

ASSESSORS JOURNAL

A QUARTERLY JOURNAL
DEVOTED TO STUDIES IN PROPERTY TAXATION
AND ASSESSMENT ADMINISTRATION

Volume 13 • Number 2 • June 1978

B. BRUCE BARE

Contents

- 63 Valuation of Partial Interests—*Morgan B. Gilreath, Jr.*
- 81 Forest-Land Valuation in Washington State: Controversy over Methodology—*B. Bruce Bare*
- 101 Equity Yield Calculation: Ellwood, Newton, or Iteration?—*Ralph Alberstrom and Arnold Tchira*
- 113 Political Implications of Public Opinion on Religious Property Tax Exemptions—*D. A. Gilbert and Paul J. Weber*

The International Association of Assessing Officers is an association of public officials engaged in the assessment of property for taxation. The Association's purposes are to improve the standards of assessment practice; to educate the taxpaying public on the true nature and importance of the work performed by assessing officers; to engage in research and publish the results of studies; to elevate the standards of personnel requirements in assessment offices; to cooperate with other public and private agencies interested in improving tax administration; and in every proper way to promote justice and equity in the distribution of the tax burden. In sponsoring the *Assessors Journal*, the International Association of Assessing Officers seeks to provide a forum for the examination of significant issues in property taxation and assessment administration.



INTERNATIONAL ASSOCIATION OF ASSESSING OFFICERS
1313 EAST SIXTIETH STREET, CHICAGO, ILLINOIS 60637

Forest-Land Valuation in Washington State: Controversy over Methodology

B. Bruce Bare

B. Bruce Bare is associate professor of forest management in the College of Forest Resources, University of Washington, Seattle, Washington.

Introduction

In 1971 the forest property tax laws in Washington State were revised. Almost all privately owned standing timber became exempt from further taxation under the general property tax. In place of the locally administered ad valorem tax on timber, a state-administered yield (excise) tax of $6\frac{1}{2}$ percent of the harvest value was initiated. This tax is paid by the harvester of standing timber at the time of harvest and not by the landowner.

Eligible forest land remains subject to the annual ad valorem tax based solely on the value of the bare land. This value is based on "current forest use" and not on "highest and best use." To qualify for this preferential treatment, the land must be dedicated to the growing and harvesting of timber. The Washington State Department of Revenue (DOR) is responsible for the annual determination of the true and fair value of each grade of bare forest land. Three site classes and four access-topography classes are used to grade forest land for this purpose.

In 1972 the DOR began using the abstraction method for the appraisal of bare forest land in Washington State. This method relies on actual market sales evidence involving comparable forested parcels but produces bare-land value estimates that are heavily influenced by the subjective opinion of the land appraiser. Multiple regression analysis (MRA) has been recommended as a superior alternative to abstraction for forest-land valuation in Washington State. In 1977 the DOR began using MRA as an indicator of bare forest land value; however, many forest owners objected

Presented to the Forty-third International Conference on Assessment Administration, September 21, 1977, Portland, Oregon. Work reported in this article was funded by McIntire-Stennis Cooperative Forestry Research Grant, Project 34.

to this. As a result legal proceedings have been initiated in an effort to force the DOR to discontinue use of MRA for forest-land appraisal.

In this paper my principal objectives are (a) to review briefly the abstraction and MRA procedures as used in Washington to derive estimates of the true and fair value of bare forest land; (b) to compare these market-based estimates with those obtained using an income approach; and (c) to discuss the relationship between bare land and timber-stand values for trees of various ages. This latter objective is extremely important because it has been alleged that MRA produces "illogical" relationships between the value of bare land and that of land stocked with trees.

Collecting Market Evidence

The DOR screens every sale of real property in Washington State, searching out all valid forest-land sales that can be used to estimate the average value of bare forest land. Any sale that exhibits a potential higher use other than timber production, or that cannot be verified as a bona fide arm's-length transaction, is not retained as a valid forest land sale. Approximately 95 percent of the sales retained include merchantable and immature timber values in addition to the land itself. Thus timber value as well as bare-land value is usually included in the transaction price observed in the marketplace. The estimated value of the merchantable timber is deducted from the gross sale price, leaving a net sale price. This residual value reflects the combined value of both land and immature timber.

For each valid sale the acres of immature timber are classified as either conifer or hardwood and reproduction (1-5 inches in diameter) or immature (5-8 inches in diameter). Each sale is further classified according to a combination of site quality, access, and topography.

At the completion of the data collection and validation process, relatively few sales are retained. For instance, in western Washington during the last four years, about 30 valid sales involving approximately 35,000 acres have been retained annually. This represents a sample of less than one-half of 1 percent of the total private timber lands in western Washington. Because of this lack of sales evidence, the DOR retains the most recent four and one-half years of sales evidence for use in determining forest-land values. To accommodate a changing land market, the net sale price of each transaction is trended to bring each sale to a common point in time. Thus the 84 valid sales (19,159 acres) used to determine bare forest land values in western Washington for the 1975 assessment year were trended to 1973. For the 1976 assessment year the 117 valid sales (37,965 acres) were trended to 1974. For 1977, 159 sales involving 49,851 acres were similarly trended to 1975. Another consequence of the dearth of sales evidence is that it is not possible to estimate land values directly for each grade of forest land.

Therefore, all sales are considered in the aggregate, and the value of an average acre of bare land is determined. Ex post facto adjustments are subsequently made for other grades of forest land.

Land-Value Estimation by Way of Abstraction

Abstraction is a method used by the DOR to identify separately the value of immature timber and bare land using market sales evidence that values their combined total. It is similar to determining the price of each item in a grocery basket when only the total sale price and the number of like items in the basket are known. In the case of forest-land valuation, the net sale price is known, as is the number of acres of immature timber classified by species group and size class. Abstraction seeks to derive the best estimate of these value elements based upon the available sales evidence. In short, abstraction seeks to identify the value of each component part of the sales bundle and not the value of the bundle as a whole.

The theoretical model underlying abstraction is summarized by the following equation:

$$y_i = \theta_1 x_{i1} + \theta_2 x_{i2} + \theta_3 x_{i3} + \theta_4 x_{i4} + \epsilon_i, \quad (1)$$

where

- y_i = Trended net sale price of i th valid forest-land sale;
- x_{i1} = Number of acres of bare land in i th sale;
- x_{i2} = Number of acres of conifer reproduction and land in i th sale;
- x_{i3} = Number of acres of immature conifer and land in i th sale;
- x_{i4} = Number of acres of hardwood reproduction, immature, and land in i th sale;
- θ_1 = Per acre dollar value of bare land;
- θ_2 = Per acre dollar value of conifer reproduction and land;
- θ_3 = Per acre dollar value of immature conifer and land;
- θ_4 = Per acre dollar value of hardwood reproduction, immature, and land;
- ϵ_i = Error or deviation between *actual* net sale price and *expected* net sale price; and
- i = Index referring to a particular sale, with $i = 1, 2, \dots n$.

The abstraction process seeks to estimate the θ_j 's in equation (1) by sequentially estimating each θ_j until the following two conditions are satisfied: (a) the difference between the actual total net sale price of all sales and the estimated total net sale price (obtained by substituting the estimated θ_j 's into eq. [1]) is approximately equal to zero, and (b) the estimated bare-land value and estimated reproduction and immature values bear a "reasonable" relationship to each other. In abstraction, to be reasonable the estimated value of land plus reproduction or immature timber must be greater than the estimated bare-land value by some specified multiple. This multiple either is derived from the personal

experience of the land appraiser or is based on some form of an income calculation.

Full details of the actual order of calculations involved in abstraction will not be reviewed in this paper. Interested readers are referred to an earlier paper by Bare and McKetta (2) for additional details. Briefly, however, the abstraction process is initiated by calculating an average for each group of sales involving only one value element. For example, all sales involving only bare land are considered first. In the 1977 assessment-year analysis, 2,865 acres of bare land in western Washington commanded a total sale price of \$493,426 (trended to 1975). The average value of bare land is then computed as \$172.23 per acre. Similarly, the average value of conifer reproduction and land in 1977 was \$261.84 per acre. These estimates are then substituted into other groups of sales that involve one of these value elements plus one other element. For instance, 12,173 acres with a total net sale price of \$1,414,774 involved both bare land (5,525 acres) and conifer reproduction plus land (6,648 acres). To obtain a second estimate of bare-land value, the land appraiser multiplies his previous per acre value estimate of conifer reproduction plus land (i.e., \$261.84 per acre) by the 6,648 acres of conifer reproduction, subtracts the resulting product from the total observed sale price of \$1,414,774, and divides by 5,525 acres, obtaining a second bare-land value estimate of -\$58.99 per acre. In a like fashion a second estimate of the value of conifer reproduction plus land is computed as \$69.68 per acre. This process of sequential substitution is then continued through all the remaining groups of sales, resulting in a range of estimates for each value element. At this point the land appraiser exercises his judgment in deciding which estimate of each value element to retain. To guide his decision, he follows the two general guidelines previously presented. The whole process is then repeated using the appraiser's selected value estimates until a set of satisfactory values are obtained.

One of the most serious deficiencies of the abstraction process concerns the use of the criterion of zero deviations between the sum of the actual and estimated net sales prices. Bare and McKetta (2) have shown that an infinite number of combinations of value estimates exist that will satisfy this criterion. Furthermore, a large number of these combinations of value estimates will also pass the test of "reasonableness." Thus, in actual practice, the two guidelines used in abstraction are virtually meaningless to the land appraiser, since they provide him with very little guidance in making his value judgments.

The second serious deficiency of abstraction is that the process sequentially estimates each value element, when in fact the problem calls for a procedure that estimates all value elements simultaneously. Compounding this, the land appraiser intervenes during the sequential estimation process and interjects his personal perceptions of value. This permits the appraiser to substitute his preconceived notion concerning value

without regard to market evidence. While judgment will always play a significant role in property appraisal, extra caution must be exercised in a mass appraisal, where it is crucial that an objective, systematic, and unbiased estimation procedure be employed. In fact, in any mass appraisal this should be a paramount concern. Unfortunately, in abstraction the subjective personal opinion of the appraiser can replace valid sales evidence as the basis of the process.

Land-Value Estimation by Way of Multiple Regression

In light of the deficiencies associated with abstraction, an alternative estimation procedure that provides unbiased estimates and that utilizes the same sales evidence collected by the DOR is clearly needed. Multiple regression analysis fulfills these two requirements. Further, it is a tool that has been accepted by the appraisal profession (3) and is particularly adapted to income-producing properties (7).

The same market sales evidence and model (i.e., eq. [1]) used in abstraction were also retained for use in the MRA. Whereas abstraction relies on a subjective sequential procedure for estimating the θ_j 's in equation (1), MRA uses the principle of least-squares analysis, where all θ_j 's are estimated simultaneously. Given that the model is correctly specified, MRA simultaneously estimates all θ_j 's and produces results that are statistically unbiased. When MRA was applied to the western Washington sales data for the 1975 and 1976 assessment years, it was found that variance of the error terms (i.e., the ϵ_i 's in eq. [1]) increased with increasing parcel size. This indicated that weighted least-squares regression analysis was required if the best linear unbiased estimates of value were desired. As discussed by Bare (1), a weight equal to the squared inverse of parcel size produced the desired homogeneous variance. Under the stated assumptions, weighted least-squares regression produces the best (i.e., minimum-variance) linear unbiased estimate of the θ_j 's. This model was used to analyze the 1975-77 western Washington sales evidence. While the estimate of θ_1 is of prime concern, the other θ_j 's are also important because they provide a check on the "reasonableness" of the regression results.

The results of the MRA for the 1975-77 assessment years in western Washington are shown in table 1. Results of the abstraction process are shown in table 2. Statistical properties of the regression estimates will not be discussed in this paper, but interested readers may consult Bare and McKetta (2) and the Department of Revenue technical subcommittee report *Use of Multiple Regression Analysis in Forest Land Valuation* (10). In brief the regression coefficients and the model itself (i.e., eq. [1]) exhibited no unusual statistical characteristics. The standard error of the regression coefficient representing bare-land value ranged from 10 to 13 percent when expressed as a percentage of the coefficient. The overall

goodness of fit of the model as expressed by R_2 (uncorrected for the mean) ranged between 0.76 and 0.83. Further, multicollinearity and interaction were not found to be problems. Therefore, the regression coefficients can be safely interpreted as per acre values.

As previously stated, all valid forest-land sales, regardless of land grade, are treated in the aggregate in both the abstraction and the regression analysis. Therefore, results reported in tables 1 and 2 are for the average acre of forest land represented by the western Washington forest-land sales data. Before applying the results of either abstraction or regression to all forest lands in western Washington, an adjustment from the average land grade in the data base to the assumed average land grade in western Washington must be made. Only the value estimates of bare land are

TABLE 1
REGRESSION ESTIMATES OF EACH VALUE ELEMENT
FOR WESTERN WASHINGTON

VALUE ELEMENT	ASSESSMENT YEAR		
	1975 (n=84) (\$/acre)	1976 (n=117) (\$/acre)	1977 (n=159) (\$/acre)*
θ_1 †	128.17	144.93	147.17
θ_2 ‡	191.80	212.36	219.84
θ_3 §	271.44	287.05	240.28
θ_4	188.88	190.30	216.49#

* Estimates for 1977 utilize untreated sales data.

† Per acre value of bare land.

‡ Per acre value of conifer reproduction and land.

§ Per acre value of conifer immature and land.

|| Per acre value of hardwood reproduction, immature, and land.

Weighted average of \$204.98 per acre for hardwood reproduction and land and \$218.47 per acre for hardwood immature and land.

TABLE 2
ABSTRACTION ESTIMATES OF EACH VALUE ELEMENT
FOR WESTERN WASHINGTON

VALUE ELEMENT	ASSESSMENT YEAR		
	1975 (\$/acre)	1976 (\$/acre)	1977 (\$/acre)
θ_1 *	77	83	76
θ_2 .	211	167	206
θ_3 .	317	334	333
θ_4 .	161	244†	276‡

* See table 1 for definition of each θ .

† Weighted average of \$138 per acre for hardwood reproduction and land and \$261 per acre for hardwood immature and land.

‡ Weighted average of \$291 per acre for hardwood reproduction and \$291 per acre for hardwood immature.

adjusted. For all three years the sales were determined to have above-average site, access, and topography as compared with the assumed overall average. Therefore, downward adjustments in the value estimates were required. A comparison of the adjusted abstraction and regression results is shown in table 3. As illustrated, abstraction undervalued forest land in western Washington when compared with MRA during all three years.

In 1977 the DOR began to use MRA for estimating the value of bare forest land. For prior years, only abstraction was used. As shown in table 3, the western Washington bare-land value estimates produced by abstraction and MRA differ markedly. When such a discrepancy is encountered, the common procedure is to reexamine the underlying philosophy and procedures embodied in each valuation methodology, with the final selection favoring the methodology that is based on the most logical, objective, and consistent set of premises. In keeping with this practice, the DOR formed a technical advisory committee and asked it to evaluate each procedure. After eight months of intensive study, the technical advisory committee reported that the DOR should use both MRA and abstraction. While the majority of the committee members were strongly in favor of MRA, it was felt that a "go-slow" policy would be the best course of action, pending additional study. This cautious approach was adopted in spite of the known weaknesses of abstraction as an estimation procedure, because several committee members felt that the results of MRA produced "illogical" relationships among the different value elements. Thus they reasoned that the method should not be used until this issue was resolved. These committee members reasoned further that the illogical value relationships occurred because MRA overestimated the value of bare land and underestimated the value of immature timber. While some concern was voiced also over the statistical properties of the model, the principal argument concerned the illogical value relationships produced by MRA.

In summary, two forest-land valuation methods—abstraction and MRA—have been applied to transaction evidence during the 1975-77 as-

TABLE 3
COMPARISON OF ADJUSTED BARE-LAND VALUES FOR AN AVERAGE
ACRE IN WESTERN WASHINGTON

ASSESSMENT YEAR	UNADJUSTED BARE-LAND VALUE		ADJUSTED BARE-LAND VALUE		DIFFERENCE IN ADJUSTED VALUES (%)
	Abstraction (\$/acre)	Regression (\$/acre)	Abstraction (\$/acre)	Regression (\$/acre)	
1975.....	77	128.17	58.82	102.31	73.9
1976.....	83	144.93	64.59	118.43	83.4
1977.....	76	147.17	65.31	132.84	103.4

assessment years in western Washington. During this time MRA has produced estimates of bare-land value that range from 74 to 103 percent greater than those produced by abstraction. Both procedures utilize the same sales evidence, employ similar model forms (i.e., eq. [1]), and use the same independent variables to predict net sale price. Different results occur because, in abstraction, it is possible to derive an arbitrary set of value estimates that meet the minimum-difference criterion (i.e., zero deviations between actual and expected net sales prices) and bear a "reasonable" relationship to each other, whereas in MRA an objective, well-established statistical procedure produces a unique best fit. Further, in abstraction, judgment and intuition may be substituted freely for the objective analysis of market evidence. When MRA is used, the bare-land value estimate is determined by relationships inherent in the data and is not influenced by the subjective personal opinion of the land appraiser. Last, in MRA, sales are weighted inversely to the square of parcel size to produce the best linear unbiased estimate of value. This is necessary to correct for the changes in variance of the net sale price when observed over different parcel sizes. Thus, in a methodological perspective, MRA is far superior to abstraction as a forest-land valuation tool in western Washington; however, the charge that MRA has produced illogical value relationships when applied to the western Washington transaction evidence requires further investigation. This subject is addressed in the remaining portion of this paper.

Forest-Land Valuation Using an Income Approach

To ascertain another estimate of bare forest land value in western Washington, a forest income model was tested. This model specifies that the per acre value of bare forest land is equal to the sum of all expected revenues less all expected costs when discounted to the present at the market rate of interest. Thus, the bare forest land value represents the capitalized value of all incomes and expenses that are expected to occur. The application of the income approach was first discussed by Faustmann in 1849 (4) and has received wide application to forest-land appraisal ever since (5, 8, 9).

Recently the Washington State Department of Natural Resources (DNR) completed a study that included the derivation of bare forest land values using an income approach (6). This comprehensive study received the input of many organizations with a diverse set of forest management programs and objectives. In table 4 bare forest land values computed by the DNR are shown for two types of western Washington landowners—forest industry and other private ones. An example illustrating the inputs and procedure used to calculate these values is shown in table 5. Depending upon site quality, intensity of management, and ownership, bare forest land value is reported to vary over a wide range. However, for

comparative purposes, it is instructive to compute an average western Washington bare-land value. This is shown in table 6, where the bare-land values reported in table 4 are weighted by (a) the percentage of land in western Washington currently managed under each forest management regime and (b) the number of acres of different-quality land owned by forest industry and other private owners. An average bare-land value for all privately owned timber lands can be estimated by weighting the average forest industry bare-land value of \$211 per acre and the other privately owned average bare-land value of \$63 per acre by the number of acres of forest land each owner possesses in western Washington. As of 1975, the average value of bare forest land for western Washington was \$163 per acre. Therefore, the land values shown in table 3 for the 1977 assessment year can be compared with the value derived using the income approach. Clearly, the MRA bare-land value of \$133 per acre agrees more favorably with the income approach than does the abstraction bare-land value of \$76 per acre.

While the foregoing income analysis does not prove that an average acre of bare forest land in western Washington is worth \$163 per acre, it does indicate that MRA is producing bare-land value estimates that might actually be found in the market. Last, the income analysis agrees favorably with the average bare-land value of \$172.23 per acre, which was computed directly from the pure bare-land sales in 1977.

TABLE 4
AFTER-TAX BARE FOREST LAND VALUES IN WESTERN WASHINGTON*

FOREST MANAGEMENT REGIME †	FOREST INDUSTRY SITE QUALITY (\$/acre)			OTHER PRIVATE SITE QUALITY (\$/acre)		
	Low	Medium	High	Low	Medium	High
Natural ‡	24	62	98	18	62	105
Stand establishment §	-3	64	128	-4	76	154
Thinning	49	165	306	56	193	354
Intensive (no thinning) #	37	128	251	40	148	299
Intensive '75 (with thinning) **	72	196	342	74	217	388

* From Larson (6). All bare-land values in this table are derived using a 6 percent real (uninflated) discount rate with a 2 percent real increase per year in stumpage prices over the first rotation and constant costs. An example illustrating the procedure used to calculate the after-tax bare-land values is contained in table 5.

† Management regimes are as defined in Larson (6).

‡ Stand established by natural regeneration with no further silvicultural treatments.

§ Stand establishment by site preparation and planting. Spraying for brush control is done five years after stand origin.

|| Same silvicultural treatments as for stand establishment plus "precommercial" thinning fifteen years after stand origin and commercial thinnings at ten-year intervals (beginning thirty years after stand origin for high sites and forty years after stand origin for medium and low sites).

Same silvicultural treatments as for stand establishment plus "precommercial" thinning and fertilization fifteen years after stand origin, with additional fertilizations twenty-five and thirty-five years after stand origin. No commercial thinnings.

** Same silvicultural treatments as intensive (no thinning) plus commercial thinnings as in thinning regime.

TABLE 5

DERIVATION OF THE AFTER-TAX BARE-LAND VALUE FOR AN ACRE OF
FOREST INDUSTRY LAND, MEDIUM SITE, THINNING REGIME*

END OF YEAR	ITEM	CASH FLOW		AFTER-TAX DISCOUNTED CASH FLOW FOR ONE ROTATION AT 6%
		Before Tax	After Tax	
5.....	Reforestation†	—\$ 80.00	—\$ 80.00†	—\$ 59.78
8.....	Brush control	— 15.00	— 7.50§	— 4.71
18.....	"Precommercial" thinning	— 35.00	— 17.50§	— 6.13
44.....	Thinning	466.37	326.46	25.14
	10.27 cunits @ \$19(1.02) ⁵⁴ per cunit:			
44.....	Depletion	11.23†	3.37**	0.26
44.....	Yield tax (6.5%)	— 30.31	— 15.16§	— 1.17
54.....	Final harvest	8,247.86	5,773.50	248.27
	62.91 cunits @ \$45(1.02) ⁵⁴ per cunit:			
54.....	Depletion	68.77#	20.63**	0.89
54.....	Yield tax (6.5%)	— 536.11	— 268.06§	— 11.53
1-54..	Annual costs	— 3.90	— 1.95§	— 32.97
	Total discounted cash flow for one rotation.....			\$158.27
	Bare-land value††.....			165.38

* From Larson (6).

† A five-year regeneration delay is assumed for all DNR regimes.

‡ Capitalized into the timber account to form the depletion base.

§ Expensed against ordinary income at the corporate income tax rate of 50 percent.

|| Calculated as 70 percent of before-tax income, thus reflecting a long-term capital gains tax rate of 30 percent.

Calculated by multiplying the unit depletion rate (\$1.09/cunit) times the volume harvested.

** Calculated as 30 percent of before-tax depletion, thus reflecting a long-term capital gains tax rate of 30 percent.

†† Calculated by multiplying the discounted cash flow for one rotation by the infinite rotations adjustment factor, $(1.06)^{54}/[(1.06)^{54} - 1]$.

TABLE 6

AVERAGE AFTER-TAX BARE-LAND VALUES IN WESTERN WASHINGTON BY
OWNERSHIP, MANAGEMENT REGIME, AND SITE QUALITY

OWNERSHIP	MANAGEMENT REGIME* (\$/acre)					SITE QUALITY† (\$/acre)			WEIGHT- ED AV- ERAGE
	Natural	Stand Estab- lish- ment	Thin- ning	In- tensive (no thin- ning)	Inten- sive '75 (with thin- ning)	Low	Me- dium	High	
Forest industry	73	83	213	172	245	53	165	299	211
Other private	56	66	183	147	207	19	69	120	63

* Per acre bare-land values in table 4 are weighted according to the percentage of low-, medium-, and high-site lands owned by each forest owner. These percentages are taken from table C-1 of Larson (6).

† Per acre bare-land values in table 4 are weighted according to the percentage of each forest owner's land currently managed under each regime. These percentages are taken from table 7 of Larson (6).

Value Relationships in Forest-Land Valuation

Both abstraction and MRA produce estimates of immature timber values as well as of bare forest land. One way of testing the reasonableness of these value estimates is to pass judgment on the progression in value from bare land to land stocked with immature timber stands of various ages. It is commonly accepted that forest land dedicated to timber production that is stocked with reproduction is "worth more" than bare land devoid of reproduction. While this statement sounds intuitively obvious, it unfortunately is not always true. It depends entirely on the expectations and objectives of those individuals involved in any particular land-sale transaction. For instance, a shopping center developer may attach a negative value to a plantation of ten-year-old trees if he must expend funds to clear the land prior to developing the site. To a buyer interested in raising trees, the ten-year-old plantation would possess a different value. Thus, the relationship between the value of bare land and the value of the land plus trees is not always a "logical" one, nor does the latter always exceed the former.

Consider the following simple example. Suppose Mr. A is the proud owner of a five-year-old Douglas fir plantation on medium-site land that has been naturally reforested. Suppose further that Mr. A intends to manage this stand according to the "natural" forest management regime defined in table 4. From table 4 we observe that the after-tax bare-land value of an acre of such land is \$62. On the basis of this information Mr. A computes the per acre value of his five-year-old plantation to be worth the sum of (a) the land rent for five years and (b) the annual cost of taxes, protection, and administration. Algebraically this is expressed as

$$H = (a + iB) \left[\frac{(1 + i)^n - 1}{i} \right],$$

where H is the stand value of an n -year-old timber stand; i is the discount rate specified in real (uninflated) terms; B is Mr. A's bare-land value; n is the age of the timber stand; and a is the annual cost of taxes, protection, and administration. Using a real (uninflated) discount rate of 6 percent and annual costs of \$3 per acre, the per acre stand value of Mr. A's five-year-old trees is computed to be

$$H = [\$3 + 0.06(\$62)] \left[\frac{(1.06)^5 - 1}{0.06} \right] = \$37.88 \text{ per acre.}$$

To this stand value (H) we must add the bare-land value (B) to obtain the forest value (W). This provides a combined value of an acre of land plus five-year-old reproduction. For Mr. A this forest value of \$99.88 per acre represents a price below which he could not sell his acre and still earn a real rate of return of 6 percent.

Now suppose that Mr. B, a potential buyer, shows interest in buying Mr. A's acre. Mr. B also plans to devote the acre to timber production,

but he plans to practice a more intensive form of management. Specifically, Mr. B plans to follow the intensive '75 regime defined in table 4. The bare-land value under this form of intensive management is calculated to be \$217 per acre. Mr. B further observes that Mr. A's naturally regenerated five-year-old timber stand is not stocked and spaced as it would be if he managed it intensively. Therefore, he realizes that if he buys Mr. A's acre he can either (a) expend funds by "precommercially" thinning Mr. A's plantation if it is overstocked relative to his stocking goal (or underplant Mr. A's plantation if it is understocked relative to his stocking goal), (b) manage Mr. A's plantation as a natural stand (see table 4) until the crop is mature and then manage succeeding timber crops intensively, or (c) immediately clear the land of existing vegetation, reforest, and manage the acre according to the intensive '75 management regime. While other management strategies are possible, these three illustrate the range of alternatives.

If Mr. B follows the first strategy, he will incur an additional silvicultural expenditure. Knowing this, he will lower his bid price for Mr. A's trees. In the case of the second strategy, Mr. B will suffer reduced earnings during the first rotation relative to what he could earn if the acre was managed intensively. Again he will lower his bid price for Mr. A's trees from that which he would offer if Mr. A's plantation were stocked and managed according to his intensive schedule. Under the third strategy Mr. B will view the plantation as a liability that must be removed prior to planting a new timber stand. Thus, he will lower his bid price by the cost of removing the existing trees.

For illustrative purposes we will assume that Mr. B elects to follow the second strategy (i.e., take depressed yields during the first rotation and then convert to the intensive '75 management regime). In this instance he calculates the stand value (h) of Mr. A's five-year-old trees as

$$h = \frac{e + B'}{(1 + i)^{t-n}} - B' - \frac{a}{i} \left[\frac{(1 + i)^{t-n} - 1}{(1 + i)^{t-n}} \right],$$

where h is the stand value of an n -year-old timber stand that is not properly stocked; B' is Mr. B's bare-land value; e is the reduced final harvest of the first (i.e., current) crop; t is the year in which the current stand will be harvested; n is the age of the timber stand; a is the annual cost of taxes, protection, and administration; and i is the discount rate in real (uninflated) terms. Mr. B calculates that the current stand will be mature at age sixty, whereas under intensive management a fifty-year rotation will be used. At age sixty the after-tax harvest value is calculated to be \$4,000 per acre. Using a real (uninflated) discount rate of 6 percent, Mr. B calculates that the five-year-old stand value is

$$\begin{aligned} h &= \frac{\$4,000 + \$217}{(1.06)^{55}} - \$217 - \frac{\$3}{0.06} \left[\frac{(1.06)^{55} - 1}{(1.06)^{55}} \right] \\ &= -\$93.90 \text{ per acre.} \end{aligned}$$

In essence, this means that, by occupying the site, the current five-year-old stand if held to maturity is more of a liability than an asset. If the expense of clearing the acre is less than \$93.90, Mr. B would be wiser to clear the land immediately rather than wait 55 years for the current crop to mature. However, assuming that this is not the case, and given the decision to hold the current stand until maturity, Mr. B would bid the combined total of \$217 for the bare land minus \$93.90 for Mr. A's five-year-old trees, thus yielding a forest value of \$123.10 per acre. Obviously, since this exceeds Mr. A's appraised price of \$99.88 per acre, the sale would still be consummated.

This simple example demonstrates that forest land with trees is not always "worth more" than bare forest land. Furthermore, this situation can be observed in the forest-land market where the value perceptions of both buyers and sellers influence the actual transaction price. Certainly, investment values as calculated by Mr. A do not predominate in the forest-land market. Hence, a smooth progression in value from bare land to land stocked with trees should not be expected when transaction evidence is analyzed.

Finally, as a measure of the reasonableness of the progression in value from bare land to land stocked with timber stands of various ages, the common procedure is to compute the ratio of the stand value to the bare-land value. To date most of those demanding "reasonable" value relationships have used as their standard of comparison the type of ratio adopted by Mr. A. Symbolically, this can be represented as

$$V = H/B.$$

For Mr. A's five-year-old plantation we obtain a value ratio of

$$V = H/B = \$37.88/\$62 = 0.61.$$

However, a market transaction requires both a willing seller and a willing buyer in order for a sale to occur. Therefore, it is necessary to incorporate Mr. B's information by calculating a ratio that expresses his perception of the value relationships. Symbolically, we can write this as

$$v = h/B'.$$

For our five-year-old plantation, Mr. B obtains a value ratio of

$$v = h/B' = \frac{-\$93.90}{\$217} = -0.43.$$

Thus, value relationships as computed by Mr. A, the seller, would not necessarily dominate the market transaction where the value perceptions of Mr. B, the buyer, are also incorporated. And it is for this reason that transaction evidence may not produce the types of value relationships expected by some students of forest-land appraisal.

Value Relationships in Western Washington Land Appraisal

I now wish to compare the actual value relationships derived using both abstraction and MRA. For clarity I restrict my presentation to western Washington bare land, conifer reproduction, and conifer immature timber values. Table 7 contains the ratio of stand value to bare-land value for the average acre unadjusted for site, access, and topography as derived using both abstraction and MRA. These ratios reveal why so much attention has been focused on the question of value relationships. Those who favor use of abstraction argue that their ratios are reasonable, while suggesting that the MRA-based ratios cannot possibly occur in reality and hence are illogical. Those who argue against MRA further believe that the illogical value relationships result primarily from an overvaluation of bare land. However, as the "Mr. A-Mr. B" example has illustrated, this is not necessarily true.

To provide additional insight into this concern over value relationships, a series of ratios was computed using the bare-land values found in Larson (6). Since these values were derived using an income approach, they serve as a check on the values derived from transaction evidence. A series of value ratios based on the thinning and intensive '75 regimes defined in table 4 for forest industry owners and the natural and intensive '75 regimes for other private owners are presented. These ratios assume that the current stand is being managed in the desired manner. Thus, they are analogous to the ratios computed by Mr. A. As shown in table 8, ratios for conifer reproduction (five to ten years old) on medium site quality land range from about 1.3 to 2.4. This agrees favorably with the abstraction conifer reproduction ratios shown in table 7. Similarly, the ratios in table 8 for conifer immature (fifteen to twenty-five years old) on medium-site land range from 3.7 to 8.4. While these are higher than either the abstraction or the MRA estimates, they agree more closely with the former than the latter.

The value ratios in table 8—which assume that the current stand is

TABLE 7
RATIO OF STAND VALUE TO BARE-LAND VALUE FOR AN
AVERAGE ACRE IN WESTERN WASHINGTON*

ASSESSMENT YEAR	RATIO OF CONIFER REPRODUCTION TO BARE LAND		RATIO OF CONIFER IMMATURE TO BARE LAND	
	Abstraction	MRA	Abstraction	MRA
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

* Calculated from regression and abstraction estimates shown in tables 1 and 2, respectively.

TABLE 8
RATIO ($V = H/B$) OF STAND VALUE TO BARE-LAND VALUE BY TREE AGE,
SITE QUALITY, MANAGEMENT REGIME, AND OWNERSHIP*

TREE AGE	SITE QUALITY	FOREST INDUSTRY		OTHER PRIVATE	
		Thinning Regime	Intensive '75 Regime	Intensive '75 Regime	Natural Regime
5	Low	3.34	2.49	2.67	2.53
5	Medium	1.49	1.37	1.39	1.30
5	High	1.14	1.09	1.10	1.11
10	Low	5.01	3.81	4.14	4.63
10	Medium	2.41	2.23	2.28	2.38
10	High	1.90	1.83	1.86	2.02
15	Low	7.63	6.44	7.11	7.43
15	Medium	3.74	3.69	3.83	3.83
15	High	2.99	3.01	3.08	3.25
20	Low	10.75	8.80	9.97	11.19
20	Medium	5.42	5.23	5.51	5.76
20	High	4.38	4.35	4.49	4.90
25	Low	14.94	12.86	14.51	16.21
25	Medium	7.66	7.62	8.01	8.35
25	High	6.22	6.32	6.52	7.09

* Based upon bare-land values shown in table 4 and stand values that assume the current stand to be optimal (i.e., neither overstocked nor understocked with respect to the most desirable level of management).

being managed at the desired level of intensity—support the contention that abstraction produces valid value relationships while MRA does not. However, to observe such value relationships in the land market, one would have to make the assumption that all parcels being exchanged are currently stocked and spaced in a manner appropriate for the type of management intensity visualized by the buyer. In other words, one would have to assume that an investment value such as that calculated by Mr. A is the sole appropriate measure of value. This assumption is not entirely valid in western Washington because (a) many of the stands of immature timber being exchanged in the market were naturally regenerated and not given any subsequent treatment and (b) buyers and sellers possess varying levels of information and expectations about future market conditions for timber. This information is reflected in present-day decisions concerning the appropriate degree of management intensity to practice. In both instances, one would strongly suspect that stand values and hence value ratios existing in the forest-land market would be less than those indicated in table 8, since the immature timber stands do not possess fully, the characteristics desired of intensively managed stands at the same stage of development. Therefore, we would not expect the forest-land market to be characterized by the value ratios exhibited in table 8. Similarly, we would not expect the value ratios derived using abstraction necessarily to characterize the forest-land market.

In abstraction the land appraiser strives to produce value relationships based upon the same type of logic advanced by Mr. A. This approach of

standard valuation is not appropriate, however, unless all buyers and sellers have the same perception of value. This can hardly be accepted in the forest-land market, where diversity and not homogeneity is a known quantity. Therefore, built into the abstraction process is a bias that tends to produce value relationships that do not predominate in the market. However, under a facade of objectivity, it is difficult to trace the actual evolution of this bias in the process of estimation.

Following the logic of Mr. B, we acknowledge the possibility that because of differing objectives and expectations, current immature timber stands being exchanged in the market will not necessarily be managed under the same regime as practiced by previous owners. Therefore, as revealed by Mr. B, current stand values will be reduced below those calculated by previous owners. Again, we use the report of the DNR Washington Forest Productivity Study, Phase II (6) as the basic source of information for this analysis.

Table 9 gives a series of value ratios for forest industry and other private owners. These ratios assume (a) that the existing immature timber stands are understocked or overstocked relative to a stand of the same age managed under a more desirable form of management and (b) that the decision has been made to allow the existing stand to reach maturity before harvest, with all subsequent stands to be managed under the in-

TABLE 9
RATIO ($v = h/B'$) OF STAND VALUE TO BARE-LAND VALUE BY
TREE AGE, SITE QUALITY, CURRENT MANAGEMENT
REGIME, AND OWNERSHIP*

TREE AGE (years)	SITE QUALITY	FOREST INDUSTRY: CURRENT STAND UNDER TWO REGIMES		OTHER PRIVATE: CURRENT STAND UNDER NATURAL REGIME
		Natural Regime	Stand Establishment Regime	
5.....	Low	-0.33	0.41	-0.36
5.....	Medium	-0.45	0.03	-0.46
5.....	High	-0.52	-0.13	-0.52
10.....	Low	-0.09	0.81	-0.09
10.....	Medium	-0.29	0.29	-0.28
10.....	High	-0.38	0.09	-0.37
15.....	Low	0.21	1.29	0.25
15.....	Medium	-0.09	0.61	-0.06
15.....	High	-0.22	0.35	-0.20
20.....	Low	0.57	1.87	0.66
20.....	Medium	0.15	1.00	0.20
20.....	High	-0.02	0.68	0.02
25.....	Low	1.01	2.58	1.17
25.....	Medium	0.45	1.48	0.52
25.....	High	0.23	1.07	0.28

* Based upon bare-land values shown in table 4 and stand values that assume that the current stand is not optimal with respect to the intensive '75 regime assumed for all subsequent rotations.

tensive '75 management regime. As seen in table 9, these value ratios differ significantly from those presented in table 8. For instance, on medium-site land, conifer reproduction (five to ten years old) managed under the stand establishment regime possessed a value ratio that ranges from 0.03 to 0.29 under forest industry ownership. In many instances value ratios in table 9 are negative, indicating that the current stand is sub-optimal with respect to the type of management envisioned for all subsequent stands.

Value ratios shown in tables 8 and 9 illustrate that the progression in value from bare land to land stocked with immature trees is directly related to the goals and aspirations of the current or potential landowner. Relating this latter information to the value ratios produced by abstraction and MRA now becomes straightforward. As previously asserted, we would not expect value ratios such as those exhibited in table 8 to predominate in the forest-land market, nor would we expect the abstraction-based ratios shown in table 7 to predominate. However, it is logical to expect some sales evidence to "support" value ratios of this magnitude. It is much more likely that most of the sales evidence will corroborate the validity of the value ratios shown in table 9. This suggests that the type of value ratios one would logically expect to observe in the market would reflect values ranging from those shown in table 8 on the high side to those shown in table 9 on the low side.

As an example, suppose that we observe six sales involving 1,000 acres. For simplicity we assume further that these acres are all medium-site land and involve bare land as well as five-to-ten-year-old conifer reproduction. Suppose further that on 400 of these acres current stands are optimally stocked with respect to ownership objectives, whereas on 600 acres existing stands are understocked with respect to ownership objectives. From table 8 we select a value ratio of 1.8 to represent the 400 acres, and from table 9 we select a value ratio of -0.37 to represent the remaining 600 acres of understocked land. The weighted average of these two ratios therefore is computed to be 0.50. Although contrived to illustrate a point, this value ratio correlates with those produced by MRA as previously shown in table 7. Thus, it again shows that value ratios derived using MRA are not illogical but in fact can occur in the forest-land market. Value relationships derived by abstraction also can occur in the market. However, as previously asserted, methodological weaknesses inherent in abstraction seriously distort the value estimates in both numerator and denominator of the value ratio. Thus, the results of such an analysis are meaningless.

Summary

Since 1971, forest land in Washington State has been subject to an annual ad valorem tax based solely on the value of bare land for the growing and

harvesting of timber crops. All sales of valid forest land are used by the Washington State Department of Revenue when determining the true and fair value of bare forest land. Once these sales data have been collected, the DOR uses the abstraction method to derive an estimate of the average value of bare land. This method has been criticized as being highly subjective and dependent upon the preconceived notion of the land appraiser. Multiple regression analysis has been recommended as a superior valuation methodology.

Results of both abstraction and MRA for the 1975-77 assessment years for western Washington are presented and discussed. These results illustrate that abstraction is undervaluing bare forest land in western Washington by over 100 percent as compared with MRA. An income approach is also examined in an effort to gain additional insight and understanding. Results of this analysis tend to support the MRA bare-land estimate of value.

Last, the relationship between the value of bare forest land and that of land stocked with trees is discussed. Contrary to popular opinion, it is shown that a smooth progression in value from bare land to land stocked with trees may be the exception rather than the rule. An analysis of the ratio of stand (tree) value to bare-land value illustrates that MRA is producing results that are perfectly "logical" and not "illogical" or "impossible" as alleged by critics of the approach. In summary, it is recommended that MRA replace abstraction as a forest-land valuation tool in western Washington.

References

1. Bare, B. B. "An Evaluation of the Abstraction Process of Forest Land Valuation in the State of Washington." Mimeographed. Seattle: College of Forest Resources, University of Washington, 1975.
2. Bare, B. B., and McKetta, C. W. "Forest Land Valuation in Washington State: Comparison of Abstraction and Regression." *Real Estate Appraiser* 43(1977): 25-31.
3. Bruce, R. W., and Sundell, D. J. "Multiple Regression Analysis: History and Applications in the Appraisal Profession." *Real Estate Appraiser* 43 (1977): 37-44.
4. Faustmann, M. "Calculation of the Value Which Forest Land and Immature Stands Possess for Forestry." Reproduced in Institute Paper No. 42, Commonwealth Forestry Institute, Oxford University, 1968. Translated by W. Linnard.
5. Klemperer, W. D. "Forest Income Valuation Revisited." *Real Estate Appraiser* 43 (1977): 18-24.
6. Larson, D. N. "Washington Forest Productivity Study, Phase 11." Draft report. Olympia: Washington State Department of Natural Resources, October 1977.

7. Shenkel, W. "The Valuation of Income Property by Multiple Regression Techniques." In *The Application of Multiple Regression Analysis in Assessment Administration*. Proceedings of a symposium conducted by the International Association of Assessing Officers, Research and Technical Services Department, in cooperation with the John C. Lincoln Institute. Chicago: International Association of Assessing Officers, 1974.
8. Teeguarden, D. E. "Appraisal of Timber Land through Capitalization of the Value of Average Annual Growth." *Assessors Journal* 7 (1972): 29-42.
9. ———. "Forest Valuation Approaches under the California Land Conservation Act." *Appraisal Journal*, July 1973, pp. 366-81.
10. Washington State Department of Revenue. *Use of Multiple Regression Analysis in Forest Land Valuation*. Report of a technical subcommittee. Olympia: Washington State Department of Revenue, June 1976.