

# Trends in southern forest harvesting equipment and logging costs

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## Abstract

Southern timber harvesting equipment and on-road vehicle costs were obtained for the years from 1967 to 1984. Average cost trends for equipment and vehicles were determined for the period. Average logging contract rates and price trends were also estimated. Comparisons indicated that equipment costs increased more than the general inflation rate and less than the prices of other industrial commodities. Logging costs have increased less than logging equipment prices and both measures of inflation, which indicates increased productivity during the period.

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The costs associated with harvesting timber are a continual concern to foresters and loggers. Logging costs directly concern procurement foresters (who pay loggers) and the contract rates received affect loggers (who hope to profit in their business). This paper summarizes and analyzes historical data on timber harvesting equipment costs and logging costs. Trends in equipment and logging costs are compared with the general rates of inflation, and implications for the logging industry are discussed.

## Data

### Equipment prices

Logging equipment prices were gathered from various sources for this study. Delivered purchase price data were obtained from Cabbage (1), Cabbage and Werblow (2), and Plummer (10), who gathered their data from surveys of equipment dealers throughout the South. Table 1 summarizes price information collected by year and equipment type. A weighted average price was calculated for each year that data were available for woods equipment, road equipment, and all equipment, with weights being assigned in proportion to the purchase prices. In this analysis, only the equipment

commonly used in the South was selected to determine the weighted average prices. Price trends were then calculated based on this weighted index. This procedure prevented incidental or seldom used equipment from disproportionately influencing the analysis of price increases.

### Logging costs

Data on logging costs or logging contract rates per se are not published on a regular basis, but they can be derived from secondary sources. Timber Mart-South (4,5) has reported average prices for stumpage and delivered-to-the-mill wood products in the South since 1976. The difference between the two is a measure of logging costs. Also, the State of Louisiana has published stumpage and delivered prices for sawtimber and pulpwood in the State since 1955 (9,12). For comparison, logging cost measures were calculated from 1967 to 1984 for Louisiana pine pulpwood and sawtimber, and from 1976 to 1984 for Timber Mart-South pine pulpwood and sawtimber (Table 2).

The difference between stumpage and delivered price represents more than harvesting cost per se. It also includes handling and transportation expenses for delivery to the mill and the profit made by the logging contractor. Margins for pulpwood and sawlogs may not fully reflect the total harvest margin if significant amounts of other products, such as poles and plywood bolts, are

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TABLE 1. — Average equipment purchase prices by category and year.

Equipment category	1967	1972	1974	1976	1979	1980	1982	1984
	----- (\$) -----							
Chain saw—straight blade <sup>a</sup>	200	260	300	340	440	460	425	550
Feller-bunchers								
Small rubber-tired, 65 to 80 Hp <sup>a</sup>	--	--	--	37,000	42,000	55,000	57,000	75,000
Med. rubber-tired, 83 to 100 Hp <sup>a</sup>	--	--	--	--	70,000	73,000	86,000	85,000
Large rubber-tired, 110 to 130 Hp	--	--	--	--	--	--	99,500	109,500
Large limited-area tracked <sup>a</sup>	--	40,000	75,000	90,000	120,000	120,000	--	188,000
Small bulldozer with shear <sup>a</sup>	--	30,000	36,000	60,000	65,500	65,500	79,000	--
Cable skidders								
Small, 70 to 85 Hp <sup>a</sup>	16,000	--	--	--	40,000	--	--	51,000
Medium, 86 to 115 Hp <sup>a</sup>	--	19,000	23,000	29,200	46,000	41,000	56,000	62,000
Large, 116+ Hp	--	--	--	--	60,000	--	--	70,000
Grapple skidders								
Small, 70 to 100 Hp	--	--	--	--	48,000	--	--	70,000
Medium, 101 to 129 Hp <sup>a</sup>	21,000	29,000	34,000	54,000	62,000	62,000	79,000	89,000
Other skidders								
Tracked cable skidder	--	--	--	--	180,000	--	--	115,000
Clambunk skidder	--	--	--	--	--	--	--	225,000
Farm tractor	5,500	6,500	9,000	--	27,000	--	--	36,000
Forwarders								
Shortwood, 80 to 100 Hp <sup>a</sup>	--	18,000	28,000	38,500	40,000	44,000	45,000	63,500
Longwood, 110+ Hp	--	22,000	32,000	50,000	55,000	58,000	--	75,500
Slasher/Delimiters								
Small hydraulic chain slasher	--	--	--	5,850	6,000	6,000	10,000	11,500
17 ft. iron gate delimeter	--	--	--	--	1,700	1,700	2,200	2,400
Loaders								
Bigstick cable <sup>a</sup>	800	1,500	1,500	2,500	2,500	2,500	3,500	3,700
Small hydraulic knuckleboom <sup>a</sup>	10,000	12,500	16,000	20,000	24,000	27,000	29,000	27,300
9,000 to 15,000 lb. max. lift								
Medium knuckleboom <sup>a</sup>	--	14,000	26,000	30,000	38,000	42,000	46,000	60,000
15,000 to 23,000 lb. max. lift								
Front end fork loader <sup>a</sup>	--	35,000	35,000	41,000	54,000	58,000	72,000	--
Whole-tree chippers								
Medium, 18 to 20 in.,	--	--	--	--	82,000	82,000	122,000	137,000
300 to 400 Hp								
Large, 20 to 23 in.,	--	--	--	128,000	160,000	174,000	215,000	229,000
500+ Hp <sup>a</sup>								
Road work equipment								
Small bulldozer, 80 Hp <sup>a</sup>	15,000	28,000	32,000	55,000	65,000	66,000	77,000	61,000
Medium bulldozer, 140 Hp	--	--	--	--	75,300	--	--	125,000
Road grader, 135 Hp	--	--	--	--	65,000	--	--	116,000
Trucks								
Dead tandem bobtail <sup>a</sup>	3,500	6,200	8,000	11,000	11,800	14,800	17,500	19,500
Live tandem bobtail <sup>a</sup>	9,000	13,000	14,000	15,500	19,000	19,000	24,000	27,500
Diesel truck-tractor <sup>a</sup>	18,000	24,000	26,000	41,000	44,000	48,000	53,000	70,000
Small pickup <sup>a</sup>	2,000	2,800	3,800	4,300	6,000	6,000	8,000	9,000
Large service/crew truck	--	--	--	--	25,000	5,000	30,000	30,000
Trailers								
Shortwood frame trailer <sup>a</sup>	4,000	3,800	5,000	6,500	7,600	8,500	10,400	11,000
Pole trailer <sup>a</sup>	4,000	2,500	5,000	6,000	7,000	8,000	9,500	10,000
Chip van	8,000	--	8,000	9,200	12,500	13,000	14,500	19,000
Lowboy	--	--	--	--	7,600	--	--	14,000

Source: Plummer (10) 1967 to 1977 and 1980 to 1982; Cabbage (1) for year 1979; equipment dealers for 1984.

<sup>a</sup>Equipment items used to calculate the South's weighted average cost increases.

sorted and sold and do not have separately identified stumpage prices. But with increased tree-length logging and merchandising at mill sites, the latter may not be a serious problem. With the bulk of the timber harvest cut and sold as pulpwood and sawlogs, the difference between delivered and stumpage prices for these products is a reasonable approximation of contract rates for har-

vesting. As such, it is a relevant measure of harvest cost for much of the timber cut in the South. Variations among regions or the components of logging costs may affect the accuracy of the derived measures for any individual year. But for historical trends, these fluctuations would not deleteriously affect estimation of aggregate rates of cost increases.

TABLE 2. — Average southern logging costs and general inflation rates, 1967 to 1984.

Year	Difference between stumpage and mill prices for southern pine (logging costs)				Inflation measurement	
	Timber Mart—South		Louisiana Market Report		GNP Deflator	PPI-Industrial
	Pulpwood (\$/CD)	Sawtimber (\$/MBF)	Pulpwood (\$/CD)	Sawtimber (\$/MBF)		
1967	--	--	11.90	21.70	76.06	100.00
1968	--	--	12.35	22.90	82.54	102.50
1969	--	--	13.10	22.10	86.79	106.00
1970	--	--	13.05	22.00	91.45	110.00
1971	--	--	--	24.90	96.01	114.10
1972	--	--	14.50	26.80	100.00	117.90
1973	--	--	17.30	31.00	105.75	125.90
1974	--	--	22.25	33.70	115.08	153.80
1975	--	--	22.85	36.00	125.79	171.50
1976	22.80	41.20	23.75	36.90	132.34	182.40
1977	22.80	41.60	24.55	40.90	140.05	195.10
1978	23.20	38.30	26.75	44.90	150.42	209.40
1979	25.30	35.90	29.65	40.30	163.42	236.50
1980	28.40	45.80	31.15	41.40	178.42	274.80
1981	28.40	40.30	31.55	59.40	195.60	304.10
1982	29.20	42.80	32.65	62.90	207.38	312.30
1983	31.40	50.80	32.75	65.60	215.34	315.70
1984	32.90	57.50	25.15	68.50	223.38	322.60

### Inflation rates

The Gross National Product (GNP) implicit price deflator and the Producer Price Index for Industrial Commodities (PPI-Industrial), as published in the Economic Report of the President (13), were selected to reflect inflation during the time period (Table 2). These indexes are representative of inflation in the overall economy (GNP) and the industrial sector (PPI-Industrial).

### Analyses

Because data for each set of prices cover different periods of time depending on how long the time series information had been collected, trends were determined using the longest price series available. Using the preceding costs, the average annual percentage rates of increase were calculated using the standard compounding formula of:

$$V_n = V_0 (1 + i)^n$$

where:

- $V_n$  = value in last year (usually 1984)
- $V_0$  = value in first year
- $n$  = number of years between first and last years
- $i$  = interest rate

In this case  $V_n$ ,  $V_0$ , and  $n$  are known, so solving for  $i$  yielded the average annual increase for equipment prices, logging costs, and inflation. Average interest (inflation) rates were determined for each piece of equipment and weighted averages were determined by equipment class (in-woods or road equipment), product class (pulpwood or sawtimber), and inflation index class (GNP deflator or PPI-Industrial). Essentially, the interest rates derived measure the average inflation rate between two points in time, i.e., 1967 and 1984 or 1972 and 1984.

The average inflation rate between two points in time is one method to determine the trend in price increases, but does not use all the statistical data available for analysis. Essentially, the preceding measures use only two points in time— $V_0$  and  $V_n$ . Alternatively,

trend analysis is a more statistically efficient procedure for determining annual growth rates, which can be used if enough data are available. It uses regression analysis and the prices for each year to determine the average rates of increase throughout the period. In order to find the trend growth rate, the equation is linearized by taking the logarithm of the data. The model is fit by regressing the log of price over year. Solving for the trend growth rate involves taking the antilog of the slope estimate and subtracting 1 to determine the average interest throughout the time period (3).

This procedure was also applied to the equipment cost, logging cost, and inflation measures when there was adequate data for a regression. Again, trend rates of inflation were determined for each piece of equipment and weighted average inflation rates were calculated by equipment class. Table 3 summarizes the average inflation rates computed using both methods for all the data.

In order to test the possibility that the South-wide averages for Timber Mart data were unrepresentative, or distorted the state-by-state trends, pulpwood and sawtimber logging costs for each state were deflated using the GNP implicit price deflator. This provided a conservative measure of whether real logging cost trends for each state were decreasing or increasing. It could also be compared to the South-wide averages calculated above and to the prices derived from the Louisiana Quarterly Market Report.

### Results

Nominal prices for forest harvesting and road equipment have increased dramatically since 1967. Purchase prices increased at least fourfold from 1967 to 1984. Of course, the nominal prices of most other goods have increased as well. Are loggers and wood buyers doing better or worse?

The results from this analysis indicate that forest harvesting equipment prices increased at rates similar to prices for general goods and producer goods. Using the discounting formulas to calculate point-to-point es-

timates from a beginning and ending year, logging equipment consistently had greater purchase price increases (1.1% to 2.2% per year, depending on the equipment price series used) than the general inflation rate (GNP deflator) and the PPI-Industrial (0.3% to 0.8% per year). Trend analysis of the time series data indicated that harvesting equipment inflation was considerably greater than the general inflation rate (1.1% to 1.6%, depending on the equipment series) but slightly less (0% to 0.5%) than that of the PPI-Industrial. These results were consistent for all equipment classes and time periods analyzed. Cost increases for highway vehicles were slightly less than for in-woods equipment. Tufts et al. (11) also found that harvesting equipment prices tracked the general inflation rate and were less than PPI-Industrial.

The costs of logging equipment have increased at rates considerably greater than the prices received by loggers. Timber Mart-South logging cost trends increased at 4.9 percent and 3.3 percent annually for pulpwood and sawtimber, respectively, from 1976 to 1984; Louisiana price increases were 2.2 percent and 8.7 percent per year from 1967 to 1984. Trend-line inflation rates for these periods varied from 7.2 percent to 8.3 percent. The compounded year-to-year increase calculations yielded similar results. The cost increases for all but Louisiana sawtimber harvesting were significantly less than inflation and equipment cost increases—almost half as much. This implies that real (inflation-adjusted) logging costs have decreased substantially since 1967.

The GNP deflator was used to gauge trends in real logging costs for pulpwood and sawtimber in each southern state. Point-to-point estimates of increases in real costs from 1977 to 1983 in each southern state confirm the South-wide and Louisiana trends just calculated. For the 13 southern states, including Kentucky, the derived average sawtimber and pulpwood real logging costs decreased in 21 of the 26 time series. Overall, the average South-wide real price decrease for sawtimber was \$8.17 per thousand board feet; for pulpwood \$2.32 per cord. The only real cost increases for logging occurred

for sawtimber in Louisiana and Oklahoma, and for pulpwood in North Carolina, Oklahoma, and Texas. The Louisiana Timber Mart sawtimber and pulpwood logging cost difference trend also moved in the same direction with respect to inflation as did the margins derived from the Louisiana Market Report.

The findings of decreased real logging costs are corroborated by other studies. Hassler et al. (7) found that logging equipment prices in Minnesota had increased more than logging fees. They concluded that this reflected general productivity increases in logging, rather than a reduction in profitability. Herrick (8) found that the adoption of mechanized whole-tree chipping in the Northeast led to a substantial decrease in logging costs.

### Conclusions

This study indicates that when measuring inflation, better results are obtained using trend analysis to determine annual cost increase rates. Trend analysis avoids the bias inherent in measuring increases between only a beginning and an ending year. The use of both trend analysis and point-to-point estimation indicates that costs for purchasing logging equipment have increased significantly in the last 15 years. For the types of equipment commonly used in southern harvesting operations, equipment price increases since 1967 have exceeded annual inflation rates as measured by the GNP price deflator and were slightly less than the PPI-Industrial.

Because data for logging costs are not published on a regular basis, an indirect measure was calculated from secondary sources. This derived measure of logging costs is subject to limitations, particularly in precise cost estimation at a point in time. The stumpage prices in Timber Mart are reported predominantly by forest consultants and are probably representative of bid sales (6). Mill prices are reported mostly by wood dealers, who have considerable experience and knowledge of local markets. The difference between these two prices may vary somewhat from contract rates established by firms negotiating cutting contracts. If reporting procedures are

TABLE 3. — Average annual percent increases for equipment prices, logging costs, and inflation rates.

Cost item index	Average from initial year to 1984				Trend for time period through 1984			
	Initial year				Initial year			
	1967	1970	1971	1976	1967	1970	1971	1976
	----- (%) -----							
<b>Purchase prices</b>								
In-woods equipment	--	--	8.9	--	--	--	8.8	--
Highway vehicles	7.4	--	--	--	8.3	--	--	--
All logging equipment	--	8.8	--	--	--	8.7	--	--
<b>Logging costs</b>								
Timber Mart-South								
Pulpwood	--	--	--	4.7	--	--	--	4.9
Sawtimber	--	--	--	4.3	--	--	--	3.3
Louisiana								
Pulpwood	4.5	4.8	--	0.7	2.2	6.2	5.4	2.6
Sawtimber	7.0	8.5	--	8.0	8.7	8.0	7.8	8.6
<b>Inflation indexes</b>								
GNP deflator	6.3	6.6	6.7	6.8	7.2	7.1	7.3	7.3
PPI-Industrial	7.1	8.0	8.3	7.4	8.3	9.1	9.3	8.3

consistent over time, however, the differences can be used for analyzing trends and making comparisons with changes in price or cost indexes. Results from the Timber Mart and the Louisiana Market Report generally indicated that logging costs have decreased in real terms over the periods examined. Additionally, the findings of significant real price decreases were consistent among 21 of the 26 Timber Mart state price series and were also consistent between the Timber Mart and Louisiana price series. This consistency supports the validity of using these derived logging costs to measure trends in prices.

The finding that equipment costs increased much more than logging costs is significant. The smaller increases for logging costs indicate that loggers have increased productivity or are receiving lower profit margins, or both. Profits per unit may decline, but a larger total profit may result from increased volume.

If logging productivity has increased, it probably is attributable to improved equipment. Few, if any, formal logger training programs exist that could have helped to increase regionwide productivity. The educational level of loggers, however, may have improved, and the changing industry structure (fewer, larger operations) may have resulted in better management practices.

Grapple skidders and feller-bunchers are examples of new types of logging equipment designed to improve productivity. But there have also been improvements in the performance and reliability of traditional equipment. Both types of equipment improvements have resulted in increased costs, but the costs have been more than offset by increased productivity. Therefore, the research,

development, and adoption of equipment improvements reduced real logging costs for the southern forest industry.

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