C I N T R A F O R

Working Paper

55

WASHINGTON'S FOREST SECTOR:

GROWTH TRENDS AND THEIR SOURCES

Guy C. Robertson

Bruce R. Lippke

July 1996

∧ ∧ ∧ ∧ ∧
∧ ∧ ∧ ∧ ∧
∧ ∧ ∧ ∧ ∧
∧ ∧ ∧ ∧ ∧

CINTRAFOR Working PAPER 55

WASHINGTON'S FOREST SECTOR:

GROWTH TRENDS AND THEIR SOURCES

Guy C. Robertson

Bruce R. Lippke

July 1996

Acknowledgments

Executive Summary

Harvest Declines and Revenue Growth

In spite of sharp declines in harvest volumes in the 1990s, Washington State's forest products sector continues to generate substantial income for the state and its inhabitants. At approximately 4.1 billion board feet, Washington State's 1994 timber harvest was 33% lower than the 1965-94 annual average of 6.1 billion board feet and was the lowest level reported during the 1965-94 time period. Total business revenue generated by the state's wood products sector in 1994 was approximately $9.1 billion (revenues reported in real 1994 dollars). In contrast to the harvest volume, this revenue figure exceeded the 1960-94 annual average of $8.3 billion by 9%. The state's forest products sector generated, on average, a total of $2,196 revenue per thousand board feet (Mbf) harvested in 1994--the highest figure ever recorded. While this record level is the partial result of sharp increases in real wood product prices due to recent supply constraints, trend analysis shows that growth in revenues per harvest volume prior to 1990 was also relatively robust. While yearly growth for the 1965-94 period was estimated to be 2%, that for the 1965-89 period was estimated at 1.7%. Washington State forest product firms have been successful at garnering increased revenues using fewer raw material inputs. This has been very important in mitigating at least some of the impact of recent harvest declines in the region.

Increases in the Real Price of Wood Products

The purpose of this report is to identify the primary sources of revenue growth for the Washington State wood products sector. While increases in the real price of wood products has certainly been important in the last few years, they should not be overemphasized in the explanation of long-term revenue growth. Indeed, the trendline for Washington wood products prices (weighted by 1965 product shares) is essentially flat, and, in spite of sharp price increases since 1991, current levels are well below peaks occurring in the late 1970s. Structural change, particularly a shift to greater secondary manufacturing, and increases in product recovery from log inputs are more important in explaining increases in revenue generated per unit volume of harvest.

Secondary Manufacturing

Total revenue from secondary manufacturing was $2.6 billion in 1994, 142% higher than the 1965 level, with much of the increase occurring in the last ten years. Similarly, secondary manufacturing's share of

total wood product sector revenues increased from 17% to 29% over this same 29-year period. While many secondary manufactured products require clear wood or other high quality characteristics, raw material inputs comprise a relatively smaller proportion of total product value, and the industry is less dependent upon the gross volume of harvest than lumber, paper or log exports. As a result, the strong performance of secondary manufacturing in both domestic and export markets represents a particularly promising adaptation to decreased harvests.

Exports

Another source from which Washington State producers have been able to generate increasing returns from a declining raw material base is the increase of exports, thus taking advantage of the export premiums associated with the trade in logs, lumber and other wood products. Log exports have constituted a major business since the early 1970s, fluctuating between $1.0 and $2.5 billion since that time. 1994 log exports totaled $1.4 billion, a level slightly higher than the 1965-94 average but significantly less than the $2.5 billion record high in 1979 or the recent peak of $1.7 billion in 1988. Lumber exports were slower to develop and remain less significant than log exports. The record level of $494 million was reached in 1988. Since that time, the percentage decline in lumber exports has exceeded that in log exports, with 1994 lumber export revenues falling to $365 million. Japan remains the most important foreign consumer of Washington State wood products. The Japan wood trade began with a heavy emphasis on high-quality old-growth logs but, more recently, has shifted to mostly second-growth products. Given that recent harvest restrictions fall most heavily upon these higher log grades, it is not surprising that exports of both logs and lumber have been in decline since 1990 in spite of rising prices. In contrast to log and lumber exports, exports of secondary manufactured goods have more than doubled since 1989, and, at $232 million, 1994 revenues for this group of products are rapidly approaching those of lumber exports.

Efficiency Gains in Raw Material Conversion

Efficiency gains in the conversion of wood raw materials to final products has been another important contributor to Washington wood products manufacturers' increasing revenues in spite of declining wood inputs. Lumber overrun (a measure of the amount of lumber produced from a given unit of log input) is estimated to have increased approximately 27% since 1960, and the increase in the amount of pulp produced from a unit of log input is estimated to have increased 35% since 1970. Likewise, efficiencies in plywood production (a significantly reduced part of Washington State's wood product mix) are estimated at 40% since 1960. Taken together, this means that the wood products sector requires approximately one third fewer logs to produce the same volume of output relative to the 1960s.

Timber Prices

Declining supply, increasing conversion efficiency, and greater export premiums could all be cited as reasons for rising timber prices (or "stumpage prices"). At $441/Mbf, 1994 stumpage prices were over four times the 1965 level and close to three times the 1986 level. The price that log buyers can pay for timber reflects the price they receive for products sold less processing costs--a residual price. Due to the nature of the stumpage price as a residual price and the volatility of wood products markets in general, the high variance in stumpage prices is not surprising. In particular, the sharp increases in stumpage prices since the late 1980s provide ample evidence of increasing supply constraints and conform with general observations about recent market developments. Prior to 1989, the positive trend in the price of timber was more directly related to other value increases in the use of wood.

Employment and Productivity

Direct employment in the wood products sector peaked at 72 thousand workers in 1978. Since that time employment has declined to 54 thousand workers, with most of this fall occurring during the severe recession in the wood products industries in the early to mid 1980s. Though falling employment is expected from declining harvests and from increased labor productivity, shrinkage in the labor force was significantly less than the fall in harvest. Contrary to expectations given productivity increases, the total number of employees per Mbf of timber harvested shows no discernible trend. The most important factor underlying this is the increase in secondary manufacturing and similar value-added activities which use more labor per unit volume of log input. Total 1994 Washington State employment (direct, indirect and induced) generated by the wood products sector is estimated at 194 thousand employees. Technology gains are usually associated with increased capital intensity (*i.e.*, more machinery per employee) and thereby more purchases of outside goods and services. This will result in increased indirect employment partially offsetting losses in direct employment. Evidence suggests that the ratio of total employment to direct employment in the wood products sector has increased approximately 6% over the last decade.

Conclusion

Washington State wood products producers have made steady gains over the last three decades in the amount of revenue generated per unit of resource harvested. These gains have helped to mitigate the impacts of recent harvest declines and belie the image of the wood products sector as an overly mature or dying industry. While real price increases in wood products have been partially responsible for revenue increases, especially in the last few years, increases in secondary manufacturing and exports have been more important in the long run. Because secondary manufacturing is both more labor intensive and less reliant upon gross volumes of timber harvest, expansion in this product category represents a particularly

promising development. The traditional export categories of logs and lumber have relied more heavily upon the availability of high quality stumpage, particularly old-growth. The maintenance and further expansion of revenues in these categories will depend upon the management of the state's second-growth forests and marketing efforts to gain increased foreign acceptance of products produced from them.

Table of Contents

Figures

Tables

Introduction

Recent sharp declines in timber harvests and an increasing recognition of the non-commodity values associated with the Pacific Northwest's forest resources have prompted some to characterize the region's wood products sector as an overly mature or declining industry. Certainly, harvest reductions related to conservation of spotted owl habitat and other riparian or old-growth preservation decisions have severely impacted the wood products industry. These impacts have not been evenly distributed across the various industries making up Washington State's wood products sector, nor have they been evenly distributed across the many towns and rural communities which participate in these industries. Consequently, the economic hardships imposed by timber harvest reductions have been both acute and profound for many but are not as apparent for the total sector. Nonetheless, the media attention given to these hardships and their perceived tradeoffs in regard to conservation has obscured two important points. The first is the region's vast second-growth resource which offers many possibilities for creative management to supply both industrial demands and also non-timber uses of the forest. The second is that, in spite of supply constraints, revenues for Washington State's wood products sector have remained relatively stable, and the industry continues to be a world-class supplier of wood products. The first point was characterized in a recent CINTRAFOR publication (Lippke and Robertson, 1995) that suggests a new paradigm for the sector's future. This report will concentrate upon the second point and will describe the industry's growth trends and their sources over the last thirty years.

More specifically, the purpose of this paper is to identify the key sources of growth in Washington State forest product revenues since 1965. Forest sector business income has been on a positive trend in spite of the recent decline in harvest volume. Moreover, as old-growth stocks have been largely depleted over the last few decades, log quality has also declined, or at least the proportion of large diameter knot-free logs has declined. These developments indicate that the state's wood products sector has been successful at generating increasing revenues from a declining resource base. While real price increases have certainly been important, especially those occurring in the last few years, they only account for a small proportion of total revenue increases in the period considered. Structural changes within the industry are more important. These changes include an increase in secondary manufacturing and a shift to export markets. In the first instance, additional value-added processing has generated revenue for the state using smaller volumes of wood materials. In the second, export premiums have increased revenue relative to that which would be obtained from domestic sales. Another source of revenue growth in the face of declining raw material inputs is found in the increasing efficiency in the conversion of raw timber to final products; firms are able to produce more using the same amount of log input. While the aforementioned structural

1

changes suggest that the industry is able to locate and exploit new market opportunities, increased efficiency in product conversion points to an ability to compete within these markets relative to one of the industry's principal inputs--raw material (labor and capital, of course, being the other major inputs). Once having adjusted to the available timber supply and assuming stability in that supply, even if at a reduced level, Washington State's wood products sector should find itself in a relatively favorable position. Even if future harvest volumes never approach the record levels of the past, those volumes which are available can be used more effectively to garner profits and overall revenue for the state and its inhabitants.

Data

This report relies primarily upon revenue, price and volume statistics for raw log production and the various end product areas comprising Washington State's wood products sector. The product areas considered in this report are log exports, lumber, plywood, pulp and paper, and secondary manufacturing (doors, windows, cabinets, moldings, *etc.*). Various sources were used in the development of data related to these categories, with the US Department of Commerce (DOC), the USDA Forest Service (USFS) and the Washington State Department of Natural Resources (WDNR) being chief among them. Numerous adjustments were made to certain of the data series, and several series had to be estimated or derived. The complete data set is presented in the statistical appendix along with a description of the adjustments and derivations made. In addition to the analysis of changing trends and their causes, the presentation and documentation of this data is an important second objective of this report.

While volume measurements are available for most product categories, there is no physical volume measure of output for the secondary manufacturing sector, and consequently, no reliable price information or volume-based share of total output is available for this sector.[1] An added complication here is that the secondary manufacturing industry uses lumber as a major input. Aggregating revenue from lumber sales and secondary manufacturing sales will result in double counting as a certain volume of wood may be sold twice, first as an input to secondary manufacture and latter as a final product. While this may upwardly bias gross revenue figures for the sector as a whole, it will not obscure trends within and between industry subsectors. In any case, trying to measure the amount of interindustry trade between lumber and

---

[1] While business income is reported by product area, there is substantial misclassification of firms based upon their primary product code. In this report we have preferred to use, where possible, an estimated average price times a volume of production for each product to derive total revenues for that sector.

secondary manufacturing is beyond the scope of this paper. No allowance is made for double counting here, and the reader is advised to bear the preceding caveats in mind.

Another problem comes from efforts to derive state level export statistics from trade data compiled at the customs district level. The DOC divides the Pacific Northwest into two customs districts: the Columbia-Snake and the Seattle district. While the Seattle district generally corresponds with Washington State, certain Washington ports, notably that at Longview, are included in the Columbia-Snake district figures, and adjustments using port level data are necessary. Similarly, products loaded in one port may be reported as originating from another. This is particularly true in regards to the large volume of log exports reported as originating in Portland. In this instance, other sources of port level data (Jones Stevedoring) were used to scale the DOC data.

Finally, it should be noted that reliable price statistics for various categories (primarily private stumpage and secondary manufactured goods) were not available. In some cases, price series were estimated using other data as a proxy. The main example of this is that WDNR timber prices adjusted for export bans are used as a proxy for private timber prices. In other cases no estimation was attempted but proxies were used to approximate price growth in the absence of an estimated price per unit volume sold. These techniques are described in the text and further documented in the Statistical Appendix.

Historical Trends in Harvest and Revenues

The fact that Washington State has enjoyed increasing revenues from wood products production in spite of falling harvests is readily apparent from an examination of harvest and revenue data. Figure 1 shows Washington State harvest volumes since 1965 broken out by ownership class. A linear trend line is included in the figure, and it clearly shows a declining trend. Furthermore, simple regression analysis indicates that harvest levels have been declining approximately 1% on average over the period considered.[2] At 4.1 billion board feet, 1994 harvest was 24% below the linear trend level for that year and fully 47% below the peak level of 7.8 billion board feet occurring in 1973. It should be noted, however, that most if not all of this decline is due to harvest restrictions imposed since 1989. If recent harvests had followed the same trend as that prevailing during the 1965-90 period, then 1994 harvests would have been approximately 6.2 billion board feet.

---

[2] Unless otherwise noted, all growth estimates given in this report are based on a simple model regressing the natural log of the dependent variable on a constant and on the year.

Figure 1. Volume of Washington State Timber Harvest, 1965-94
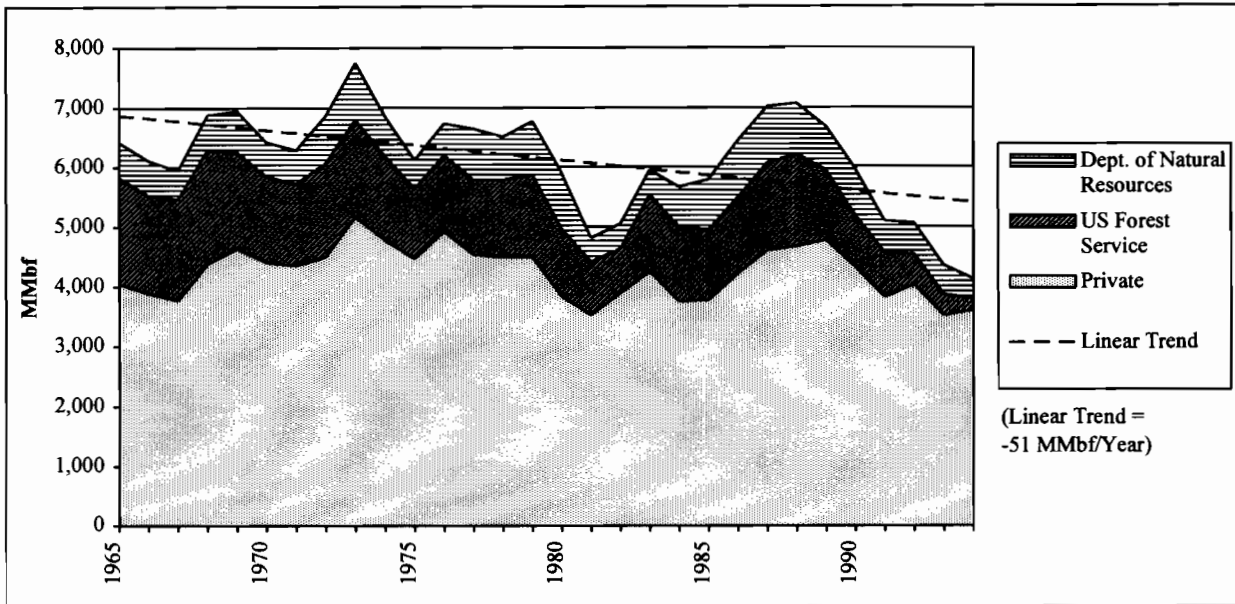
Source: CINTRAFOR. See statistical appendix for sources and derivations.

Figure 2. Total Revenue Generated by Washington State Wood Products Production, 1965-94
(Real 1994 Dollars)
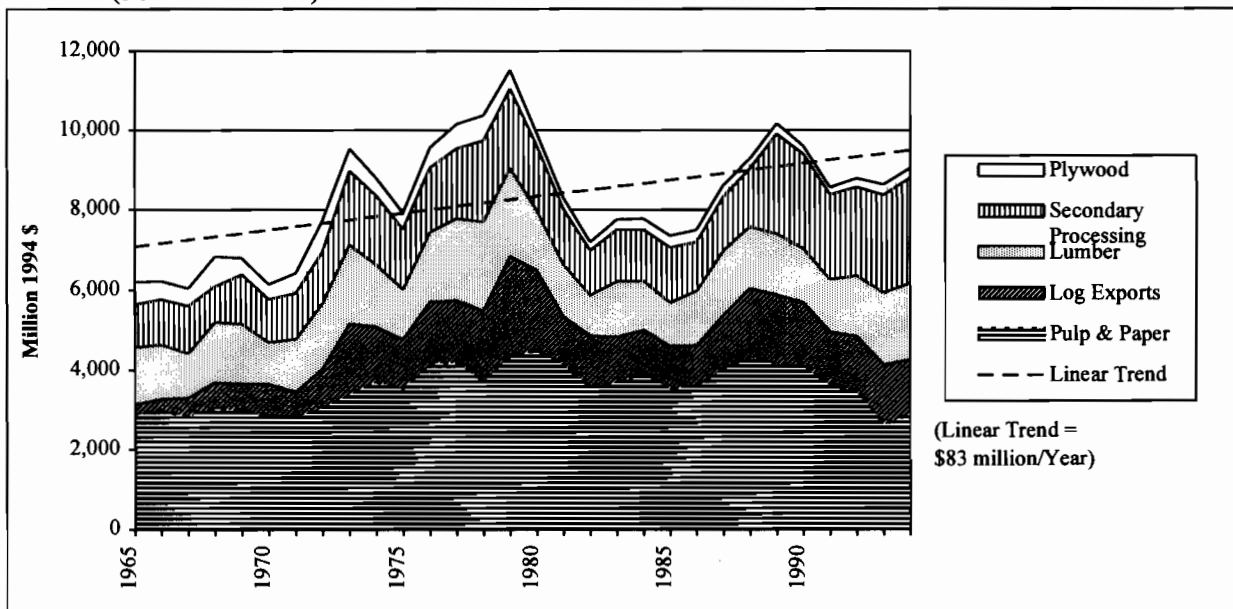
Source: CINTRAFOR. See statistical appendix for sources and derivations.
Graph depicts aggregate revenue for all industries included in this report (i.e. lumber, log exports, plywood, pulp & paper and secondary manufacturing).

4

Throughout this report the state harvest volume is taken as the resource base from which all Washington wood products revenues are generated. This ignores state level imports of wood raw materials. Washington Department of Natural Resources (WDNR) mill surveys, which are available for every other year from 1968 to 1992, indicate that on average 3.8% of log inputs to Washington state processors originate from out of state and that this figure is increasing somewhat over time. Logs from Oregon comprise the majority share of this volume. At the same time, there is an indication of increasing exports of Washington logs from WDNR lands to Oregon mills in recent years. Data to quantify these partially offsetting changes in log flows is not available. For the sake of convenience, we have assumed that interstate trade in logs balances out and have made no log flow adjustments to Washington State data. Out-of-state inputs to pulp and paper mills in the form of chips and mill residues is another factor that complicates the relationship between state harvests and final product sales. Unfortunately, consistent data on these flows were not available for this report. Net imports of chips and residues to Washington State pulp and paper mills has been estimated to be roughly equal to the state's supply. It is assumed in this report that the ratio of out-of-state chips and residues is constant over time. A final complication arises from the large volume of lumber imports from British Columbia, a proportion of which is used in the secondary manufacturing industry. This issue is discussed in further detail in the section specific to that industry.

Total revenues generated by Washington State wood products industries (Figure 2) presents a strikingly different picture from that of harvests. Here the linear trend is strongly positive and average yearly growth is estimated at 1.1%. The 1994 figure of $9 billion[3] is still below the trend but to a much smaller extent (5%) than the harvest figure. Likewise, 1994 revenues are only 21% off the peak of $11.5 billion occurring in 1979.

By dividing total revenues by harvest volume, the information presented in Figures 1 and 2 can be combined in a single series representing revenue generated per unit volume harvested. This sort of measure will be referred to frequently in this report. It should be noted that, unlike unit value measures which report revenues per volume of product sold, this measure of output per unit of input does not constitute a price. While end-product prices will certainly have an influence upon revenue per harvest, other factors including shifts between product categories and gains in processing efficiency may be equally or even more important. Revenue per harvest data are shown in Figure 3 along with a linear trend. Growth for this measure was estimated at 2% per annum, nearly twice that of the simple revenue figure.

---

[3] All dollar figures in this report are expressed in real 1994 dollars which, in most cases, are derived using the GDP Deflator as reported in *The Economic Report of the President*. Exceptions to this rule are noted where appropriate.

Figure 3. Total Revenue Generated by Washington State Wood Products Production per Unit Volume of Harvest, 1965-94 (Real 1994 $ / Mbf)
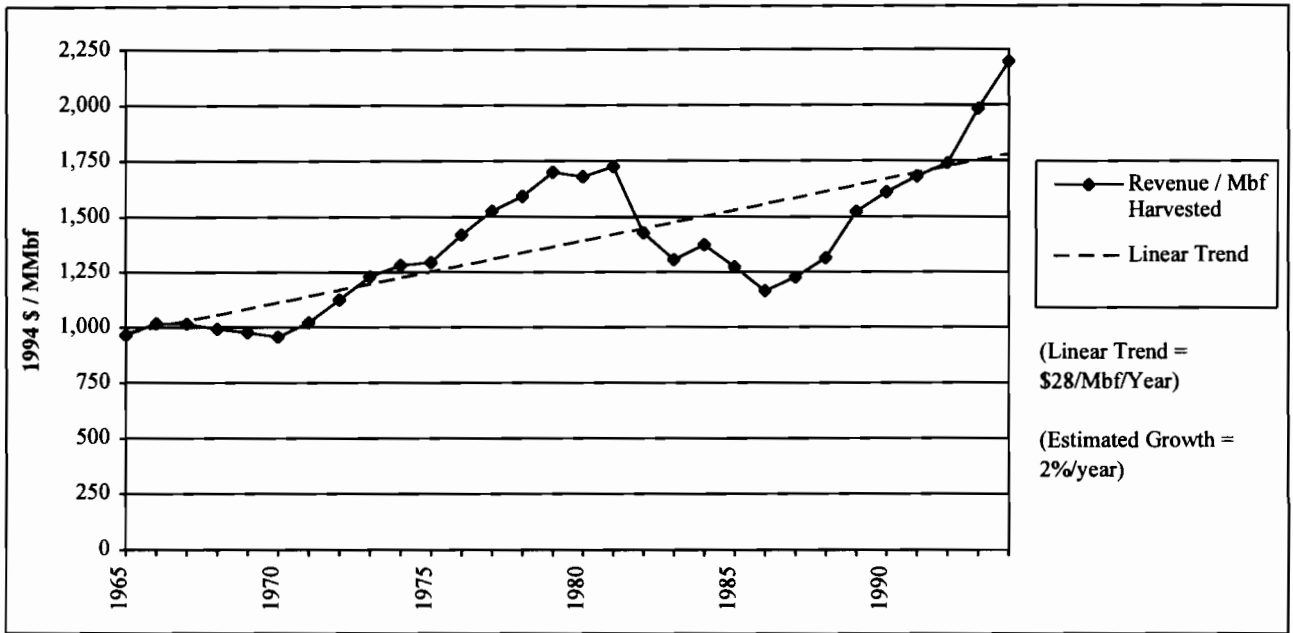
Source: CINTRAFOR. See statistical appendix for sources and derivations.

Figure 4. Industry Share Weighted Real Price Index for Washington State Wood Products, 1965-94
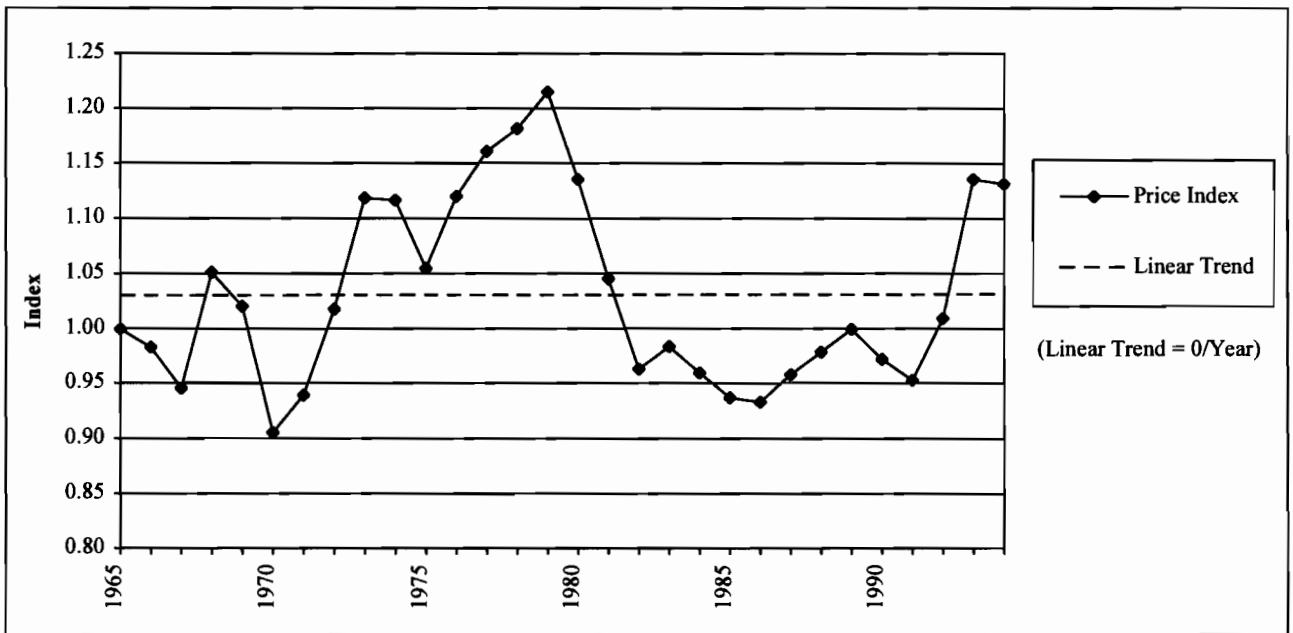
Source: CINTRAFOR. See statistical appendix for sources and derivations.
Index assumes no change in industry shares in sale volume nor changes in conversion rates of raw log inputs to final product. See text for further details.

Moreover, at \$2,196/Mbf harvested, the 1994 figure is 23% above the trend, more than twice the level obtained in 1965 and is the highest figure on record. The relative size of the 1994 level no doubt owes much to rapid gains in real price since 1991 due to supply constraints, but the importance of these price gains in regards to the overall trend should not be overemphasized. Even when data for 1991-94 is excluded from the regression analysis, growth in revenues per harvest is estimated at 1.8% per annum; increasing revenue per timber input is not an artifact of recent events but part of a continuing trend. This trend, in turn, has allowed the state's wood products industry to generate increasing revenues in the face of generally declining levels of harvest. Much of the rest of this report will be devoted to outlining the causes underlying this growth in revenues.

Sources of Growth

Prices

An examination of growth trends in the real price of Washington State wood products would be a logical first step in identifying the sources of growth in industry revenues. Increases in real prices, however, account for only a small proportion of total revenue growth over the time period considered in this report. In order to ascertain the importance of real price growth, price series or suitable proxies were needed for each of the product categories treated. For log exports, domestic lumber and export lumber, unit values derived by dividing total revenue by total sales were used. Plywood prices are market prices reported by the American Plywood Association. Pulp and paper, and secondary manufactured products were more problematic, and producer price indexes, as reported by the US Department of Labor, were used as proxies. Undoubtedly, there are errors associated with some of these measures, but the primary goal is to establish general trends in product prices and not actual price levels. To the extent that trends in the chosen measures mirror actual developments in product prices, the results of this section of the analysis will be robust.

Each of the price series or related proxies discussed above was indexed to 1965 and weighted by the ratio of its respective industry's revenue to total revenues in that year. By summing these time series, we obtain a weighted index of prices for Washington State's forest products industries given their 1965 industry revenue share (Figure 4).[4] This index shows a 13% increase from 1965 to 1994. However, due to generally strong prices in the mid 1970s and a depressed market throughout much of the 1980s, the value

for this index was less than one as recently as 1991, and the linear trend for this variable is flat. In any event, the estimated 13% real increase in prices is relatively small compared to the over 100% increase in revenue per unit harvested discussed in the previous section. Obviously real price gains are not a significant contributor to the growth in revenues.

This is graphically shown in Figure 5. Here, the weighted price index developed above was further indexed to the harvest level (1965=1) and then multiplied by the total revenue obtained in 1965. The resulting series (termed "Estimated Revenue" in Figure 5) shows the revenues we would expect to receive in a given year under historic price changes and changes in harvest level but no change in other factors (specifically industry shares in total volume output and efficiency of conversion of log inputs into final products). When compared with the actual revenue obtained by the state wood products industries, we see that the two series mirror each other in yearly fluctuations, but that they increasingly diverge over time in the general trend they follow. At $4.5 billion, the estimated revenue in 1994 was less than half the $9.1 billion in revenue which was actually received. It is likewise 27% less than the revenue received in 1965, indicating that, by themselves, real price increases were insufficient to counteract the impacts of decreased harvest, much less account for revenue growth.

Sector Shifts

The above analysis of price related growth was made under the assumption of constant shares for each industry in the total volume of Washington State wood products production. Such an assumption is clearly unrealistic. Relative industry shares have, in fact, changed substantially since 1965, and these changes comprise a major source of revenue growth for the state. Table 1 shows statistics related to revenues and revenue shares for each industry in 1965 and 1994. Changes in relative share of total revenue indicate substantial changes in the structure of the wood products sector since 1965. Specifically, secondary manufacturing and export logs and lumber have more than doubled their share, while domestic lumber sales, pulp and paper, and plywood have declined in relative importance. In the case of the latter two industries, 1994 revenues were actually less than those obtained in 1965,[5] with plywood showing particularly poor performance no doubt due in part to competition with Southern pine and the increasing

---

[4] The derivation of this price index is further detailed in the Statistical Appendix.

[5] Due in part to a sharp recession in the pulp and paper market, revenues for this industry have been in precipitous decline in recent years. As late as 1984, pulp and paper industry revenues accounted for 50% of state wood products totals, and, if the years following 1990 are excluded from the analysis, the trendline for pulp and paper industry share of total revenue is essentially flat. While 1994 figures indicate a slight recovery in the industry, further increases in revenue and relative share can be expected for 1995.

8

Figure 5. Estimated and Actual Revenue for Washington State Wood Products Industries, 1965-94
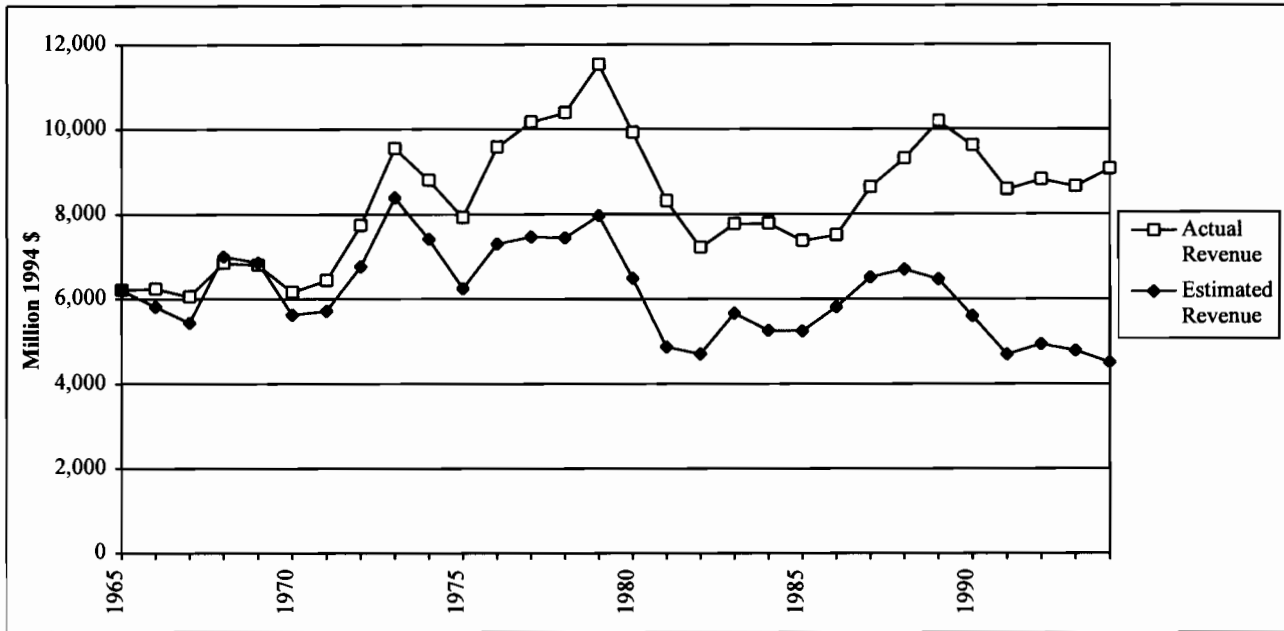
Source: CINTRAFOR. See statistical appendix for sources and derivations.
"Estimated Revenue" is 1965 revenue indexed to harvest volumes and to real price changes weighted by industry shares prevailing in that year. This series represents the revenue which would be realized assuming historical trends in prices and harvest but no change in industry structure or efficiency. See text for further details.

Figure 6. Secondary Manufacturing Total Revenue (Left Axis) and Share of Wood Products Sector
　　　　　Total Revenue (Right Axis), 1965-94
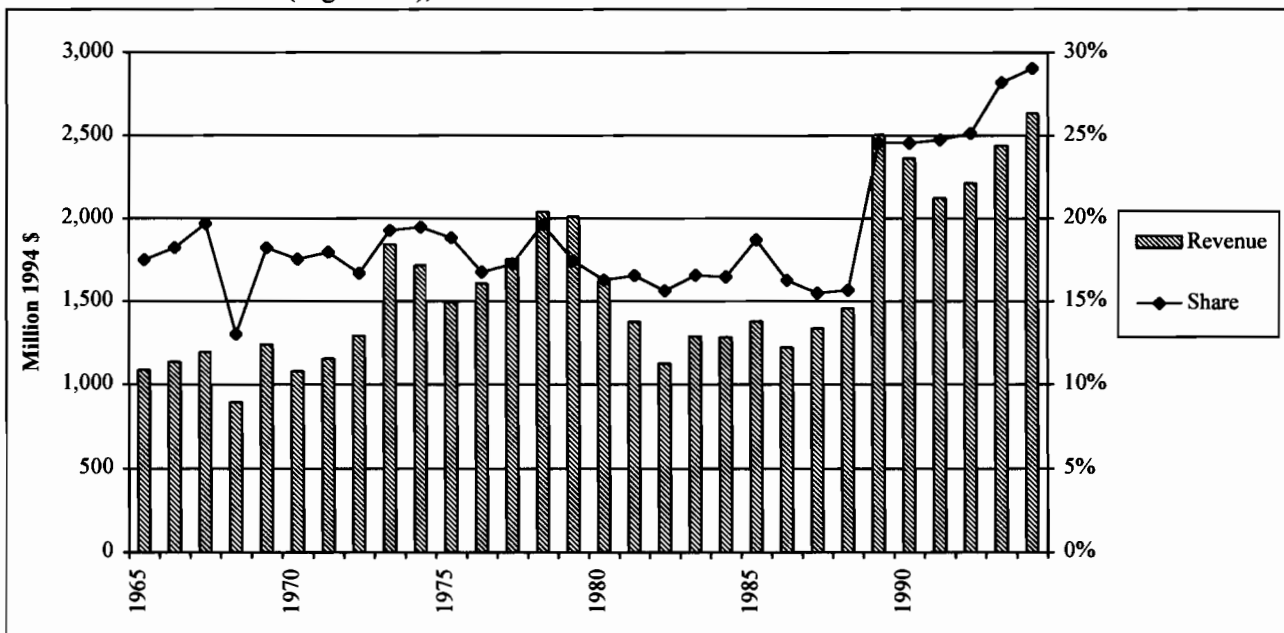
Source: CINTRAFOR. See statistical appendix for sources and derivations.

9

Table 1. Total Revenue and Relative Shares for Washington State Forest Product Industries

(Million 1994 $)	1965	1994	Total Revenue Change	% Change	Share of Total Revenue 1965	Share of Total Revenue 1994
Domestic Lumber	1,365	1,556	191	14%	22%	17%
Export Lumber	57	365	307	539%	1%	4%
Log Exports	241	1,359	1,118	464%	4%	15%
Secondary Mfg.	1,088	2,633	1,545	142%	18%	29%
Plywood	554	245	-309	-56%	9%	3%
Pulp & Paper	2,913	2,902	-11	0%	47%	32%
Total	6,216	9,059	2,843	46%	100%	100%
Harvest (MMbf)	6,424	4,126	-2,298	-36%	--	--

Source: CINTRAFOR. See statistical appendix for details.

popularity of OSB and other substitutes. In absolute terms, increased revenues in secondary manufacturing and exports accounted for an increase of approximately $3 billion over 1964 levels, with the former industry responsible for slightly over half of this increase. Growth in these two sectors accounts for the vast majority of total revenue growth, and each will be discussed separately in the following subsections.

Secondary Manufacturing[6]

Increased revenues in secondary manufacturing have been responsible for a majority of revenue growth in the wood products sector, providing an additional $1.5 billion per annum to Washington State's economy relative to 1965 levels. Growth in this sector represents a particularly bright spot for the wood products industry. Though wood quality (especially the availability of clear wood) is an important consideration for many secondary manufactured products, the industry is far less dependent upon gross volume wood inputs than the other industries considered in this report. While the high quality of Pacific Northwest timber may be used to further leverage sales, the main inputs (and therefore competitive advantage) for the industry lies in expertise in manufacturing and marketing. As such, secondary manufacturing need not be highly constrained by timber shortages and consequent high stumpage prices; growth potential in this industry remains substantial in spite of harvest declines.

Revenue generated by secondary manufacturing and the share of this revenue in the wood products sector total is shown in Figure 6. As mentioned above, there are several difficulties associated with measuring activity within this industry. Aggregate volume output and its average unit value are impossible to measure. In this report, we have relied upon gross business revenue figures as reported by the

---

[6] Washington state secondary manufacturing has been treated more extensively in Dirks and Briggs, 1991.

Washington Department of Revenue. As a result, our series is highly dependent upon definitions and reporting standards used by that agency. This is a source of particular concern given that much of the total growth in the industry is recorded as occurring in 1989, a year in which definitions of secondary manufactured products were expanded. Nonetheless, a comparison with the sawmill series from the same source reveals no concomitant decline which one would expect if lumber goods were reclassified as secondary manufactured goods. While this is somewhat reassuring, this definition change could have an impact upon our conclusions. Nevertheless, continued growth in the industry since 1991 (a period in which other sectors were generally flat or declining) bears out the argument in the preceding paragraph. Another argument for the strength of secondary manufacturing is that exports in this category have increased more than two-fold since 1989 while exports in all other categories with the exception of paper have declined (see Table 2). This export growth is undoubtedly a significant source of revenue growth.

In this analysis, it is assumed that secondary manufacturing output is based upon Washington State domestic timber inputs. There is, however, a substantial volume of lumber imported into the Seattle Customs District from British Columbia, and a portion of this lumber is used in the production of secondary manufactured goods in Washington State. Since 1990, the average volume of lumber imports from British Columbia has been approximately three billion board feet at an average cost of $300 per Mbf. Estimates of the proportion of this volume going to Washington State secondary manufacturing (as opposed to directly into construction uses or transshipment to other states) are not available.

Table 2. Washington State (Seattle Customs District) Exports of Wood Products, 1989-94

(million 1994 dollars)	1989	1990	1991	1992	1993	1994	Change	1994 Share
Logs & Lumber[1]	2,201	2,038	1,755	1,766	1,859	1,724	-22%	63%
Secondary Mfg.	112	168	187	207	220	232	108%	8%
Solid Wood Total	2,313	2,206	1,942	1,973	2,079	1,955	-15%	72%
Pulp	458	337	288	218	161	199	-57%	7%
Paper	491	452	520	544	467	530	8%	19%
Pulp & Paper Total[2]	1,012	854	858	808	663	778	-23%	28%
Total Exports[2]	3,299	3,030	2,800	2,781	2,745	2,735	-18%	100%

Source: US Department of Commerce

[1]Log and lumber figures were corrected for Columbia river exports. See statistical appendix for details regarding volume and value corrections.

[2]Totals do not sum due to exclusion of minor products.

Increased Exports

Growth in exports represents the expansion of Washington State wood product industries into new markets and their ability to take advantage of new opportunities. Trade with Japan has been responsible for the vast majority of export volumes and values, but other Asian countries have become an important

market in their own right for Pacific Northwest products.[7] Data covering the time period considered in this paper were only available for logs and lumber, and these series are shown in Figures 7 and 8. Starting at relatively low levels, these two sectors experienced explosive growth in the 1970s and, later, in the last half of the 1980s. Taken together, total revenues for log and lumber exports increased from $298 million in 1965 to $1.7 billion in 1994, and the share of total wood products sector revenue increased from 5% to 19%. Recent developments within these industries, however, have not been as important as in secondary manufacturing. Driven by a surge in log shipments to Japan, total revenues for log and lumber exports peaked in 1979 at $2.9 billion (25% of total revenues). Likewise, lumber exports peaked in 1988 and have since fallen 26%. Recent poor performance in these two product categories is due partially to a slight downturn in the Japanese housing market, but it is largely the result of supply constraints related to harvest declines. Unit values (*i.e.*, average value per Mbf exported) have, in fact, increased rapidly and steadily since 1990, but export volumes have declined precipitously both in absolute terms and relative to domestic lumber sales. This is not surprising since log and lumber exports have depended primarily upon higher quality log grades, particularly old-growth timber, and these grades currently face the most severe supply constraints. Growth in export levels, or even the maintenance of current levels, will depend upon the ability of Washington producers to obtain high quality raw materials, to increase product quality at the manufacturing level, and to gain greater market acceptance for products produced from second-growth timber.

Department of Commerce (DOC) data are shown for the period beginning in 1989 in Table 2. Here, the relative trends in value of exports for all major wood products are readily apparent. Logs and lumber account for a majority of export revenues, and, as described above, they have been declining. Secondary manufacturing is less important in terms of total export revenue, but recent growth in this category has been explosive.[8] In pulp and paper, declines in pulp exports have been only partially offset by increases in paper exports, and total export revenues for the sector are down 23% relative to 1989. It should be noted, however, that much of the 1989-94 period was a time of deep recession for the industry. 1994 witnessed a recovery in prices, and export volumes have begun to climb again. Due to declines in log and lumber exports and in pulp exports, total revenues generated by exports have fallen 17% since 1989. The share of exports in total revenue has likewise fallen from 32% to 30% during this period.

---

[7] Japanese consumption of wood products and its implications for Washington state producers is discussed in greater depth in a recent CINTRAFOR working paper (Robertson and Waggener, 1995).

[8] Note that this data series is independent of that reported by the Washington Department of Revenue. Consequently, it will not be affected by definition changes undertaken by that agency in 1989.

Figure 7. Log Exports Total Revenue (Left Axis) and Share of Wood Products Sector Total
Revenue (Right Axis), 1965-94
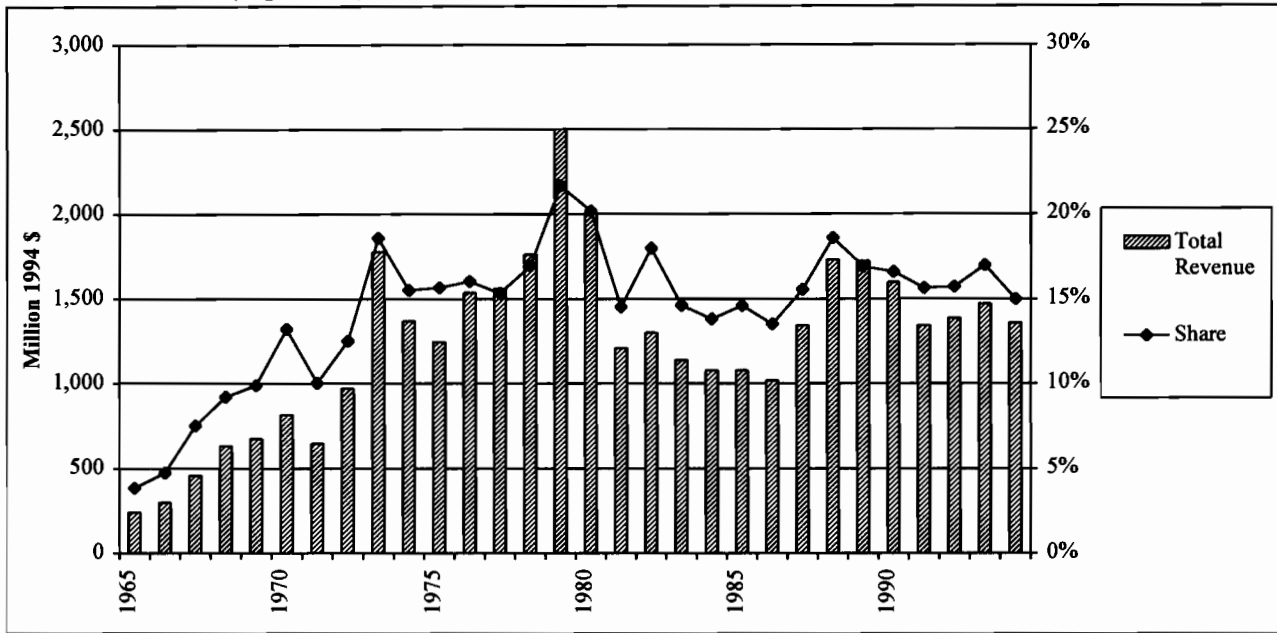
Source: CINTRAFOR. See statistical appendix for sources and derivations.

Figure 8. Lumber Exports Total Revenue (Left Axis) and Share of Wood Products Sector
Total Revenue (Right Axis), 1965-94

Source: CINTRAFOR. See statistical appendix for sources and derivations.

13
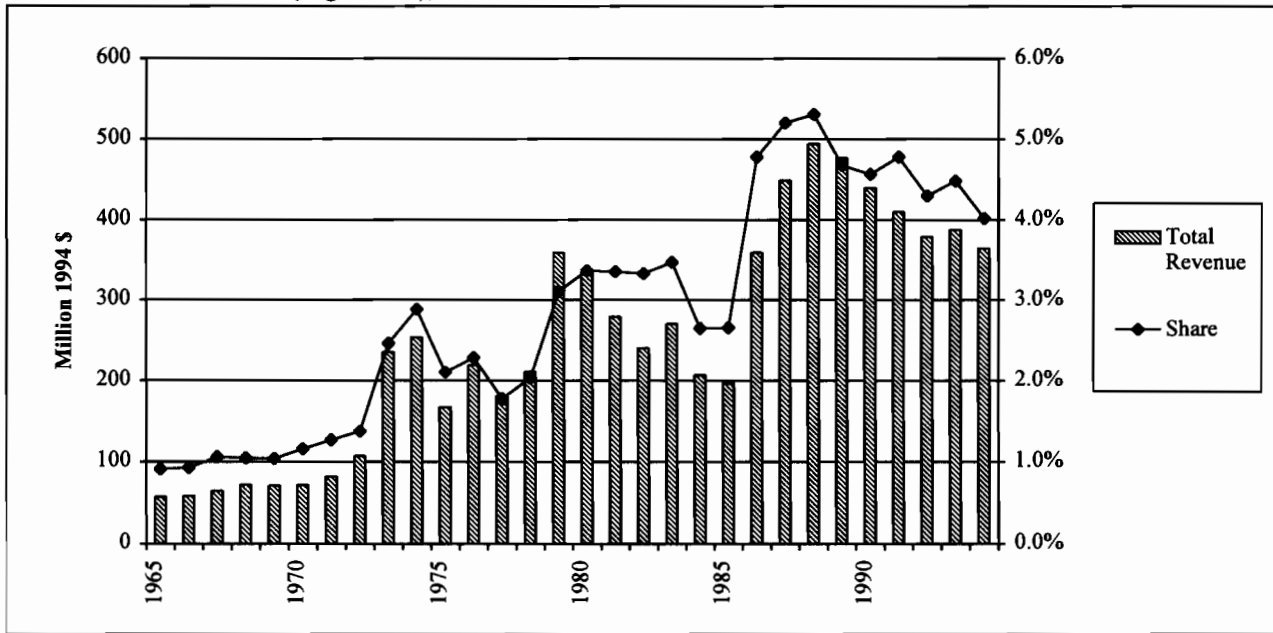
Increased Efficiency (output per unit of wood input)

Increased efficiency in the conversion of wood raw material inputs to finished products is another important factor in the ability of Washington State's wood products industries to increase revenues in spite of harvest declines. Simply put, increased efficiency in this area allows processors to produce more product using the same amount of timber. With the exception of lumber and plywood, direct measures of conversion efficiency are not readily available for the industries here included. Ongoing technological advances, however, support the assumption of increasing efficiencies in all industries. Likewise, with increases in the relative prices of stumpage (see next section), it is reasonable to expect that producers would substitute other inputs (labor and capital) for more expensive raw material inputs. Efficiency measures for lumber production and estimates of input/output ratios for pulp production are shown in Table 3 and are further described below. These figures indicate large increases in conversion efficiencies over the last three decades.

Table 3. Overrun and Estimated Ratio of Product Outputs to Wood Inputs

	1960	1970	1980	1990	Change
Lumber Overrun (bf lt / bf ls)	1.29	1.36	1.51	1.63*	27%
Plywood Overrun (sq. ft / bf ls)	2.39	2.52	2.83	3.35*	40%
Estimated Lumber Conversion Ratio (bf lt / bf ls)	--	1.21	1.30	1.47	21%
Estimated Pulp Conversion Ratio (short tons / Mbf ls)	--	1.09	1.40	1.47**	35%

Source: Darius Adams (personal communication), WDNR. See text and statistical appendix for details.

* Figures are for 1989. **Figures for 1988

Overrun factors calculate the amount of finished product which may be produced from a board foot log scale scribner (bf) of log input.[9] Figures presented here indicate Washington lumber mills were able to produce 27% more lumber in 1990 than in 1960 using the same measure of log inputs. At 40%, the increase in efficiency in plywood production is even higher. The other measure presented in Table 3 is what we have termed "conversion ratio" and is derived by dividing total output by raw material input. Data from different sources were used to derive these figures, and there is no guarantee of internal consistency. As a result, substantial errors may be included in the values given. Trends, however, will be less prone to error. Our estimates yield a 20.3% increase in lumber conversion efficiency in the 1970-90 period. This is surprisingly close to the trend in the lumber overrun series, which gives a 20.6% increase for that same period. More striking is the 35%% increase from 1970 to 1988 in the production of pulp for

---

[9] A scribner board foot ostensibly measures the amount of log input needed to manufacture a board foot of lumber. With increasing efficiencies, however, the one-to-one ratio between material input and product output is increasingly inaccurate, hence the use of overrun factors.

14

a given unit of log input. While the consistency of the two data series used in this estimate are particularly suspect since no import adjustments were made, the magnitude of the increase provides evidence of substantial increases in production efficiencies in pulp and paper manufacturing.

A portion of these efficiency gains, however, are the result of the increasing proportion of harvests from second-growth stands, and it is debatable whether the rate of increase can be maintained now that virtually all harvests are from second, or even third-growth stands.[10] Nevertheless, technological advances can reasonably be counted upon to provide continued gains in the efficient use of timber inputs. This is especially true if current stumpage prices hold, and the incentive to economize on timber inputs is thus maintained.

Stumpage Prices

While not specifically germane to the central argument of this report, stumpage prices (*i.e.*, the price paid for standing timber) and their changes over time deserve some mention. Economists characterize stumpage prices as a residual price, meaning stumpage prices will reflect end-product prices net of harvest, transportation and processing costs. In a timber supply constrained market, increases in final product prices will result in equivalent increases in stumpage prices as producers bid up the price of scarce timber until a stumpage price is reached which allows for no processor profit. In general, increases in end-product values will be bid back to the stump as long as there are enough producers to support competitive bidding for timber and there are no changes in transportation and processing costs. On a percentage basis, a change in final product price will result in a much larger change in stumpage price. This results in an extremely high variation for stumpage prices over time.

Stumpage prices for Washington State timber are shown in Figure 9 along with the share of stumpage prices in the total revenue generated by the wood products sector per Mbf harvested.[11] At $441/Mbf, the 1994 stumpage price is over four times its 1965 level (once again expressed in real 1994 dollars), and nearly three times the level occurring in the most recent trough in 1986. In 1994, approximately 20% of all revenues earned by the forest products sector went to stumpage, and the share of stumpage prices in

---

[10] Scribner log scale does not account for increased conversion efficiency of smaller diameter logs, and thus the overrun associated with these logs is greater than that for larger diameter old-growth logs. Likewise, greater uniformity and lack of defect in many second-growth stands will increase product recovery.

[11] To derive this series we have used value of timber harvested statistics as reported by the WDNR and USFS. Private stumpage prices were estimated. See statistical appendix for details.

15

revenue totals has tracked the stumpage value series rather closely, doubling since 1965. This, in turn, serves as another indication that supply of stumpage has been constraining, particularly in recent years.

Employment and Productivity

Given large declines in harvest and technological gains which have increased labor productivity, it is not surprising that direct employment in the wood products sector has been declining (see Figure 10 and Table 4). On a percentage basis, however, employment declines are significantly less than harvest declines (19% vs. 36%). This is counter to what one would expect due to technology gains, but, when shifts between industries and especially the expansion of secondary manufacturing are considered, this result becomes more reasonable. By normalizing to the harvest level (see the second section of Table 4) we obtain a measure of average persons employed per Mbf harvested. This figure demonstrates no discernible trend over the period considered (once again due in part to the expansion of more labor intensive secondary manufacturing). 1994 figures, however, are significantly higher than those of 1990, indicating the possibility of future declines in total employment in order to obtain previous (equilibrium) ratios of jobs to timber inputs. Another explanation for the recent increase in this measure may lie in the substitution of labor for logs resulting from higher stumpage prices. In any case, current jobs to harvest volume ratios are well above historical averages.

When analyzing employment levels, it is important to draw a distinction between direct and total employment. Direct employment refers to jobs occurring directly within a certain industry (*e.g.*, persons employed in sawmills). Total employment refers to the total number of jobs generated in a local economy by final sales within the given industry through what is known as the "multiplier effect." Sawmill operations, for example, will entail purchases from other industries in the region. Likewise, the wages earned by sawmill employees will generate additional demand for goods and services in the region, thereby generating additional indirect employment. The ratio of total employment generated by an industry to direct employment within the industry is termed the "employment multiplier." Conway (1994) estimated the 1992 employment multiplier for the entire forest products sector to be 3.6. Applying this number to the 53.9 thousand employees working directly in the sector in 1994, the total employment generated in the state of Washington is estimated to be 194 thousand employees. Increases in technology and capital investments in harvesting and processing result in larger amounts of capital invested per employee. This leads to increasing purchases and indirect costs and hence an increase in indirect employment as a partial offset for declines in direct employment. Consequently, the full employment impacts due to technology change are more complex than simply tracking direct employment. This assertion is supported by Conway's estimates which show a 6% increase in the employment multiplier between 1982 and 1992.

Figure 9. Stumpage Price for Washington State Timber (Left Axis) and Percent of Stumpage
Price in Total Revenue Generated per Mbf Harvested (Right Axis), 1965-94
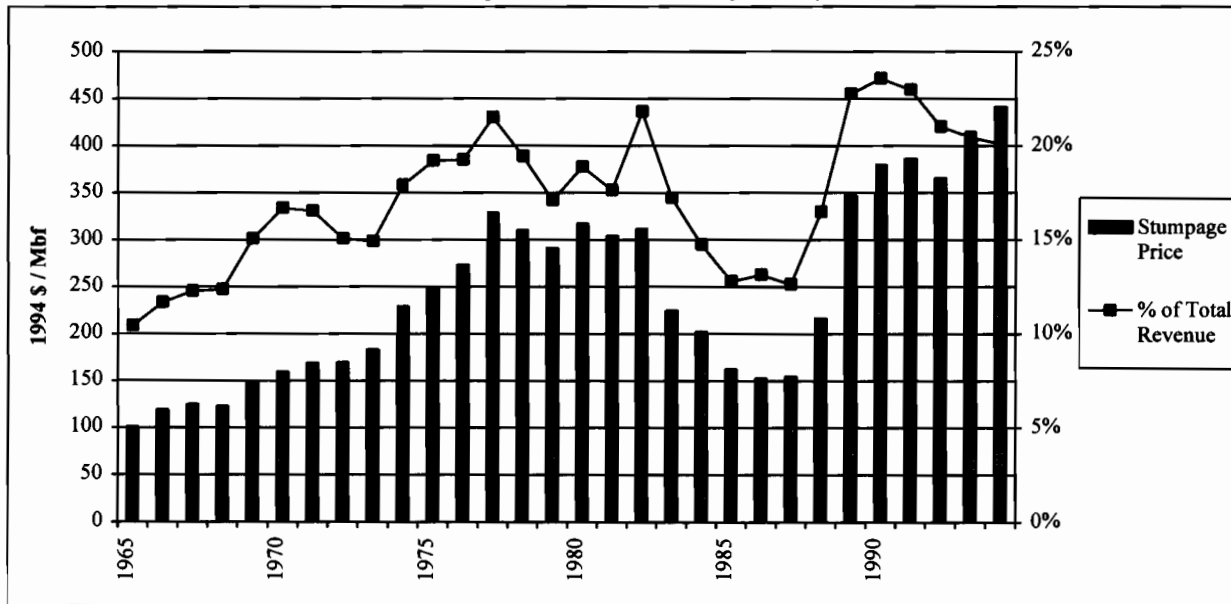
Source: CINTRAFOR. See statistical appendix for sources and derivations.

Figure 10. Employment in Washington State Wood Products Industries, 1965-94
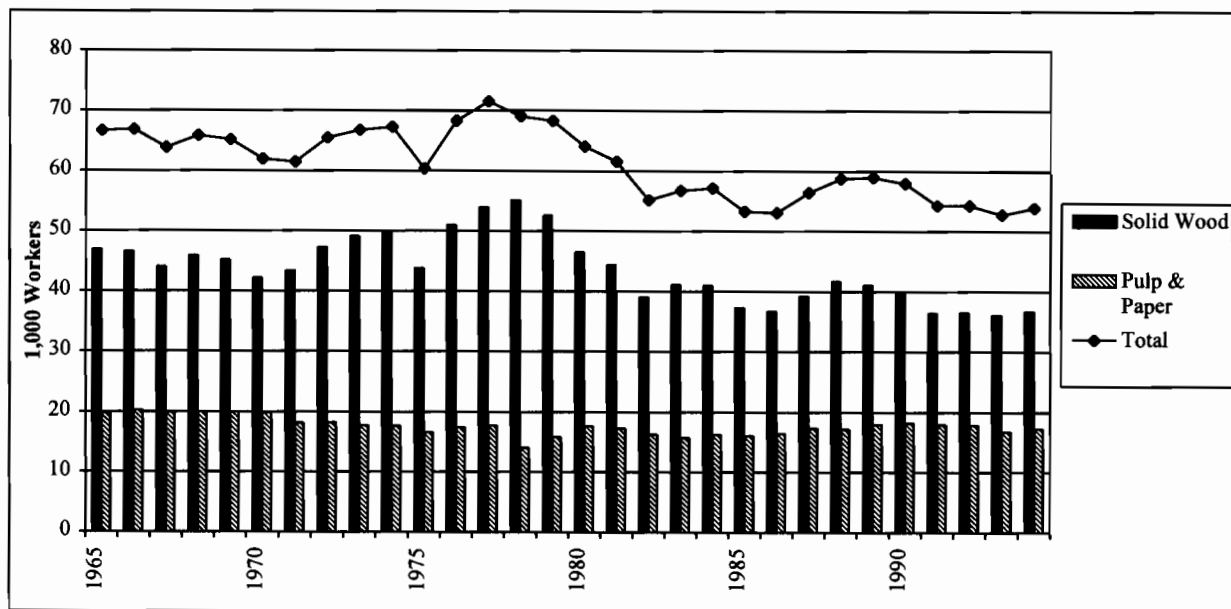
Source: CINTRAFOR. See statistical appendix for sources and derivations.
"Solid Wood" includes logging, log exports, lumber, plywood and secondary manufacturing.

Table 4. Employment in Washington State Wood Products Industries

	1965	1970	1975	1980	1985	1990	1994	Change
Employment (1,000 Workers)								
Solid Wood	46.9	42.2	43.8	46.5	37.3	39.9	36.7	-22%
Pulp & Paper	19.8	19.8	16.6	17.6	16.0	18.1	17.2	-13%
Total	66.7	62.0	60.4	64.1	53.3	58.0	53.9	-19%
Employees per MMbf Harvested								
Solid Wood	7.3	6.6	7.2	7.9	6.4	6.7	8.9	22%
Pulp & Paper	3.1	3.1	2.7	3.0	2.8	3.0	4.2	35%
Total	10.4	9.6	9.9	10.9	9.2	9.7	13.1	26%
Revenue per Employee (1,000 1994 $)								
Solid Wood	70.4	78.5	100.4	116.8	103.2	138.2	167.8	138%
Pulp & Paper	147.1	143.9	212.9	255.5	220.3	226.7	168.7	15%
Total	93.2	99.4	131.3	154.9	138.4	165.8	168.1	80%

Source: CINTRAFOR. See statistical appendix for details on sources and derivations.

"Solid Wood" includes log exports, lumber, plywood and secondary manufacturing.

A final measure presented in Table 4 is the ratio of gross revenues to employment, a common measure of labor productivity. Solid wood products (log exports, lumber, plywood and secondary manufacturing) have registered impressive gains in productivity since 1965. However, it must be remembered that this figure will include the effect of increased stumpage prices, an effect which owes nothing to gains in labor productivity. Productivity gains in the pulp and paper sector are far more modest. However, here the impact of depressed prices in the pulp and paper sector in the last few years must be taken into account. If 1990 is used as an endpoint rather than 1994, productivity gains since 1965 are estimated at 54% rather than 15%. This is still significantly lower than gains in the solid wood products sector. When viewed in conjunction with the raw material conversion efficiency estimates given in Table 3, a divergence between solid wood products and the pulp and paper sector becomes apparent. While solid wood products producers have concentrated their efficiency gains in the area of labor, higher stumpage prices combined with relatively smaller increases in raw material conversion efficiencies mean that timber inputs are gaining relative to labor as a component in total revenues from final product sales. The pulp and paper industry, on the other hand, has made impressive gains in raw material conversion efficiency but more modest gains in labor productivity. This seems reasonable given that pulp and paper mills cannot command the same sort of quality premiums for Pacific Northwest softwoods as can the solid wood products sector but will nonetheless be adversely affected by rising stumpage prices.

Any study which seeks to aggregate and combine various measures pertaining to a number of different industries will face difficulties in regards to comparability and consistency of statistics, and this report is

18

no exception. Nonetheless, several broad themes clearly emerge from an examination of statistics presented in this report. First and foremost is the fact that gross revenues generated by the wood products sector have been rising in spite of a decline in harvest. While gains in the real price of wood products may have contributed somewhat to this increase in revenue, the major sources of revenue expansion have been a shift to exports and secondary manufacturing, and an increase in the amount of final product produced from a given quantity of timber input. Secondary manufacturing has been particularly important in generating new revenue (and new employment). Since this industry need not rely upon timber inputs to the same extent as log exports or lumber, future expansion is possible in spite of constrained log supplies. Competitive advantage will lie in the ability of firms to produce quality products and market them effectively. Exports, particularly those to Japan, are another area in which growth over the last three decades has been considerable. Though recent log and lumber export performance has been poor due to a decline in log supply, exports of these products promise to remain a major component in the state's wood products sector, and the export of secondary manufactured products is increasing rapidly with no limit in sight. Washington State has now emerged as a major supplier in the global marketplace, and future success in exports will depend upon the willingness of firms to locate and exploit foreign market opportunities. While the pulp and paper sector has received a less detailed analysis in this report, it must be noted that it is the single largest contributor to wood products sector revenues. Increased efficiencies in the use of raw material inputs have largely allowed this sector to maintain historic levels of activity and revenue in the face of harvest declines.

The above mentioned factors account for much of the revenue growth in Washington State's forest products industries. They also characterize a forest products sector changing to meet changes in its environment. When the current timber supply crisis is resolved, it is likely that the state's wood products sector will emerge somewhat reduced in size but stronger and able to effectively compete both nationally and internationally. The next challenge for the industry will be to most efficiently utilize the large volumes of second-growth timber which are predicted to be available in the early years of the next century.

Bibliography

Conway, Richard S., G. Pascall, and D. H. Pedersen. 1994. *The Forest Products Economic Impact Study.* Prepared for the Washington Forest Protection Association. Dick Conway & Associates, Seattle.

Dirks, John and David Briggs. 1991. Wood Products in Washington State: The Secondary Manufacturing Industries. WP 30, CINTRAFOR, College of Forest Resources, University of Washington, Seattle. 103 pp.

Lippke, Bruce and Guy Robertson. 1995. *Washington Forest Products: Transition to a New Paradigm.* SP 19, CINTRAFOR, College of Forest Resources, University of Washington, Seattle. 11 pp.

Lippke, Holly L. 1993. Timber Price and Trade Impacts from Declining USFS Sales and the State Log Export Ban: An Analysis of Changing Export Markets. RE 25, CINTRAFOR, College of Forest Resources, University of Washington, Seattle. 22 pp.

Robertson, Guy and Thomas R. Waggener. 1995. *The Japanese Market for Softwood Sawnwood and Changing Pacific Rim Wood Supply Conditions: Implications for US Pacific Northwest Producers.* WP 52, CINTRAFOR, College of Forest Resources, University of Washington, Seattle. 93 pp.

Warren, Debra D. 1995 (and previous). Production, Prices, Employment, and Trade in Northwest Forest Industries, Quarterly Report. USDA Forest Service, Pacific Northwest Research Station, PNW-RB-209.

Washington Department of Natural Resources. *Washington Mill Survey.* Report #12; May, 1994 (and previous).

Washington Department of Revenue. *Washington State Quarterly Business Review.*

Statistical Appendix

List of Tables

Overview

Statistics from various sources were used in the production of this report. While most derivations are relatively direct, others involve adjustments or warrant explicit caveats. Accompanying the following tables is a variable list which is organized thematically and includes general information about sources, derivations and units for each data series. Primary sources are cited wherever possible. Many of the series are taken from data compiled in the Forest Service quarterly publication "Production, Prices and Trade in Northwest Forest Products Industries" (coded USFS PP&T in the variable list). Other essential data sources include the Washington State Dept. of Revenue "Quarterly Business Review," and the Washington Dept. of Natural Resources (WDNR) mill survey which is conducted every other year (1992 figures are the last year available). See the bibliography for full citations. All dollar figures in this data set are reported in real 1994 dollars using the implicit GDP price deflator (Dept. of Commerce, Bureau of Economic Analysis).

Notes on Specific Data Series

Stumpage Prices

Stumpage prices used in this report are prices paid for timber removed ("harvest price") rather than the high bid (i.e., the bid winning the sale). A comparison of harvest price and high bid indicates that the latter is more speculative and is a poor indication of market cost at the time of delivery. Stumpage prices for private timber are not generally available and were estimated. For this study we have used WDNR prices through 1990. Following that year, an export ban on much of WDNR timber was imposed. A study on the impact of the log export ban estimated that the average affect of the ban was approximately $75/Mbf from 1991 to 1992 (H. Lippke, 1993). To correct for this, $75 was added to the WDNR series beginning in 1989 to derive an estimate of private stumpage price. The correction is undoubtedly even larger from 1992 to 1994 as foreign markets grew stronger, but no consistent estimate was available.

Washington Log Exports

Dept. of Commerce (DOC) customs districts for the Pacific Northwest do not directly correspond with state borders. Specifically, Washington State ports on the Columbia river are included in the Columbia-Snake customs district rather than the Seattle customs district. Longview is the main Washington log exporting port on the Columbia, and, in deriving Washington State totals Longview's log export volumes (available from port-level DOC data) were added to the Seattle customs district aggregates. This ignores the potentially significant volumes of Oregon logs coming across the bridge at Longview, but no estimate is available for this traffic.

Another potential source of error is the assignment of exports volumes to ports other than the actual port where they originate. This is a problem throughout the DOC statistics, but, within the context of this report, the error relates mainly to the assignment of Washington exports (once again mostly out of Longview) to the port of Portland. Independent port level data from Jones Stevedoring for 1986-93 indicates that during this period fully 84 percent of Portland log exports actually originated in Longview and that this percentage was relatively stable. In absolute terms the error is quite large, averaging over 340 MMbf per annum. To correct for this, the estimated percentage of Portland volume originating in Longview was added back to the Washington total. In years where Jones Stevedoring data was unavailable, the 84 percent figure cited above was used. The potential error associated with this approach increases the further one gets from the 1986-93 period for which data was available. As average unit

values (\$ / Mbf) vary by port, the aggregate figure for Washington State was adjusted to reflect the increased volumes and value.

Washington Lumber Exports

Lumber exports were similarly derived by adding Longview volumes to Seattle customs district volumes. As there was no indication of substantial misreporting between Portland and Longview, no further adjustment was made.

Washington Pulp and Paper

Pulp and paper production volumes at the state level are not readily available. The data presented here is obtained from the Bureau of Census, Current Industry Reports, MA26B. There are several gaps in the series, and the data reporting stopped after 1989. Consequently, the price times volume derivation used to estimate gross values from production for most of the other industries was not possible here. Instead, gross business revenue figures provided by the Washington Dept. of Revenue were used. Production volumes were used only to calculate the estimated raw material conversion ratios.

Secondary Manufacturing

Volume measures for secondary manufacturing were not available due to the differing dimensions and units used in this industry. The Washington Dept. of Revenue gross business income statistics were used directly.

Derivation of Industry Revenue Share Weighted Price Index

The derivation of the industry revenue share weighted price index used to estimate the role of price changes in the growth of Washington forest products sector revenues is as follows:

$$PX_{it} = \frac{P_{it}}{P_{i65}} * 100$$

Where P_{it} = price of product i in year t in 1994 dollars. PX_{it} = price index for product i (1965=100).

$$SH_i = \frac{V_{i65}}{\sum_i V_{i65}}$$

Where V_{it} = total revenues generated by product i in year t (volume x value, or gross business income).

SHi = share of 1965 revenue for product i in total 1965 revenue for the wood products sector.

$$PX'_t = \sum_i (PX_{it} * SH_i)$$

Where PX_t'= index of prices weighted by 1965 revenue shares (1965=100).

$$HX_t = \frac{Harvest_t}{Harvest_{65}}$$

Where HX_t index of harvest volume (1965=100)

$$PX''_t = HX_t * PX'$$

Where PX_t'' = weighted price index further indexed by harvest volume (1965=100)

$$V'_t = PX''_t * \sum_i V_{i65}$$

Where V_t' = Estimated total revenue for the wood products sector assuming price and harvest change only (no change in structural composition or conversion efficiencies).

Table A1. Derivation of Industry Revenue Share Weighted Price Index
See accompanying "Derivation of Industry Revenue Share Weighted Price Index"

			Simple Price Indexes (PXit)				Derived Indexes			Estimated Revenue
	Lbr.	Lbr. X	Log x	Ply	Pulp & Pap	2nd Mfg.	PXt'	HXt	PX"t	V't million '94$
1965	100	100	100	100	100	100	100	100	100	6,216
1966	99	99	104	84	99	101	98	95	94	5,822
1967	86	97	109	88	97	98	95	93	88	5,448
1968	112	116	119	136	94	106	105	107	113	7,008
1969	118	112	130	83	92	111	102	108	111	6,871
1970	83	88	133	78	91	96	91	100	91	5,635
1971	96	105	127	90	88	102	94	98	92	5,723
1972	112	109	132	128	86	110	102	107	109	6,774
1973	138	122	235	93	87	127	112	121	135	8,397
1974	118	128	225	89	100	121	112	107	119	7,423
1975	101	106	209	87	102	106	105	95	101	6,252
1976	119	118	205	101	101	116	112	105	118	7,311
1977	129	118	217	115	99	125	116	104	120	7,474
1978	137	114	216	114	96	135	118	101	120	7,453
1979	141	146	263	101	99	136	122	106	128	7,978
1980	116	107	263	89	103	119	114	92	104	6,492
1981	98	100	209	76	102	110	105	75	78	4,877
1982	80	85	177	67	102	101	96	79	76	4,710
1983	91	82	149	71	101	104	98	93	91	5,667
1984	83	82	138	65	103	100	96	88	85	5,267
1985	79	78	129	67	102	95	94	90	84	5,253
1986	79	81	130	66	102	93	93	100	94	5,820
1987	84	82	147	64	104	95	96	109	105	6,514
1988	84	79	169	58	107	96	98	110	108	6,706
1989	87	80	163	67	108	98	100	104	104	6,469
1990	80	89	183	58	106	96	97	93	90	5,613
1991	78	92	182	58	104	95	95	79	76	4,704
1992	89	97	214	72	102	102	101	79	80	4,946
1993	115	110	304	80	102	119	114	68	77	4,791
1994	111	121	290	79	103	120	113	64	73	4,518

1965 Revenue shares by Industry

Domestic Lumber	22%
Export Lumber	1%
Export Logs	4%
Plywood	9%
Pulp & Paper	47%
Secondary Mfg.	17%

Definition of Derived Indexes (1965=100)

PXt'	=	1965 Industry revenue share weighted price index
HXt	=	Harvest volume index
PX"t	=	1965 harvest and revenue share weighted index (PXt' * HXt)
V"t	=	Estimated total revenue assuming change in harvest and prices only (PX*t * Total Revenue) in million '94$

Table A2. Harvest Volumes, Stumpage Prices and Harvest Revenues

	Harvest Volume (MMBF)				Stumpage Price (1994 \$/MBF)				Calculated Revenues from Harvest (Million 1994 \$)			
	FSVOL	PRVOL	WDNRVOL	THVOL	FSHP	PRHP	WDNRHP	THP	FSV	PRV	WDNRV	THV
1965	1,786	4,051	587	6,424	89.69	105.72	105.72	101.26	160	428	62	651
1966	1,646	3,891	580	6,117	108.46	123.44	123.44	119.41	179	480	72	730
1967	1,692	3,777	484	5,953	134.09	121.61	121.61	125.16	227	459	59	745
1968	1,904	4,386	598	6,888	130.63	120.25	120.25	123.12	249	527	72	848
1969	1,609	4,651	697	6,957	152.15	146.02	146.02	147.44	245	679	102	1,026
1970	1,444	4,413	573	6,430	122.93	170.79	170.79	160.04	178	754	98	1,029
1971	1,366	4,362	567	6,295	123.45	182.06	182.06	169.34	169	794	103	1,066
1972	1,573	4,504	799	6,876	142.19	178.13	178.13	169.91	224	802	142	1,168
1973	1,638	5,173	945	7,756	147.02	193.49	193.49	183.67	241	1,001	183	1,425
1974	1,402	4,789	678	6,869	159.99	247.48	247.48	229.62	224	1,185	168	1,577
1975	1,164	4,481	480	6,125	150.52	271.94	271.94	248.86	175	1,219	131	1,524
1976	1,272	4,930	543	6,745	202.81	290.05	290.05	273.60	258	1,430	157	1,845
1977	1,250	4,545	857	6,652	239.68	349.76	349.76	329.08	300	1,590	300	2,189
1978	1,300	4,496	721	6,517	260.06	322.72	322.72	310.22	338	1,451	233	2,022
1979	1,374	4,500	910	6,784	260.91	298.62	298.62	290.98	358	1,344	272	1,974
1980	1,132	3,843	932	5,907	220.47	340.61	340.61	317.59	250	1,309	317	1,876
1981	896	3,526	398	4,820	189.29	330.80	330.80	304.50	170	1,166	132	1,468
1982	747	3,892	414	5,053	112.91	346.11	346.11	311.64	84	1,347	143	1,575
1983	1,276	4,263	411	5,950	138.56	248.95	248.95	225.27	177	1,061	102	1,340
1984	1,257	3,750	664	5,671	132.42	222.73	222.73	202.71	166	835	148	1,150
1985	1,176	3,774	842	5,792	116.15	174.96	174.96	163.02	137	660	147	944
1986	1,268	4,224	954	6,446	125.98	159.99	159.99	153.30	160	676	153	988
1987	1,463	4,605	958	7,026	143.80	158.17	158.17	155.18	210	728	152	1,090
1988	1,542	4,677	859	7,078	184.67	225.79	225.79	216.83	285	1,056	194	1,535
1989	1,164	4,782	741	6,687	196.42	303.00	303.00	346.78	229	1,866	225	2,319
1990	863	4,329	774	5,966	207.88	338.39	338.39	380.08	179	1,826	262	2,268
1991	747	3,822	533	5,102	228.70	423.29	342.87	386.40	171	1,618	183	1,971
1992	512	4,030	521	5,063	240.85	388.88	310.65	365.86	123	1,567	162	1,852
1993	355	3,513	491	4,359	299.43	425.11	348.53	406.24	106	1,493	171	1,771
1994	200	3,600	326	4,126	287.77	455.63	380.63	441.57	58	1,640	124	1,822

A6

Table A3. Lumber and Plywood Production and Sales

	Lumber Products & Domestic Sales*			Plywood Production and Sales		
	LBPRO	LBDUV	LBDV	PLYPRO	PLYUV	PLYV
	MMbf lt	94/MMbf lt	1000 1994$	MMsf	1990$/Msf	1000 1994$
1965	3,648	385.36	1,364,578	2,069	267.57	553,602
1966	3,513	381.95	1,299,713	2,022	226.02	457,005
1967	3,279	331.26	1,045,007	1,849	236.74	437,729
1968	3,441	433.51	1,441,129	2,058	364.45	750,036
1969	3,262	455.06	1,430,373	1,802	222.23	400,453
1970	3,189	319.27	969,535	1,805	208.67	376,647
1971	3,498	369.94	1,240,194	2,070	240.81	498,470
1972	3,749	431.11	1,536,923	2,251	342.51	770,998
1973	3,642	531.09	1,741,355	2,232	248.65	554,993
1974	3,222	454.92	1,296,913	1,853	238.80	442,501
1975	3,104	389.08	1,092,917	1,724	231.74	399,522
1976	3,661	460.09	1,524,048	1,894	269.98	511,344
1977	4,031	497.28	1,861,748	2,013	306.62	617,236
1978	4,150	527.04	2,004,410	2,084	305.54	636,753
1979	3,841	542.82	1,833,840	1,727	270.91	467,860
1980	3,161	447.94	1,154,565	1,333	238.00	317,255
1981	3,243	378.00	1,028,037	1,382	203.85	281,719
1982	3,059	306.71	775,988	1,166	178.40	208,020
1983	3,821	351.21	1,124,889	1,369	189.64	259,616
1984	3,697	318.07	1,025,270	1,540	175.08	269,583
1985	3,419	305.41	899,261	1,645	179.97	296,090
1986	4,132	306.22	1,009,356	1,719	176.89	304,001
1987	4,645	321.94	1,164,837	1,712	172.16	294,768
1988	4,408	323.35	1,046,852	1,586	156.25	247,787
1989	4,274	333.76	1,052,342	1,462	178.16	260,499
1990	3,919	307.28	918,796	1,255	153.95	193,274
1991	3,820	300.74	896,202	1,179	154.74	182,376
1992	4,072	341.59	1,140,388	1,156	192.98	222,993
1993	3,863	443.55	1,421,278	1,243	212.77	264,540
1994	4,200	427.83	1,555,591	1,151	212.55	244,663

*Lumber exports are shown in table A5

Table A4. Pulp & Paper and Secondary Mfg. Production and Sales

	Pulp & Paper Production and Sales			Secondary Mfg.
	PPV	PAVOL	PUVOL	VADV
	1000 1994$	1,000 tons	1,000 tons	1000 1994$
1965	2,912,732	2,350	3,552	1,087,634
1966	2,993,803	2,518	3,750	1,137,224
1967	2,863,261	2,413	3,734	1,194,380
1968	3,066,975	2,593	3,883	894,023
1969	2,995,348	2,566	3,788	1,240,944
1970	2,848,926	2,531	3,848	1,080,961
1971	2,815,097	2,481	3,308	1,156,417
1972	3,071,250	2,750	3,635	1,292,761
1973	3,395,235	NA	NA	1,841,751
1974	3,726,831	NA	NA	1,715,522
1975	3,534,388	2,291	3,127	1,493,516
1976	4,178,419	NA	3,375	1,606,799
1977	4,195,814	2,687	3,576	1,753,850
1978	3,732,811	2,199	2,849	2,041,879
1979	4,362,482	2,781	3,313	2,012,171
1980	4,497,039	2,895	3,585	1,617,875
1981	4,139,404	2,928	3,518	1,376,764
1982	3,564,808	3,013	3,274	1,128,425
1983	3,693,342	NA	3,758	1,289,002
1984	3,929,886	3,462	4,031	1,284,273
1985	3,525,190	3,494	4,101	1,380,211
1986	3,603,415	3,750	4,285	1,223,608
1987	4,037,722	3,898	4,531	1,337,375
1988	4,323,082	3,980	4,597	1,457,434
1989	4,167,692	4,023	4,628	2,504,545
1990	4,102,424	NA	NA	2,363,104
1991	3,620,014	NA	NA	2,124,565
1992	3,463,839	NA	NA	2,213,886
1993	2,662,905	NA	NA	2,439,343
1994	2,901,911	NA	NA	2,632,901

Table A5. Log and Lumber Exports, Volumes and Values

| | Log Exports | | | Lumber Exports | | |
| | LGXVOL | LGXUV | LGXV | LBX | LBXUV | LBXV |
	MMbf ls	94$/Mbf	1000 '94$	MMbf lt	94$/Mbf	1000 '94$
1965	728	330.54	240,775	107	533.72	57,079
1966	869	343.12	298,073	110	529.05	58,259
1967	1,272	359.82	457,538	124	518.24	64,457
1968	1,605	394.47	632,995	117	617.49	72,059
1969	1,569	429.98	674,496	119	597.49	70,964
1970	1,849	441.25	815,772	152	470.06	71,563
1971	1,537	420.86	646,690	146	561.57	81,765
1972	2,222	436.41	969,648	184	580.73	106,824
1973	2,291	775.92	1,777,734	363	649.93	236,050
1974	1,837	744.34	1,367,152	371	684.69	254,097
1975	1,800	691.01	1,243,686	295	567.41	167,377
1976	2,271	677.01	1,537,319	348	630.35	219,675
1977	2,170	718.83	1,560,107	287	630.46	181,005
1978	2,466	715.48	1,764,105	347	609.66	211,444
1979	2,876	869.97	2,502,266	463	776.57	359,287
1980	2,309	868.60	2,005,615	584	573.56	334,680
1981	1,749	691.22	1,208,628	523	534.07	279,473
1982	2,221	585.05	1,299,627	529	455.05	240,706
1983	2,309	492.55	1,137,072	618	437.67	270,536
1984	2,362	456.21	1,077,720	474	437.15	207,043
1985	2,523	427.10	1,077,591	475	413.81	196,380
1986	2,361	430.37	1,016,316	836	430.17	359,536
1987	2,768	485.56	1,344,123	1,027	437.46	449,198
1988	3,107	557.42	1,731,861	1,170	422.13	494,103
1989	3,195	539.65	1,723,988	1,121	425.44	476,931
1990	2,639	605.55	1,597,948	929	473.36	439,713
1991	2,236	601.28	1,344,273	840	488.43	410,304
1992	1,960	707.70	1,387,006	734	516.91	379,172
1993	1,464	1,005.18	1,471,406	659	589.15	388,055
1994	1,418	958.82	1,359,141	564	646.34	364,552

Table A6. Total Revenues, Lumber Prices, Price Indexes and GDP Deflator

	Total Revenues	Real Lumber Price	Price Indexes		GDP Deflator
	TV	DFIRPR	LBPRX	PPPRX	GDPDEF
	94$	94$/Mbf	(index)	(index)	(index)
1965	6,216,400	296.25	18.71	21.85	22.52
1966	6,244,077	295.56	19.54	22.44	23.31
1967	6,062,371	290.20	19.49	22.70	24.03
1968	6,857,217	362.47	22.10	22.97	25.14
1969	6,812,578	351.79	24.43	23.62	26.41
1970	6,163,404	266.32	22.15	24.61	27.84
1971	6,438,634	333.21	24.82	25.00	29.34
1972	7,748,403	381.81	28.15	25.79	30.77
1973	9,547,118	464.80	34.54	27.76	32.75
1974	8,803,016	379.28	35.81	34.45	35.61
1975	7,931,407	352.77	34.48	38.71	39.02
1976	9,577,603	405.01	40.09	40.75	41.48
1977	10,169,760	461.90	46.09	42.39	44.33
1978	10,391,402	503.98	53.80	44.42	47.82
1979	11,537,906	500.55	58.58	49.80	51.94
1980	9,927,029	367.57	56.36	56.63	56.86
1981	8,314,026	303.66	57.08	62.20	62.57
1982	7,217,573	251.30	55.52	65.62	66.46
1983	7,774,458	321.03	59.91	67.78	69.15
1984	7,793,776	279.93	59.97	72.38	72.16
1985	7,374,723	275.38	59.19	74.34	74.86
1986	7,516,231	279.71	59.52	76.18	76.84
1987	8,628,023	286.90	62.63	79.92	79.30
1988	9,301,119	281.80	66.02	85.56	82.39
1989	10,185,997	306.25	70.35	90.42	86.04
1990	9,615,257	269.05	72.02	92.65	89.85
1991	8,577,732	268.06	73.35	93.77	93.26
1992	8,807,283	307.18	81.40	95.31	95.88
1993	8,647,526	427.08	96.61	96.65	97.94
1994	9,058,759	408.92	100.00	100.00	100.00

Table A7. Employment

	Employees			Employees / Harvest
	PPEMP	WDEMP	TOTEMP	UNITEMP
	persons	persons	persons	persons / MMbf ls
1965	19,800	46,900	66,700	10.38
1966	20,300	46,600	66,900	10.94
1967	19,900	44,000	63,900	10.73
1968	20,000	45,900	65,900	9.57
1969	20,000	45,200	65,200	9.37
1970	19,800	42,200	62,000	9.64
1971	18,100	43,400	61,500	9.77
1972	18,200	47,300	65,500	9.53
1973	17,700	49,100	66,800	8.61
1974	17,600	49,700	67,300	9.80
1975	16,600	43,800	60,400	9.86
1976	17,400	51,000	68,400	10.14
1977	17,700	53,900	71,600	10.76
1978	14,000	55,100	69,100	10.60
1979	15,800	52,600	68,400	10.08
1980	17,600	46,500	64,100	10.85
1981	17,200	44,400	61,600	12.78
1982	16,200	39,000	55,200	10.92
1983	15,700	41,100	56,800	9.55
1984	16,200	41,000	57,200	10.09
1985	16,000	37,300	53,300	9.20
1986	16,400	36,700	53,100	8.24
1987	17,300	39,200	56,500	8.04
1988	17,100	41,700	58,800	8.31
1989	17,900	41,100	59,000	8.82
1990	18,100	39,900	58,000	9.72
1991	17,900	36,400	54,300	10.64
1992	17,800	36,500	54,300	10.72
1993	16,700	36,100	52,800	12.11
1994	17,200	36,700	53,900	13.06

Table A8. WDNR Mill Survey

	Roundwood Inputs by Source		Roundwood Inputs by Industry				
	MSDLG MMbf ls	MSMLG MMbf ls	MSLBIN MMbf ls	MSPYIN MMbf ls	MSPPIN MMbf ls	MSLGX MMbf ls	MSOTIN MMbf ls
1968	6,467	235	3,141	844	2,975		
1969							
1970	6,866	211	2,633	688	3,545	1,697	250
1971							
1972	6,874	122	2,886	860	2,946	1,956	320
1973							
1974	6,477	167	2,800	711	2,757	1,611	330
1975							
1976	6,455	186	3,001	646	2,679	2,116	333
1977							
1978	6,759	177	3,134	674	2,183	2,597	260
1979							
1980	5,588	247	2,434	483	2,557	2,308	173
1981							
1982	4,957	263	2,128	332	2,567	2,134	113
1983							
1984	5,488	281	2,597	392	2,912	2,265	121
1985							
1986	5,669	188	2,733	429	3,027	2,168	114
1987							
1988	6,595	349	3,015	457	3,130	2,847	85
1989							
1990	5,520	276	2,668	330	3,315	2,372	108
1991							
1992	4,755	275	2,545	282		1,844	54

Table A9. Overrun Factors and Estimated Conversion Ratios

	Overrun Factors		Estimated Conversion Ratios	
	LBOR	PLYOR	ESTLCR	ESTPPCR
	bf lt/bf ls	Sq.ft./bf ls	bf lt/bf ls	Short ton/Mbf ls
1965	1.320	2.42		
1966	1.327	2.49		
1967	1.334	2.50		
1968	1.341	2.48	1.096	
1969	1.348	2.50		
1970	1.355	2.52	1.211	1.09
1971	1.471	2.52		
1972	1.485	2.52	1.299	1.23
1973	1.536	2.56		
1974	1.518	2.57	1.151	1.38
1975	1.477	2.62		
1976	1.563	2.61	1.220	1.26
1977	1.546	2.67		
1978	1.534	2.72	1.324	1.31
1979	1.545	2.73		
1980	1.513	2.83	1.299	1.40
1981	1.523	2.92		
1982	1.507	2.90	1.438	1.28
1983	1.538	2.91		
1984	1.561	3.00	1.424	1.38
1985	1.579	3.10		
1986	1.607	3.15	1.512	1.42
1987	1.616	3.20		
1988	1.616	3.20	1.462	1.47
1989	1.634	3.35		
1990	NA	NA	1.469	NA
1991	NA	NA		
1992	NA	NA	1.600	NA
1993	NA	NA		
1994	NA	NA	NA	NA

Table A.10 Real Value of WA State Exports (1994$)

	Primary Total	Secondary Total	Pulp Total	Paper Total	Recycled Total	Byproducts Total	Total
1989	2,201	86	458	491	63	0.12	3,299
1990	2,038	137	337	452	65	0.83	3,030
1991	1,755	187	288	520	49	1.49	2,801
1992	1,766	207	218	544	45	0.43	2,780
1993	1,859	220	161	467	35	2.59	2,745
1994	1,724	232	199	530	48	2.26	2,736

Source: US Dept. of Commerce
Primary Total corrected for Longview and Portland.

Products Included:

Primary	Secondary	Pulp	Paper
softwood logs	softwood moulding	chemical woodpulp, sulfite	other paper
softwood lumber	wood household furniture	chemical woodpulp, dissolving	coated paper
hardwood lumber	wood seats	chemical woodpulp, soda	newsprint
hardwood logs	other builders joinery	mechanical pulp	
other wood panels	wood doors & frames	semichem woodpulp	
hardwood veneer	prefab. wood buildings	nonwood pulps	
other primary products	fabricated structural members		
plywood	other secondary products		
particleboard	wood windows & frames		
mdf	hardwood moulding		
softwood veneer	hardwood flooring		
OSB & waferboard	wood office furniture		
	wood cabinets		
	wood furniture parts		
	treated lumber		
	softwood flooring		
	casks and barrels		
	pallets and packing cases		
	parquet panels		

List of Variables

Name	Description	Units	Table	Derivation	Source	Notes
(all prices and unit values deflated using GDP deflator "GDPDEF")						
Harvest Volumes						
FSVOL	USFS & NonState Public Harvest Volume	MMbf ls	A2		USFS PP&T	Includes BLM, BIA & Other Public
PRVOL	Private Harvest Volume	MMbf ls	A2		USFS PP&T	
WDNRVOL	WDNR Harvest Volume	MMbf ls	A2		WDNR	
THVOL	Total Harvest Volume	MMBF	A2	FSVOL+WDNRVOL+PRVOL	US Dept. of Commerce. Jones Steevedoring	
Stumpage Prices						
FSHP	Deflated USFS Harvest Price	1994$/Mbf	A2		USFS PP&T (1985-93); Adams, et al. (1960-85)	
PRHP	Deflated Private Harvest Price	1994$/Mbf	A2	WDNR price + appx. 75$ after '91	Derived	
WDNRHP	Deflated WDNR Harvest Price	1994$/Mbf	A2		WDNR	
THP	Deflated Harvest Price for all Ownerships	1994$/Mbf	A2	THV / THVOL	Derived	
Revenues Generated From Harvest						
FSV	USFS & NonState Public Value of Harvest	1000 1994$	A2	FSHP*FSVOL	Derived	
PRV	Private Value of Harvest	1000 1994$	A2	PRVOL*PRHP	Derived	
WDNRV	DNR Value of Harvest	1000 1994$	A2	DNRVOL*WDNRHP	Derived	
THV	Total Value of Harvest	1000 1994$		FSV+DNRV+PRV	Derived	
Lumber Production & Domestic Sales						
LBPRO	WA Lumber Production	MMbf lt	A3		USFS PP&T	
LBDUV	Unit Value of WA Domestic Lumber	1994$/Mbf	A3		Western Wood Products Association, USFS PP&T	
LBDV	Value of Domestic Lumber Sales	Thousand 1994$	A3	(LBPRO-LBX) * LBDUV	Derived	
Plywood Production and Sales						
PLYPRO	WA Plywood Production 3/8" basis	MMsf	A3		USFS PP&T	
PLYUV	Unit Value of WA Plywood Production 3/8" basis	1990$/Msf	A3		American Plywood Association	Corrected for 3/4" basis. 1994 estimated w / extCD price
PLYV	Value of WA Plywood Production 3/8" basis	Thousand 1994$	A3	PLYPRO * PLYUV	Derived	

A15

Name	Description	Units	Table	Derivation	Source	Notes
Pulp & Paper Production and Sales						
(all prices and unit values deflated using GDP deflator "GDPDEF")						
PPV	Total Value of WA Pulp & Paper Production	Thousand 1994$	A4		WA State Quarterly Business Review, various; NW Pulp & Paper Association	1994 from WA GBI
PAVOL	WA State Paper Production	1,000 short tons	A4		Bureau of Census, Current Industry Reports, MA26B	
PUVOL	WA State Pulp Production	1,000 short tons	A4		Bureau of Census, Current Industry Reports, MA26B	
Secondary Manufacturing						
VADV	Total Value of WA Value Added Production	Thousand 1994$	A4		WA State Quarterly Business Review, various, 1960-68 extrapolated (see Value Added)	Plywood netted out
Log Exports						
LGXVOL	Volume of WA Log Exports	MMbf	A5		US Dept. of Commerce. Jones Steevedoring	Seattle Customs District data corrected for Longview and Portland
LGXUV	Unit Value of WA Log Exports	1994$/Mbf	A5		US Dept.of Commerce. Jones Steevedoring	Seattle Customs District data corrected for Longview and Portland
LGXV	Value of WA Log Exports	Thousand 1994$	A5	LGXVOL*LGXUV	Derived	
Lumber Exports						
LBX	WA Lumber Exports	MMbf	A5		US Dept. of Commerce	Adjusted for Longview
LBXUV	Unit value of WA Lumber Exports	1994$/Mbf	A5		US Dept. of Commerce	Adjusted for Longview
LBXV	Total Value of WA Lumber Exports	Thousand 1994$	A5	LBX * LBXUV	Derived	
Total Revenues						
TV	Total Value of WA Wood Products Production	Thousand 1994$	A6			
Prices & Price Indexes						
DFIRPR	Real Price of DFir studs	1994$/Mbf	A6		USFS PP&T	
LBPRX	Lumber & Wood Products Producers Price Index	Index (1994=100)	A6		US Dept. of Labor	
PPPRX	Pulp & Paper Producers Price Index	Index (1994=100)	A6		US Dept. of Labor	
GDPDEF	GDP Deflator	Index (1994=100)	A6		Council of Economic Advisors, Economic Report of the President	

Name	Description	Units	Table	Derivation	Source	Notes
(all prices and unit values deflated using GDP deflator "GDPDEF")						
Employment						
PPEMP	Employment in Paper & Allied Products	Employees	A7		USFS PP&T	
WDEMP	Employment in Logging, Lumber and Solid Wood Products (Excludes Furniture)	Employees	A7		USFS PP&T	
TOTEMP	Total Employment in Wood Products	Employees	A7	WDEMP+PPEMP	Derived	
UNITEMP	Employees per Unit Harvest	Employees / MMbf ls	A7	TOTEMP/THVOL	Derived	
WDNR Mill Survey						
MSDLG	Roundwood Mill Inputs Originating in WA	MMbf ls	A8		WDNR Mill Survey	
MSMLG	Roundwood Mill Inputs Originating Out-of-State	MMbf ls	A8		WDNR Mill Survey	
MSLBIN	Roundwood Mill Inputs, Lumber Mills	MMbf ls	A8		WDNR Mill Survey	
MSPYIN	Roundwood Mill Inputs, Plywood Mills	MMbf ls	A8		US Dept. of Commerce. Jones Steevedoring	
MSPPIN	Roundwood Mill Inputs, Pulp & Paper Mills	MMbf ls	A8		WDNR Mill Survey	Includes mill residues and chips from chip mills
MSLGX	Roundwood Mill Inputs, Log Exports	MMbf ls	A8		WDNR Mill Survey	
MSOTIN	Roundwood Mill Inputs, Other Mills	MMbf ls	A8		WDNR Mill Survey	Other" includes shake & shingle and Post, Pole and Pilings.
Overrun and Conversion Ratio Estimates						
LBOR	Lumber Overrun Factor	bf lt / bf ls	A9		USFS, Darius Adams (pers. com.)	
PLYOR	Plywood Overrun Factor	Sq.ft/bf (3/4" basis?)	A9		USFS, Darius Adams (pers. com.)	
ESTLCR	Estimated Lumber Log Input Conversion Ratio	bf lt / bf ls	A9	LBPRO/MSLBIN	Derived	
ESTPPCR	Estimated Pulp & Paper Log Input Conversion Ratio	Short ton / Mbf ls	A9	PLYPRO/MSPYIN	Derived	
Dept. of Commerce Export Data						
	Seattle Customs District Export Data Corrected for Lonview and Portlad		A10		US Dept. of Commerce	See text and table for details

A17