mmbf, down from the 1980 average of 770 mmbf because of the new spotted owl critical habitat policy. DNR revenue losses were then estimated to range from \$30 to \$123 million per year, depending on the export premium. The price changes caused by the ban, however, have not been isolated from the price changes due to owl set-asides and replanning in either of these studies.

Washington Governor, Booth Gardner, created a group known as the Governor's Timber Team to review the restrictions on the export of logs from public lands after one year in effect. Log price elasticities determined by previous studies conducted by the Department of Revenue were used to estimate price changes resulting from changes in quantity. The study used 1989 as a base for US Forest Service volume changes that was 692 mmbf less than average volume harvested 1988 to 1990. The change in DNR volume was based on the DNR sales projections. This price and volume information was

---

<sup>15</sup> Janet Baker(1991).

<sup>16</sup> McKillop, William (1991).

then condensed into a model to project timber sales revenues with and without the Shortage Relief Act log export restrictions. It was estimated that in 1991 \$15 million would be lost from DNR revenues. This loss increased to \$21 million in 1992, up to \$28 million in 1995.

The Governor also requested an independent review of the Shortage Relief Act to evaluate the results of the first year of the Act's implementation. This study, which was completed by Paul F. Ehinger & Associates (1992), measured the impact on timber sale revenues using the overbids of appraised prices as the primary basis of analysis. Sales in each region were compared by various characteristics of each sale to determine the percent of overbid plus average overbid for each sale.

It was concluded that the average difference in overbid between unrestricted and restricted sales was 9% of the average bid price for unrestricted sales. Applying 9% to the past 5 years revenues shows a 5 year revenue loss of \$83 million; \$16.6 million per year. This does not include quality and species adjustments, which would decrease the difference because of the higher price received for higher quality logs that account for the majority of log exports.

Another study specific to the Shortage Relief Act has been completed by Northwest Economic Associates (NEA) (1992). NEA assessed the Act's impacts by comparing restricted and unrestricted 1991 bid prices to derive a measure of the price premium offered by access to the export market. Their estimates assume the appraisal price includes all relevant information on tract characteristics that affect price.

| <b>Sale Type</b> | <b>Bid<br/>Price<br/>\$/mbf</b> | <b>Original<br/>Appraised Price<br/>\$/mbf</b> |
|------------------|---------------------------------|--|
| Unrestricted     | \$352.85                        | \$289.25                                       |
| Restricted       | <u>\$288.19</u>                 | <u>\$262.26</u>                                |
| Difference       | \$64.66                         | \$26.99  |

(average prices were used)

The export premium was determined by subtracting restricted from unrestricted bid price. It was adjusted for quality by subtracting the difference of the unrestricted and restricted average prices of the original appraisal price (appraisal before discounting for minimum bid price). The difference of the original appraisal price, \$26.99, is the quality premium. The export premium, which represents the premium purchasers paid for an exportable timber sale, does not account for the exportable and non-exportable components within each sale. A figure of 59% of DNR sales volume was used as an estimate of the exportable portion of a tract (based on 1988 Washington Mill Study). This relationship can be calculated as follows:

$$.59 \times \text{Price}_{\text{export}} + .41 \times \text{Price}_{\text{domestic}} = \text{Aggregate Unrestricted Bid Price}$$

$$.59 \times \text{Price}_{\text{export}} + .41 \times (\$288.19 + \$26.99) = \$352.95$$

Therefore:

$$\text{Price}_{\text{export}} = \$379.20$$

So, the export premium (difference between 100% export stumpage and 100% domestic stumpage) was estimated to be \$64.02 ( $379.20 - 288.19 - 26.99 = 64.02$ ). Sales for 1991, the first year with the Act in effect, showed an export/domestic price ratio of 1.2 ( $\$379.20 : \$315.18^{17}$ ).

The conclusions of the NEA study differ from those of the McKillop study (1991) because of the decrease in Forest Service harvest, or change in supply, incorporated in the analysis since the McKillop study was completed. This decrease in supply forced domestic stumpage prices up \$219 while export prices were up only \$154.<sup>18</sup>

None of these studies used a regression model to characterize how prices were related to quality and sale characteristic factors. Just recently, enough data has become available to make regression analysis useful. With the ban on DNR sales it is possible to incorporate both quality factors and the impact of the restriction on prices in a regression analysis.

<sup>17</sup>  $288.19 + 26.99 = 315.18$   
(restricted bid price) + (quality premium) = (domestic price adjusted for quality).

<sup>18</sup> NEA (1992).

## CHAPTER 3

## THE MODEL

Model Development

Neoclassical production theory assumes homogeneous factors of production. A tract of timber is an input into the production of other products following harvest and transport to mill or port. Any particular timber tract will vary in its species composition, quality, volume, accessibility, and so on. Thus, a hedonic pricing approach<sup>19</sup> is used to estimate the implicit prices of each characteristic. The differences in characteristics should be reflected in the stumpage price paid for the tract.

The hedonic price equation of a tract dependent upon its characteristics is represented by:

$$B = B(Z_1, \dots, Z_n),$$

where B is the winning bid price for the tract and the Z's are the quantities of the characteristics on the tract. An equilibrium is determined by the interaction between timber suppliers (tract owners) and timber demanders (mill owners, manufacturers and exporters).<sup>20</sup>

On the demand side are individuals who wish to purchase the timber for mill processing or to transport for export. The timber is a factor of production. The buyer of the timber will maximize profits subject to their production function. Production is a function of inputs and outputs exclusive of the timber, timber

---

<sup>19</sup> See Rosen (1974) for development of the hedonic model.

<sup>20</sup> See Munn and Rucker (1992) and Palmquist (1989) for similar hedonic analysis concerning factors of production.

characteristics, and other productive ability relating to diversity of buyers. Following is an implicit production function for logging:

$$I(X, Z, W) = 0,$$

where  $X$  = netputs<sup>21</sup> exclusive of timber tract ( $X > 0$ , outputs;  $X < 0$ , inputs),  
 $Z$  = timber tract characteristics,  
 $W$  = buyer characteristics that influence productive ability.

The bid price a buyer is willing to pay is dependent on gross, or variable, profits; buyer total revenue or value of outputs less non-timber input costs such as harvest and haul costs. The buyer's optimum is determined by maximizing variable profits subject to the production function,

$$\max_X V\Pi_B = \sum_{i=1}^n p_i X_i \text{ subject to } I(X, Z, W) = 0,$$

$$V\Pi_B \geq 0,$$

where  $V\Pi_B$  = variable profits of timber demander,  
 $p_i$  = price for the  $i$ th netput (outputs & non land inputs).

Solving the maximization problem yields the variable profit function,  $V\Pi_B^*$ ,

$$V\Pi_B^* = V\Pi_B^*(p, Z, W) = \sum_{i=1}^n p_i X_i(p, Z, W).$$

A prospective purchaser's bid depends on characteristics of the tract, input and output prices, desired profit level  $\Pi_B$ , and production skills. Actual profits equal variable profits less timber costs and any other fixed factors of production. The bid function,  $\theta$ , is defined by<sup>22</sup>

$$\theta(Z, p, \Pi_B, W) = V\Pi_B^*(p, Z, W) - \Pi_B.$$

<sup>21</sup> Netputs are the net of inputs and outputs exclusive of timber.

<sup>22</sup> If competition exists among buyers and all relevant economic costs are included in variable profits, then actual profits are zero and the bid function is simply the variable profit function. See Munn and Rucker (1992).

On the supply side, landowners maximize profits from selling a tract of timber by altering the characteristics within their control,

$$\text{Max}_{Z_c} \Pi_S = B(Z_U, Z_C) - C(Z_U, Z_C, r, V), \text{ subject to } \Pi_S \geq 0,$$

where  $\Pi_S$  = landowner profits,  
 $B$  = bid price of timber,  
 $Z_U = Z_U(Z_1, \dots, Z_k)$ ; characteristics uncontrollable by landowner,  
 $Z_C = Z_C(Z_{k+1}, \dots, Z_n)$ ; characteristics within the control of the landowner,  
 $r$  = vector of input prices,  
 $t$  = vector of technical parameters or landowner characteristics.

Solving the maximization problem leads to the landowner offer function,  $\phi$ . This is the minimum acceptable price for the timber,

$$\phi(Z_U, Z_C, \Pi'_S, r, t) = \Pi'_S + C(Z_U, Z_C, r, t),$$

$\Pi'_S$  = desired profit level.<sup>23</sup>

The equilibrium price schedule can be traced by the points of tangency between the bid and offer functions.<sup>24</sup>

### Regression Model

The bid price paid for any particular stand of timber is dependent upon the characteristics of the timber and the attributes of the sale itself. As an input to lumber, characteristics expected to influence stumpage include quality, volume, grade and species. Sale attributes, such as road costs, accessibility, additional fees and marketing restrictions, which affect purchaser costs and

---

<sup>23</sup> As with buyer's actual profits, an all inclusive cost function and the presence of competition will lead to actual profits of zero. Thus, the offer function will be the cost function. See Munn and Rucker (1992).

<sup>24</sup> See Rosen (1974).

expected returns, will also influence stumpage price. These characteristics are included in the regression model that follows.

$$RBid_i = f(LNVOL_i, RC_i, RFV_i, CNL_i, PDF_i, LNNB_i, PMT_i, SLE_i, BAN_i, UR_i, PTq_i, URPTq_i, HSA_t, EXC_t, FS_t)$$

where<sup>25</sup>

- RBid<sub>i</sub> = real winning bid price per mbf of the ith sale,
- LNVOL<sub>i</sub> = natural logarithm of the volume of timber on the ith sale,
- RC<sub>i</sub> = stations (100 feet) of road construction required on the ith sale,
- RFV<sub>i</sub> = real fees per mbf of the ith sale,
- CNL<sub>i</sub> = contract length of the ith sale,
- PDF<sub>i</sub> = percent of total volume of timber on the ith sale that is Douglas fir,
- UR<sub>i</sub> = unrestricted dummy variable on the ith sale (0 = restricted from export; 1 = unrestricted),
- URPDF<sub>i</sub> = unrestricted dummy variable x PDF<sub>i</sub>,
- LNNB<sub>i</sub> = logarithm of the number of bidders of the ith sale,
- PMT<sub>i</sub> = payment type of the ith sale (0 = scale sale; 1 = lump sum),
- SLE<sub>i</sub> = sale type of the ith sale (0 = oral bid; 1 = sealed bid),
- BAN<sub>i</sub> = ban dummy variable on the ith sale (0 = pre-ban; 1 = post-ban),
- PTq<sub>i</sub> = Volume of grade q, Douglas fir plus white woods, as a percentage of total volume of timber (all grades) on the tract, on the ith sale, q = (1, 2, 3),
- URPTq<sub>i</sub> = unrestricted dummy variable x PTq<sub>i</sub>,
- HSA<sub>t</sub> = US + Japanese housing starts (in thousands of units, seasonally adjusted) in the tth quarter,
- EXC<sub>t</sub> = relative exchange rates (yen/dollar) in the tth quarter,
- FS<sub>t</sub> = cumulative deviation from average(1984-88 average) on Forest Service sales in the tth quarter.

---

<sup>25</sup> See appendix B for complete variable description.

To estimate the above relationship the following regression model is used:

$$\begin{aligned} \text{RBid}_i = & \alpha_0 + \alpha_{11} \text{LNVOL}_i + \alpha_{12} \text{RC}_i + \alpha_{13} \text{RFV}_i + \alpha_{14} \text{CNL}_i + \alpha_{15} \text{LNNB}_i + \\ & \alpha_{16} \text{PMT}_i + \alpha_{17} \text{SLE}_i + \alpha_2 \text{PDF}_i + \alpha_3 \text{BAN}_i + \alpha_4 \text{UR}_i + \\ & \alpha_{51} \text{PT1}_i + \alpha_{52} \text{PT2}_i + \alpha_{53} \text{PT3}_i + \\ & \alpha_{61} \text{URPT1}_i + \alpha_{62} \text{URPT2}_i + \alpha_{63} \text{URPT3}_i + \\ & \alpha_{71} \text{HSA}_t + \alpha_{72} \text{FS}_t + \alpha_{73} \text{EXR}_t + u_i, \end{aligned}$$

where  $u_i$  is a disturbance term.

CHAPTER 4  
DATA AND RESULTS

Data

The hedonic price model described above is used to estimate the determinants of bid price on Washington Department of Natural Resource sales from January, 1989 to October, 1992.

The DNR publishes monthly sales listing sale characteristics and a minimum bid price that is the appraisal price discounted. Potential purchasers place their bid during auction, and the timber is sold to the highest bidder. Because DNR timber sales follow a sustained yield policy, the volume offered for sale is not sensitive to market price.

Under the Shortage Relief Act, the sale is advertised and sold as either unrestricted or restricted from export. A comparison of bid prices on restricted and unrestricted sales produces a measure of the price premium. All other characteristics of the sale must be included in order to isolate the effects of restrictions on the premium.

Data were obtained from timber sales notices and summaries from the Washington Department of Natural Resources.<sup>26</sup> The winning bid price (or stumpage value) was divided by the total sales volume to determine the stumpage value per mbf. The stumpage value was deflated by a producer price index to convert it to real terms in 1991 dollars. Adjusted (real) bid price (per mbf) is the dependent variable in the regression model.

A portion of the amount bid for a tract is dependent upon the discounted sum of expected net returns. A minimum of 10% of the appraisal price is required as a deposit upon purchase of a tract. Tract purchasers use the timber as an input for future production or export. They, therefore, must discount the deposit amount of their expected earnings for future value. The total expected

---

<sup>26</sup> See appendix A for a list of information available from DNR for individual sales.

returns depend on several factors including tract characteristics, market behavior and timber regulation. Timber characteristics are included as explanatory variables, including dummy variables for payment type, sale type, ban (which includes all sales after January 1991), and unrestricted sales (those sales legal for the export market).<sup>27</sup>

### Predictions

Total volume represents the total amount of marketable timber on a tract. Volume is expected to have a positive effect on bid price per mbf. The greater the volume of timber on a tract the higher the expected bid price, however, because of economies of scale bid price would be expected to increase at a decreasing rate. Thus, the natural log of volume is the variable used (LNVOL).

Many tracts require a substantial amount of road construction. Road construction required for a sale is measured in stations, where one station equals 100 feet. Road construction, RC, is a cost in addition to bid price, and thus is expected to have an inverse relationship with the tract value. Other fees, paid in addition to the bid price, may also exist. They, too, are expected to have a negative impact.

Contract length (CNL) varies among DNR timber sales. It is expected that longer contracts reduce risk. Having a longer period of time in which to market the timber reduces the risk of bid prices remaining above market price throughout the contract interval and allows more flexibility of scheduling. A longer contract length, however, may be indicative of more difficult harvest conditions which would imply greater harvesting costs and have a negative effect on price. Thus, the total effect of contract length on bid price is ambiguous.

Quality by grade and species varies greatly among sales. Douglas fir is included to test species quality effects. This study involves the West side of Washington State in which Douglas fir could be assumed to be the highest quality species. It must be noted, however, that while the domestic market has

---

<sup>27</sup> See appendix B for complete list of data and definitions.

treated Douglas fir as the premium quality, many overseas markets believe white woods to be of greater quality. This is because higher quality Japanese domestic timber are white woods. So, white woods are more familiar and preferred in some offshore markets as substitutes for their own domestic wood. Accordingly, while an increase in the percent of Douglas fir on the tract is expected to have a positive effect on price, this effect may be smaller on unrestricted sales. The opposite would then hold true for white woods; the effect of an increase in white woods would be greater in the international market than in the domestic market.

Because Douglas fir and white woods account for the majority of log exports, the sum of the two species are measured as a percent of total volume of timber that is in each sale and are used as the sample to determine the significance of grades. All other species are omitted. Three standard grades are all inclusive of the two wood types. Number 1 quality, PT1, includes all special mill, #1 sawmill and peeler logs. Number 2 quality, PT2, is all #2 sawmill and number 3 quality, PT3, includes all lower grades. The export market generally requires high quality logs, thus few number 3 quality logs are exported.

Number of bidders is included as an explanatory variable to control for the level of competition. The logarithm of the number of bidders (LNNB) has been used to allow for the marginal effect of an increase in the number of bidders to be variable. It is assumed that the number of bidders is an exogenous variable.

The DNR used both lump sum and log scale payment types until October of 1990, when all sales became lump sum sales. A dummy variable (PMT) is used for lump sum sales, this variable is assigned a value of one for lump sum and zero for scale sales. Prior to the requirement of all sales being lump sum, payment type was likely determined based on various characteristics of the sale that affect the transaction costs of the sale.<sup>28</sup>

Another dummy variable (SLE) is used for sale or auction type, it equals one for a sealed bid and zero for an oral bid. Since June 1990, all sales have

---

<sup>28</sup> See Leffler and Rucker (1991) for a discussion of the effect of transaction costs on payment type.

been sealed bid. Prior to this date many sales had oral auctions. Again, the method of sale used most likely was determined largely by other aspects of each tract.<sup>29</sup>

The ban on 75% of log exports, put into effect by the Shortage Relief Act, should have a significant effect on bid price. The ban itself is included as a dummy variable (BAN), as is a dummy variable for unrestricted sales (UR). The ban reflects a shift in supply due to restricted exports overseas, thus increasing the supply of logs in domestic markets. All sales were unrestricted prior to the ban. Unrestricted sales, which are available to overseas customers, are expected to have a price premium over restricted sales. This is especially true for quality number 1, which is the quality with the greatest offshore demand.

Unrestricted quality variables are also included as interactive terms (URPTq). That is, a set of multiplicative variables, the product of the unrestricted dummy variable and the quality by grade variables, are included to determine the interaction between the export restriction and log quality. The estimated coefficients on these variables provide a measure of the price premium on exportable logs by quality grade. The coefficient on the interactive term for number 1 quality is expected to be positive; a high grade export should receive a large and significant price premium because it is the quality with greatest demand in export markets. Number 2 quality would be expected to have a smaller premium than quality 1, as a low grade export is not expected to have a significant premium. Number 3 quality should have an even smaller premium, if any premium at all because it will rarely enter the export market and the larger its share the less suitable the sale is for the export market.

Several proxies for market supply and demand conditions are also included in the regression. U.S. plus Japanese housing starts corrected for seasonality are included as a proxy for timber demand. Relative exchange rates, yen per dollar, are also expected to affect demand; the less yen necessary to purchase one dollar, the less expensive American goods are perceived by Japanese, thus an increase in demand for American goods. An increase in Japanese demand for American unprocessed logs would be

---

<sup>29</sup> See Johnson (1979) for a discussion of oral versus sealed bids.

expected to increase log prices, consequently an inverse relationship should exist between the bid price and exchange rate ratio.

A deviation from average Forest Service sales volume is included as a proxy for supply constraints from spotted owl litigation and other causes of federal sales declines. This term is the cumulative deviation from a four year average (1984-1988) of USDA Forest Service sales levels. This variable accounts for the decrease in Forest Service harvest due to both replanning and spotted owl set asides. If a simple difference between a Forest Service sales volume trend and actual sales volume were used, it would not account for the shortage in supply over time. That is, if the sales level returned to the trend there would be no volume difference such that no price differential could be expected. In reality, however, price would not return to the previous equilibrium by a volume return to the trend because there is still a shortfall of timber sales in the market. In the short run the price will not return to the original equilibrium unless there is an excess of sales as great as the previous shortage. Because there has not been sufficient time for adjustment in the market<sup>30</sup>, the cumulative deviation is a more useful variable to measure the effects of the spotted owl on federal supply and on bid prices for DNR timber.

There are several factors that may be thought of as influencing bid price that are not included in the regression model. Volume of timber per acre could be included as a cost variable. The more dense the forest the less set up necessary to harvest a given volume of timber, and therefore the lower the cost. When included in the model however, volume per acre acted as a proxy for quality and reduced the significance of the other quality variables.<sup>31</sup> This variable measured the commercial volume per acre or volume available for processing versus actual standing volume. That is, it measured old growth stands as having greater volume per acre, which are higher in quality. The square of volume per acre was also included as an explanatory variable to determine if there existed some point of extreme density affecting the cost of

---

<sup>30</sup> It takes several years for the industry to adjust to a change in market conditions. This is because mills usually maintain 1 year of backlog inventory and continue to run during this time regardless of supply. If they do shut down equipment is maintained. Thus, full adjustment does not occur for several years when all equipment is actually sold.

<sup>31</sup> The correlation coefficient between volume per acre and quality 1 is .52.

harvesting, but this variable was insignificant. Both variables were deleted from the model to reduce the collinearity problem with grade quality levels.

Appraisal price is another variable that may be hypothesized to influence bid price. The DNR uses a regression equation to set the appraisal price. The appraisal equation is a function of volume per acre, species by grade, lagged mean selling price and location, based on 6 months of data. The final minimum bid is discounted 20 to 40% from the regression determined appraisal price. The amount of discount is determined by other characteristics of the sale. Because the DNR's minimum bid, or appraisal price, is determined by many characteristics within the model it too was collinear with other variables in the model. The included variables should account for everything appraisal value would have added. The only contribution not included elsewhere, is that an appraisal value is a constraint for minimum bid price, and hence, may have an effect on number of bidders. An increase (decrease) in the appraisal value, holding all other tract attributes constant, would be expected to decrease (increase) the number of bidders.

Miles to mill may also affect bid price. Sufficient data, however, were not available to estimate this effect.<sup>32</sup>

Data from the Western half of Washington were used (split along the Cascade mountain range). East-side sales, whether restricted or unrestricted, generally are bid upon for domestic processing. West and East side also have different markets and different quality by species. Another result supporting the separation of the markets is a F-test applied to the residuals. A F-statistic of 13.57 was calculated by comparing east and west-side sales to all sales.<sup>33</sup> Other sales deleted from the data include thinning and pole sales because of their atypical prices; low and high respectively. Region sales, sales with a value less than \$100,000, were also left out due to lack of available data.

<sup>32</sup> Brown and Smith (1992) found haul zone, or distance to market to be an insignificant factor in stumpage value.

<sup>33</sup>  $F = \frac{RSS_T - (RSS_W + RSS_E)}{(RSS_W + RSS_E)} \times \frac{(N-2K)}{K} = 13.57$

for  $RSS_T$ ,  $RSS_W$ ,  $RSS_E$ , respectively the sum of squared residuals for all Washington sales, for west side sales only, for east side sales only.  $N$  is the total number of observations and  $K$  the number of independent variables in the model including the constant. At a level of significance of .05 the critical value is approximately 1.57 for  $F(K, N-2K)$ . The hypothesis of equality for coefficients for the entire state is rejected because the calculated F-statistic is greater than the critical value.

After omitting inappropriate sales from the series, 627 sales were left for the analysis described below.

### Regression Results

Table 1 presents the results of the regressions run. Part (A) is the exact model previously stated. Part (B) includes an interactive term of the unrestricted dummy variable, UR, and the percent of Douglas fir, PDF. The URPDF variable is added to determine the effect of species on quality in the export market as a function of price distinct from grade.

The estimated coefficients can be interpreted as the marginal implicit prices for the timber tract characteristics.

Table 1. Estimates of Regression Equations Explaining Implicit Price Characteristics.

| Variable                   | (A)         |        | (B)         |        |
|----------------------------|-------------|--------|-------------|--------|
|                            | Coefficient | T-Test | Coefficient | T-Test |
| C                          | -590.099    | -4.398 | -603.585    | -4.543 |
| LNVOL                      | 27.957      | 4.628  | 27.433      | 4.586  |
| RC                         | -0.493      | -5.446 | -0.479      | -5.343 |
| RFV                        | 2.002       | 2.522  | 1.922       | 2.445  |
| CNL                        | -3.027      | -6.256 | -2.791      | -5.775 |
| PDF                        | .519        | 4.597  | 1.200       | 5.544  |
| URPDF                      |             |        | -.894       | -3.673 |
| LNNB                       | 41.244      | 5.927  | 40.793      | 5.922  |
| PMT                        | -11.510     | -1.150 | -12.550     | -1.267 |
| SLE                        | 8.819       | .951   | 8.433       | .919   |
| BAN                        | 53.502      | 2.108  | 58.046      | 2.308  |
| UR                         | 111.467     | 3.877  | 109.107     | 3.833  |
| PT1                        | 3.147       | 3.903  | 3.030       | 3.794  |
| PT2                        | 1.976       | 5.129  | 1.256       | 2.928  |
| PT3                        | .603        | 1.622  | .397        | 1.068  |
| URPT1                      | 2.937       | 3.363  | 3.078       | 3.556  |
| URPT2                      | -.963       | -2.130 | -0.041      | -0.080 |
| URPT3                      | -.918       | -1.967 | -.592       | -1.258 |
| HSA                        | .296        | 2.117  | .312        | 2.251  |
| EXC                        | 1.524       | 3.615  | 1.560       | 3.736  |
| FS                         | -.0000152   | -7.317 | -.0000145   | -7.008 |
| No. of Observations        | 627         |        | 627         |        |
| R-squared                  | 0.612       |        | 0.621       |        |
| Adjusted R-squared         | 0.600       |        | 0.608       |        |
| Mean of dependent variable | 334.0979    |        | 334.0979    |        |
| S.E. of regression         | 74.293      |        | 73.540      |        |
| Sum of squared resid       | 3350335.000 |        | 3277362.000 |        |
| F-Statistic                | 50.458      |        | 49.596      |        |

Nearly all variables are significant at the .05 level of significance with the expected sign. An adjusted R-squared of .60 indicates that 60% of the variation in bid price is explained by the independent variables of the regression equation. A prediction error of 22.3% is estimated.<sup>34</sup> An F-statistic<sup>35</sup> of 50 shows that the explanatory variables are very significant in explaining the variation of bid price about its mean. That is, the F-test for the joint significance of the explanatory variables strongly rejects the null hypothesis that these variables equal zero.

As expected, volume (LNVOL) is significant and positive. Road construction (RC) also is significant with a negative impact on price, as it is an increased cost. Real fees per volume (RFV, 1991 dollars) are significant but positive. There is no logical explanation for fees to be positive; they are an additional cost and should therefore be inversely related to bid price. The length of contract (CNL) is negative reflecting the higher costs associated with longer harvests.

The percent of Douglas fir (PDF) on a tract has a positive and significant influence as expected. It is interesting to compare regression (A) and regression (B) from table 1. The impact of the percent of Douglas fir has increased in (B) relative to (A). Unrestricted percent of Douglas fir (URPDF) has a smaller effect on price than when restricted. This is explained because Douglas fir is seen as the highest quality species in the domestic market. However, white woods are perceived as higher quality in the offshore market. For this reason, when comparing unrestricted percent of Douglas fir with the restricted percent, it shows that the Douglas fir species has a smaller price premium in the international market than in the domestic market.

Number of bidders (LNNB) is positively related to bid price as expected. As the number of bidders increases the competition increases, thus the actual

<sup>34</sup>  $S_y = \sqrt{\frac{RSS}{DoF}} = 74.29 \quad \frac{S_y}{\bar{y}} = .222$  for  $S_y$  = standard error, DoF = degrees of freedom,

$\bar{y}$  = mean of dependent variable.

<sup>35</sup>  $F = \frac{RSS/(k-1)}{ESS/(n-k)} = \left( \frac{R^2}{1-R^2} \right) \frac{n-k}{k-1}$  for RSS = regression sum of squares, ESS = error sum of squares, n = number of observations, and k = number of independent variables.

bid also increases. It might be expected that the ban would reduce the effective competition for restricted sales because of the tight substitution laws that prevent an exporter of logs from bidding on these sales. When the regression is run including an interactive term with ban and the log of the number of bidders the coefficient is insignificant.

Payment type (PMT), although insignificant, has a negative coefficient suggesting that scale sales receive a greater price than lump sum sales. This is supported by Leffler and Rucker (1991) who provide a transactions cost explanation for prediction of payment type. Other analysis of contract choice for natural resources, rejected by Leffler and Rucker's empirical analysis, suggest risk as the determining factor.<sup>36</sup> Sale type (SLE) is also insignificant and has a positive relationship with price. Although insignificant, it implies that sealed bids received higher prices than oral bids. As is suggested by Johnson (1979), the higher price for sealed bids is not necessarily due to collusive agreements on oral bids, but to profit maximizers in a competitive heterogeneous market.

The estimated coefficient on the ban dummy variable (BAN) measures the effect of the ban on the average DNR sales price. This measures the decrease in domestic price from the influx of logs in the market for domestic processing, and the increase in the export premium from the loss of logs there. The positive coefficient here shows that the average price after the ban is more than \$50 greater per mbf than it was before the ban.

The significance of the estimated coefficient on the unrestricted dummy (UR) shows that unrestricted and restricted sales prices are significantly different from each other.

The estimated coefficients on the quality by grade variables (PT1, PT2, PT3) are positive for all three grades with the magnitude and significance of the coefficients decreasing by grade.

The interactive terms of unrestricted sales and quality (URPT1, URPT2, URPT3) are all significant in table 1 (A). Only the quality one interactive term is significant in (B). This means the price for unrestricted quality 1 timber is significantly different from restricted quality 1 price in both models. Unrestricted

---

<sup>36</sup> See Leland (1978) and Mead et al. (1985).

quality 1 has a price premium of approximately \$2.94 per mbf greater than restricted quality 1 for every 1 percentage point share shift into quality 1. Unrestricted qualities 2 and 3 are insignificant and negative in (B), but significant with much larger coefficients in (A). When looking at the unrestricted dummy variable and the unrestricted quality variables it becomes obvious that quality 1 is the only quality with a price premium in the offshore market. Quality 2, which is a low quality export, has very little premium.<sup>37</sup> Quality 3, which also has little to no premium, is rarely demanded in the export market.

Examining table 1, regression (B), that includes the unrestricted Douglas fir term (URPDF), we see that an increased share of Douglas fir decreases the export premium and that the unrestricted interaction appears to be correlated with quality 2.<sup>38</sup> That is, by allowing both species and grade quality variables, the restricted coefficients by grade are nicely arranged from high prices for quality 1 to low prices for quality 3, and the unrestricted premium is very high for quality 1 and slightly negative for quality 3.

Housing starts (HSA) are significant with a \$.30 per 1,000 unit impact. The coefficient is positive as expected. Housing starts show the decrease in timber demand caused by the recession.

Relative exchange rates (EXC), yen per dollar, show a positive relationship with price; a negative relationship is expected. The sign error has no logical explanation, however, it may be due to a simultaneity problem between exchange rates and Japanese imports. That is, exchange rates may affect quantity of imports to Japan, but quantity of imports may have an effect on the exchange rate.

The estimated coefficient on the cumulative deviation in Forest Service sales (FS) is significant and negative as expected. A decrease in Forest Service harvest will cause an increase in price.

Similar regressions were run for before and after the ban. These results follow in table 2. Several variables were deleted from these regressions to prevent singularity, in which case estimation would not be possible. The two

---

<sup>37</sup> Both Flora and McGinnis (1989) and Sedjo and Wiseman (1983) discuss high versus low quality export premiums consistent with these results.

<sup>38</sup>The correlation coefficient between URPDF and PT2 is .26.

models are significantly different. They were tested with an F-statistic on their residuals. The calculated F-statistic of 6.67 exceeds the critical value at a .05 level of significance.<sup>39</sup>

Table 2. Estimates of Regression Equations Explaining Implicit Price Characteristics Differentiating Before and After Log Export Ban.

| Variable                   | Pre-Ban     |        | Post-Ban    |        |
|----------------------------|-------------|--------|-------------|--------|
|                            | Coefficient | T-Test | Coefficient | T-Test |
| C                          | -351.628    | -2.485 | -841.625    | -2.617 |
| LNVOL                      | 29.871      | 4.066  | 14.712      | 1.459  |
| RC                         | -0.652      | -5.367 | -0.024      | -0.183 |
| RFV                        | 5.737       | 4.191  | -0.605      | -0.693 |
| CNL                        | -3.317      | -5.157 | 0.533       | 0.704  |
| PDF                        | .358        | 2.434  | 1.014       | 5.987  |
| LNNB                       | 49.850      | 4.800  | 44.826      | 5.579  |
| PT1                        | 5.502       | 12.486 | 4.486       | 6.918  |
| PT2                        | .937        | 2.760  | 1.649       | 4.635  |
| PT3                        | -.522       | -1.625 | .485        | 1.662  |
| HSA                        | -0.026      | -0.131 | 0.196       | 0.668  |
| EXC                        | 2.117       | 2.306  | 3.821       | 2.242  |
| FS                         | -.00000586  | -0.712 | -.0000239   | -5.996 |
| No. of Observations        | 403         |        | 224         |        |
| R-squared                  | 0.599       |        | 0.687       |        |
| Adjusted R-squared         | 0.587       |        | 0.670       |        |
| Mean of dependent variable | 345.764     |        | 313.109     |        |
| S.E. of regression         | 77.418      |        | 62.719      |        |
| Sum of squared resid       | 2337508.000 |        | 830010.7    |        |
| F-Statistic                | 48.003      |        | 38.682      |        |

It is shown that the average bid price decreased following the ban (from \$346 to \$313). This is because both restricted and unrestricted prices are included in the after-ban average. Before the Shortage Relief Act, all DNR sales were unrestricted. After the ban the magnitude and statistical significance of the estimated coefficient on PDF, the percent of Douglas fir on a sale, increases. This is largely because of the increase in domestic sales and the greater value of Douglas fir in domestic markets than in overseas markets. This may also show the effect of the supply shortage raising bid prices if the proxy variable for supply is not effectively controlled for. The number 1 quality variable decreases, again because both unrestricted and restricted sales are included in after-ban prices.

<sup>39</sup> See note 33.

The Forest Service harvest term becomes very significant after the ban. Although owl set aside and replanning began in 1989, many of the sales that were held up in litigation in 1989 were released and sold causing an increase in sales in 1990. Thus, the 1989-90 period is not as indicative of the trends in owl set asides and replanning as the 1991-92 period.

Another set of regressions were run to determine the post-ban unrestricted price premium. The results follow in table 3.

Table 3. Post-ban Estimates

| Variable                   | (A)         |            | (B)<br>Omits Interaction Terms (URPTi) |          |
|----------------------------|-------------|------------|--|----------|
|                            | Coefficient | T-Test     | Coefficient                            | T-Test   |
| C                          | -852.745    | -2.792     | -911.804                               | -3.020   |
| LNVOL                      | 20.180      | 2.102      | 19.822                                 | 2.085    |
| RC                         | -.062       | -.502      | -.066                                  | -.544    |
| RFV                        | -.638       | -.771      | -.596                                  | -.727    |
| CNL                        | -1.167      | -1.615     | -1.029                                 | -1.436   |
| PDF                        | 1.104       | 6.875      | 1.110                                  | 6.945    |
| LNNB                       | 34.780      | 4.468      | 34.665                                 | 4.464    |
| UR                         | 4.468       | .102       | 56.008                                 | 5.452    |
| PT1                        | 3.919       | 5.638      | 4.306                                  | 7.069    |
| PT2                        | 1.380       | 3.932      | 1.421                                  | 4.223    |
| PT3                        | .371        | 1.246      | .481                                   | 1.758    |
| URPT1                      | 1.817       | 1.387      |  |          |
| URPT2                      | .470        | .646       |  |          |
| URPT3                      | .617        | .774       |  |          |
| HSA                        | .402        | 1.423      | .444                                   | 1.589    |
| EXC                        | 6.148       | 1.948      | 3.361                                  | 2.099    |
| FS                         | -.0000203   | -5.300     | -.0000198                              | -5.206   |
| No. of Observations        |             | 224        |  | 224      |
| R-squared                  |             | 0.730      |  | 0.726    |
| Adjusted R-squared         |             | 0.709      |  | 0.709    |
| Mean of dependent variable |             | 313.109    |  | 313.109  |
| S.E. of regression         |             | 58.901     |  | 58.842   |
| Sum of squared resid       |             | 718144.100 |  | 727105.5 |
| F-Statistic                |             | 34.910     |  | 42.853   |

When the unrestricted dummy variable (UR) and the unrestricted quality interactive terms (URPT1, URPT2, URPT3) are all included in the regression it appears that they are collinear.<sup>40</sup> It may also be true that the small size of the data set does not provide enough degrees of freedom to accurately interpret the

<sup>40</sup>The pairwise correlation coefficients between UR and the URPT<sub>q</sub> interactive terms, URPT1, URPT2, and URPT3, are .59, .95, and .90 respectively.

significance of the coefficients. When the interactive terms are omitted from the model the unrestricted term shows a significant premium of \$56.<sup>41</sup>

Thus far, the regressions have shown the export premium for unrestricted timber after the ban. The following sub-section puts some of these figures in perspective.

### Estimating Marginal Implicit Prices

The model from Table 1 (B) is used to estimate marginal implicit prices. It is summarized as follows:

$$\begin{aligned} \text{RBid}_i = & \alpha_0 + \sum \alpha_{1j} \text{Characteristics}_i + \alpha_2 \text{PDF}_i + \alpha_{21} \text{URPDF}_i + \\ & \alpha_3 \text{BAN}_i + \alpha_4 \text{UR}_i + \\ & \alpha_{51} \text{PT1} + \alpha_{52} \text{PT2} + \alpha_{53} \text{PT3} + \\ & \alpha_{61} \text{URPT1} + \alpha_{62} \text{URPT2} + \alpha_{63} \text{URPT3} + \\ & \sum \alpha_7 \text{Other} + u_i \end{aligned}$$

Using coefficient estimates and sample means for the variables we can calculate average effects of different factors on bid prices for DNR timber. Table 4 includes the mean and standard deviation for all of the variables. The implicit marginal price of unrestricted sales is found by taking the partial derivative of the dependent variable with respect to the unrestricted dummy variable.

---

<sup>41</sup> The post-ban regression was also estimated omitting the unrestricted term and including the interactive terms. The interactive estimated coefficients were then marginally significant at the 20% level of significance.

Table 4. Data Measurements

Number of observations: 627

| Series | Mean         | Standard Dev. | Maximum      | Minimum       |
|--------|--------------|---------------|--------------|---------------|
| RBID   | 334.098      | 117.494       | 1024.721     | 8.121         |
| LNVOL  | 7.921        | .606          | 10.335       | 5.720         |
| RC     | 26.270       | 37.641        | 262.000      | 0.000         |
| RFV    | 3.677        | 4.140         | 33.151       | 0.000         |
| CNL    | 25.527       | 9.091         | 50.00        | 5.000         |
| PDF    | 49.757       | 33.564        | 100.000      | 0.000         |
| URPDF  | 34.885       | 36.34         | 100.000      | 0.000         |
| LNNB   | 1.877        | 0.512         | 2.708        | 0.000         |
| PMT    | 0.866        | 0.341         | 1.000        | 0.000         |
| SLE    | 0.657        | 0.475         | 1.000        | 0.000         |
| BAN    | 0.357        | 0.480         | 1.000        | 0.000         |
| UR     | 0.718        | 0.450         | 1.000        | 0.000         |
| PT1    | 8.172        | 9.820         | 53.000       | 0.000         |
| PT2    | 42.521       | 14.247        | 81.000       | 0.000         |
| PT3    | 29.991       | 14.645        | 85.000       | 0.000         |
| URPT1  | 6.606        | 9.720         | 53.000       | 0.000         |
| URPT2  | 30.762       | 22.451        | 81.000       | 0.000         |
| URPT3  | 21.408       | 17.988        | 79.000       | 0.000         |
| HSA    | 696.283      | 67.168        | 772.600      | 587.300       |
| EXC    | 138.102      | 8.567         | 155.253      | 122.980       |
| FS     | -4789543.500 | 3038382.300   | -1027137.300 | -12155288.000 |

$$\frac{\partial \text{RBid}}{\partial \text{UR}} = \alpha_{21} \text{PDF} + \alpha_4 + \sum \alpha_{6j} \text{PT}_j \quad j=1, 2, 3$$

So, the effect of an unrestricted sale on bid price is a function of quality by species and grade. Plugging in actual mean values, the average effect of an unrestricted sale on bid price is

$$\begin{aligned} \frac{\partial \text{RBid}}{\partial \text{UR}} &= -.894(49.7) + 109 + 3.07(8.17) - 0.041(42.52) - .592(30) \\ &= \$70.15. \end{aligned}$$

Overall, an average unrestricted sale will have a price premium of \$70.15 per mbf over a restricted sale. High quality contributes approximately \$25.08 to this difference, quality 2 contributes next to nothing, and quality 3 decreases price by nearly \$18.

The amount that quality by grade affects bid price is dependent on export restrictions.

$$\frac{\partial \text{RBid}}{\partial \text{PT}_j} = \alpha_{5j} + \alpha_{6j} \text{UR} \quad j=1, 2, 3$$

This shows that the effect of changes in grade on price is determined in part by whether the sale is restricted or not from export. Following are premiums for qualities 1, 2, and 3 for unrestricted sales.

$$\frac{\partial \text{RBid}}{\partial \text{PT}_1} = 3.03 + (3.078)(1) = 6.11$$

$$\frac{\partial \text{RBid}}{\partial \text{PT}_2} = 1.256 + (-.041)(1) = 1.21$$

$$\frac{\partial \text{RBid}}{\partial \text{PT}_3} = .397 + (-.592)(1) = -.19$$

Everything else held constant, grade quality has a large effect on the bid price. For every 1 percentage point share shift in quality 1 the bid price on unrestricted sales increases by \$6.11 per mbf. This increase is \$3.08 more per mbf than the corresponding increase in the domestic market of \$3.03. This means, if the amount of quality 1 were to increase from 8 to 9%, the premium on an unrestricted sale would increase by \$3.08 per mbf. Quality 1 has an elasticity of .15.<sup>42</sup> So, at the mean values shown in table 4, a 10% increase in the share of quality 1 (from 8% to  $1.10 \times 8\% = 8.8\%$ ) will cause a 1.5% increase in price per mbf. Quality 2 has no premium in the export market over the domestic market. Quality 2 itself has a premium of \$1.26 per mbf greater than the average bid price for a 1 percentage point share shift. Quality 3 is marginally significant, thus, at the 15% level of significance unrestricted and restricted quality 3 are significantly different. Quality 3 receives a greater price in the domestic market, this lower quality is rarely demanded in the export market.

---

<sup>42</sup>  $\frac{\partial \text{RBid}}{\partial \text{PT}_1} \times \frac{\text{PT}_1}{\text{RBid}} = .149$

## CHAPTER 5

POLICY IMPLICATIONS, FUTURE RESEARCH POSSIBILITIES,  
ALTERNATIVE PROPOSALS AND CONCLUSIONPolicy Implications

The data show that the average timber price after the ban has increased. Average pre and post-ban, unrestricted and restricted, prices can be calculated from the previous model summarized as follows:

$$RBid_i = \alpha_0 + \sum \alpha_{1i} \text{All Other Characteristics}_i(C_i) + \alpha_3 \text{BAN}_i + \alpha_4 \text{UR}_i + \alpha_{61} \text{URPT1} + \alpha_{62} \text{URPT2} + \alpha_{63} \text{URPT3}$$

$$\text{Pre-ban: } B = \alpha_0 + \sum \alpha_{1i} C_i + \alpha_4 \text{UR}_i + \alpha_{61} \text{URPT1} + \alpha_{62} \text{URPT2} + \alpha_{63} \text{URPT3} = 331.73$$

$$\text{Post-ban/UR: } B = \alpha_0 + \sum \alpha_{1i} C_i + \alpha_3 \text{BAN}_i + \alpha_4 \text{UR}_i + \alpha_{61} \text{URPT1} + \alpha_{62} \text{URPT2} + \alpha_{63} \text{URPT3} = 385.24$$

$$\text{Post-ban/R: } B = \alpha_0 + \sum \alpha_{1i} C_i + \alpha_3 \text{BAN}_i = 334.99$$

So, the average pre-ban price is \$331.73. The average post-ban price can be determined by taking the weighted average of restricted and unrestricted average prices;

$$(385.24)(.25) + (318.25)(.75) = \$334.99.$$

This shows that the DNR was able to gain some monopoly rents and increase revenue by \$3.26 per mbf. With a 100% ban, however, DNR revenues are lost.

This figure should be interpreted very cautiously as it appears that the analysis may not control effectively for other supply and demand shifts that are taking place in the same time period, such as Forest Service harvest declines. Suspicion of this arises when examining the Forest Service variable (FS) that shows an increase of \$15.20 per mbf for each billion board feet of reduced

sales. The raw data suggest this could be much larger.<sup>43</sup> Because the Forest Service sales decline is occurring at the same time as the ban, a large FS coefficient would likely result in a more negative post ban restricted impact for the domestic market. As well, previous studies have all predicted a decline in revenues<sup>44</sup>, although the amount of decline is often disputed.

It must also be noted that while the DNR definitely loses with a 100% ban, it is possible that aggregate welfare for the Pacific Northwest region increases. Because Washington has market power in the log export market, it may be possible to increase aggregate domestic welfare by decreasing quantity sold. As noted, DNR revenues would decline with a total ban, that would in turn cause a welfare loss to DNR trust beneficiaries. Other exporters, however, would have an increase in welfare that may be larger than the losses to DNR and its' trust beneficiaries. Actual elasticities are necessary to determine this welfare effect.

Assuming DNR quantity is held constant<sup>45</sup>, it is implicitly shown that before the ban the elasticity of demand for unprocessed log exports is less than the elasticity of demand for domestic logs. If the ban causes an increase in price, *ceterus paribus*, then it must hold true that the marginal revenue in the Japanese market is less than the marginal revenue of the domestic market, or

$$P_j \left(1 + \frac{1}{\epsilon_j}\right) < P_{US} \left(1 + \frac{1}{\epsilon_{US}}\right),$$

where  $P_j$  = log price in export market,  
 $P_{US}$  = log price in domestic market,  
 $\epsilon_j$  = elasticity of demand in export market,  
 $\epsilon_{US}$  = elasticity of demand in domestic market.

---

<sup>43</sup> Forest Service sales declined approximately 1.7 billion board feet during a period which resulted in an average increase in stumpage price of \$100 per mbf (see Warren 1992) suggesting a coefficient of \$60 per mbf for every billion board feet of sales decline. The Forest Service coefficient in this analyses (FS), however, estimates a price increase of only \$26 per mbf for a Forest Service harvest decline of 1.7 billion board feet. The FS estimated coefficient is -.0000152 per mbf or 15.20 per mbf for each billion board feet, and therefore \$25.84 per mbf for a decline of 1.7 billion board feet (15.2x1.7=25.84). While the characteristics of actual Forest Service sales are variable and the FS coefficient assumes all other characteristics are constant, it seems unlikely that there are other explanations to cause such a large price increase in Forest Service sales.

<sup>44</sup> See McKillop (1991), Ehinger (1992), and NEA (1992).

<sup>45</sup> The regressions run assume DNR sales quantity is not held constant, when DNR timber sales quantity were included in the regressions the estimated coefficients were insignificant.

And because  $P_j > P_{US}$  it must then be true that  $(1 + \frac{1}{\epsilon_j}) < (1 + \frac{1}{\epsilon_{US}})$ , or  $\epsilon_j > \epsilon_{US}$  and  $|\epsilon_j| < |\epsilon_{US}|$ . Thus, with a profit maximizing monopolist the market segment with the more elastic demand is charged the lower price. It is shown that the domestic market pays the lower price, it therefore must follow that the elasticity in the domestic market is greater.

#### Future Research Possibilities

Because the sales decline by the Forest Service has had such a large impact, research on additional methods to characterize the impact of declining Forest Service sales might improve upon the measurement of the impact of the ban. Thus, a continuation of this analysis would be interesting.

This study has concentrated solely on the price premium caused by the Shortage Relief Act. There are many other effects of the Act that may be of great interest to the State of Washington. Many studies have forecasted effects of the export ban on employment. While it may be difficult to obtain adequate data until later in time, it would be very interesting to examine the actual job losses and gains both directly in the timber market and indirectly due to the change in capital from higher export prices and lower domestic prices. Some studies have forecasted employment effects as a result of the ban. Several have found an increase in jobs created directly in the timber market.<sup>46</sup> Other studies, however, that analyzed the entire economy have indicated an overall decrease in employment due to an assumed loss of capital by the state from the log export ban.<sup>47</sup>

Another area open for study is the more political aspect of the ban and its purpose of insuring adequate domestic supply for those mills previously dependent upon federal supply. As of November 1991, only 10% of DNR sales under the ban had been harvested.<sup>48</sup> If supply was inadequate to meet demand at any given price, a very short lag between purchase and harvest would be expected. That is, if there were a shortfall in supply, the price would

---

<sup>46</sup> See Ehinger & Associates (1992) and Governor's Timber Team (1992).

<sup>47</sup> See NEA (1989) and Washington Research Council (1992).

<sup>48</sup> Comments from Washington State Department of Natural Resources, April 23, 1992.

increase giving timber purchasers incentive to harvest quickly. As of March 1992, seven companies had purchased over half of the export restricted sales. Another seven out-of-state companies purchased 12% of these restricted sales. Only 14 purchasers of export restricted sales are new state timber purchasers previously dependent upon federal timber; the mills the ban intended to help. However, five of these are out of state mills.<sup>49</sup> Therefore, the effectiveness in reaching the objectives hypothesized by the proponents of the ban could prove to be low.

Related to this would be a study of winners and losers from the ban. Because private and native American landowners are the only groups left in the industry not restricted from the log export market, and the export price is much greater than in past history, it would be expected that these owners might have lobbied for the ban because of the increased revenues they would be able to receive. The Act has created a transfer of income from the beneficiaries of the trust lands managed by the DNR to the non-export restricted landowners. In the State of Washington, however, it is well known that the majority of private owners opposed the Act. This is largely due to the fear of federal government, which may have overstepped state boundaries with the Shortage Relief Act, also overstepping private property boundaries by enforcing a complete ban on log exports by all owners in the state. Washington State is in the process of challenging this ban in the courts because of the federal government's interference with state's rights.

#### Alternative Proposals

There are alternatives to the Shortage Relief Act that may be more equitable.<sup>50</sup> One, would be to provide financial aid and retraining to the communities hardest hit by the timber supply shortfall. This would directly attack the adverse consequences of the new federal timber resource policies. Or, if decreasing log exports appears necessary to increase domestic timber flow, decreasing the log exports from all types of ownerships would share the burden

---

<sup>49</sup> See NEA (1989) and Washington Research Council (1992).

<sup>50</sup> Several alternatives are noted by McKillop (1991).

among all landowners versus putting the entire burden on the state and state trust beneficiaries. Another possibility, examined by Lippke (1992), is to put an export tax on logs. That is, collecting an increased price on the region's high quality timber versus giving away the region's comparative advantage to competitors, as the log export ban does. This would cause an increase in the price of logs (not as much as the tax), thus slightly decreasing Washington's market share. But, the threat of retaliation by importing countries' also would exist; taxing export of goods in which they have a comparative advantage. As well, although the tax would bring in a net revenue, it is a transfer of wealth from timber growers to processors and the federal treasury unless the tax is channeled back to timber growers, such as for increased forest management.

### Conclusions

Concluding, we have determined there exists price premiums for many characteristics attributed to timber sales. And, there does exist an export price premium for timber with a portion of that premium being due to the export ban. Other policy alternatives have been suggested, each of which has costs and benefits of its own favoring one group versus another. It appears that the log ban or any alternative regulation will favor some special interest groups over others. Groups proposing a ban intend to decrease log costs for their own current benefit without concern for the effects on other parts of the timber industry which may be more negatively impacted.

BIBLIOGRAPHY

## BIBLIOGRAPHY

Butchman, Allen; and Lippke, Bruce. "Short Supply Export Controls: Investigation of Unprocessed Timber Exports from All Public Lands of Oregon and Washington Before United States Department of Commerce, Bureau of Export Administration, Office of Industrial Resource Administration." Docket No. 90916-92161, Comments of Washington Citizens for World Trade and Pacific Rim Trade Association, December 13, 1989.

Brown, Lorrie Jo, Ph.D.; and Smith, Robert. "Washington's New Model for Stumpage Valuation and Some Interesting Findings on Today's Timber Markets." Report for the Washington Department of Revenue, (May 1992).

Dowdle, Barney. "Log Export Restrictions: Causes and Consequences." Mimeo University of Washington, College of Forest Resources, March 1980, and R.A. Sedjo, ed., Issues in U.S. International Forest Products Trade, Resources for the Future, Washington, D.C., 1980.

Ehinger, Paul F., & Associates, "Review of State Implementation of Public Law 101-382, Forest Resources Conservation and Shortage Relief Act of 1990." (April, 1992).

Flora, Donald F.; and McGinnis, Wendy J. "Embargoes On and Off: Some Effects of Ending the Export Ban on Federal Logs and Halting Exports of State-Owned Logs." (February 1989). USDA Forest Service, Pacific Northwest Research Station, Trade Research, Seattle.

Flora, Donald F.; and McGinnis, Wendy J. "Effects of Spotted Owl Reservations, The Export Embargo on State Logs, and Recent Forest Replanning on Timber Flows and Prices in the Pacific Northwest and Abroad." Review Draft (November 1990). USDA Forest Service, Pacific Northwest Research Station, Trade Research, Seattle.

Flora, Donald F.; McGinnis, Wendy J.; and Lane, Christine L. "The Export Premium: Why Some Logs are Worth More Abroad." Review Draft (June, 1992). Manuscript on file with USDA Forest Service, Pacific Northwest Research Station, Trade Research, Seattle.

Gruenfield, Jay; and Flynn, Bob. "Log Exports: An Update." *American Forests*, September/October 1990.

Johnson, Ronald N. "Oral Auction versus Sealed Bids: An Empirical Investigation." *Natural Resources Journal* 19 (April 1979): 315 - 335.

Leffler, Keith B.; and Rucker, Randal R. "Transactions Costs and the Efficient Organization of Production: A Study of Timber Harvesting Contracts." *Journal of Political Economy* 99 (1991): 1060 - 1087.

Leland, Hayne E. "Optimal Risk Sharing and the Leasing of Natural Resources, with Application to Oil and Gas Leasing on the OCS." *Quarterly Journal of Economics*. 92(August 1978): 413-37.

Lippke, Bruce, R. "The Export Issue." *Northwest Woodlands*. Winter 1992: 12-13, 30..

McKillop, William, *Estimation of Losses in Timber Sale Revenues of the Washington Department of Natural Resources Due to Restriction of Log Exports Under the Shortage Relief Act*, Department of Forestry and Resource Management, University of California, Berkeley CA, July 1, 1991.

Mead, Walter J.; Moseidjord, A.; Muraoka, D.; and Sorensen, P. *Offshore Lands: Oil and Gas Leasing and Conservation on the Outer Continental Shelf*. San Francisco: Pacific Institute of Public Policy Resources, 1985.

Munn, Ian; and Rucker, Randal R. *The Value of Information Services in a Market for Factors of Production with Multiple Attributes: The Role of Consultants in Private Timber Sales*. February 23, 1992.

Northwest Economics Association, "Revenue and Job Impacts of a Ban on Log Exports from State-Owned Lands in Washington". Analysis prepared for Washington Citizens for World Trade, December 13, 1989.

Northwest Economic Associates, "The Current Log Export Premium -- Evidence from 1991 DNR Timber Sales". (1992).

Palmquist, Raymond B. "Land as a Differentiated Factor of Production: A Hedonic Model and Its Implications for Welfare Measurement." *Land Economics*, 65: (1) 23 - 28.

Rosen, Sherwin, "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition." *Journal of Political Economy*, 82:34-55

Sedjo, Roger A., and Wiseman, A. Clark. "The Effectiveness of an Export Restriction on Logs." *American Journal of Agricultural Economics* (February, 1983).

Warren, Debra, *Production, Prices, Employment and Trade in Northwest Forest Industries*, Pacific Northwest Forest and Range Experiment Station, U.S. Department of Agriculture, Forest Service, Portland, Oregon, 1968-1984, Quarterly.

*Washington Mill Survey*, State of Washington, Department of Natural Resources, Olympia, Washington, even numbered years 1968-1986.

Washington Research Council. *Winners and Losers in the Log Export Ban*.  
Policy Brief, January 27, 1992.

Washington State Governor's Timber Team. *Log Export Restrictions: Costs  
and Benefits*. Office of Financial Management, 1992.

APPENDICES

APPENDIX A  
EXAMPLE OF DATA AVAILABLE  
FROM WASHINGTON STATE  
DNR

EXAMPLE OF DATA AVAILABLE  
FROM WASHINGTON STATE  
DNR

The following information from the State of Washington DNR is available per sale on the Results of Timber Sales Auctions Offered, published monthly:

- County
- Sale agreement number
- Sale name
- Region (DNR splits the State of Washington into six regions; Central, Northeast, Northwest, Olympic, South Puget Sound, and Southwest)
- Grant type
- Restriction (restricted or unrestricted from export)
- Volume(mbf)
- Appraised value (minimum bid)
- Bid Price
- Average bid price per mbf
- Percent of overbid
- Number of bidders
- Purchaser

Additionally, the Public Auction Sale of Timber is published monthly which contains a Timber Notice of Sale for each sale auctioned. The following additional characteristics of each sale are given:

- Date and location of auction
- Tract location
- Products sold and sale area
- Timber volumes and quality by species
- Bidding method
- Bid deposit required
- Performance security
- Sale type
- Expiration date
- Logging method
- Road construction and reconstruction required and optional
- Fees in addition to the bid price
- Special remarks which include fee use permits and date restrictions on harvest, haul and road construction
- Miscellaneous notes
- Timber sale map

APPENDIX B  
DATA SPECIFICATION

## DATA SPECIFICATION

|        |  |
|--------|--|
| C*     | Constant   |
| VOL*   | Volume of timber per sale per thousand board feet (mbf)  |
| RC*    | Stations (100 feet) of road construction required per sale   |
| RFV*   | Real fees per volume, additional to bid price, in 1991 dollars   |
| CNL*   | Contract length of sale, monthly   |
| PDF*   | Percent of total volume of Douglas fir   |
| URPDF* | Unrestricted dummy variable x percent total volume of Douglas fir  |
| LNNB*  | Log of number of bidders   |
| PMT*   | Payment type dummy variable; = 1 for lump sum<br>= 0 for scale sale  |
| SLE*   | Sale type dummy variable; = 1 for sealed bid<br>= 0 for oral bid   |
| BAN*   | Ban dummy variable; = 1 after ban (January 1991)<br>= 0 before ban   |
| UR*    | Unrestricted dummy variable; = 1 for unrestricted (exportable) sales<br>= 0 for restricted sales                       |
| PTq*   | Volume of grade q of Douglas fir plus white woods, as a percentage of total volume of timber (all grades) on the tract |
| q = 1  | Best quality includes special mill, #1 sawmill and #1 peeler logs  |
| q = 2  | Mid quality includes #2 sawmill and #2 peeler logs   |
| q = 3  | Low quality includes all quality below 1 and 2   |
| URPTq* | Unrestricted dummy x PTq (above)   |
| HSA**  | US + Japanese housing starts, thousands of units, seasonally adjusted  |
| EXC*** | Relative exchange rates; yen/dollar  |
| FS**** | Cumulative deviation from trend (1984-88 avg.) on forest service sales   |

\* Source: State of Washington Department of Natural Resources Timber Sales Prospectus and Sales Summaries January, 1989 to August 1992.

\*\* Source: *Statistical Roundup*, publication of National Forest Products Association, and *Japan Lumber Reports*, published by Japan Forest Products Journal, January 1989 to August 1992, 3rd quarter of 1992 calculated from previous trends..

\*\*\* Source: *Japan Lumber Reports*, published by Japan Forest Products Journal, January 1989 to March 1992, and *Barron's National Business and Financial Weekly*, March 1992 to August 1992, 3rd quarter of 1992 calculated from previous trends..

\*\*\*\* Source: Warren, Debra. *Production, Prices, Employment, and Trade in Northwest Forest Industries*, various issues, 3rd quarter of 1992 calculated from previous trends.

Note: all nominal values were deflated to constant 1991 prices by the producer price index of commodity prices (U.S. Department of Commerce, Economics and Statistics Administration, Bureau of Economic Analysis, *Business Statistics, 1963-91*, p. 29.), October, 1992 was included in the third quarter due to lack of data.