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Estimating Stumpage Values from Lump Sum Timber Sales in Western Washington

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B. Bruce Bare and Robert L. Smith

Rachel A. Woods Professor,
College of Forest Resources,
University of Washington, Seattle, WA 98195-2100,
bare@u.washington.edu, 206.685.0878 (VM), 206.686.0790 (FAX)
and Valuation Forester, Special Programs Division,
Forest Tax Section, Washington State Department of Revenue,
Olympia, WA 98504-7472, robertsm@dor.wa.gov, 360.753.1385 (VM)

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ABSTRACT

Three procedures for estimating the stumpage value of individual species and qualities of timber in lump sum timber sales are described: (1) log price allocation, (2) individual sale allocation, and (3) multiple linear regression. Each procedure is described and applied to a sample set of western Washington public and private stumpage sales. Results indicate that the log price allocation procedure underestimates stumpage values by about 11% compared to the other two procedures. The individual sale allocation and regression procedures produce comparable results, but the former method is not as flexible nor is it as defensible methodologically as the regression approach. We recommend the regression procedure as the preferred alternative.

INTRODUCTION

Most public and private stumpage sales in western Washington are sold on a lump sum basis. For each sale transaction, the timber <u>volume</u> of individual species and grades is reported, but the <u>value</u> of each species and grade is not separately identified. Often it is necessary to generate estimates of value for individual species and grades using lump sum transaction evidence. Some examples of such use are: (1) the Washington State Department of Revenue (WDOR) which must semi-annually produce stumpage value estimates for each species and grade for state excise tax purposes, (2) property valuation disputes involving standing timber of differing species and grades that must be separately valued, (3) estate and federal income tax cases which involve standing timber, and (4) land exchanges involving standing timber

In establishing stumpage values, most appraisers use one of two methods: (1) transaction evidence involving comparable stumpage sales, or (2) a residual value (conversion return) approach based on the sale of logs or other end products (Davis and Johnson 1987). The transaction evidence approach is generally held to be a more reliable method by the Courts as well as the taxpayer as fewer assumptions are required and the method provides a more direct approach to valuation. However, when lump sum sales are used, the generation of values for individual species and grades presents an additional complication that must be addressed.

The purpose of this paper is to describe and compare three methods for analyzing lump sum timber sales for the purpose of establishing stumpage values for individual species and grades: (1) log price allocation, (2) individual sale allocation, and (3) multiple linear regression. The first two methods are better suited to appraisals of a small number of lump sum timber sales. In contrast, the multiple regression approach is better suited to situations involving the mass appraisal of a large number of lump sum timber sales. In the process of comparison of the results produced by the three approaches, we discuss these and other assumptions inherent in each approach. Each method is tested using public and private lump sum timber sales transaction evidence from western Washington. A comparison of the results and a discussion of the strengths and weaknesses of each method conclude the paper.

TIMBER TRANSACTION MODEL

Bare and Smith (1999) present a valuation strategy for analyzing lump sum timber sale transactions. They recommend that multiple regression be used to establish stumpage values for individual species and grades. The analysis presented herein follows their proposal but extends it to consider two additional estimation methods. Like Bare and Smith (1999), our analysis assumes that the basic transaction data available for analysis consist of public and private lump sum timber sales that qualify as arms length transactions between a willing buyer and seller under no compulsion to buy or sell (WDOR, 1996). In the western Washington case study examined below, certain types of transactions are excluded. Examples of the types of sales that are excluded include: (1) sales that come from an experimental study area, (2) public sales that are not advertised and open for competitive bid, (3) Washington Department of Natural Resources (WDNR) cedar salvage sales, (4) private sales that are not arms-length, (5) sales of unusually small or large size in relation to the typical private harvest unit, and (6) sales that consist of small or isolated patches of timber that have been damaged by either fire or blow down. For each lump sum sale transaction, the sales data consist of characteristics including the total sale price, the volume of standing timber by species and grade (hereafter called quality class), access road requirements, and a variety of factors used to adjust the sales price (e.g., haul distance, market region (hereafter called stumpage value area), volume per acre, logging difficulty, contract length, etc.). The basic timber transaction model used to allocate the total sale price (TSP) to the various species and quality classes present in a lump sum sale is:

$$TSP_i/V_i \quad = \quad \Sigma\, \beta_j\, SQ'_{ji} + \epsilon_i \qquad (1)$$

where,

V_i = Total volume on i^{th} stumpage sale transaction.

TSP_i/V_i = Average sale price in \$/MBF for i^{th} valid stumpage sale after pre-adjustment for a variety of factors.

β_j = Coefficient measured in \$/MBF for j^{th} species and quality class.

SQ'_{ji} = Proportion of volume represented by species and quality class SQ_j occurring on i^{th} stumpage sale transaction.

ϵ_i = Deviation between the actual adjusted TSP_i/V_i for the i^{th} stumpage sale and that predicted by equation (1).

Equation (1) provides the conceptual model for all three of the methodologies discussed in this paper. However, different analytical procedures are used to estimate the β_j – the stumpage value of individual species and qualities. These procedures lead to differences in stumpage value estimates and raise the question of which, if any, procedure produces the best estimates. In addition, two of the procedures have limitations that, in mass appraisal situations, limit their usefulness (see below).

TIMBER TRANSACTION DATABASE

All three methods require the availability of a database of comparable lump sum stumpage sales. A typical transaction database includes sales for several months preceding the date of appraisal. In the western Washington case study, we utilize sales occurring within 12 months of the date of appraisal. While older sales easily could be included, we have found that 12 months is long enough to accumulate a sufficient number of sales representative of the stumpage market at the time of appraisal. Prior to estimating the β_j coefficients using the three procedures, each sale's total price (i.e., bid price) is pre-adjusted to reflect an average condition. This adjustment ensures that each sale represents: (1) an average hauling distance (approximately 45 miles) within a stumpage valuation area (see below), (2) a logging condition class one (i.e., most of the harvest unit has less than 30% slopes and no significant rock outcrops or swamp barriers), (3) a volume per acre class one (i.e., harvest more than 40 MBF/acre), and (4) all required access roads are in place. Road construction and road betterment costs used to adjust the total sales price to reflect this latter condition are either the actual costs reported for a sale or an average value for construction and betterment. The other dollar amounts of the other harvest adjustments listed above are made using average values ($/MBF) available at the time of the analysis. In our western Washington case study these are determined by the WDOR.

The pre-adjusted bid price expressed in $/MBF is further adjusted for inflation to the date of appraisal using the monthly Producer Price Index for all commodities. This converts all nominal bid prices occurring within the previous 12 month time period into constant dollars as of the appraisal date. In the multiple regression approach, three quarterly indicator variables, representing the first three quarters of the 12 month data period, may be added to equation (1) to track trends in the stumpage market over the 12 month data period. The β_j coefficient associated with each indicator variable represents the adjustment in the average pre-adjusted bid price ($/MBF) relative to the fourth quarter of the 12 month time period – the date of appraisal. While multiple regression is particularly well suited to the use of these indictor variables, it is not possible to introduce them into the other two procedures. Therefore, in the western Washington case study, quarterly indicator variables are only used in the multiple regression approach.

Additional indicator variables representing stumpage value areas (SVA) may be used to determine the average dollar adjustment in the pre-adjusted bid price as a function of geographic location within a study area (western Washington in this case). This adjustment is made relative to one of the SVAs (SVA 4 in this case), as it is the SVA with the largest concentration of sales in the database. Stumpage value areas (see WAC-458-40-640) represent regions in western Washington with common wood processing centers. In recent years, about 60% of the western Washington timber sales analyzed by the WDOR are located in two of the five western Washington SVAs. In the western Washington case study, SVA indicator variables are only introduced into the regression approach.

To reduce the total number of species and quality classes for which β_j coefficients must be estimated, it is customary to group them into a small set of classes. In the western Washington case study, the species and quality classes for which stumpage values are estimated include: (1) Douglas-fir (four quality classes), (2) western hemlock and other conifers (two quality classes), (3) cedar (two quality classes), (4) red alder (two quality classes), (5) black cottonwood, other hardwoods, and low quality red alder (one quality class), and (6) lodgepole and ponderosa pine (one quality class). Other combinations of species and quality classes may be defined, but we have found the above to be sufficient to demonstrate the three valuation approaches.

Log Price Allocation

The objective of this procedure is to use current log selling prices to aid the determination of the proper stumpage value for the species and quality classes present on any sale. This method is similar to a residual value approach (Davis and Johnson 1987, Klemperer 1996), but differs in that it uses individual stumpage sale transactions in the calculation process and does not require that the appraiser estimate logging costs. Log selling prices, as determined from publicly available sources, are multiplied times the log grade percentages on each timber sale to develop an average log selling price for each species on each sale. The average log selling price for each sale is multiplied times the volume by species and quality class to yield a total log selling price (TLP_i) for the sale. Once determined, the actual total sale price for the stumpage (TSP_i) is subtracted leaving a residual composed of total logging cost and profit for the harvester. Dividing this residual by the total sale volume yields an average logging cost and profit (LCPRFT) expressed on a $/MBF basis. This average LCPRFT is subtracted from each average log selling price (expressed on a $/MBF basis) to derive an estimated stumpage value for each species and quality class within a given SVA for the sale. No provision is made for introducing indicator variables to account for either SVA or quarterly time differences. In the western Washington case study, a pre-stratification of the sales database permits a determination of stumpage value estimates for each SVA. However, no statistical tests are performed in the western Washington case study to ascertain whether significant differences exist between SVAs. In addition, it is difficult to undertake statistical comparisons of stumpage value estimates on an individual species and quality class basis (either within or across SVAs) because of the number of classes to examine. Unlike either of the other two procedures, this procedure can be used to allocate value if only one sale is available for analysis. Therefore, this procedure is best considered when very small amounts of sales data are available.

After all sales in the database have been sequentially analyzed following the just-described procedure, a volume weighted average is computed for each species and quality class combination by SVA to arrive at the final value estimates (β_j) for each category of stumpage.

Before starting the log price allocation method, each sale is pre-adjusted for inflation, haul distance, logging condition, volume per acre, road construction, etc. as with the other approaches. Species and quality classes used are the same as used in the regression and individual sale allocation methods. Because quarterly time indicator variables are not used to reflect changes in the stumpage market over the 12 months of sales included in the database, the stumpage value estimates produced by this method do not reflect values as of the end of the 12 month data period. Instead, the estimated stumpage values represent a date of appraisal as determined by the month where the volume weighted average occurs. And, this date is different for each species, quality class, and SVA combination.

Individual Sale Allocation

Individual sale allocation is similar to log price allocation in that it is conceptually based on equation (1) and processes sales sequentially. However, it does not utilize log selling prices as a starting point. Instead, the objective of the individual sale allocation method is to find estimates of the β_j coefficients such that ε_j for each individual sale is zero. As each lump sum transaction is sequentially analyzed, the difference between the actual total sale price per MBF and the estimated total sale price per MBF (i.e., TSP_i/V_i) is forced to equal zero by altering the estimated β_j coefficients. A previously determined estimate of each β_j coefficient is initially used to estimate the total sale price per MBF of a sale. The ratio of the actual to the estimated total sale price is subsequently used to adjust each β_j coefficient proportionally such that the estimated and actual total sale prices are equal. It is possible to use the log price allocation method to establish initial estimates for use in the individual sale allocation procedure, but this is not necessary.

To better understand the process, consider a hypothetical sale involving three species that sells for $700,000. The total volume of the sale is 1,750 MBF and consists of 45% Douglas-fir, 35% western hemlock, and 20% hardwood. The actual total sale price per MBF is $400/MBF. Suppose the predetermined initial stumpage value estimates (i.e., the β_j coefficients) of the three species are $500, 270, and 160 per MBF, respectively.

Substituting these predetermined stumpage value estimates into equation (1) produces an estimate of the total sale price per MBF of $351.50. To force the difference between the actual and estimated total sale prices per MBF to be zero, each predetermined stumpage value estimate is multiplied by the ratio of the actual to the estimated total sale prices (i.e., 400/351.50) = 1.138). When multiplied by the original coefficients this changes the individual stumpage value estimates to $569, 307.26, and 182.08, respectively, and produces a zero deviation between the actual and estimated total sale prices per MBF. This process is followed sequentially for each sale in the database.

As with the log price method, each sale is pre-adjusted for inflation, haul distance, logging condition, volume per acre, road construction, etc. prior to performing the above described calculations. And, like log price allocation, the individual sale allocation method does not introduce indicator variables to account for either SVA or quarterly time differences. Instead, after the above-described process has been applied sequentially to each sale, a volume weighted average stumpage value for each species and quality class by SVA is calculated. The species and quality classes used are the same as used by the log price allocation method. Because quarterly time indicator variables are not used to reflect changes in the stumpage market over the 12 months of sales included in the database, the stumpage value estimates produced by this method do not reflect values as of the end of the appraisal period. Instead, the estimated stumpage values represent a date of appraisal as determined by the month where the volume weighted average occurs. This date is different for each species and quality class combination. No testing for statistically significant SVA or quarterly time differences is performed.

As discussed above, in order for the individual sale allocation method to function, it is necessary to predetermine a set of initial stumpage value estimates (β_j) so that the actual and estimated total sale prices per MBF can be forced to be equal. Because of the ratio process described above, the absolute magnitude of the predetermined stumpage estimates is not important. Critical, however, is the relative magnitude of these initial estimates. As an example, consider the previous illustration. Suppose we use the following as initial predetermined values for Douglas fir, western hemlock, and hardwood

– 3.125, 1.6875, and 1.0, respectively. It can be shown that these coefficients retain the same relative magnitude as the original stumpage estimates of $500, 270, and 160 per MBF, respectively. Use of these stumpage value estimates in equation (1) produces an estimate of the total sale price per MBF of $2.1969. The ratio of the actual to the estimated total sale prices (i.e., 400/2.1969 = 182.0768) multiplied by the original coefficients yields the individual stumpage value estimates of $569, 307.26, and 182.08, respectively, and produces a zero deviation between the actual and estimated total sale prices per MBF. Initial value estimates may be established using multiple regression or log prices so long as the appropriate relative values are established among species and quality classes of stumpage.

Multiple Linear Regression

As Bare and Smith (1999) describe, the objective of the multiple regression model is to estimate each β_j coefficient such that the sum of the squared deviations (ϵ_i^2) as defined in equation (1) is minimized. One regression equation is estimated for all lump sum sales included in the database. Unlike the previous two procedures, regression is well suited for the mass appraisal of timber as all sales included in the database are used to simultaneously estimate the stumpage values. Indicator variables for both SVA and quarterly time periods may be used to help fine tune the procedure and to provide additional information to the appraiser. Further, regression allows one to perform a variety of statistical tests involving the regression coefficients. This permits the appraiser to judge whether certain variables are having a particular effect on the stumpage estimates. Lastly, the regression procedure is better suited to producing value estimates as of a specified date of appraisal than the previous two procedures.

In the western Washington case study described below, we adopt the regression approach outlined by Bare and Smith (1999). This method is briefly outlined below as the case study is discussed.

EXAMINATION AND TESTING OF THE THREE PROCEDURES

Each of the three procedures is applied to a common database representing western Washington timber sales for the 12 month period between April 1, 1999 and March 31, 2000. The database consists of 338 valid public and private timber sales. As shown in Table 1, almost 89% of the sales involve Douglas fir and western hemlock/other conifers. And, over 65% of the sales, accounting for almost 62% of the volume, occur in SVAs 2 and 4. Evident in the table is that some species and quality classes are not represented in the database. For example, df1 represents less than 0.3% of the sales volume and occurs only in SVA 2. No cd1 is represented in the database and cd4 accounts for 2.4% of the sale volume and 93% of the cedar volume. Minor western Washington species such as all pine, black cottonwood, and other hardwoods (except for ra12) occur in 1.3% of the sales and account for only 1.4% of the volume. If one tries to aggregate all quality classes into a single class for each minor species, the inherent variability in stumpage values produces a statistically insignificant average value. Therefore, stumpage values for minor species are, in practice, estimated using a standard conversion return approach. Using the individual sale allocation procedure, these estimated values (and volumes) may be deducted from the sale transaction evidence during the pre-adjustment process. This is the current practice adopted by the WDOR when estimating western Washington stumpage values. Using the regression or log price allocation procedures, the minor species are analyzed together with all species. However, it is recognized that another procedure (such as the conversion return) may be needed to set the final value estimates.

Log Price Allocation

Estimated values using this procedure are shown in Table 2. Delivered log selling prices used for the analysis are taken from the Loglines price report applicable for the month relevant to each sale (Loglines, various dates). Export log prices are applied to private unrestricted sales and domestic prices to the restricted public sales. Prices are specific to each SVA.

As seen in Table 2, considerable variation exists between stumpage value estimates when viewed across SVAs. This is particularly noticeable in SVA 3 for df3 and df4 and in SVA 5 for wh/oc 4. Also troublesome is that the western Washington average value estimate for df12 is less than for df3. Although value estimates are shown for each SVA, there is no indication whether these differences are statistically significant. Value estimates are also shown for the minor species. However, some of these are negative and others vary considerably from one SVA to another. It is unclear whether these represent real or artificial differences.

Individual Sale Allocation

Estimated values produced using this approach are shown in Table 3. Where no sales for a given species and quality class occur in the sales database, a value of "zero" is shown in the table. To start thc individual sale allocation method, it is necessary to predetermine a set of initial stumpage value estimates (β_j) so that the actual and estimated total sale prices per MBF on each sale can be forced to be equal. We use the estimates obtained from the regression procedure for this purpose. Therefore, a minimum number of observations are needed to apply this procedure. However, the sales data themselves generate the ratios needed, so that other information (such as log prices) are not required. Thus, if log price data are unavailable and there is sufficient data for a minimal regression analysis, this procedure may still be used. The initial regression estimates used are shown in Table 5. Stumpage values for minor species (all pine, black cottonwood, other hardwoods, and red alder 3) do not occur in sufficient quantity to permit estimation by the individual sale allocation approach. Thus, we modify the sale database prior to calculating estimated values for the individual sale allocation method by deducting the volume and estimated value of occurring species from each sale using the regression estimates shown in Table 5. Once this modification is complete, the individual sale allocation procedure is followed to derive the estimates for the remaining species and quality classes as shown in Table 3. For later comparisons, a volume weighted average is also computed for each species and quality class for western Washington.

As seen in Table 3, considerable variation exists between stumpage value estimates when viewed across SVAs. These are largely non-significant differences but reflect weighted average values. Since the appraiser is not able to judge which differences are significant, all estimated stumpage values are retained for each SVA. As shown at the bottom of Table 3, the total actual and estimated allocation bid values are approximately the same both within and across SVAs. Thus, the individual allocation approach is accounting for the total sale value. It is clear that average stumpage values in SVAs 3 and 5 are lower; values in SVA 4 are higher; and values in SVAs 1 and 2 are mixed relative to the western Washington average.

Multiple Linear Regression

Stumpage value estimates based on the regression approach are shown in Tables 4 and 5. The statistical results shown in Table 5 are the result of a series of regression runs. Indicator variables representing SVAs are used to determine the average adjustment in the adjusted bid price as a function of location within five western Washington areas. This adjustment is made relative to SVA 4. For the case study, we found SVAs 3 and 5 to be significantly different than the pooled set consisting of the other three SVAs. Further examination reveals that these differences are due to only certain quality classes of Douglas fir. Therefore, the final results shown in Table 5 contain these coefficients. Also shown are the regression estimates for allpine (ponderosa and lodgepole) and a combined hardwood class (black cottonwood, other hardwoods, and red alder 3). Because the regression coefficients for these two species groups are not significant at the 5% level of significance, they can be dropped from the model without causing a significant impact. They are not reported in the summary as shown in Table 4 as a different approach (i.e., conversion return) is used to determine the final stumpage values. The two classes of poles are reported separately as they are significantly different. Lastly, the three quarterly indicator variables are retained in the final model regardless of their statistical significance. Thus, the regression always estimates stumpage values for the fourth quarter of the 12-month data period. The signs and magnitudes of the regression coefficients associated with these three indicator variables illustrate that the western Washington stumpage market is essentially flat, on average, over the past 12 months.

DISCUSSION

For purposes of comparison and discussion, the actual values adopted for excise tax purposes in western Washington for the last six months of 2000 are shown in Table 6. As with value estimates derived using other procedures discussed in this paper, these represent sales that have been pre-adjusted for haul distance, logging condition, volume per acre, and road construction. However, they have not been adjusted for inflation. Values shown in Table 6 represent volume weighted averages for those species and quality classes which are reported separately for excise tax purposes but which are combined in our analysis.

Results generated by the three procedures as well as those adopted for excise tax purposes are shown in Table 7. It is apparent that the log price allocation procedure yields results that are different from values produced by the other procedures. For the sales included in the transaction database, the log price allocation estimates are 10% lower than the values adopted for excise tax purposes and about 13% lower than those produced by either the multiple regression or individual sale allocation procedures. In addition, the log price allocation procedure produces a higher value estimate for df3 than for df12 – an example of a reverse value relationship. Contrary to the general results, the log price allocation estimate for df4 and cedar appears high when compared to the estimates produced by all other procedures.

Stumpage value estimates for Douglas fir and cedar poles present an interesting situation. For excise tax purposes, the two species are averaged together across all five western Washington SVAs. However, as demonstrated in Table 7, this yields a Douglas fir pole value that is too high and a cedar pole value that is too low – relative to the estimates associated with the three procedures discussed in this paper. This suggests that the two species should not be pooled.

The estimates produced by the individual sale allocation and regression procedures are about the same in the aggregate, although the regression estimates are slightly higher. Individual sale allocation estimates for df3, wh123, and ra12 are higher than those produced by the regression procedure. Due to the nature of the regression model, it produces value estimates that are less variable across the five SVAs than those produced by all other procedures. Thus, non-significant value estimate differences are averaged out over the five SVAs. Apart from the previously mentioned differences in Douglas fir and cedar pole value estimates, the regression procedure and the values adopted for excise tax purposes are almost the same except for df12 and df3. The individual sale allocation estimates differ from the excise tax value estimates for all Douglas fir quality classes as well as for cedar and wh123. All procedures produce common value estimates for ra12.

Given the above-described results is it possible to conclude if any single procedure is superior? We believe that the regression procedure is the best overall method to employ when attempting to estimate the value of individual species and quality classes using lump sum sales for a mass appraisal. We reach this conclusion based on several criteria. First, as a mass appraisal technique, regression is the only procedure examined that is capable of simultaneously analyzing all valid sale transactions to produce a set of value estimates. The other procedures proceed sequentially and require that an auxiliary set of data and/or value estimates be available to initiate the estimation process. Second, the regression procedure permits the appraiser to time-trend all valid sales to a common date of appraisal. As previously mentioned, this is not possible for either the log price allocation or individual sale allocation procedures. In a rapidly changing timber market, these latter two methods fail to bring all sales to a common point in time. Not only does this violate a common appraisal practice, it also results in an inaccurate estimate of stumpage values. Third, the regression approach can easily incorporate indicator variables for determining whether SVA or quarterly time trends are important enough to incorporate into the final value estimates. The other two procedures cannot easily accommodate this feature. Fourth, the regression procedure can easily accommodate an expansion of the data set by incorporating a longer time period (such as three years instead of one year as in this example) and other variables (such as the above mentioned sale adjustments). Both permit the analyst to consider more factors than are reasonable using the other procedures. Fifth, the regression procedure uses a widely accepted statistical criterion (i.e., least-squares) when deriving value estimates. The other two procedures adopt a volume weighted averaging criterion to set the final value estimates. In addition, the individual sale allocation procedure sets initial value estimates using a "zero" deviations criterion. Fifth, the regression procedure is easier to use and simpler to explain to knowledgeable users. The other two procedures require the user to accept the initial data or value estimates required to initiate the valuation process as well as the mechanics of the estimation process itself. In the case of the individual sale allocation procedure, it is difficult to explain why the preliminary set of regression estimates are subjected to further analysis and not accepted at the outset. Last, multiple regression is a commonly accepted estimation approach that is widely used by the appraisal profession. The log price and individual sale allocation procedures are volume weighted averaging approaches that are unique to forest valuation and are derived from procedures used to value individual or small numbers of transactions. We believe these latter two approaches are inferior to the regression approach. They are alternatives to consider when a very limited number of observations are available and there is no ability to add significantly to the data set.

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Table 1. Characteristics of Transactions Used to Estimate Stumpage Prices for western Washington (Public and Private Stumpage Sales; Second Half Calendar 2000)

SP/QC	Percent Sales	Comment	Percent Volume
df12	33.1%	(df1 = 0.2%)	39.2%
df3	7.0%		6.3%
df4	4.1%		2.5%
dfpl	1.5%		0.5%
cd	2.2%	(cd4 = 2.0%)	2.5%
cdpl	0.1%		0.1%
wh123	29.8%	(wh23 = 29.2%)	29.4%
wh4	14.8%		12.2%
allpine	0.1%		0.1%
ra12	6.1%	(ra1 = 2.3%)	5.8%
bcohra3	1.2%		1.3%
Total	100.0%		100.0%
No. Sales	338		338
sva1	15.4%		13.0%
sva2	37.9%		32.5%
sva3	7.7%		12.9%
sva4	27.5%		29.0%
sva5	11.5%		12.7%
Total	100%		100%

Note: Species codes are defined as: (a) df = Douglas-fir and western larch, (b) cd = western redcedar and Alaska cedar, (c) wh = western hemlock and other conifers – including mountain hemlock, pacific silver fir, noble fir, grand fir, and subalipne fir, (d) ra = red alder, (e) allpine = lodgepole and ponderosa pine, (f) bcohra3 = black cottonwood, other hardwoods, and red alder 3 and pl = poles.

Table 2. Log Price Allocation Estimates for western Washington (Public and Private Stumpage Sales; Second Half Calendar 2000)

Species	QC	SVA1	SVA2	SVA3	SVA4	SVA5	Totals/ Wtd Averages	
DF	12	8898	63691	49025	101436	59419	282469	Volume (MBF)
		345	506	396	465	428	451	Value ($/MBF)
DF	3	7210	4921	556	30705	2204	45596	Volume (MBF)
		480	491	81	451	416	454	Value ($/MBF)
DF	4	979	4077	3927	5808	3247	18038	Volume (MBF)
		432	432	281	363	298	353	Value ($/MBF)
DF	PL	0	0	0	2430	1437	3867	Volume (MBF)
		0	0	0	873	515	740	Value ($/MBF)
CD	1234	1125	3659	8184	4795	458	18221	Volume (MBF)
		763	738	797	792	724	780	Value ($/MBF)
CD	PL	0	0	0	479	0	479	Volume (MBF)
		0	0	0	1094	0	1094	Value ($/MBF)
WH/OC	123	46129	108925	13953	25690	17229	211926	Volume (MBF)
		283	226	277	346	273	260	Value ($/MBF)
WH/OC	4	20673	39362	7390	17960	2787	88172	Volume (MBF)
		200	267	230	274	98	244	Value ($/MBF)
RA	12	7428	8983	6895	15203	3412	41921	Volume (MBF)
		270	251	255	259	147	249	Value ($/MBF)
Total Volume		92442	233618	89930	204506	90193	710689	Volume (MBF)

Minor Species

BCOHRA3		913	678	2737	4315	617	9260	Volume (MBF)
		20	162	44	121	-43	80	Value ($/MBF)
ALLPINE		0	59	0	168	596	823	Volume (MBF)
		0	-130	0	480	290	299	Value ($/MBF)
Total		913	737	2737	4483	1213	10083	Volume (MBF)

Note: Although estimated values are shown for allpine, black cottonwood, other hardwoods, and red alder 3, these values are determined outside the log price allocation procedure using a conversion return approach.

Table 3. Individual Sale Allocation Estimates for western Washington (Public and Private Stumpage Sales; Second Half Calendar 2000)

Species	QC	SVA1	SVA2	SVA3	SVA4	SVA5	Totals/ Wtd Averages	
DF	12	8898	63691	49025	101436	59419	282469	Volume (MBF)
		510	527	448	514	498	502	Value ($/MBF)
DF	3	7210	4921	556	30705	2204	45596	Volume (MBF)
		458	459	430	502	426	486	Value ($/MBF)
DF	4	979	4077	3927	5808	3247	18038	Volume (MBF)
		317	357	268	304	224	294	Value ($/MBF)
DF	PL	0	0	0	2430	1437	3867	Volume (MBF)
		0	0	0	855	627	770	Value ($/MBF)
CD	1234	1125	3659	8184	4795	458	18221	Volume (MBF)
		760	779	750	760	753	759	Value ($/MBF)
CD	PL	0	0	0	479	0	479	Volume (MBF)
		0	0	0	1249	0	1249	Value ($/MBF)
WH/OC	123	46129	108925	13953	25690	17229	211926	Volume (MBF)
		320	341	338	410	342	345	Value ($/MBF)
WH/OC	4	20673	39362	7390	17960	2787	88172	Volume (MBF)
		274	287	229	291	207	277	Value ($/MBF)
RA	12	7428	8983	6895	15203	3412	41921	Volume (MBF)
		251	233	246	241	225	241	Value ($/MBF)

	SVA1	SVA2	SVA3	SVA4	SVA5	Total
Total Volume	92442	233618	89930	204506	90193	710689
Total Actual Bid ($)	31310242	90611744	37506040	95046200	39740496	294214722
Total Allocation Bid ($)	31310242	90611760	37506040	95046216	39740500	294214758

Note: Allpine, black cottonwood, other hardwoods, and red alder 3 volumes and estimated values are deducted prior to the allocation calculation. These values are determined outside the allocation procedure using a conversion return approach.

Table 4. Regression Estimates for western Washington (Public and Private Stumpage Sales; Second Half Calendar 2000)

Species	QC	SVA1	SVA2	SVA3	SVA4	SVA5	Totals/ Wtd Averages	
DF	12	8898	63691	49025	101436	59419	282469	Volume (MBF)
		515	515	459	515	515	505	Value ($/MBF)
DF	3	7210	4921	556	30705	2204	45596	Volume (MBF)
		469	469	469	469	469	469	Value ($/MBF)
DF	4	979	4077	3927	5808	3247	18038	Volume (MBF)
		326	326	326	326	194	302	Value ($/MBF)
DF	PL	0	0	0	2430	1437	3867	Volume (MBF)
		851	851	851	851	643	774	Value ($/MBF)
CD	1234	1125	3659	8184	4795	458	18221	Volume (MBF)
		763	763	763	763	763	763	Value ($/MBF)
CD	PL	0	0	0	479	0	479	Volume (MBF)
		1253	1253	1253	1253	1253	1253	Value ($/MBF)
WH/OC	123	46129	108925	13953	25690	17229	211926	Volume (MBF)
		341	341	341	341	341	341	Value ($/MBF)
WH/OC	4	20673	39362	7390	17960	2787	88172	Volume (MBF)
		277	277	277	277	277	277	Value ($/MBF)
RA	12	7428	8983	6895	15203	3412	41921	Volume (MBF)
		240	240	240	240	240	240	Value ($/MBF)

Note: Allpine, black cottonwood, other hardwoods, and red alder 3 estimated values are shown in Table 5. Regression coefficients for these species are not statistically significant. Thus, final estimated values are determined outside the regression procedure using a conversion return approach.

Table 5. Regression Analysis for western Washington (Public and Private Stumpage Sales; Second Half Calendar 2000)

SP/QC	Stumpage	Std. Error	t-ratio	p
dfpl	851.10	36.33	23.43	0.00
cdpl	1253.30	152.60	8.21	0.00
df12	514.58	9.84	52.32	0.00
df3	468.94	16.80	27.92	0.00
df4	325.98	22.96	14.20	0.00
wh123	341.22	9.14	37.35	0.00
wh4	277.13	11.58	23.93	0.00
cd	763.17	93.66	8.15	0.00
allpine	479.10	277.60	1.73	0.09
ra12	239.92	30.72	7.81	0.00
bcohra3	243.90	132.90	1.84	0.07
df4s5	-131.87	67.58	-1.95	0.05
dfpls5	-208.05	78.08	-2.66	0.01
df12s3	-55.58	26.70	-2.08	0.04
q299	-4.14	8.90	-0.47	0.64
q399	9.04	11.41	0.79	0.43
q499	3.81	9.35	0.41	0.68

Standard Error of Estimate = $62.98/MBF

F = 866.95 (p = 0.00)

R^2 = 97.9% (uncorrected for the mean)

Note: df4s5 represents df4 in SVA 5; dfpls5 represents dfpl in SVA 5; and df12s3 represents df12 in SVA 3. No other species/SVA interactions were significant at the 5% level of significance. Coefficients associated with the above three variables are added (subtracted) from their respective coefficients located in the above table. Coefficients associated with the three quarterly indicator variables are not used when estimating fourth quarter stumpage values.

Table 6. Actual Adopted Estimates for western Washington (Public and Private Stumpage Sales; Second Half Calendar 2000)

Species	QC	SVA1	SVA2	SVA3	SVA4	SVA5	Totals/ Wtd Averages	
DF	12	8898	63691	49025	101436	59419	282469	Volume (MBF)
		499	515	437	492	482	486	Value ($/MBF)
DF	3	7210	4921	556	30705	2204	45596	Volume (MBF)
		448	471	428	489	410	476	Value ($/MBF)
DF	4	979	4077	3927	5808	3247	18038	Volume (MBF)
		287	374	244	283	326	303	Value ($/MBF)
DF	PL	0	0	0	2430	1437	3867	Volume (MBF)
		889	889	889	889	889	889	Value ($/MBF)
CD	1234	1125	3659	8184	4795	458	18221	Volume (MBF)
		768	767	767	767	768	767	Value ($/MBF)
CD	PL	0	0	0	479	0	479	Volume (MBF)
		889	889	889	889	889	889	Value ($/MBF)
WH/OC	123	46129	108925	13953	25690	17229	211926	Volume (MBF)
		306	351	305	337	351	337	Value ($/MBF)
WH/OC	4	20673	39362	7390	17960	2787	88172	Volume (MBF)
		213	304	213	294	316	273	Value ($/MBF)
RA	12	7428	8983	6895	15203	3412	41921	Volume (MBF)
		239	245	253	234	237	241	Value ($/MBF)

Minor Species

BCOHRA3		913	678	2737	4315	617	9260	Volume (MBF)
		141	95	52	118	121	99	Value ($/MBF)
ALLPINE		0	59	0	168	596	823	Volume (MBF)
		0	228	0	228	248	242	Value ($/MBF)
Total		913	737	2737	4483	1213	10083	Volume (MBF)

Note: Values are computed as volume-weighted averages for species shown with combined quality classes.

Table 7. Comparison of Estimates for western Washington (Public and Private Stumpage Sales; Second Half Calendar 2000)

Species	QC/ Procedure	SVA1	SVA2	SVA3	SVA4	SVA5	Totals/	Wtd Averages	Total MM $
DF	12	8898	63691	49025	101436	59419	282469	Volume (MBF)	
	Allocation	510	527	448	514	498	502	Value ($/MBF)	141.8
	Regression	515	515	459	515	515	505	Value ($/MBF)	142.7
	Log price	345	506	396	465	428	451	Value ($/MBF)	127.3
	Adopted	499	515	437	492	482	486	Value ($/MBF)	137.2
DF	3	7210	4921	556	30705	2204	45596	Volume (MBF)	
	Allocation	458	459	430	502	426	486	Value ($/MBF)	22.2
	Regression	469	469	469	469	469	469	Value ($/MBF)	21.4
	Log price	480	491	81	451	416	454	Value ($/MBF)	20.7
	Adopted	448	471	428	489	410	476	Value ($/MBF)	21.7
DF	4	979	4077	3927	5808	3247	18038	Volume (MBF)	
	Allocation	317	357	268	304	224	294	Value ($/MBF)	5.3
	Regression	326	326	326	326	194	302	Value ($/MBF)	5.5
	Log price	432	432	281	363	298	353	Value ($/MBF)	6.4
	Adopted	287	374	244	283	326	303	Value ($/MBF)	5.5
DF	PL	0	0	0	2430	1437	3867	Volume (MBF)	
	Allocation	0	0	0	855	627	770	Value ($/MBF)	3.0
	Regression	851	851	851	851	643	774	Value ($/MBF)	3.0
	Log price	0	0	0	873	515	740	Value ($/MBF)	2.9
	Adopted	889	889	889	889	889	889	Value ($/MBF)	3.4
CD	1234	1125	3659	8184	4795	458	18221	Volume (MBF)	
	Allocation	760	779	750	760	753	759	Value ($/MBF)	13.8
	Regression	763	763	763	763	763	763	Value ($/MBF)	13.9
	Log price	763	738	797	792	724	780	Value ($/MBF)	14.2
	Adopted	768	767	767	767	768	767	Value ($/MBF)	14.0
CD	PL	0	0	0	479	0	479	Volume (MBF)	
	Allocation	0	0	0	1249	0	1249	Value ($/MBF)	0.6
	Regression	1253	1253	1253	1253	1253	1253	Value ($/MBF)	0.6
	Log price	0	0	0	1094	0	1094	Value ($/MBF)	0.5
	Adopted	889	889	889	889	889	889	Value ($/MBF)	0.4
WH/OC	123	46129	108925	13953	25690	17229	211926	Volume (MBF)	
	Allocation	320	341	338	410	342	345	Value ($/MBF)	73.0
	Regression	341	341	341	341	341	341	Value ($/MBF)	72.3
	Log price	283	226	277	346	273	260	Value ($/MBF)	55.1
	Adopted	306	351	305	337	351	337	Value ($/MBF)	71.4
WH/OC	4	20673	39362	7390	17960	2787	88172	Volume (MBF)	
	Allocation	274	287	229	291	207	277	Value ($/MBF)	24.5
	Regression	277	277	277	277	277	277	Value ($/MBF)	24.4
	Log price	200	267	230	274	98	244	Value ($/MBF)	21.5
	Adopted	213	304	213	294	316	273	Value ($/MBF)	24.1
RA	12	7428	8983	6895	15203	3412	41921	Volume (MBF)	
	Allocation	251	233	246	241	225	241	Value ($/MBF)	10.1
	Regression	240	240	240	240	240	240	Value ($/MBF)	10.1
	Log price	270	251	255	259	147	249	Value ($/MBF)	10.5
	Adopted	239	245	253	234	237	241	Value ($/MBF)	10.1
						Totals	% Difference		

Total Volume (MBF)	710689	-----
Total Value -- Allocation (million $)	294.2	2.2%
Total Value -- Regression (million $)	293.8	2.1%
Total Value -- Log price (million $)	259.1	-10.0%
Total Value -- Adopted (million $)	287.8	-----

Note: % difference is relative to the adopted values.