LOGGING PRODUCTIVITY AND COSTS IN THE SOUTH: TRENDS AND CAUSES[1]

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ABSTRACT.--Trends in forest harvesting equipment costs, labor costs, and harvesting costs in the South since the 1960's are summarized based on data collected from available price reporting services. Equipment costs and wage rates have generally increased at a rate greater than that of inflation in general but less than that of industrial commodities. Logging costs have increased at a rate considerably less than inflation. This indicates that logging productivity has increased significantly in the last two decades.

INTRODUCTION

Harvesting productivity and costs are priority concerns for the forest products industry. Productivity gains are needed to offset rising costs of personnel, materials, and equipment. How well these factors are combined by management will determine logging costs for individual operations and affect the competitiveness of the industry.

This paper examines recent trends in productivity and costs for labor and machines involved in harvesting timber in the South. First, the development of modern logging methods and mechanization will be reviewed. Second, the available data on logging labor and equipment productivity and costs are summarized. Third, the trends in average southern logging costs are determined. Based on this data, the overall trends in and causes for changes in southern logging productivity and costs are discussed.

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HISTORICAL LOGGING METHODS AND MECHANIZATION

Before World War II, logging in the South was performed by labor-intensive methods. Trees were usually felled and bucked in the woods using crosscut and bow saws. Sawtimber and pulpwood were hauled from the woods using horses or mules, either as individual trees or using pallet skids that held stacked pulpwood. Once at the deck, sawlogs were loaded by using elevated ramps to pull it up across the bed of a truck or by A-frame with cables and winches. Pulpwood harvested at this time was often cut with hand saws, delimbed and bucked in the woods, and piled in flat stacks or in "teepees." Small 2- or 3-axle straight (bobtail) trucks would then drive to the woods and 2 persons would hand load the pulpwood bolts onto the truck. In the 1950's, the use of pulpwood pallets was introduced. These allowed loggers to stack bolts on steel frames in the woods, which could later be winched onto a straight truck or trailer, either directly in the woods or after being pulled to the roadside by a bulldozer.

Simple loading by rollaway (hand) and elevated ramps has now given way to efficient, modern, hydraulic loaders. Earlier methods included crosshaul, and some type of cable hoists. Front-end wheel loaders were introduced in 1950's and the cable (bigstick) loader was generally replaced by the hydraulic knuckleboom, beginning in the 1960's. From the 1950's to the present, roads and trucking equipment have improved, leading trucks to gradually supplant railroads as the primary means for log transport in the South.

The gasoline-powered chain saw has become the most widely-used tool in logging. Most early saws were very cumbersome and could not cut trees well. Over time, many loggers, inventors, machinists, and engineers worked at developing and improving the

chain saw. Charlie Wolf developed and marketed a forerunner to the modern chain saw in 1920. In Germany, Andreas Stihl was working in reducing the size and weight of the portable saw. Some of these saws were imported to the United States during World War II when there was a great demand for powered saws for the woods. Efficiency increased greatly with the development of a unique saw chain by Joe Cox in the 1940's (Lucia 1981). Development of the first light-weight chain saws in the early 1960's facilitated their use for cutting pulpwood and delimbing.

The first wheel tractors were four-wheel-drive trucks with Ackermann steering. An articulated forest tractor was developed in 1955 in eastern Canada, while a concurrent development was being made in the Pacific Northwest (Silversides 1966). The tractors were used either as forwarders, which carried shortwood on elevated bunks, or as ground skidders, which dragged longwood with cables. Development of bundled wood forwarders had been tried unsuccessfully with rigid-frame wheel tractors. The articulated wheel tractor became an ideal carrier. Concurrent with the development of an articulated machine was the introduction of the integral arch, which permitted the lifting of logs with steel cables. "Chokerless" skidders were introduced in the 1960's. Chokers were replaced with grapples on a fixed boom or on a swing boom. They were more efficient, especially for pulpwood, once feller-bunchers were adopted, because they allowed skidders to carry more small stems at once than could be choked with cables. Most grapple skidders sold now also have factory-installed cables as well.

Portable chippers were developed in the early 1950's but did not become popular until the 1970's. Several versions of portable chippers have been manufactured in response to a need or regional application. Their use is still limited by a small demand for the dirty chips that are produced in the woods.

Tree shears were introduced in the 1960's also. The early shears were directional felling devices. After mechanical felling was accepted, holding arms were added to accumulate, transport, and bunch trees. Mechanized felling led to development of multi-functional machines to mechanize shortwood harvesting. These machines felled, delimbed, bucked, and bunched. Others were developed to fell and delimb whole trees. In general, however, these machines have not been widely adopted.

Canada had systems in which all functions were completely mechanized in the mid-60's. These systems either had multi-functional machines or several single-functional machines. The past trends, as well as future prospects for mechanization in Sweden are summarized in figure 1. These trends generally parallel the mechanization of timber harvesting in North America and the southern United States, except the South has relied more on rail and less on river transport.

Despite adoption of new equipment, many labor-intensive operations remain in use. Cubbage (1982) found that bobtail systems are still the

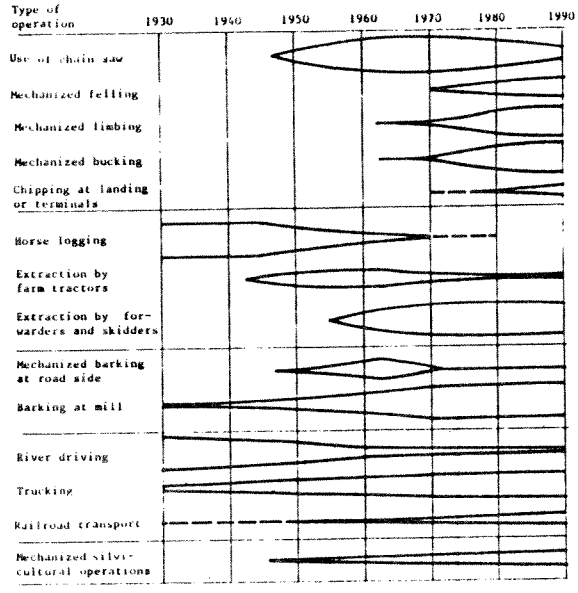

Figure 1. Trends in Logging Mechanization. Source: Skogsarbeten 1980.

lowest average cost producers for pulpwood on very small tracts. Even large operations in the Coastal Plain usually have at least one cable skidder. Rough or swampy terrain reduce the productivity of rubber-tired feller bunchers and grapple skidders, so less mechanized systems may be more cost-efficient. Large trees, hardwoods, and high-value species are still harvested with chainsaws, in order to prevent butt damage.

PRODUCTIVITY AND COSTS

A uniform, well constructed data base for logging productivity and costs does not exist. Thus, one must use various secondary measures to roughly estimate these factors.

Labor

PRODUCTIVITY.--Productivity is an important measure of the success of mechanization. Although often expressed in terms of labor productivity, such as output per employee or person-hour, it actually represents the output resulting from the entire set of resources used in the production process.

Changes in output per employee in the United States, the South, and Louisiana were calculated for the periods reported by the Census of Manufactures (U.S. Bureau of Census 1967-1982), as shown in Table 1. Output was measured by value of shipments data, adjusted for price changes by the PPI-All Commodities index. Productivity in all areas increased from 1967 to 1977, but showed a decline for the most recent period because 1982 figures reflect recessionary conditions. The Louisiana logging industry had the best record. Greater capital investment resulted in higher productivity relative to the South and the U.S.

TABLE 1.--Average annual growth rates in output per employee in timber harvesting, 1967-1982.

Area	1967-1972	1972-1977	1977-1982	1967-1982
U.S.	5.5	7.1	-2.4	3.3
South	6.3	8.1	-2.7	3.8
La.	3.9	10.7	-1.1	4.4

COSTS.--Periodic data on employment and earnings in the logging industry are also contained in the Census of Manufactures. Table 2 shows various measures of labor cost and capital expenditures for the logging industry. Total payroll costs per employee and wage rates for production workers have increased steadily since 1967; however, payroll as a percent of value added has generally declined.

Value added is the amount remaining after the cost of stumpage is subtracted from the revenue received from product sales. This must cover all the expenses of operation and a margin for profit. A declining ratio of payroll to value added is indicative of an increasing importance of capital to labor. New capital investment per employee increased rapidly from 1967 to 1977, but 1982 levels were down due to the severe recession that year. The logging industry in Louisiana has performed best in reducing payroll as a percent of value added and increasing the level of capital investment.

TABLE 2.--Historical Timber Harvesting Labor Costs and Investment from Census of Manufactures Data, S.I.C. Code 2411.

Year	Payroll per Employee (dollars)	Wage/Hour Production Workers (dollars)	Payroll as % of Value Added (percent)	New Capital Investment Per Employee (dollars)
		SOUTH		
1967	3,550	1.77	45.2	1,204
1972	4,955	2.63	42.9	1,612
1977	9,813	5.07	40.3	4,135
1982	10,908	6.23	42.1	2,787
		LOUISIANA		
1967	3,810	1.79	39.6	1,429
1972	5,583	2.72	39.6	1,917
1977	10,045	5.65	43.5	5,136
1982	12,600	7.05	36.0	4,680
		UNITED STATES		
1967	4,799	2.44	48.7	1,438
1972	6,549	3.52	45.0	1,962
1977	12,113	6.58	41.7	4,640
1982	14,931	8.27	48.3	3,109

Equipment

PRODUCTIVITY.--Based on a 1976 pulpwood producers survey reported in Watson et al. (1978), we calculated the average weekly production rates and firm assets for the different systems shown in Table 3. The systems ranged from labor-intensive to highly mechanized.

The number of personnel in each firm increased as the mechanization level increased. As mechanization increased, the output per week increased, as did the weekly production per person. Output per amount of capital invested decreased with increasing mechanization. The 1976 survey did not include feller-buncher systems, which would have increased production for systems with grapple skidders. However, a 1980 survey made specifically of 123 high volume southern wood producers found that systems using rubber-tired feller bunchers and grapple skidders harvested an average of 400 cords per week (Weaver et al. 1982). This data provides additional evidence that mechanized systems are more productive. Today, mechanized high-volume producers probably constitute an even greater share of southern pulpwood production capacity.

COSTS.--Data on southern forestry equipment prices have been published over a period of years by Plummer (1967-1982), Cubbage (1982) and Werblow and Cubbage (1986). To determine historical price trends for this equipment, price data were summarized by year and equipment type (Cubbage and Werblow 1985). The equipment commonly used in the South was selected to form a weighted average index to determine average price increases over time. Weights were assigned according to the purchase prices for each piece of equipment.

Logging Costs

Data on logging costs or logging contract rates per se are not published in any references, but they can be derived from secondary sources. Timber Mart South (1985) has reported average southern prices for stumpage and delivered-to-the-mill wood products since 1976. The difference between the two is a measure of logging costs. Also, Louisiana has published stumpage and delivered prices for sawtimber and pulpwood state since 1955 (Louisiana Department of Agriculture 1967-1984, Ulrich 1985). 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.

COST TRENDS

Using the above information, the average trend in labor, equipment, and logging costs and for inflation was calculated for the years for which data were available (Table 4). Regression analysis was used to estimate average annual rates of increase for all but the labor costs, which were calculated by determining the simple internal rate of return.

TABLE 3.--Average Weekly Southern Pulpwood Production Rates for Selected Harvesting Systems, 1976. Source: Adapted from Watson et al. 1978.

Harvesting System	No. Firms	Characteristic Equipment	Average Number of Employees	Approximate Average Assets 1979 dollars	Average Weekly Production cords	per person	per $10,000
Shortwood:							
A Manual Bobtail	398	Straight Truck/Hand Loading	1.6	3,800	16	10.0	42.1
B Big Stick Bobtail	2880	Straight Truck/Bigstick Loader	1.8	5,700	21	11.7	36.8
C Farm Tractor/Bobtail	1105	Straight Truck/Bigstick/Farm Tractor	2.0	29,500	25	12.5	8.5
D Forwarder	329	Forwarder	3.4	49,000	55	16.2	11.2
E Skidder	142	Cable &/or Grapple Skidder/ Knuckleboom/Trailer	4.3	108,000	99	23.0	9.2
Longwood:							
F Cable Skidder	369	Cable Skidder/Knuckleboom/ Front End Loaders	4.8	150,000	132	27.5	8.8
G Grapple Skidder	20	Cable/Grapple Skidder/ Knuckleboom	6.9	250,000	201	29.1	8.0

TABLE 4.--Average Wage Rate, Equipment Price, Logging Cost, and Inflation Rates of Increase

Cost Item/Index	Trend from Initial Year to 1984 Initial Year 1967	1970	1971	1976
Payroll per Employee				
South	7.8	-	-	-
Louisiana	8.3	-	-	-
Equipment Purchase Prices				
In-Woods Equipment	-	-	8.8	-
Highway Vehicles	8.3	-	-	-
All Logging Eqpt.	-	8.7	-	-
Logging Costs				
Timber Mart South				
Pulpwood	-	-	-	4.9
Sawtimber	-	-	-	3.3
Louisiana				
Pulpwood	2.2	6.2	5.4	2.6
Sawtimber	8.7	8.0	7.8	8.6
Inflation Indices				
GNP Deflator	7.2	7.1	7.3	7.3
PPI-Industrial	8.3	9.1	9.3	8.3

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 (1985), were used to reflect inflation rates during the time period. These are representative of inflation in the overall economy (GNP) and the industrial sector (PPI-Industrial).

The weighted average rates of inflation calculated for purchase prices of in-woods equipment increased at an average rate of 8.8 percent per year from 1971 to 1984--the years for which data were available. Highway vehicles increased at a rate of 8.3 percent per year from 1967 to 1984, and all logging and highway equipment at 8.7 percent from 1970 to 1984. During the time period from 1967 to 1984, trend analysis indicated that the rate of inflation increased at 7.2 percent per year as measured by the GNP deflator and 8.3 percent for the PPI-Industrial index.

During all time periods, the costs for both logging equipment and labor generally increased at rates greater than the general inflation rate, as measured by the GNP implicit price deflator, but less than the Producer Price Index for Industrial Commodities. Equipment and labor costs have increased at rates considerably greater than the prices received by loggers. The cost trends for all but Louisiana sawtimber harvesting were significantly less than inflation, labor, and equipment cost increases--almost half as much. This implies that real (inflation-adjusted) logging costs have decreased substantially since 1967.

CONCLUSIONS

Costs for hourly wages and for purchasing logging equipment have increased significantly in the last 15 years. While neither the available wage rate or equipment cost data bases are without faults, they should provide a reasonable basis for estimating trends. The smaller annual price increases for logging costs than for its component factors indicate that loggers have increased their productivity greatly or are accepting lower profit margins. It could be both. Loggers can have a lower profit margin but still make more money from increased volume.

Overall, the results suggest that despite greater costs for labor and equipment, new harvesting equipment has increased logging productivity. Adoption of new logging equipment and improvements to existing equipment have decreased real logging costs, making the forestry sector more competitive. However, no new major equipment innovations seem imminent. For the near future, at least, it appears that refinements to existing equipment will prevail. In this situation, some gains in productivity will continue for the short term as more loggers move from the older, less productive systems to modern feller-buncher grapple-skidder systems. But better labor training and logging management are likely to be the long-term keys to continued productivity improvements in the logging sector. Let's hope we can capture this opportunity as we have with equipment development and adoption.

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