HARDWOOD TIMBER SALES ON STATE FORESTS IN INDIANA: CHARACTERISTICS INFLUENCING COSTS AND PRICES

J. Michael Vasievich, W. L. Mills, Jr. and Heidi R. Cherry[1]

Abstract: Timber sales conducted on State-owned forests in Indiana from 1982 to 1994 were analyzed to determine changes in costs and prices and the effect of sale conditions on costs and prices. The data set included 445 sales that ranged in size from less than 1 acre to more than 500 acres. Sales were predominantly partial cuts in mature hardwood timber. Marked timber volume was less than 5 Mbf (thousand board feet) per acre for most sales. Some sales included other methods, such as clearcutting or seedtree harvests, on some or all of the sale area.

Direct costs for planning and conducting timber sales averaged $8.19 per Mbf, excluding overhead. This represented 3.9% of the high bid. Direct sale costs per Mbf increased only slightly from 1982 to 1994, about 0.1% faster than inflation over the period. Bid prices averaged $181 per Mbf over the time period and rose by 3.77% faster than inflation.

Linear regression was used to identify sale characteristics that significantly affect costs and prices. Analysis showed that much of the variability in direct costs and bid prices per Mbf could be explained by available information for each sale. The r-square values were 0.74 for direct costs and 0.91 for high bid. Sale date, contract length, percent preferred species, total number of trees sold, and number of trees sold per acre all increased direct costs per Mbf for conducting sales. Total sale volume and volume per acre were negatively correlated with costs, indicating economies of scale. For stumpage prices, sale date, total sale volume, and percent preferred species were positively correlated. Size of sales in acres, number of culls, and number of trees in the sale reduced bid prices per Mbf. Although not a useful predictor of price, the number of bids was positively correlated with per unit price.

INTRODUCTION

Marketing and harvesting timber is one of the most important tools used to achieve forest management goals (Callahan and others 1979, Flick 1985). The market value of timber is influenced by many factors, including market conditions, location, site conditions, type and quality of timber offered, and conditions of the sale. Knowledge of how these factors affect the market value of particular timber offerings can be used to determine fair market values and set minimum acceptable bids, estimate bid prices prior to sale, and identify strategies to craft more profitable timber sale offerings. Understanding how changes in harvesting and management practices can affect sale price is important to increased profitability of forest management investments. Information on the costs of managing timber is essential for cost-effective harvesting and management decisions, yet few published sources provide information on the costs of selling timber or describe the relationship between stand characteristics and timber sale economics. This information is particularly lacking for the high-value timber found growing in Central Hardwood forests where selective harvesting provides the financial means to achieve desired species mixes, accomplish regeneration objectives, and sustain productivity. Models developed for mixed sales in Wisconsin (Buongiorno and Young 1984) provide a starting point for this approach.

Most experienced foresters who regularly sell timber are aware of the many factors that influence timber sale values. However, most do not have quantitative estimates of these factors, and their effect on both the costs of conducting

[1]The authors are Project Leader, North Central Forest Experiment Station (NCFES), USDA Forest Service, 1407 S. Harrison Road, East Lansing, MI 48823; Professor of Forestry, Purdue University, West Lafayette, IN 47907; and Forester, NCFES, East Lansing, MI.

timber sales and the resulting timber prices. In this paper, we describe an empirical analysis of the costs and revenues derived from mixed hardwood timber sales in Indiana. Our approach follows hedonic price theory, which indicates that the market value of goods such as timber are determined by their characteristics (Prescott and Puttock 1990, Puttock and others 1990, Rosen 1974). This approach, as we have applied it, considers how different attributes of a timber sale, such as volume, quality, and sale conditions, contribute to the cost of conducting sales and market price. This method, sometimes termed statistical transaction appraisal (Vasievich and others 1988), uses statistical procedures to quantify the relationship between sale characteristics and prices for a set of actual timber sale transactions.

Our primary objective was to describe the characteristics of a typical set of Central Hardwood timber sales and to quantify the effect of timber sale factors and site conditions on the costs of conducting timber sales and the prices that are paid for those sales.

DATA AND METHODS

Data for this study were taken from 445 individual timber sale reports from State Forests in Indiana[2] as shown in Figure 1. The timber sale reports (Indiana Department of Natural Resources form SF-200) contained information on timber sale characteristics, volume of timber sold by species, and resources used and costs associated with conducting each timber sale such as tree marking, boundary marking, sale preparation, advertising, and showing the sale. Also included was information on the number of bids and the price offered by each bidder. The sale reports contained a general description of the purposes and management objectives for the sale and factors that were considered limitations.

The 445 sales available for analysis were offered from mid-1982 to mid-1994 as shown in Table 1. Sales were sold by competitive bid, and most represented partial harvests of mixed hardwoods (Figure 2) with individual trees marked for cutting. Although specific timber sale objectives differed, information contained on the sale forms indicated that common goals were to sustain and increase stand productivity through the harvest of mature trees and to remove undesired trees. Sales ranged in size from 1 to more than 500 acres. Timber volume sold ranged from less than 1 Mbf per acre to more than 25 Mbf per acre. Several sales had very high volumes per acre, but all these were small – less than 3 acres. Timber sales composed primarily of cut logs were excluded from analysis as were sales with missing data and outliers that represented extremely high priced sales. We recorded information on sale date, size, volume and number of trees sold, volume of preferred species, length of cutting contract, number of bids, high and low bid values, and various costs for administering the sale. We also reviewed comments on marking objectives and silvicultural methods. This information helped us identify factors that could affect costs and prices.

[2] We gratefully acknowledge the assistance of Dr. Burnell C. Fischer and staff of the Indiana Division of Forestry, Indianapolis, IN for providing timber sale reports and additional information required for this study.

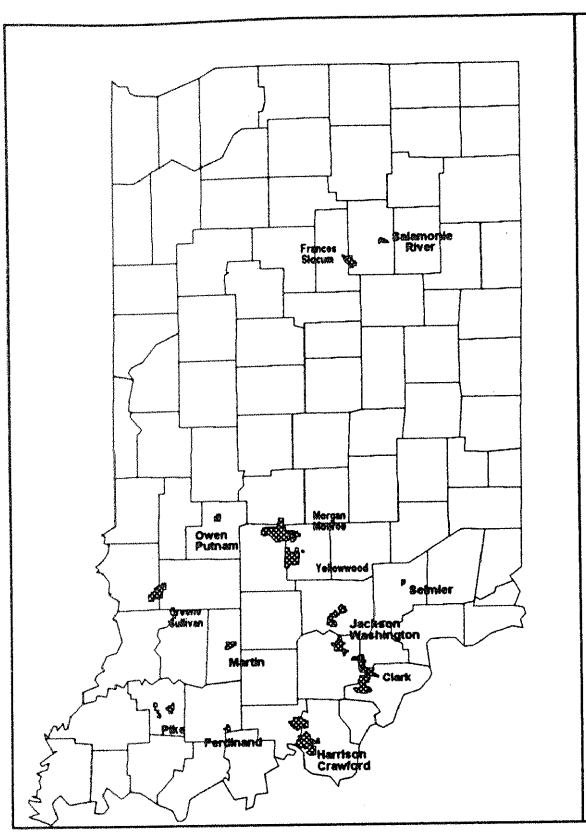

Figure 1. Location of State Forest lands in Indiana included in timber sale cost analysis.

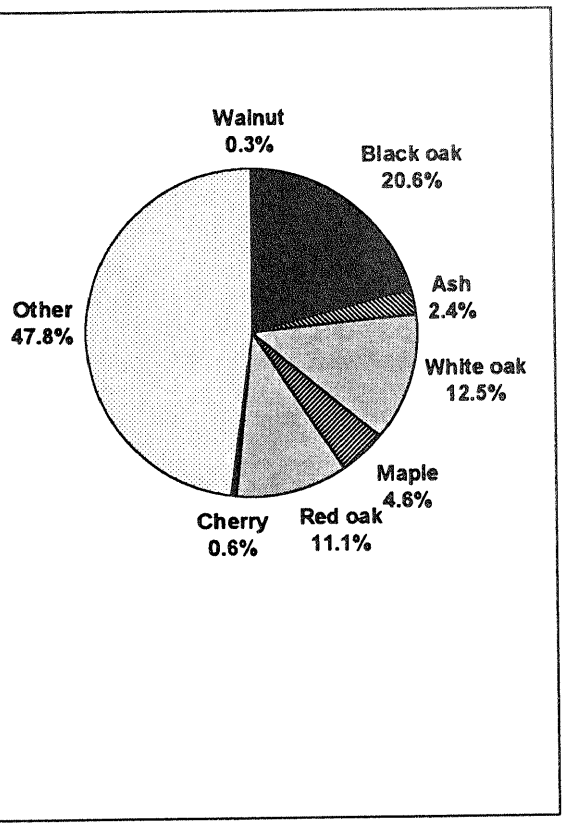

Figure 2. Distribution of timber volume sold, by species.

Table 1. Number, area, and volume sold of 445 hardwood timber sales in Indiana by State Forest

Forest	Sales	Sale area			Volume sold		
		Average	Minimum	Maximum	Average	Minimum	Maximum
	Number	------- Acres -------			------- Mbf -------		
Clark	32	101.3	12	359	149.9	11.0	338.0
Deam Lake	1	13.0	13	13	23.0	23.0	23.0
Ferdinand	33	60.6	1	240	109.6	13.0	377.0
Frances Slocum	5	49.2	25	80	68.6	40.0	137.0
Greene Sullivan	3	28.3	25	32	107.3	75.0	150.0
Harrison-Crawford	46	98.1	5	537	123.7	6.0	334.0
Jackson-Washington	45	64.6	2	209	111.5	2.0	408.0
Martin	30	68.0	2	158	119.7	3.0	245.0
Morgan Monroe	78	96.1	7	213	154.6	18.0	378.0
Owen Putnam	29	73.4	14	200	120.4	33.0	223.0
Pike	18	45.9	1	88	70.5	22.0	165.0
Salmonie	3	50.0	20	100	68.7	37.0	116.0
Selmier	3	38.3	16	58	95.0	60.0	132.0
Wyandot	4	115.0	33	280	77.0	58.0	108.0
Yellowwood	115	67.2	3	294	117.9	8.0	411.0
All sales	445	76.3	1	537	122.6	2.0	411.0

Timber sales averaged 76.3 acres in size with 122.6 Mbf (Table 2). Sale volume averaged 2.0 Mbf per acre and approximately 206 board feet per tree. The distribution of volume sold per acre is shown in Figure 3, and the distribution of sizes of sales is shown in Figure 4. Fifty-two percent of all volume sold over the period was represented by seven species we considered preferred for market purposes. These included walnut, red oak, white oak, white ash, black cherry, maple, and black oak. More than 40 other hardwood and softwood species made up the remaining volume, including various hickories, butternut, other oaks, yellow poplar, beech, sycamore, sweetgum, elms, bigtooth aspen, sassafras, basswood, cottonwood, hackberry, persimmon, river birch, other ashes, soft maples, black locust, honey locust, black gum, buckeye, and Kentucky coffee tree. Softwoods included on sales were white, Virginia, and red pines, and Eastern redcedar. The sale reports also identified the volume of timber in each sale considered prime—the best veneer quality of desired species. This averaged less than 1% of the total sale volume for all sales.

Table 2. Average timber sale characteristics for 445 timber sales on Indiana State forests

Year	Sales	Sale area	Volume	Volume	Trees sold	Average volume	Preferred species	Prime timber	Cutting period
	Number	Acres	Mbf	Mbf/ac	Number	bf/tree	%	%	Months
1982	14	58.0	89.6	1.6	436	205	45.0	1.4	11.1
1983	36	98.3	131.5	1.8	617	213	48.4	1.0	11.2
1984	35	81.6	118.1	1.7	554	213	55.9	0.4	11.2
1985	44	84.7	135.5	1.9	691	196	53.0	0.5	11.9
1986	52	77.0	136.0	2.2	679	200	49.9	0.4	12.3
1987	45	69.4	132.8	2.0	635	209	48.2	0.2	11.3
1988	42	70.5	119.6	3.0	557	215	52.0	0.5	11.8
1989	40	61.0	112.7	2.5	583	193	47.9	0.4	11.4
1990	41	77.7	111.5	1.6	527	212	49.8	0.4	11.5
1991	37	88.2	123.9	1.9	611	203	44.8	0.4	10.8
1992	26	62.6	107.8	1.7	501	215	51.8	0.6	11.7
1993	23	67.3	108.7	1.7	465	234	53.0	2.6	12.0
1994	10	87.1	145.8	1.7	776	188	59.5	1.4	12.5
All	445	76.3	122.6	2.0	594	206	50.3	0.6	11.6

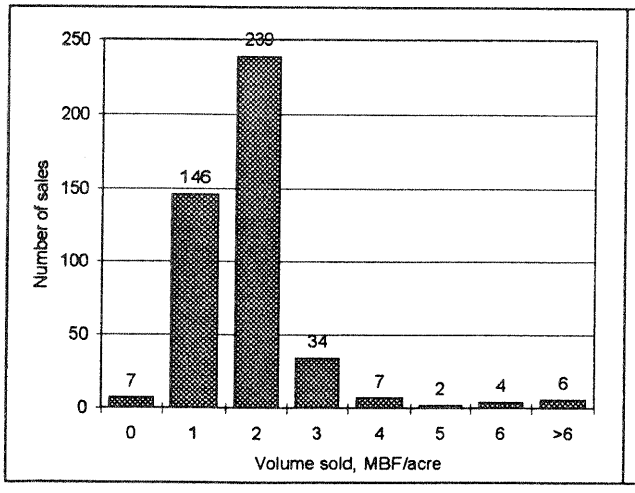

Figure 3. Distribution of timber sales by volume per acre.

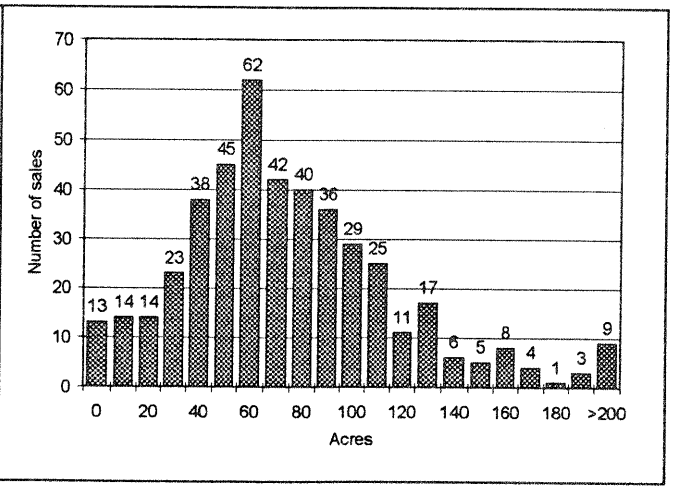

Figure 4. Distribution of timber sales by size of sale.

Timber Sale Costs and Revenues

Timber sale bids ranged from less than $50 per Mbf to more than $500 per Mbf and averaged $181 per Mbf for all sales as shown in Figure 5. The average timber sale was sold for $22,209 for 122.6 Mbf. The average sale attracted 3.3 bids. High bids averaged 175% of low bids (Table 3).

Table 3. Average timber sale revenues and volume characteristics for 445 mixed hardwood timber sales in Indiana

Year	Sales	Volume sold	Volume sold	Sale price	Unit price	Bids	Bid spread
	Number	Mbf	Mbf/ac	$/sale	$/Mbf	Number	%
1982	14	89.6	1.6	12,050	126	3.2	164
1983	36	131.5	1.8	19,666	135	3.4	162
1984	35	118.1	1.7	18,598	152	2.9	139
1985	44	135.5	1.9	16,938	130	2.9	154
1986	52	136.0	2.2	19,329	138	3.1	156
1987	45	132.8	2.0	23,323	173	4.0	167
1988	42	119.6	3.0	26,831	214	3.4	168
1989	40	112.7	2.5	24,701	213	4.6	355
1990	41	111.5	1.6	20,559	192	3.0	160
1991	37	123.9	1.9	19,146	161	3.6	171
1992	26	107.8	1.7	27,884	258	3.7	165
1993	23	108.7	1.7	30,752	272	2.3	128
1994	10	145.8	1.7	45,688	347	2.4	142
All	445	122.6	2.0	22,209	181	3.3	175

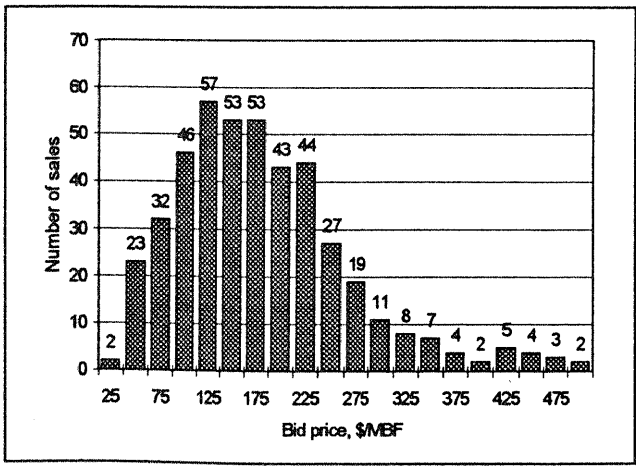

Figure 5. Distribution of timber sales by price per Mbf.

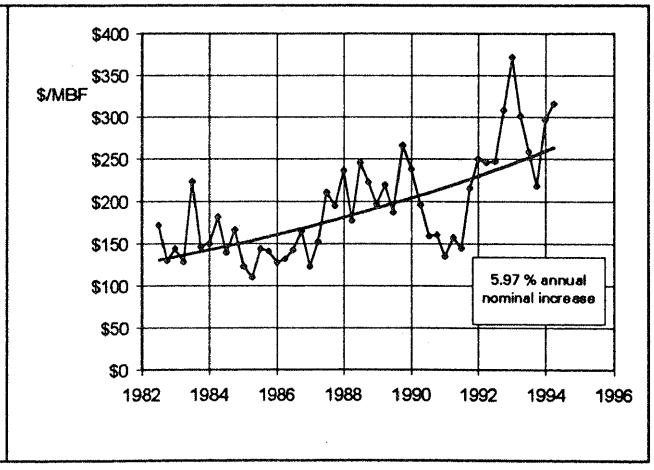

Figure 6. Average bid price for all sales by year and quarter in $/Mbf.

Average total costs for conducting timber sales were $1,348 per sale, or about $11 per Mbf (Table 4). Most sales cost less than $15 per Mbf, but a few were more costly, as indicated in Figure 7. Direct costs represented 64% of total sale costs or about $869 per sale on average. Other costs, mostly related to road construction, maintenance, and site improvements, added $479 per sale. Timber marking made up the greatest proportion of total costs, 71% of all direct costs, as shown in Table 5 and Figure 8. Other components included paperwork at 11% of direct costs; boundary marking, 7%; advertising, 5%; and showing the sale, 6%.

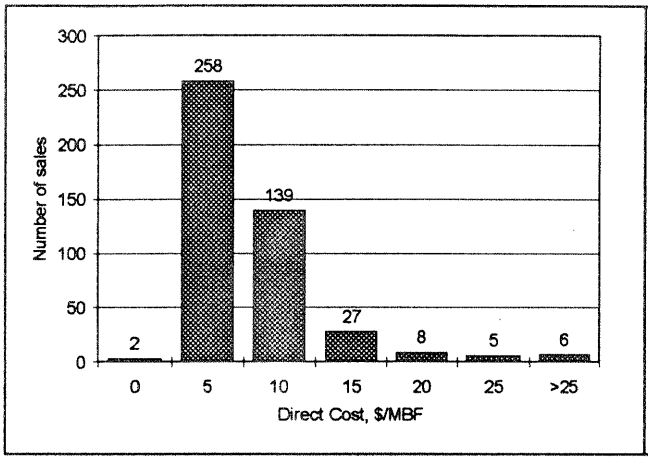

Figure 7. Distribution of sales by cost in $/Mbf.

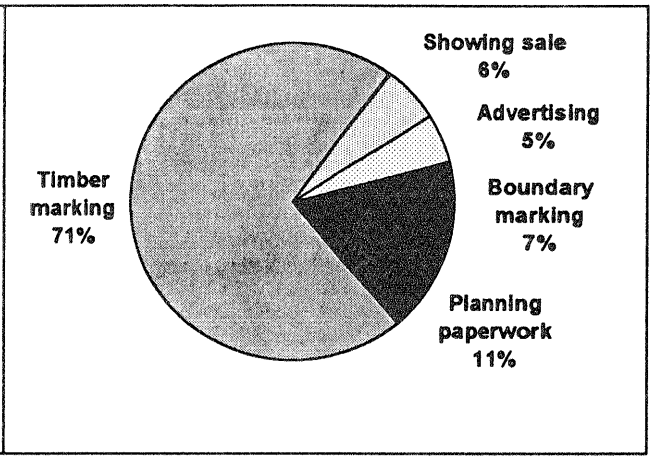

Figure 8. Distribution of sale costs by activity.

Table 4. Average timber sale costs for 445 mixed hardwood sales in Indiana

Year	Sales Number	Sale area Acres	Total costs $/sale	Direct costs $/sale	Direct costs $/Mbf	Direct costs % of sale
1982	14	58.0	926.86	682.11	13.93	5.66
1983	36	98.3	1,113.70	833.12	7.82	4.24
1984	35	81.6	1,003.50	819.43	9.15	4.41
1985	44	84.7	1,011.54	874.83	6.96	5.17
1986	52	77.0	1,040.42	852.41	7.50	4.41
1987	45	69.4	1,491.71	1,004.50	7.72	4.31
1988	42	70.5	1,338.80	905.12	9.19	3.37
1989	40	61.0	1,422.05	783.70	8.44	3.17
1990	41	77.7	1,317.05	795.52	8.05	3.87
1991	37	88.2	1,950.97	930.51	7.42	4.86
1992	26	62.6	1,607.93	870.86	8.11	3.12
1993	23	67.3	1,430.14	817.47	7.50	2.66
1994	10	87.1	3,202.67	1,256.15	9.40	2.75
All	445	76.3	1,348.20	868.89	8.19	3.91

Table 5. Average costs by timber sale activity

Year	Sales	Planning paperwork	Boundary marking	Timber marking	Advertising	Showing sale	Other costs
	Number	$/sale					
1982	14	359	48	53	64	41	245
1983	36	557	58	58	96	50	281
1984	35	561	57	52	98	51	184
1985	44	634	38	54	93	56	137
1986	52	602	59	47	88	55	188
1987	45	688	71	40	102	102	487
1988	42	614	60	53	97	81	434
1989	40	540	68	51	101	37	625
1990	41	464	50	39	78	60	522
1991	37	602	45	40	101	83	1,020
1992	26	633	49	47	107	35	737
1993	23	563	39	58	95	64	613
1994	10	915	28	67	148	99	1,947
All	445	589	54	49	96	63	478

Rates of Change for Costs and Prices

Costs and prices reported for the set of timber sales were analyzed to determine rates of change for the period mid-1982 to mid-1994. Linear regression methods were used to fit a log-transform model—Ln(price) = a + b(year)—to determine the annual rate of change in prices. Selected values were also adjusted for inflation with the Producer Price Index. Results are shown in Table 6. Producer prices rose by 2.2% per year over the analysis period. During the same time, average timber prices increased at a compound annual rate of 5.97% and 3.77% faster than inflation as indicated in Figure 6. Total sale costs rose by 6.09% per year after adjusting for inflation. Direct costs (i.e., planning, marking, showing, and advertising the sale, excluding other costs) increased by only 0.11% per year over inflation, indicating that other costs included on the sale report increased substantially faster than inflation.

Table 6. Rates of price change for timber sale costs and bid prices, before and after adjusting for inflation

	Nominal rate of value change	Real rate of value change
	%/year	%/year
Bid price, $/Mbf	5.97	3.77
Total sale cost, $/Mbf	6.09	3.89
Direct sale cost, $/Mbf	2.31	0.11
Producer Price Index	2.20	NA

Effects Of Sale Conditions On Costs, Prices, And Number Of Bids

Stepwise regression was used to fit linear models based on sale characteristics for effects on costs, bid price, and number of bids received. Seven models were fit for four dependent sale variables: total sale cost in $/Mbf (Total cost); direct sale costs, (excluding other costs) in $/Mbf (Direct cost); high bid price in $/Mbf (High bid); and number of bids (Bids). Models fit with intercepts did not perform as well as models without intercepts and are not reported.

We tested two measures of sale cost—total cost and direct costs. The total cost model included extraordinary costs that generally represented site or road improvements or maintenance. For the direct cost model, we considered only the costs directly associated with setting up and administering each sale.

Separate price models were fit for high bid without adjusting for inflation (referred to as nominal in Table 7) and after adjusting for inflation with the producer price index (referred to as real in Table 7). These high bid models were also fit with the number of bids included and excluded as an independent variable. The number of bids is not known prior to sale closure, so this variable would not normally be available for predictive models. We hypothesized that additional competition as reflected by a higher number of bids would lead to higher market prices. So, we included the number of bids for real and nominal price models to test the effect of added competition on price.

The final dependent variable, the number of bids, was estimated to identify those sale characteristics that increased sale attractiveness for buyers and contributed to higher levels of competition.

We tested 11 sale characteristics, listed below, as independent variables. We did not have information on some variables, such as access or distance to markets, that we expect would also be useful price determinants.

ACRES	Acres in the sale
CULLS	Number of cull trees included in the sale
CUTLEN	Length of cutting contract, months
MBFVOL	Total sale volume in Mbf
MONTHS80	Date of the sale as number of months since January 1, 1980
PCTPRSP	Percent of sale volume in preferred species (walnut, red, white, and black oak, ash, cherry, and hard maple)
TREES	Number of trees included in the sale
TREESAC	Number of trees sold per acre
VOLACRE	Sale volume in Mbf/acre
PCTPRIME	Percent of sale volume identified on sale report as prime
BIDS	Number of bids

We selected these variables because they were likely to affect the effort or costs associated with preparing the sale or harvesting timber, because they represented practical economic aspects of operating timber sales, and because most were measured continuous values (as compared to categorical data) and were well documented on the sale forms. We expected the number of culls to reduce average timber quality and be negatively correlated with bid prices. Higher volumes give buyers greater harvesting efficiencies and reduce average transaction costs per unit volume for the buyer. Higher sale volumes also lead to higher marking costs. So, we expected volume sold to be positively correlated with price, but negatively correlated with costs. We expected and found some interactions between variables too. For example, the number of trees offered in a sale was highly correlated with total sale volume. But more trees for the same volume indicated smaller timber and higher logging costs. We found that the number of trees in a sale was negatively related to price, all else being constant.

Results of our statistical analyses are shown in Table 7. Simple linear models performed quite well and resulted in coefficients of determination (r-square) values ranging from 0.71 to 0.93. The signs and magnitudes of the parameter estimates provide some useful insights into the timber sale process and market dynamics. All variables, except PCTPRIME were significant in one or more models. Three variables, CULLS, MBFVOL, and PCTPRSP were significant in all models. Variables were retained in models if they were significant at the 0.10 level.

Table 7. Parameter estimates for models of costs, bid price, and number of bids based on sale characteristics variables only

Independent Variable	Total costs	Direct costs	High bid (nominal)	High bid (real)	High bid (nominal)	High bid (real)	Bids
	$/Mbf	$/Mbf	$/Mbf	$/Mbf	$/Mbf	$/Mbf	Number
ACRES			-0.27697	-0.24563	-0.25610	-0.19601	
CULLS	0.00867	0.00417	-0.09663	-0.08461	-0.08110	-0.06691	-0.00179
CUTLEN	0.02866	0.01922					0.00192
MBFVOL	-0.07149	-0.04868	0.53018	0.48583	0.38913	0.33403	0.00720
MONTHS80	0.06373	0.02043	0.91657	0.62803	0.87551	0.55163	
PCTPRSP	-0.03060	0.03060	2.11453	2.12859	1.66378	1.68779	0.03715
TREES	0.00661	0.00427	-0.06783	-0.05483	-0.05776	-0.04827	
TREESAC		0.08476					0.09820
VOLACRE		-0.43446			-2.20020		
BIDS					11.51625	11.47334	
R-square	0.71	0.74	0.91	0.92	0.92	0.93	0.79
MSE	60.74	24.32	3512.07	2629.50	3107.41	2216.60	3.14

We included a variable for time in the model—MONTH80—the date of the sale represented as the number of months since January 1980. This variable served as a simple linear trend term to account for increases in costs and prices over time. MONTH80 was significant and positive for all cost and price models.

Two models were fit to describe sale costs—total costs that included other additional costs mostly related to road access and site improvements and direct costs. The direct cost measure included only costs for marking, showing, advertising, and planning the sale. The other cost component added a significant amount of variability. The model fit for direct costs was substantially better than for total costs and had a higher r-square as well as a mean-squared error (MSE) of less than half of the total cost model. Total sale volume was negatively correlated with costs in $/Mbf indicating the significance of economies of scale. Each additional thousand board feet in the sale reduced average direct costs by 4.9 cents and total costs by 7.1 cents. The coefficient for volume per acre was also negative, indicating lower direct costs for sales with higher volumes per acre. Some sales represented clearcuts, diameter limit cuts, or creation of openings on part or all of the area, and these had generally lower sale administration costs. The coefficient for percent of volume in preferred species (PCTPRSP) was positive for direct costs only. This effect—higher average costs—may indicate greater attention and marking effort for sales with higher amounts of the most valuable species. The coefficient for MONTH80 was positive and significant for all cost and price models, reflecting a general trend of increasing costs and prices.

Two models were fit for bid price—one without the number of bids and one with the number. The number of bids was significant and positive indicating a strong effect due to competition. Each additional bid added approximately $11.50 to the high bid per Mbf. However, including the number of bids increased the model fit only slightly, pushing r-square up by about 0.01. This was not surprising because we found that much of the variability associated with number of bids (as evidenced by the bid model) was explained by independent variables already included in the price models. Percent prime timber volume in the sale was not significant for any model. Percent of the sale in preferred species was positive and added more than $2.12 per Mbf to the high bid for each 1% increase in the combined seven preferred species. Number of trees in the sale was negatively correlated with bid price. This may be due to possibly smaller average tree size in sales with higher numbers of trees, but this has not been otherwise tested. Number of culls in the sale also showed a negative coefficient for all price models. A large number of culls is often seen by buyers as an indicator of lower quality or defect in trees with volume leading to lower value. Volume per acre was significant with a negative coefficient in the nominal price regression that included the number of bids. Interpretation of this negative effect is not clear and may be due to interactions between several independent variables or specific characteristics of this set of timber sales.

A model was fit for the number of bids to analyze sales that attract more competition. The model fit resulted in an r-square of 0.79. Sale volume, percent preferred species, trees per acre, and cutting contract length were all positive, indicating that sales with higher volumes, more trees, higher proportions of the most desirable species, and longer timeframes attract more bidders. Number of culls had a negative coefficient, indicating that including more culls in a sale would reduce the number of potential buyers.

We tested subjective management variables such as the harvesting method, management objective, and cutting restrictions as independent dummy variables (0/1). Models with these variables produced inconclusive results and are not reported in detail here. Several difficulties were apparent. Many measures of cutting method or sale limitations are highly subjective, and we could not effectively differentiate among sales. In most cases, sales included multiple silvicultural objectives, cutting methods, and limitations. We could not determine the extent to which any single method or limitation affected most sales.

Some interesting findings did result, but are inconclusive largely because most sales included a mixture of conditions and methods. Direct costs were $5 less per Mbf for sales where clearcutting was indicated as one of the harvesting methods used for the sale. Selection thinning and seedtree cuts were positively correlated with total costs and direct costs, respectively. These sales require more timber marking effort and increase costs by an estimated $6 to $10 per Mbf. The greatest effect of these variables on bid prices was due to salvage cuts. The high-bid price for salvage cuts was from $48 to $56 lower per Mbf. Several cutting methods and limitation variables appeared in the model for number of bids. We found that substantially more (2.5) bidders were, on average, willing to bid on sales where the seedtree method was indicated. Fewer bidders were interested in sales with poor quality timber or pre-salvage sales. Also, more bidders were interested in sales we classified as having an age restriction—either young or overmature. Sales of overmature timber may have larger and more valuable timber, on average. Although these observations can not be statistically verified for these sales, they do suggest some additional areas for consideration for other analyses.

SUMMARY

Our analysis of 445 Central Hardwood timber sales on State Forests in Indiana provides insights into the dynamics of timber markets operating primarily in southern Indiana. These forests are managed by the Indiana Department of Natural Resources to produce hardwood sawtimber. Most sales involved partial cutting that favored release of crop trees, systematic removal of culls, and harvest of mature sawtimber trees. Sales averaged 76.3 acres with 122.6 Mbf. The average tree had 206 board feet. Fifty-two percent of the volume sold was in seven preferred species we considered preferred: white, red, and black oak; white ash; black cherry; hard maple; and walnut.

The average sale was for $22,209 and $181 per Mbf. We found that prices for hardwood sawtimber generally increased in both real and nominal terms over the 1982 to 1994 time period, but that the price path demonstrated typical increases and decreases we have observed in hardwood sawtimber markets in other areas. Prices for these high-quality hardwood sawtimber sales increased almost 4% faster than inflation. Sales attracted an average of 3.3 bids each, and the high bid was 175% of the low bid for the typical sale.

Direct costs for conducting these timber sales averaged $8.19 per Mbf and $869 per sale. This included labor and materials for planning and administering the sales, but excluded overhead costs for forest administration and post-sale follow-up. Hence, these figures are likely to underestimate the total costs for conducting these sales by as much as 25 to 40% (our estimate). Additional costs for improvements and maintenance items added another $479 in cost to each sale. Most direct costs, about 71%, were for timber marking, a key management action requiring skilled personnel.

We statistically analyzed 11 site and sale conditions to determine their effect on sale costs, bid prices and number of bids. We were able to explain most of the variability in per unit costs and prices with simple linear models. Model coefficients indicate the comparative effects of sale conditions on cost, price, and number of bids. For total and direct costs in $/Mbf, we found that eight variables were statistically significant at the 0.10 level. R-square was 0.71 for the total cost model and 0.74 for the direct cost model. Six independent variables were significant for all price

models. Acres, number of culls, and number of trees had negative coefficients. Volume sold, sale date, and percent of volume in preferred species had positive coefficients. R-square for price models ranged from 0.91 to 0.93. Models describing real and nominal bid prices performed similarly. We found that sales with higher numbers of bids contributed significantly to higher prices and that each additional bidder added $11.50 per Mbf to the high bid price.

We estimated the number of bids as a function of number of culls (negative), cutting contract length, sale volume, sale date, percent preferred species, and trees per acre. R-square was 0.79 for this model.

Although we have not verified the predictive ability of these models, they are useful in judging the relative value of alternative timber sale configurations. We expect that additional analysis of these sales to refine model formulations would yield more useful predictive models. This analysis involved timber sales conducted only on State Forests in Indiana. We caution readers that these results, while illustrative of timber markets in one place, are not necessarily applicable to other ownerships or locations.

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