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Stumpage Price Projections for Selected Western Species

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Abstract

The 1980 Resources Planning Act Timber Assessment and Program prepared in response to provisions of the Forest and Rangeland Renewable Resources Planning Act of 1974 (as amended by the National Forest Management Act of 1976) contains regional projections of average stumpage prices that are potentially useful in National Forest planning. Their usefulness can be improved if the average prices are separated by species. This separation process depends on assumptions about changes in relative importance (as measured by volume) of the various species. Further refinement of stumpage prices to the National Forest level is also discussed.

KEYWORDS: Stumpage prices, timber management planning, National Forest administration, long-range planning.

Introduction

The National Forest Management Act regulations outline a process and establish criteria for identifying National Forest lands not suited for timber production (USDA Forest Service 1979). An important step in the process is determining the costs for and benefits from a range of timber management regimes for the available land. The costs and benefits are tested against criteria representing National Forest objectives, silvicultural requirements, and cost efficiency. Lands failing to pass these tests are classed as not suited to timber production.

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An important component in computing benefits of various timber management regimes is some means of evaluating the output in stumpage value one to five decades in the future. One source of such stumpage values comes from the comprehensive analysis of the renewable resources of forest and rangeland and associated waters prepared in response to provisions of the Forest and Rangeland Renewable Resources Planning Act of 1974 (as amended by the National Forest Management Act of 1976). The drawback to using these prices is that they represent the average high bid (minus road costs) for all species weighted by the volume of each species. These volume weighted averages are useful as general indicators of trends in stumpage prices but are of limited usefulness to planners who need prices for each species.

The purpose of this note is to provide projections of stumpage prices for individual species that can be used in regional and National Forest planning. The projections for specific species are based on regional softwood stumpage price projections that were made as a part of the 1980 Resources Planning Act (RPA) assessment (USDA Forest Service 1980) of the Nation's timber resource (table 1). The RPA projections are applicable only to the regions (fig. 1A) for which they were prepared. This imposes a further problem to USDA Forest Service planners who are developing plans for Forest Service Regions (fig. IB). To avoid confusion, Forest Service administrative Regions are capitalized.

Table I--Historical trend,[1] softwood stumpage price levels,[2] and projection of equilibrium prices[3] to 2030

(Dollars per thousand board feet, Scribner log scale)

Geographic region	Forest Service Region[4]	19b2	1962	1970	1976	1978	1980	1990	2000	2010	2020	2030
PacifIC Northwest	6											
West side		16.64	28.84	44.84	62.40	69.68	69.79	95.19	81.04	105.23	129.64	157.76
East side		15.77	18.22	20.43	22 27	22.92	24.63	53.76	61.35	79.63	94.41	116.98
Pacific Southwest	5	12.45	19.04	26.73	34.49	37.53	40.22	64.21	71.53	87.66	102.37	122.95
Rockies	1, 2, 3, and 4	6.45	9.29	12.40	15.42	16.58	22.22	48.80	54.79	76.47	94.56	134.12
South central	8	21.43	30.88	41.37	51.49	55.40	56.13	83.47	103.05	128.79	155.26	188.19
Southeast	8	21.43	30.88	41.37	51.49	55.40	54.83	83.99	102.96	128.63	155.96	188.13
North central	9	18.96	18.96	18.96	18.96	18.96	31.25	36.12	40.85	47.95	57 70	66.29
Northeast	9	18.96	18.96	18.96	18.96	18.96	26.72	37.11	42.35	49.02	58.13	66.59

[1]Prices on a least squares regression line fitted to time series price data for the years 1950-78.
[2]Prices are measured in constant (1967) dollars and are net of inflation or deflation. They measure price changes relative to changes in the wholesale price index (all commodities).
[3]The prices that would result if stumpage prices rose enough to maintain an equilibrium between projected timber demanus ana supplies (USDA Forest Service 1980)
[4]Region 1 is tne Northern Region, 2, Rocky Mountain, 3, Southwestern, 4, Intermountain; 5, Pacific Southwest, 6, Pacific Northwest, 8, Southern, and 9, Eastern.

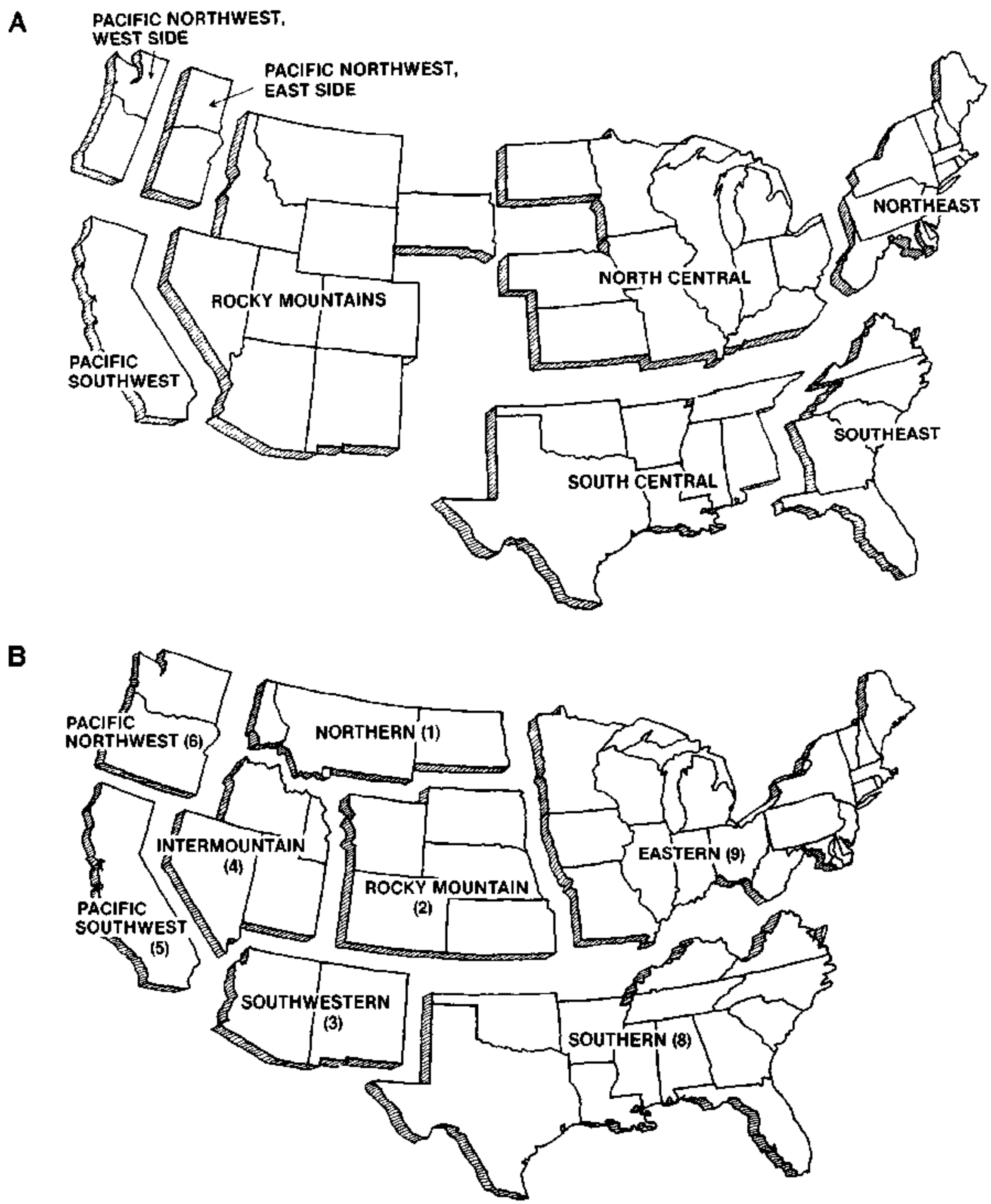

Figure 1.--A, Geographic regions used in the 1980 RPA; B, USDA Forest Service administrative Regions.

The projections of prices that were prepared for the RPA timber assessment represent the market equilibrium price[1] of the average of all species within the region where prices for individual species were weighted by their respective proportional contribution to annual regional harvest volume. Symbolically, the projected RPA prices can be expressed as

$$\bar{s}_t = \sum_{j=1}^{n} w_{jt} s_{jt}; \tag{1}$$

where,

$\bar{s}_t$ = regional, volume-weighted stumpage price for year t;

w_{jt} = the proportion of total regional harvest in year t, which comes from j-th species; and

s_{jt} = regional stumpage price in year t for the j-th species.

In this note, we describe a methodology to derive regional, volume-weighted stumpage prices for individual species from the RPA projections of $\bar{s}_t$. We also developed a methodology for projecting the price of stumpage for individual species on the National Forests.

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[1]Equilibrium prices and quantities represent the balance between supply and demand relationships.

Prices for Individual Species by USDA Forest Service Region

The first step in the development of price projections for individual species is to estimate the relationship between the price of each species and the price of the major species in the Region.

Annual time series data on the volume and prices (statistical high bid[2] deflated by the wholesale price index for all commodities) by species for each Region were taken from annual summaries prepared by the Timber Management staff of the USDA Forest Service in Washington, D.C. For Western Regions other than Region 6 (the Pacific Northwest Region), the data covered the period 1959-78; the data for Region 6, 1964-78.

These data were used to obtain the following relationship for each species for each Region:

$$S_{jt} = \hat{B}_{1j} + \hat{B}_{2j} S_{1t}; \qquad (2)$$

where,

S_{jt} = price (statistical high bid) of species j ($j \neq 1$) in year t;

S_{1t} = Price (statistical high bid) for the major species in the Region in year t;

$\hat{B}_{1j}$ = estimated intercept value; and

B_{2j} = estimated coefficient representing the change in S_{jt} resulting from a change in S_{1t}

Equation (2) also contains a stochastic error-term ($\hat{e}_{jt}$) whose assumed mean is zero so that on the average the model specified in equation (2) is correct.

Estimated equations for each species, by Region, are shown in appendix 1. The equations should be judged by their usefulness in deriving prices for individual species, as well as on their statistical properties. The equations are presented so that analysts can modify the assumptions and produce a revised set of price projections.

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[2]Statistical high bid is total bid price adjusted for road construction costs for which purchasers receive a credit.

The next step is to develop an expression for the projected price for each major species (s_{1t}). If the historical relationships in equation (2) are assumed to hold for the projection period, then the predicted price of each species (obtained from equation (2) if $\hat{e}_{jt} = 0$) can be substituted in equation (1) and solved for s_{1t}. The expression for the projected price of the major species, s_{1t} is, therefore,

$$s_{1t} = \frac{\bar{s}_t - \sum_{j=2}^{n} w_{jt} \hat{B}_{1j}}{w_{1t} + \sum_{j=2}^{n} w_{jt} \hat{B}_{2j}}; \qquad (3)$$

where w_{1t} is the proportion of total regional harvest accounted for by the major species. The major species for each Region are:

Region 1 (Northern)	Douglas-fir[3]
Region 2 (Rocky Mountain)	"
Region 3 (Southwestern)	"
Region 4 (Intermountain)	"
Region 5 (Pacific Southwest)	Ponderosa pine
Region 6 (Pacific Northwest):	
West side	Douglas-fir
East side	Ponderosa pine

The projected values of $\bar{s}_t$ are the RPA price projections by geographic region (table 1), and the values of $\hat{B}_{1j}$ and $\hat{B}_{2j}$ are estimated by the process described above. For the approach to work, however, projections of w_{1t} and W_{jt} are necessary. The assumption here is that future weights will follow the trends of the past two decades until the year 2000, after which the weights will remain constant at the year 2000 level. The assumed values of the projected weights are shown in table 2.

The four USDA Forest Service Regions (Regions 1, 2, 3, and 4) in the Rocky Mountains present a special problem because the analysis for the RPA combines them into a single section with a single accompanying price projection. Douglas-fir in Region 1 was selected as the major species to use in the calculation of equation (2) for all species in each of the four Regions (including Douglas-fir in Regions 2, 3, and 4).

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[3]See appendix 2 for common and scientific names of trees.

Table 2--Historical averages[1] and projections of National Forest sawtimber stumpage sold in each Forest Service Region, by selected species

USDA Forest Service Region	Year	Species										
		Douglas-fir	True firs	Western hemlock	Cedars	Western larch	Lodgepole pine	Ponderosa pine	Sugar and western white pines	Spruces	Incense cedar	All other species
		Percent										
1 Northern	1959-78	19.97	13.94	2.29	4.54	16.44	11.80	6.42	11.73	9.39		
	1980	15.19	18.35	2.06	5.83	13.70	21.05	4.82	11.91	7.15		
	1990	13.59	20.56	2.00	7.09	11.40	24.27	3.67	11.91	5.51		
	2000	12.06	22.32	2.00	6.73	9.62	26.49	2.83	11.91	4.30		
2 Rocky Mountain	1959-78	[illegible]	4.05				25.57	28.99		30.24		
	1980	1.16	1.47				25.53	34.19		37.65		
	1990	1.00	1.00				25.53	61.43		11.04		
	2000	1.00	1.00				25.53	65.56		6.91		
3 Southwestern	1959-78	7.67	5.31					79.27		2.87		
	1980	6.90	4.19					87.56		1.35		
	1990	6.30	3.69					89.01		1.00		
	2000	6.00	3.00					90.00		1.00		
4 Intermountain	1959-78	26.96	8.05				19.05	33.03		8.27		
	1980	26.65	6.85				31.48	28.79		6.23		
	1990	27.15	5.96				34.05	27.23		5.61		
	2000	27.65	5.18				37.28	24.89		5.00		
5 Pacific Southwest	1959-78	24.98	28.36				.31	40.76			4.09	9.61
	1980	21.25	29.12				.57	43.91			4.54	.61
	1990	18.46	29.80				.98	45.41			4.84	.51
	2000	16.07	30.20				1.65	46.58			5.00	.47
6 Pacific Northwest												
West side	1964-78	54.77		21.33								22.22
	1980	54.72		16.16								27.12
	1990	54.72		15.19								30.09
	2000	54.72		12.72								32.56
East side	1964-78						3.90	52.48				43.03
	1980						5.54	51.26				43.20
	1990						6.74	49.87				43.39
	2000						7.86	48.56				43.58

[1]Annual average for the data period.

Results

Once the price of a Region's major species is known, it is substituted into the price equations (of the form illustrated by equation (2)) to obtain projected values for other species in the Region. A further step was taken in preparing tables 3-5. Rates of change (in percent) by decade were directly calculated from the projections of prices for individual species. Consequently, tables 3-5 display projected average annual rates of change in prices for individual species (by Region) for the next five decades. The rates of change vary by decade, mirroring changes in forest products markets. The rates of change for the first decade in the USDA Forest Service Regions comprising the Rocky Mountain geographical region may seem high but are the consequence of low base prices used in the initial calculations.

The projections are in real terms; that is, they do not account for inflation and are consistent with the RPA market equilibrium analyses of the timber resource of the Nation. The rates of change can be directly applied to regional prices in a base year to obtain future stumpage prices. For example, the 1992 price of Douglas-fir in Region 1 would be computed as the 1980 price multiplied by $(1.0812)^{10} \times (1.0126)^{2}$.

Table 3--Average annual rate of chanqe in stumpage price by decade and species in the Rocky Mountain geographical region

Species by USDA Forest Service Region	1981-1990	1991-2000	2001--2010	2011-2020	2021-2030	All decades, 1981-2030
				Percent		
1. Northern:						
Douglas-fir	8.12	1.26	3.35	2.12	3.54	3.66
True firs	9.50	1.38	3.60	2.24	3.69	4.04
Western hemlocks	9.57	1.40	3. 61	2.26	3.69	4.07
Cedars	7.76	1.24	3.29	2.09	3.50	3.55
Western larcn	7.87	1.25	3.31	2.11	3.51	3.57
Lougepo le pine	8.44	1.29	3.41	2.15	3.58	3.74
Ponderosa pine	7.46	1.21	3.21	2.07	3.45	3.45
Sugar and western white pines	6.44	1.10	2.98	1.95	3.30	3.14
spruce	8.40	1.30	3.42	2.15	3.56	3.73
2. Rocky Mountain:						
Douglas-fir	9.02	1.34	3.53	2.20	3.63	3.92
True firs	7.91	1.25	3.32	2.11	3.52	3.59
Lougepole pine	8.74	1.32	3.47	2.18	3.60	3.83
Ponderosa pine	b.46	1.09	2.99	1.94	3.29	3.15
Spruces	8.22	1.27	3.37	2.14	3.54	3.68
3. Southwestern:						
Douglas-fir	8.97	1.34	3.51	2.20	3.64	3.91
True firs	9.25	1.37	3.56	2.22	3.67	3.99
Ponderosa pine	8.20	1.27	3.38	2.13	3.54	3.69
Spruces	9.55	1.40	3.61	2.26	3.69	4.07
4. Intermountain:						
Douglas-fir	10.25	1.44	3.72	2.31	3.75	4.24
True firs	10.43	1.46	3.75	2.32	3.76	4.30
Lougepo le pine	8.57	1.32	3.45	2.18	3.59	3.78
Ponderosa, sugar, and western white pines	8.67	1.31	3.47	2.18	3.60	3.82
Spruces	9.69	1.41	3.63	2.27	3.70	4.09
Regions 1, 2, 3, and 4:						
All species	8.19	1.17	3.39	2.14	3.55	3.66

The rate of change of price for each species depends on the assumptions of the underlying model. Specifically, we assumed that the historical relationships in equation (2) will continue to be valid in the future and that the projections of weights (table 2) and volume weighted prices for all species (table 1) are reasonable.

Two aspects of table 5 need to be explained. First, the values for the west side represent long log scale rather than the short log scale used in the east side of Region 6 and other Regions. Second, stumpage prices decline on the west side during the second decade. The decline on the west side is a product of falling demand for timber brought on by diminishing lumber production.

Table 4--Average annual rate of change of stumbaqe price by decade and species in the Pacific Southwest Region (Region 5)

Species	1981-1990	1991-2000	2001-2010	2011-2020	2021-2030	All decades, 1981-2030
			Percent			
Incense-cedar	3.40	2.02	1.94	1.48	1.79	2.13
Douglas-fir	5.14	2.71	2.47	1.80	2.10	2.83
True firs	3.50	2.06	1.97	1.50	1.81	2.16
Loagepole pine	4.22	2.36	2.22	1.65	1.96	2.47
Ponaerosa pine	5.40	2.80	2.52	1.85	2.13	2.93
All other species	1.90	1.25	1.31	1.06	1.32	1.36
All species	4.78	1.09	2.06	1.57	1.84	2.26

Table 5--Average annual rate of change of stumpage price by decade and species in the Pacific Northwest Region (Region 6)

Subregion and species	1981-1990	1991-2000[1]	2001-2010	2011-2020	2021-2030	All decades, 1981-2030
				Percent		
West side:[2]						
Douglas-fir	3.25	-1.59	2.70	2.13	2.01	1.68
Western hemlock	3.22	-1.56	2.67	2.11	1.99	1.66
All other species	2.90	-1.43	2.42	1.96	1.88	1.53
All species	3.16	-1.59	2.64	1.10	1.99	1.65
East side:[3]						
Ponderosa pine	8.60	1.51	2.68	1.76	2.20	3.31
Lodgepole pine	5.89	1.18	2.19	1.48	1.92	2.52
All other species	7.62	1.40	2.54	1.68	2.12	3.05
All species	8.11	1.32	2.64	1.72	2.16	3.17

[1]Decline in this decade is the result of a falling demand for timber.
[2]Long log scale.
[3]Short log scale.

Relationship Between Stumpage Prices of the Regions and Individual National Forests

The methods and results described in the preceding sections are useful for analysis for the USDA Forest Service Regions, but they are not sensitive to prices at the National Forest level. The following procedure is suggested to adapt a Region's price projections for individual National Forests. The procedure should be used as a first approximation; alternative methods may be more appropriate, depending on the particular case.

The Forest analyst begins by hypothesizing the following relationship (not necessarily causative) between the Forest price and the Region's price for each species:

$$P_{ft} = A_0 + A_1 P_{rt}; \tag{4}$$

where,

P_{ft} = price (deflated) for the species in year t on the Forest;

P_{rt} = price (deflated) for the species in year t for the Region; and

A_0, A_1 = parameters to be estimated.

A word of caution about specific prices for species and how they may be influenced by the way bidding takes place. Most bidding is done on the major species; this implies a possible biased price for minor species. Bidding policies may vary by Region. For example, a Region might have a policy of no bidding on a species unless it accounts for at least 20 percent of the sale volume. There is no way around this problem. Its existence should be recognized in the planning process, and price projections for minor species should be examined for reasonableness.

Equation (4) can be estimated with annual time series data (deflated) on statistical high bid (see footnote 2, page 5). The results follow one of the three cases illustrated in figure 2. Each case represents a different interpretation of equation (4) and has different implications for obtaining price projections for specific species for the Forest:

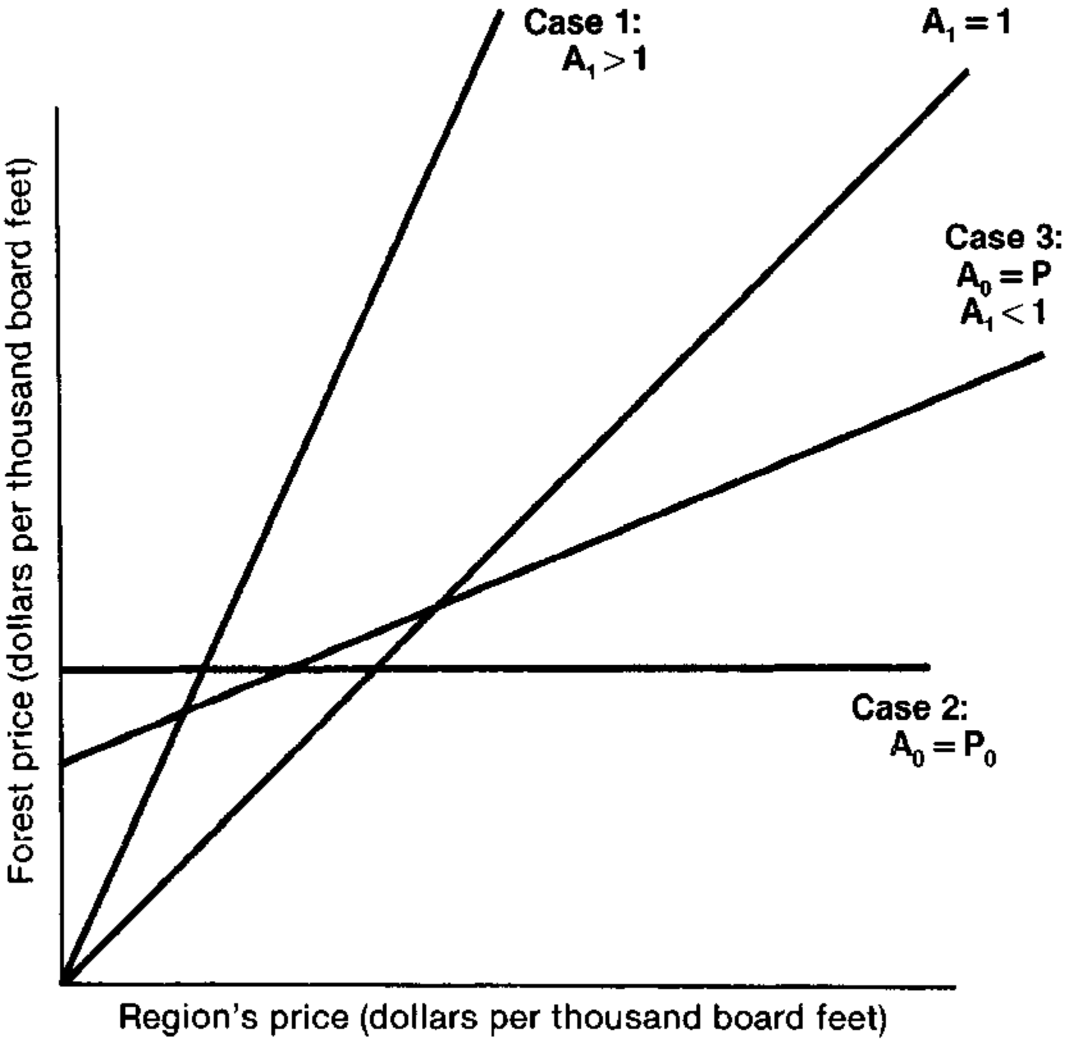

Figure 2.—Possible relationships between Forest price and the Region's price.

Case 1. The Forest price is some constant proportion of Reqion's price if the estimate of A_0 is not significantly different from zero (at, say, the 0.05 level). There are three possibilities in this case: (1) A_1 may be not significantly different from 1 if Forest and Region's prices are the same, (2) A_1 may be significantly greater than 1 if the Forest price increases more than the Region's price (fig. 2), or (3) A_1 may be significantly less than 1 if the Forest price increases less than the Region's price. Tf any of the above is the case, one could assume that the proportion would remain constant in the future and the rate of real price increase from tables 3-5 could be directly applied to the current price of the species to obtain the future price.

Case 2. The Forest price is a constant if the estimate of A_1 is not significantly different from zero but the estimate of A_0 is significant. Constant Forest prices should also be used in the rare instance where neither A_0 or A_1 are significantly different from zero. If this is the case, it may be best to assume that the real price of stumpage for the particular species will remain constant through time. Therefore, none of the price increases in tables 3-5 will be applicable.

Case 3. The Forest price is a combination of the first two cases if A_0 and A_1 are both significantly different from zero. Projections of Forest prices are obtained by substituting projections of the Region's stumpage prices into equation (4).

The procedure requires some judgment on the part of the analyst; for example, if the estimated relationship had negative rather than positive coefficients implied in figure 2 or if the relationship is nonlinear. In either case, the analyst needs to judge how well the estimated relationship works for the likely range of prices. Further judgment is needed in assessing the assumption that historical relationships will continue unchanged through the projection period. For example, the price data for the Forest may have included cost adjustments for road construction that will not be applicable in the future. If road construction costs for the Region continue to influence the Region's prices for some time, there will be a fundamental or parametric shift in the relationship specified by éauation (4). Another example of the need for judgment would be to correct the bias caused as the average diameter of timber offered for sale in the future changes from the historical pattern.

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Appendix 1 Statistical relationships 1/ between prices for individual species and prices for major species

Region	Species	$\hat{B}_1$	$\hat{B}_2$	t_1 2/	t_2 2/	R^2
1. Northern	True firs	-4.60	1.00	-4.42	15.98	.93
	Western hemlock	-4.77	.99	-2.67	9.23	.82
	Cedars	1.62	1.13	.29	3.32	.38
	Western larch	1.35	1.33	.78	12.66	.90
	Lodgepole pine	-.85	.70	-.48	6.65	.71
	Ponderosa pine	4.06	1.45	1.13	6.70	.71
	Sugar and white pines	11.37	1.35	1.60	3.15	.35
2. Rocky Mountain	Douglas-fir	-1.79	.56	-1.16	6.06	.67
	True firs	.26	.33	.18	3.71	.43
	Lodgepole pine	-1.22	.53	-1.08	7.83	.77
	Ponderosa pine	3.73	.45	2.32	4.69	.55
	Spruces	-.26	.60	-.16	6.10	.67
3. Southwestern	Douglas-fir	-2.86	.94	-1.12	6.08	.67
	True firs	-3.54	.90	-1.99	8.40	.80
	Ponderosa pine	-.50	1.34	-.11	4.86	.56
	Spruces	-6.43	1.34	-1.30	4.51	.53
4. Intermountain	Douglas-fir	-8.43	1.28	-2.35	5.94	.66
	True firs	-10.26	1.46	-1.92	4.53	.53
	Lodgepole pine	-.90	.52	-.57	5.52	.63
	Ponderosa pine	-3.17	1.55	-.70	5.67	.64
	Spruces	-5.98	1.17	-1.79	5.78	.65
5. Pacific Southwest	Incense-cedar	-41.08	2.09	-2.06	4.74	.55
	Douglas-fir	-1.26	.82	-.46	13.62	.91
	True firs	-6.26	.55	-1.75	6.99	.73
	Lodgepole pine	-12.84	.60	-1.47	3.09	.35
	All other species	11.46	.25	.85	.83	.04
6. Pacific Northwest: West side	Hemlock	.67	.48	.15	8.56	.86
	All other species	4.53	.33	1.55	9.17	.87
East side	Lodgepole pine	3.37	.15	1.36	2.74	.36
	All other species	2.52	.42	1.22	8.96	.86

1/Linear relationships were estimated in all cases.
2/student's "t" ratio for testing whether the coefficients ($\hat{B}_1$ and $\hat{B}_2$) are significantly different from zero. Significant (5-percent level) test results require a "t" ratio greater than 2.10 for Regions 1-5 and 2.16 for Region 6.

Appendix 2

TREES

Common name	Scientific name
Douglas-fir	Pseudotsuga menzlesll (Mirb.) Franco
True firs:	
Red fir	Abies magnifica A Murr.
Grand fir	Abies grandis (Dougl. ex D. Don) Lindl.
Noble fir	Abies procera Rehd.
Silver fir	Abies amabilis Dougl. ex Forbes
White fir	Abies concolor (Gord. and Glend.) Lindl. ex Hildebr.
Subalpine fir	Abies lasiocarpa (Hook.) Nutt.
Western hemlock	Tsuga heterophylla (Raf.) Sarg.
Western redcedar	Thuja plicata Donn ex D. Don
Western larch	Larix occidentalis Nutt.
Lodgepole pine	Pinus contorta Dougl. ex Loud.
Ponderosa pine	Pinus ponderosa Dougl. ex Laws.
Jeffrey pine	Pinus jeffreyi Grev. and Balf.
Sugar pine	Pinus lambertiana Dougl.
Western white pine	Pinus monticola Dougl. ex D. Don
Spruce:	
Engelmann spruce	Picea engelmannll Parry ex Engelm.
Sitka spruce	Picea sitchensis (Bong.) Carr.
Incense-cedar	Libocedrus decurrens (Torr.)

The **Forest Service** of the U.S. Department of Agriculture is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives — as directed by Congress — to provide increasingly greater service to a growing Nation.

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