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Contents

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Forest Land Valuation in Washington State Under the 1971 Forest Tax Law

B. Bruce Bare

B. Bruce Bare is a professor at the College of Forest Resources, University of Washington, Seattle.

One of the fundamental problems in the administration of the property tax on forest land is determining the true and fair value for land and timber. Historically, property tax assessments in Washington State have been characterized by outdated and inaccurate timber appraisals and a lack of uniformity among counties in appraisal practices (Conklin, 1980). Most county assessors had neither the time nor the expertise to keep up with the task of appraising nearly nine million acres of privately owned commercial forest land. Consequently, in 1971, the Washington State legislature attempted to bring greater uniformity and equity to the taxation of forest lands with the adoption of a yield (excise) tax for timber and a modified annual property tax for land. Responsibility for the administration of forest taxes was shifted from the counties to the State Department of Revenue.

The enactment of the 1971 Forest Tax Law improved the tax climate for forest land owners, but it did not resolve the controversy over valuations. Major controversies have centered on determinations of an equitable yield tax rate and the valuation of forest land. In the 12 years since the law was enacted, foresters, appraisers, economists, statisticians, educators, politicians, and finally lawyers and judges all have had a role in determining the value of forest land in Washington. Finally, in 1981, the legislature adopted a set of statutory land values in hopes of ending the dilemma.

The objectives of this article are to review the history surrounding the controversy over land values, to evaluate the procedures utilized in the valuation process, and to discuss the land values calculated using different procedures.

Statutory Requirements

The 1971 Forest Tax Law exempts private timber from the annual ad valorem property tax and imposes in its place a 6.5 percent yield tax on the stumpage value of timber when it is cut.[1] The tax is paid by the harvester and not the land owner. The land under the trees, however, is still subject to an annual ad valorem property tax, with valuations based on current use for timber production. Only those ownerships of 20 or more acres which are primarily devoted to the growing and harvesting of timber are eligible for forest land classification and current use valuation.

Land Valuation from 1972-1981

Before the adoption of statutory land values in 1981, the State Department of Revenue was charged with the responsibility of annually determining the true and fair value of bare forest land, and of certifying the values to the counties for use in assessment of all classified or designated forest land. The law further required the department to determine separate values for eastern and western Washington, and to recognize different productivity and access/topography grades within each region. The only function retained by county assessors was to identify and classify eligible ownerships and assign a land grade to each parcel. Prior to 1982, the department certified bare land values for three discrete productivity classes and four access/topography classes. However, following completion of a statewide forest land grading project authorized by the legislature in 1974, the department adopted a new grading scale consisting of eight land grades. In establishing statutory land values for 1982, the legislature adopted the new system of land grades.

Although the statutory requirements for land valuation appear straightforward, the department immediately ran into difficulties in implementing the 1971 law. First, the judicial interpretation of the phrase "true and fair value" in Washington is fair market value. For certain kinds of property for which adequate numbers of market sales do not exist, a cost or income approach to valuation can be used. However, the objective of the valuation process is always to determine fair market value. This legal framework created a unique valuation problem in that the department was required to develop a system for the statewide mass appraisal of forest land based on market evidence of value. In 1971, no other state had ever attempted to implement a market-based mass appraisal system for forest land. The fact that the department's values are applied in the taxation of over 6.3 million acres of land demanded

[1]In 1982, the legislature expanded the scope of the yield tax by making it applicable to public as well as privately harvested timber. The land tax, however, is still only applicable to private forest lands.

special attention to careful sale selection and objectivity in the valuation process.

Collecting Market Evidence

The first practical problem encountered in the land valuation process was related to the extreme scarcity of usable forest land sales. The vast majority of forest land sales are made with land uses other than forest production in mind. Consequently, a time-consuming and expensive sale-screening process was needed to ensure that the sales used in the analysis were purchased primarily for the purpose of growing and harvesting timber.

Secondly, very few of the sales finally selected as legitimate sales of forest land are truly bare land. Approximately 95 percent of the sales included immature and merchantable timber values in addition to the land itself. However, to obtain a sample of sufficient size to determine a meaningful average land value, the department chose to include in its data base sales including timber as well as land values. This led the department to find some way of segregating the value of land from the total purchase price. The analytical process used in separating bare land value from forest land sale prices eventually became the focal point of the land valuation controversy which developed between 1972 and 1981.

At the completion of the sale-screening process, relatively few valid forest land sales were retained. Thus, a third problem concerned the lack of sufficient/representative sales observed in any single assessment year. To increase the size of the data base, the department chose to retain sales evidence from the previous 4½ years, and to trend all sale prices to a common point in time. For example, the purchase prices of the 159 valid sales in western Washington (49,851 A.) were trended to 1975 during the determination of the January 1, 1977 assessed values.

The Abstraction Method

An analytical technique first employed by the department in 1972 to separate land and immature timber values was the abstraction system, originally developed during the early 1960s for estimating land values for the western Oregon forest ad valorem tax. This system provides a means of attempting to deduce bare land values from sales involving land and immature trees by solving a sequence of linear equations. The department adopted this method, but modified it to allow the judgment of the analyst to play a greater role than it did in Oregon.

Although there is no explicitly defined model for the abstraction process, the implicit theoretical model is summarized by equation 1:

$$NSP_i = \beta_1 BL_i + \beta_2 IMC_i + \beta_3 CREP_i + \beta_4 IMH_i + \beta_5 HREP_i + E_i$$

where:

NSP_i = Trended net sale price of i^{th} valid forest land sale.
BL_i = Number of acres of bare land on i^{th} sale.
IMC_i = Number of acres of immature conifer on i^{th} sale.
$CREP_i$ = Number of acres of conifer reproduction on i^{th} sale.
IMH_i = Number of acres of immature hardwood on i^{th} sale.
$HREP_i$ = Number of acres of hardwood reproduction on i^{th} sale.
E_i = Error or deviation between actual net sale price and expected net sale price.
β_1 = Per acre value of bare land.
β_2 = Per acre value of immature conifer (5-8 inches in diameter) and land.
β_3 = Per acre value of conifer reproduction (1-5 inches in diameter) and land.
β_4 = Per acre value of immature hardwood (5-8 inches in diameter) and land.
β_5 = Per acre value of hardwood reproduction (1-5 inches in diameter) and land.

Before applying equation 1, the estimated value of merchantable timber was deducted from the gross sale price, leaving a net sale price comprised of bare land and immature and reproduction timber values.

Each sale was also characterized by its site productivity, access, and topography. However, in abstraction, all sales were considered in the aggregate to determine an average bare land value. Ex post facto adjustments subsequently were made for the other grades of forest land.

The department used an iterative approach to estimating the β_i shown in equation 1. Iterations ceased when two conditions were satisfied: (a) the difference between the actual total net sale price of all properties and the predicted total net sale price of all properties was approximately equal to zero (i.e., $\Sigma NSP- (\beta_1 \Sigma BL + \beta_2 \Sigma IMC + \beta_3 \Sigma CREP + \beta_4 \Sigma IMH + \beta_5 \Sigma HREP) \cong 0$); and (b) the values estimated for bare land, reproduction, and immature timber bore a "reasonable" relationship to each other. This latter condition was interpreted to mean that land stocked with reproduction or immature timber should be valued higher than bare land. While this statement appears intuitively obvious, it is probably the exception rather than the rule in Washington and led to further complications in the land valuation process (Bare, 1978).

The abstraction process began by grouping together all sales within the same acreage class. A per-acre value was then calculated for those sale groupings which consisted of only one type of acreage (i.e., 100 percent bare land, 100 percent conifer reproduction, etc.). Initial per-acre value estimates were used to derive additional per-acre value estimates for each acreage type from more complex sale groupings (i.e., sale groupings consisting of two or more types of acreage). Suppose, for example, a per-acre value of conifer reproduction calculated from the conifer reproduction sale grouping was $250 and bare land was valued at $150. By substituting the $250 value for the value of conifer reproduction acreage in the sale grouping composed of both bare land and conifer reproduction acres, a second per-acre estimate of bare land was computed. In this way, each sale grouping was treated as a separate equation which, when solved in sequence with other equations, produced a range of value estimates for each acreage type. Some of the value estimates derived in this manner were negative; others were extremely high for the same type of acreage.

At this point, the analyst used subjective judgment to reject value estimates which appeared to be unreasonably high or low. Value estimates that passed the review were then combined to derive a new estimate of per-acre value for each acreage class. The whole process was then repeated using these selected value estimates until the two stopping conditions presented above were satisfied. Several iterations were normally required before the process was completed.

For several years, the abstraction analysis produced bare land values that were low enough to cause little concern among forest land owners. In 1975, however, analysts outside the department began to examine the abstraction process and found what they believed to be serious problems.

The Search for a Better Method

The sequential estimation process of abstraction has several major deficiencies that leave the process a meaningless exercise fraught with subjectivity. Bare and McKetta (1977) demonstrated that an infinite number of solutions to the abstraction equations will satisfy the first ("zero deviation") stopping criterion. Further, many of these solutions pass the test of "reasonable" value relationships. The analyst is therefore permitted to substitute preconceived notions concerning value without regard to market evidence when deriving final value estimates for each acreage type. While judgment has a place in valuation work, it is essential that an objective and unbiased procedure be utilized in any large-scale appraisal. A second deficiency of abstraction is that the sequential estimation process does not produce valid estimates. Instead, a procedure which estimates all value elements simultaneously is needed (Bare and McKetta, 1977). In 1975, a search for a better valuation method was initiated.

Multiple Regression Analysis

Multiple regression analysis was recommended as a possible land valuation method (Bare 1975, 1978). For regression, the same sales data and model (equation 1) used in abstraction were retained. However, using the principle of least-squares, regression analysis estimated each β_i in equation 1 simultaneously. Thus, unlike with abstraction, once the data are collected and the model is specified, the subjective opinions of the analyst do not influence the derivation of value estimates. Lastly, since least-squares minimizes the sum of squared deviations between actual and estimated sale prices, the previously discussed weakness of the "zero deviations" criterion is eliminated.

Although details of the regression analysis will not be reported here (see Bare, 1975, 1978, or Department of Revenue, 1976), it should be noted that the regression model contains no intercept term (i.e., regression is forced through the origin) and weighted least-squares are utilized to stabilize the unequal variation in net sale price over increasing sale size. The latter step is necessary to obtain the minimum variance linear unbiased estimate of bare land value. As with abstraction, all valid sales are considered in the aggregate with ex post facto adjustments made for site, access, and topography differences.

Bare land values for western Washington calculated using regression and abstraction are shown in table 1, for seven assessment years. A striking feature in table 1 is the significant difference shown between the abstraction and regression estimates for the 1975-77 assessment years. Several taxpayers objected to the use of regression analysis because of this large (positive) increase in assessed value. However, as also shown in table 1, beginning in 1978, the abstraction estimates of bare land value rose to the level of the regression-based estimates. Although possible explanations for this are discussed later, it is apparent that the high degree of subjectivity inherent in the abstraction method permitted a wide array of value estimates to be produced.

Also shown in table 1 are the actual bare land values adopted by the department (adjusted for average site, access, and topography). For the 1975-77 assessment years, the adopted value was based on the abstraction method. However, beginning in 1978, the adopted value was based on neither abstraction nor regression. Instead, a trending of the

TABLE 1

REGRESSION, ABSTRACTION AND ADOPTED ESTIMATES OF BARE LAND VALUE FOR WESTERN WASHINGTON

	1975	1976	1977	1978	1979	1980	1981
Abstraction[1]	77	83	76	148	164	133	162
Regression[1]	128	145	147	161	156	156	166
Adopted Value[2]	59	65	66	69	76	82	87

[1]Values unadjusted for the assumed average site, access, and topography in western Washington
[2]Values adjusted for average site, access, and topography

previous year's bare land value was used to obtain the value estimate for the year in question. This trending factor was derived by dividing the average NSP of all valid forest land sales for year X by the same statistic for year X-1. Converted to percent, this trending factor was multiplied by the bare land value estimate for year X-1 to obtain the value estimate for year X. The rationale for adopting this method in 1978 arose from a lawsuit in 1977, and will be examined later in this paper.

Much controversy followed the introduction of the multiple regression analysis in 1975. Consequently, the department appointed two technical subcommittees to study the two appraisal methods and recommend possible changes. The first subcommittee, made up of forest industry, county assessor, small land owner, academic and department representatives, recommended that the department continue to use abstraction until a better procedure was perfected. The committee believed that additional research on the use of the regression approach was needed. Not satisfied, the department appointed another technical subcommittee to extensively study abstraction and regression. Reporting in 1976, this second subcommittee recommended that both abstraction and regression be used in the bare land valuation process with primary emphasis placed on the older abstraction method (Department of Revenue, 1976). While the majority of the subcommittee favored regression over abstraction, a sincere attempt was made to reach a compromise solution. Forest industry representatives favored abstraction because it produced low bare land values and "reasonable" relationships between the different value classes. Other members of the subcommittee believed that use of abstraction should be discontinued.

The department accepted the second committee's conclusion and for the 1977 assessment year began using both valuation methods for the first time. As shown in table 1, regression produced a substantially larger bare land value estimate than did abstraction. The department concluded that the two estimates could be averaged together to obtain the 1977 assessed value. Applying a weight of 75 percent to abstraction and 25 percent to regression, a final average land value of $82/acre was derived.[2] Arguing that the method produced unreasonable value relationships resulting in an overestimate of the bare land value, forest land owners reacted swiftly with a lawsuit asking that the department discontinue any use of regression analysis.

Relationship Among Value Elements

One of the primary reasons cited by both the department's subcommittees for continuing the use of abstraction was that the regression

[2]Adjusted for the assumed average site quality, access, and topography in western Washington.

analysis did not produce "reasonable" value relationships. Forest industry representatives argued that illogical value relationships produced by the regression analysis occurred because too much of the net sale price was allocated to land and not enough to reproduction and immature timber values. It was further alleged that the progression in value from bare land to land stocked with trees was a valid test of the "reasonableness" of the bare land estimate itself. This section is a discussion of this aspect of the land valuation argument.

Table 2 shows the ratios of conifer tree value to bare land value, produced by abstraction and multiple regression for western Washington, unadjusted for the assumed average site quality, access, and topography for seven assessment years.

Generally, abstraction allocated a larger portion of net sale price to tree value than did regression. However, beginning in 1978, the abstraction-based ratios shrank to almost equal those based on regression. Thus, the allegation that regression assigns too much value to land cannot be substantiated with the abstraction-based estimates. Still, however, regression-based ratios are generally less than those produced by abstraction.

To further examine this critical issue, consider the series of value ratios shown in table 3. The first column of ratios (H/B) reveals the progression in value of a stand under intensive management throughout the entire rotation. This is a standard valuation ratio used to measure the relationship between tree and bare land values in situations where *current* and *future* stands are assumed identical at a common age. Also shown in table 3 is a set of ratios (h/B) of tree to bare land values in cases where the current stand is under- or overstocked relative to a stand of the same age managed under an intensive management strategy. It is further assumed that the current stand will be retained until it reaches financial maturity. Generally, one would not expect market sales

TABLE 2

RATIO OF TREE VALUE TO BARE LAND VALUE FOR WESTERN WASHINGTON[1]

Assessment Year	Value Ratio of Conifer Reproduction (5-10 yrs. old) to Bare Land: Abstraction	Regression	Value Ratio of Immature Conifer (15-25 yrs. old) to Bare Land: Abstraction	Regression
1975	1.74	0.50	3.12	1.12
1976	1.01	0.47	3.02	0.98
1977	1.71	0.49	3.38	0.63
1978	0.45	0.56	1.79	0.66
1979	0.75	0.67	1.51	1.02
1980	1.30	0.66	1.56	0.67
1981	0.41	0.30	1.47	0.66

[1]Unadjusted for assumed average site quality, access, and topography

evidence to support value ratios of the form (H/B) because many current stands of immature timber on transacted properties in western Washington were naturally regenerated and are not being managed under the intensive management regime forecast for future stands. Thus, the value ratios (H/B) shown in table 3 tend to overstate the ratios the forest land market produces.

TABLE 3

RATIO OF TREE VALUE TO BARE LAND VALUE USING AN INCOME MODEL, MEDIUM SITE QUALITY, ACCESS AND TOPOGRAPHY[1]

Tree Age	H/B[2]	h/B[3]
5	1.37	0.03
10	2.23	0.29
15	3.69	0.61
20	5.23	1.00
25	7.62	1.48

[1]Values derived from Larson (1977) for forest industry ownership

[2]Tree values (H) assume the current stand is being managed under an intensive management regime (planting, site preparation, spraying, fertilization, pre-commercial and commercial thinning) which is the optimal management regime for the site. The bare land value (B) is the bare land value under intensive management and is equal to $196/acre.

[3]Tree values (h) assume the current stand is extensively managed (planting, site preparation and spraying with no other silvicultural treatments), is under- or over-stocked in relation to an intensively managed stand of the same age and will be held to financial maturity.

For the 1975-77 assessment years, the abstraction-based value ratios (table 2) for conifer reproduction (5-10 years old) range from 1.0-1.7, while values for conifer immature (15-25 years old) range from 3.0-3.4. While lower than the H/B ratios shown in table 3, they agree more closely than do the regression-based value ratios shown in table 2. However, the regression-based value ratios shown in table 2 generally parallel the h/B ratios (table 3) more closely than do those obtained by abstraction.

Thus, it appears that the abstraction-based ratios were derived using an assumption that H/B value ratios should prevail in the market, while the regression-based ratios more closely emulated the type of value relationship actually occurring in the market.

Information presented to the two department subcommittees confirmed that the logic underlying the derivation of value relationships using abstraction paralleled the logic embodied in the development of the H/B ratios. Thus, the consistent results shown in tables _ and 3 conform to prior expectations. Of critical importance, however, is that this logic is inappropriate unless future timber management practices are expected to be identical to those currently applied. This seems highly unlikely given the rapid advances in intensive management practices in western Washington over the past 20 years. Furthermore, because most forest land properties transacted in western Washington involve stands established and managed differently than future stands to be grown on the property, it is much more likely to expect h/B value ratios to be observed in the market place. Thus, contrary to the arguments put forth by critics of regression, it is more likely that regression, and not abstraction, correctly read the market and allocated the appropriate portion of the net sale price to bare land.

Court Case

The above discussion and rationale notwithstanding, a group of six forest land owners and one western Washington county initiated a lawsuit in 1977 asking the court to declare the 1977 assessed land values invalid. Both sets of petitioners claimed that the department had erred by averaging the regression- and abstraction-based bare land values. The land owner petitioners argued that the regression analysis was erroneous and improper and should not be used by the department; the county petitioner argued that abstraction was the erroneous method and should not be used to value forest land. The department defended its position on the grounds that an averaging of two disparate values was the only reasonable course of action to pursue, especially after months of intensive review of each method by the aforementioned subcommittees.

After a six-week trial, the court ruled that the department had erred in averaging the abstraction and regression values, and declared the 1977 bare land values invalid. The court further remanded the matter to the department in order that it might correctly perform its statutory duty. The court did not rule specifically on the merits either of abstraction or regression, although it was noted that abstraction values in eastern Washington were largely unchallenged by any party in the case.

Having supported both land valuation methods during the trial, the department faced a dilemma. Following intense negotiations with attorneys for the petitioners, the department decided to drop the regression estimate of land value for 1977 and rely solely on abstraction. Although the county petitioner vigorously objected, the court ruled in favor of the department and the 1977 forest land value was established.

Beginning with the 1978 assessment year, the department rejected the use of abstraction and resorted to a method involving the simple trending of past land values to obtain current assessed values. As previously discussed, this method is extremely easy to implement once the data base of valid forest land sales is constructed. Unfortunately, the simple trending can produce erroneous results if: (a) the base value being trended is incorrect, (b) a shift occurs in the relative value of the acreage types, or (c) other factors influencing the forest land market (i.e., mortgage rates, product prices, etc.) change relative to one another. The county petitioner asked the court to declare the 1978 land values invalid. However, the court ultimately accepted the department's bare land value, and the department continued to use the trending procedure to set the 1979-81 forest land values. As previously shown in table 1, this has resulted in a substantial under-valuation of forest land vis-a-vis the abstraction- or regression-based estimates.

Perhaps the most significant impact of the land valuation dispute has been the substitution of political expediency for sound technical analysis in valuing forest land in Washington State. Although forest land values have been kept arbitrarily low by this process, it is difficult to see how equity is best served across differing forms of taxable property in the long run.

Statutory Land Values for 1982

Reacting to the department's request, the legislature adopted a set of statutory land values for use in the 1982 assessment year. These values were initially set equal to the 1981 bare land values but were subsequently updated for use in 1982. Under the current law, the bare land values are to be updated annually. The procedure is to change the bare land value by one-half the percentage change in a five-year moving average stumpage value. This procedure will systematically underestimate land values in a rising stumpage market, and overestimate the same in a falling stumpage market.

Other Land Valuation Methods

Although abstraction and regression received extensive review as land valuation procedures during the court case, other methods have also been suggested for use in Washington State. Although space limitations preclude an extensive review, several of these proposals are discussed in the following paragraphs.

Rickard (1976) proposed a "relative market value" method to derive bare land forest values using a combined income/market sales approach. An income approach was used to calculate a series of value ratios to establish the relationship between the value of bare land and the value of land stocked with reproduction and immature trees. Then, these value ratios were subsequently forced onto market sales evidence to derive bare land values.

As in any income approach, a series of assumptions were made concerning the incomes and costs associated with all future timber crops to be grown on a given acre of land. Using a fixed interest rate and an assumed level of management intensity, a bare land value (B) and a series of tree values (H) were calculated over the life of the stand. A series of value ratios (1 + H/B) were then computed for each site class. These ratios are identical to those shown in table 3 (column 2) except for the constant one (1) which is added to each ratio. These income ratios are applied to sales evidence to derive an estimate of bare land value. An example of this calculation is shown in table 4, where a sale involving 78 acres of conifer reproduction, immature, and bare land selling for $10,000 is represented. Using relative value ratios shown in table 3 (column 2), the value of acreage covered by immature trees is converted to its bare land value equivalent. The sum of these bare land equivalents — when divided into the net sale price — yields an estimate of bare land value for the sale.

TABLE 4

ILLUSTRATION OF RELATIVE MARKET VALUE FOR ESTIMATING BARE LAND VALUES

Sale No. 1

Net Sale Price = $10,000 for 78 acres (land, reproduction and immature conifer) of medium site quality, access, and topography.

Tree Age	Acres	Value Ratio 1 + H/B[1]	Bare Land Equivalents	Value Ratio 1 + h/B[2]	Bare Land Equivalents
Bare Land	6	1.00	6.00	1.00	6.00
5	12	2.37	28.44	1.03	12.36
10	15	3.23	48.45	1.29	19.35
20	27	6.23	168.21	2.00	54.00
25	18	8.62	155.16	2.48	44.64
Total	78		406.26		136.35
Bare Land Value Estimate			$10,000/406.26 = $24.61		$10,000/136.35 = $73.34

[1]From table 3 (column 2)
[2]From table 3 (column 3)

This process is repeated for all sales in the transaction data base, and an average bare land value for all sales is computed. Although procedures for estimating this average bare land value are not presented by Rickard (1976), this extremely important portion of the analysis could require substantial analysis.

The major alleged strengths of the relative market value method are the insensitivity of the value ratios under a range of input assumptions, and the forcing of value relationships on market sales data (i.e., forcing land with immature trees always to be worth more than bare land).

The critical element of the relative market value method involves the calculation of the value ratios; if these are incorrectly calculated, the resulting derivation of bare land value is meaningless. Evidence to date suggests that this is the case, since Rickard (1976) fails to properly distinguish between the current stand occupying a site, and future stands of immature trees which may occupy the site. This leads to an over-estimate of the value ratios and a subsequent under-valuation of bare land. For example, suppose a current immature stand is not being managed under the same management strategy assumed in the calculation of the value ratios (1 + H/B). Since the ratios apply to all future stands, they can not be applied to the current stand under the above conditions. Instead, a set of modified ratios such as those shown in table 3 (column 3) are required. These latter ratios recognize that the portion of the net sale price to be allocated to immature tree values must reflect the value of the current trees—not just those to be grown in the future.

To demonstrate the pervasiveness of this conceptual error, reconsider table 4 (columns 5 and 6). Using value ratios taken from table 3 (column 3), the value of the acreage devoted to the current crop of immature trees is converted to its equivalent value in terms of bare land. Because the current trees are worth less than the value of subsequent trees of the same age, the revised value ratios (1 + h/B) are much lower. Consequently, the derived bare land value estimate is greater than the estimate produced by Rickard's value ratio.

Another weakness of Rickard's (1976) method is that no objective method has been proposed for determining an average bare land value once each sale has been subjected to his analysis. This is a serious deficiency for Washington, where the mass appraisal of forest land and not the fee appraisal of an individual parcel is being conducted.

Dowdle (1978) proposed the following "economic model" to estimate bare forest land value (equation 2):

$$ANSP_i = \beta_1 [BL_i + IMC_i e^{it_1} + CREP_i e^{it_2} + IMH_i + HREP_i] + E_i,$$

where $ANSP_i$ = Adjusted net sale price of i^{th} valid forest land sale = $NSP_i - \$50 (IMH_i)$; where e^{it_1}, e^{it_2} =interest factors, to continuously compound the value of immature and reproduction conifer values to ages t_1 and t_2, respectively, using interest rate i; and where all other terms are as defined in equation 1.

The Dowdle proposal is based on the premise that the value of land plus the maturing timber asset can be represented as $\beta_j = \beta_1 e^{it}$, where β_1 is the value of bare land plus regeneration costs, and β_j is the value of land and regeneration t years later compounded at i percent interest. By setting $\beta_2 = \beta_1 e^{it_1}$; $\beta_3 = \beta_1 e^{it_2}$; $\beta_4 = \beta_1 + \$50$; and $\beta_5 = \beta_1$, equation 1 is transformed into equation 2.

Rickard's (1976) relative market value and Dowdle's (1978) economic models are very similar in that they both attempt to force a series of value ratios, obtained through the logic of an income model, onto a collection of market transactions. The additional strength of the Dowdle model is that it uses regression to estimate an average bare land value for all sales considered simultaneously — something Richard fails to adequately consider.

The major conceptual error found in the Dowdle model is very similar to the flaw of the Rickard approach. Dowdle assumes that one can derive an estimate of bare land value by simply computing the present value of a market transaction price involving both land and immature timber values. This will result in a meaningful bare land estimate *if and only if* all participants in the forest land market are in agreement that the *current* immature timber stands are identical in all respects to the *future* stands of timber (of the same age) to be grown on the acres in question. If this condition does not hold, Dowdle's model will produce erroneous results. A simple example will clarify Dowdle's oversight. Suppose one acre of a 15-year-old, poorly stocked, naturally regenerated Douglas fir forest sells for $150. Using Dowdle's logic, we attempt to deduce the bare land value as $\beta_1 = \beta_3 / e^{it_2}$.

For i = 6 percent; t_2 = 15 years; and β_3 = $150/acre, the bare land value is calculated to be β_1 = $60.99/acre. This is a valid estimate if the buyer intends to manage the acre such that all future 15-year-old stands are identical to the poorly stocked stand presently occupying the acre. In this case, the "true" bare land value is $60.99/acre and the value of the 15-year-old reproduction is $89.01/acre, yielding a combined total forest value of $150/acre.

However, suppose the buyer intends to practice intensive management in the future, with an attendant bare land value of $250/acre. Further assume that because of the poorly stocked condition of the acre, the buyer intends to clear the acre immediately and initiate an intensive management strategy. If the clearing cost is $100/acre, the buyer will still bid $150 for the acre (i.e., Forest value (W) = Bare land value (B) + Tree value (h), where the tree value equals –$100/acre in this case). Nevertheless, using Dowdle's model, the value of bare land is still estimated as $60.99/acre. This is computed by discounting the observed forest value by e^{it_2}, as previously shown. This is clearly incorrect, as bare land is actually valued at $250/acre. Thus, if *current* and *future* crops are not identical, Dowdle's model will underestimate bare land values. Since current and future crops in Washington are, in most cases, expected to be significantly different, Dowdle's model does not accurately estimate the value of bare forest land.

Another variation of an income/market sales approach is attributed to Klemperer (1979, 1981). The main distinctions between his model and those of Rickard and Dowdle are: (a) the interest rate used in the income phase of the analysis is not specified, but is determined as part of the analysis of sales evidence, and (b) land values for different site qualities are estimated. Given an assumed management regime with its associated cost and revenue stream, Klemperer solves for the rate of interest that equates the net present value of the assumed investment with the net sale price of the land plus immature trees. This interest rate is then used to determine a bare land value (B) for each site class present in a particular sale. The assumed management premise used in calculating the rate of interest is also used in calculating the bare land values. A weighted average, by site class, over all sales in the data base yields an estimate of bare land value. Lastly, a smooth curve is fit to finalize the relationship of bare land value over site class.

The primary advantage of Klemperer's model over the Rickard and Dowdle approaches is that an interest rate is not specified a priori. However, this is of little significance because the model still possesses all of the disadvantages of the other two models. Clearly, the management intensity assumptions apply to *current* as well as *future* stands and lead to the same conceptual flaws identified earlier for the Rickard and Dowdle models. Thus, the final bare land value estimates of the Klemperer model can bear little relationship to the true unknown bare land value.

Both Rickard's and Dowdle's methods were introduced during the land value court dispute in 1978. However, the department has not used either method in estimating forest land value. To date, Klemperer's model has not had any use in Washington, but some use has been made of it in Oregon. As discussed above, Rickard's method can easily be corrected by incorporating appropriate sets of value ratios. To date, these corrections have not been assimilated into his method. Presently, it appears that a promising land valuation technique worth pursuing in more detail is based on a regression approach. Some potential improvements that need to be considered in making this a useful appraisal technique are next discussed.

Improvements to the Regression Model

During the court proceedings concerning the 1977 assessed values, several major criticisms were leveled at the regression model used in the trial. These can be categorized as: (1) data problems with market sales, (2) model specification errors, and (3) poor goodness-of-fit statistics. Data problems with market sales, a criticism which can be leveled at any market-based valuation method, concern the selection of valid forest land sales. Any sale which contains an element of speculation, is not an arms-length transaction, or implies a land use other than timber production, should be excluded. If such sales are included in the data base, they can distort the estimates of value. In the court proceedings, both abstraction and regression analyses were performed using the same data base. Thus, a deficiency in the sales base applies to both valuation procedures. However, such deficiencies are probably of less concern if abstraction is used because the appraiser can interject judgments to counter the influence of a "weak" sale.

The concern over model specification is a legitimate and important aspect of the valuation process. Certainly, if a model is mis-specified, the results of the analysis are questionable. The model specified in equation 1 — used in both abstraction and regression — can be modified in several ways to improve its utility. The first improvement is to directly incorporate site quality, access, and topography into the regression model. Theoretically, this is a more representative way to adjust for the influence of these factors on bare land value than the ex post facto approach used to date. Equation 1 can be altered to read as follows:

$$NSP_i = \beta_1 f(S,A,T)\, TA_i + \beta_2' IMC_i + \beta_3' CREP_i + \beta_4' IMH_i + \beta_5' HREP_i + E_i$$

where:

f(S,A,T) = The relationship of value (or volume) across different site, access, and topography classes.

TA_i = Total number of forest land acres on i^{th} sale.

β_1 =Per-acre value of bare land per unit of site quality, access, and topography.

β_2' β_3' β_4' β_5' = Per-acre values of reproduction and immature timber classes as defined in equation 1, *exclusive* of land value.

During the court proceedings, time permitted only a limited number of functions (f(S,A,T)) to be explored. However, Bare and Hann (1980) have extended this improvement on the model by introducing more realistic site-quality relationships.

Of critical importance is the fact that none of site quality, access, or topography is considered a value element in this last equation. Instead of being assigned a portion of the net sale price, these latter variables only influence the allocation across the value elements. For this reason, the three variables are incorporated in this equation as multiplicative and not additive terms. To incorporate these variables as additive terms would result in a mis-specified model because a portion of the net sale price would conceptually be allocated to a site, access, or topography variable.

Another aspect of the model specification criticism concerns the lack of control over the value relationships produced by the analysis. Dowdle (1978) has suggested a constrained regression model where certain value relationships are forced on the market data. If correctly done, this might strengthen the model. However, if the wrong constraints are selected, the regression model will again be mis-specified.

During the court proceedings, it was alleged that the regression model was mis-specified because additional independent variables could have been added to the model with a subsequent increase in the model's predictive capability. This criticism is not appropriate for several reasons. First, the objective of the model depicted in equation 1 was not for purposes of prediction. Rather, it was a descriptive (structural) model constructed for purposes of describing the partitioning of value across known acreage classes (i.e., value elements) present in a sale. In such a model, the primary objective is to select as few variables as possible which explain the largest amount of variation (Chatterjee and Price, 1977). Second, any variables added to equation 1 must also represent value elements or the model will again be mis-specified. Lastly, if measured by R^2, a model's predictive capability can always be increased by adding additional variables. However, this can easily produce a mis-specified model.

Concerns over the goodness of fit of the regression model involved two issues. The first was the use and interpretation of R^2 — a commonly used goodness-of-fit statistic — when: (1) regression is forced through the origin (i.e., no intercept term) and (2) the regression is weighted to correct for unequal variation in the dependent variable. The model shown in equation 1 can be rewritten to include an intercept term because the sum of the acreage types present in any sale equals the total acres of the sale. Thus, $BL_i = TA_i - (IMC_i + CREP_i + IMH_i + HREP_i)$.

By substituting the above expression for BL_i into equation 1, we obtain: $NSP_i = \beta_1 TA_i - \beta_1 (IMC_i + CREP_i + IMH_i + HREP_i) + \beta_2 IMC_i + \beta_3 CREP_i + \beta_4 IMH_i + \beta_5 HREP_i) + E_i$. Upon reduction, this yields:

$NSP_i = \beta_1 TA_i + \beta'_2 IMC_i + \beta'_3 CREP_i + \beta'_4 IMH_i + \beta'_5 HREP_i + E_i (4)$, where $\beta'_j = (\beta_j - \beta_1)$ for j = 2,3,4,5, and β_j is the per-acre value of reproduction and immature timber for the classes defined in equation 1, exclusive of land value.

To complete the transformation of equation 1 into its revised form, it was next observed that the variation in NSP_i was approximately proportional to the square of sale size (i.e., total area). Thus, transforming equation 4 by dividing through by TA_i yields the model shown below:

$$\frac{NSP_i}{TA_i} = \beta_1 + \beta'_2 \frac{IMC_i}{TA_i} + \beta'_3 \frac{CREP_i}{TA_i} + \beta'_4 \frac{IMH_i}{TA_i} + \beta'_5 \frac{HREP}{TA_i} + E_i \qquad (5)$$

This form of equation 1 was introduced during the court proceedings by representatives of forest industry.

Because equation 5 bears a direct relationship to equation 1, we would expect the estimates of the β_i for either equation to be directly comparable. This, in fact, is true for the two equations. However, the goodness-of-fit statistics, as measured by R^2, for the two equations are not equivalent and must be interpreted differently. To sort this out, we first observe that equation 1 is the "true" model form, which for purposes of this discussion is assumed to be correctly specified. No intercept term is included because the theory underlying equation 1 seeks to allocate the net sale price for each sale to its constituent value elements. To allocate a portion of the net sale price to a constant term is inconsistent with this theory. Secondly, a weighted least-squares analysis procedure was used to estimate the coefficients in equation 1. In this analysis, the dependent variable is net sale price and the goodness-of-fit statistic measures the fit for this variable. An R^2 statistic calculated for such an analysis includes the effect due to the average net sale price but is entirely appropriate: no constant term is included in equation 1.

In transforming equation 1 into equation 5, the dependent variable is redefined to be net sale price/acre and a constant term is incorporated. Accordingly, the R^2 calculated for equation 5 bears no direct relationship to the R^2 for equation 1. First, with a different dependent variable, the two R^2's are not comparable. Second, the R^2 associated with equation 5 is calculated after allowing for the constant (intercept) term. It is apparent that the goodness-of-fit statistics for equations 1 and 5 are not comparable. Furthermore, the only R^2 value that is of concern is the one associated with equation 1 and not equation 5. Equation 5 was only developed to produce comparable estimates of the β_i, but the corresponding goodness-of-fit statistics bear no relation to the original "true" model depicted in equation 1.

Another refinement to equation 1 introduced by Bare and Hann (1980) was to change the dependent variable from net sale price to gross sale price and to add an independent variable representing thousands of board feet of merchantable timber. The introduction of this latter term obviates the need to estimate this value prior to the regression analysis and thus improves the objectivity of the appraisal process.

Concluding Remarks

The objectives of this paper were to discuss: (1) the history of forest land valuation in Washington State, (2) the procedures used to derive the values, and (3) the values themselves. Having completed the discussion attendant to the first two objectives, attention now focuses on the value estimates themselves.

Referring again to table 1, it is readily apparent that the bare forest land values adopted by the department are substantially below estimates produced by the multiple regression approach. Similar results for a different set of forest land sales occurring in western Oregon show a bare land value of $166/acre for the average site (Bare and Hann, 1980). The apparent conclusion is that the adopted bare land values are approximately one-half what the regression analysis indicates they should be. Also, the abstraction method provides a similar estimate of value from 1978 to 1981. Interestingly, in 1978, the department discontinued used of the abstraction method, upon which it had primarily relied between 1972 and 1977. Thus, both regression and abstraction show that the adopted bare land values from 1978 to 1981 underestimate the "true and fair" value of bare forest land in western Washington.

Beginning in the 1982 assessment year, the state began using a set of statutory bare land values. These values continue the underassessment instituted throughout the 1970s. However, the term "true and fair" value is no longer associated with the land values, perhaps inferring that the legislature fully recognized the extent of underassessment they were perpetuating.

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