SAWMILL PRODUCTIVITY AND PERFORMANCE: NORTH AND SOUTH

Gilbert P. Dempsey

Abstract.--A single period assessment was made of the sawmill (lumber products) industry's operational structure and performance in 11 eastern states--6 northern and 5 southern. The northern states were predominantly grade hardwood lumber producers and operated in a mature market. Outputs of softwood dimension and lumber products dominated southern production and most states were in a combined growth and species transition mode.

During 1982, the 11-state industry produced 26 percent of the Nation's total output of lumber products. The south's industry was larger than the north's in production capacity, plant size, use of productive inputs, and receipts. The south led also in capital investment, number and quality of employment (such as the provision of higher wages and full-year employment), and labor and capital productivity. Material costs were relatively lower in the north, which also had the highest value added by manufactures.

Keywords: Economics (forest products industries), sawmills, north, south, productivity, performance, hardwoods, softwoods

INTRODUCTION

Sawmills are the basic link between a valuable and growing timber resource and the domestic and foreign users of lumber products. In a competitive economy, their effectiveness is crucial to the growth and development of timbering as well as to the secondary solid wood-using industries among locales, states, and regions. Given the sparsity of information on the industry's performance in the east, an exploratory study was done to discern the relative efficiency of the lumber-producing sawmills in 11 eastern states--both north and south.

The results provide an insight into the differences in productivity and performance within the sawmill industry especially with regard to materials, capital, and labor. In displaying these findings, I present a descriptive overview of the operational structure and performance of sawmills in two contrasting regions comprising six northern and five southern states. Included is a brief review of the industries' physical plant, gross outputs and inputs, and measures of productivity and general performance.

1/Economist, USDA Forest Service, Northeastern Forest Experiment Station, Forestry Sciences Laboratory, Princeton, West Virginia.
THE AREA

For comparison, the study area is divided into the northern (north) and southern (south) areas (Figure 1). They share many structural similarities but also differ in significant ways. The northern area comprises the states of New York, Pennsylvania, Ohio, Kentucky, West Virginia, and Tennessee. Since the late 1800's, these states have been predominantly hardwood lumber-producing areas. Their annual output of lumber products has been fairly stable over the past 30 years; except for exporting, their sawmill industries have been operating in a mature market.

Figure 1.—The northern and southern study areas.

The southern area consists of the states of Arkansas, Louisiana, Mississippi, Alabama, and Georgia. These states are predominantly softwood lumber producers. They also differ from the northern group in that over the past 30 years their annual output of softwood lumber products has been increasing and output of hardwood lumber decreasing. In effect, the sawmill industry in the south has been in both a growth and a species-transition mode.

Two general forest types predominate in the northern area: the northern and central hardwood forests. From New York southward, the northern forest types are characterized generally as Spruce-Fir-White Pine, Beech-Birch-Maple, and Northern Red Oak and White Oak. They contain many other important species, including cherry, ash, and hickory. The northern forest types are predominant in New York, Pennsylvania, and West Virginia and are prevalent in the Appalachian Mountains southward into northern Georgia. The central hardwood forest types predominate in Ohio, Kentucky, and Tennessee and also are found in the other northern-area states. Generally characterized as Red Oak-White Oak-Hickory and Shortleaf-Virginia-White Pine areas, they contain other important species such as yellow-poplar, ash, elm, maple, and walnut.

The southern forest types predominate in the southern area. However, the central hardwood species are prominent in the northern parts of all of the states except Louisiana. The southern types include the Shortleaf-Longleaf Pines, Loblolly-Slash Pines, Cypress, and Red Oak-White Oak-Pecan, and also include gum, white ash, and yellow-poplar.
PHYSICAL PLANT

In addition to the timber resource, an area's production facilities provide the foundation for the effective manufacture of solid-wood products. There are dramatic differences in the number and size of sawmills between the northern and southern areas (Figure 2). The southern area had significantly fewer sawmills in operation in 1986. However, it had a much larger proportion of its mills producing 1 million board feet (MMbf) or more annually. Most of the south's lumber output was derived from mills in the 10 MMbf and larger class. This is in sharp contrast to the northern area, where mills in the 2 to 10 MMbf class produce most of the lumber.

<table>
<thead>
<tr>
<th>Production (MMbf)</th>
<th>Southern Area (%)</th>
<th>Northern Area (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 &gt;</td>
<td>6.0</td>
<td>0.0</td>
</tr>
<tr>
<td>25 - 50</td>
<td>8.1</td>
<td>0.0</td>
</tr>
<tr>
<td>10 - 25</td>
<td>12.8</td>
<td>3.1</td>
</tr>
<tr>
<td>10 &gt;</td>
<td>(26.9)</td>
<td>(3.1)</td>
</tr>
<tr>
<td>5 - 10</td>
<td>23.2</td>
<td>12.7</td>
</tr>
<tr>
<td>2 - 5</td>
<td>32.9</td>
<td>41.6</td>
</tr>
<tr>
<td>1 - 2</td>
<td>17.0</td>
<td>42.6</td>
</tr>
</tbody>
</table>

Figure 2.—Sawmills by production class, 1986.

The most current information from the forestry division of each state shows an estimated 1,260 southern-area sawmills in operation during 1986. The majority (768) of these produced 1 MMbf or more of lumber products annually. By contrast, less than one-third of the northern area's estimated 3,300 mills (999) produced more than 1 MMbf of lumber per year. More important, 27 percent of the south's commercial mills produced 10 to 160 MMbf annually while only about 3 percent of the northern mills produced more than 10 MMbf of lumber during the year.

All of the south's largest mills—those producing 25 MMbf or more—were predominantly manufacturers of softwood lumber products. As in the north, none of the hardwood lumber sawmills were in the 25 MMbf and larger class. (However, with shift adjustments, several hardwood mills in both the south and north have the potential to produce at this level.) The remaining mills—those producing 1 to 25 MMbf—were (1) predominantly hardwood lumber producers in the north, and (2) combination hardwood/softwood lumber producers in the south whose prevalent output mix was strongly related to their location and its associated forest cover.
Three of the principal and most useful productive outputs available for measuring the industry's economic efficiency and socially desired performance are (1) physical products produced, (2) value received for products sold, and (3) value added by the manufacturing process. Excluding lumber production, the latest data available on these factors were obtained from the 1982 Census of Manufactures (USDC Bureau of Census 1985a) on sawmills and planing mills (SIC-2421). Data were reported for 1,425 northern area and 1,008 southern area plants. To a limited extent, the data interpretation has been influenced by results from the author's current work on 30-year trends in sawmill productivity in these states.

Lumber Products Output

In 1982, the southern-area states produced nearly 6 billion board feet of lumber products (USDC Bureau of Census 1985b), more than 3 times that of the northern area and one-fifth of the Nation's total output (Figure 3). The south's subclass composition was 83 percent softwoods and 17 percent hardwoods by volume, exactly the same as the U.S. sawmill industry but almost the direct opposite of the north's product output of 13 percent softwoods and 87 percent hardwoods. The southern area's average output of 5.9 MMBf per mill was about 25 percent larger than the mean production per U.S. mill and more than 4 times the output of the average hardwood mill in the northern area.

Northern States:
Total - 1,875 MMBf
Per mill - 1,385 MMBf

United States:
Total - 30,010 MMBf
Per mill - 4,751 MMBf

Southern States:
Total - 5,964 MMBf
Per mill - 5.917 MMBf

*USDOC estimates based on mills surveyed.

Figure 3.--Lumber output by area and U.S. sawmills, 1982.

Among the southern states, Georgia reported the largest output at 1.622 billion board feet (86 percent softwoods). Mean output per mill, however, was highest in Mississippi (7.2 MMBf) and the least in Louisiana (5.1 MMBf). In the north, Pennsylvania's predominately hardwood lumber industry (97 percent) led in total output with 416 MMBf, averaging slightly more than 1.1 MMBf per sawmill. West Virginia produced the least lumber among the northern states (252 MMBf) but averaged nearly 1.4 MMBf per mill. Species composition, a major factor affecting the size of mills, ranged from 71 to 98 percent hardwoods in the north and from 75 to 87 percent softwoods in the south.
Value of Shipments

In 1982, sawmills in the 11-state area shipped more than 7.8 billion board feet of lumber products valued at $2.8 billion. Shipments from the southern area states, while accounting for over 76 percent of the total volume of products sold, represented less than 73 percent of the value received. This was primarily a result of lower unit prices received. For example, the south's receipts for lumber products averaged $377 per thousand board feet (Mbf), ranging from $333/Mbf in Mississippi to $323 in Alabama. In contrast, the prices received in the north averaged $405/Mbf and ranged from $464/Mbf in Pennsylvania to $349/Mbf in Kentucky.

![Bar chart: Value of lumber product shipments, 1982.](chart)

In the south, Georgia had the highest value of shipments, $559.8 million, while Louisiana had the lowest, $188 million, (Figure 4). In the north, receipts for shipments totaled $759 million in 1982. Pennsylvania's mills, with the largest output and highest price received per unit sold, led in total shipments with $193 million. Average receipts per plant in the south ranged from $2.2 million in Georgia to $1.8 million in Louisiana. This was above the U.S. mill average of $1.6 million and far above the $533,000 average for hardwood sawmills in the north. However, there was less disparity in mean values of shipments per employee—$74,000 in the south and $54,000 in the north, though both shipped less per employee than the U.S. industry ($76,000).

Value Added

The dollar value added in lumber production—the value of shipments less the cost of all materials—varied significantly between the northern and southern areas, and among each area's states. Value added by sawmills was the highest in the north. It averaged 37.5 percent of the value of shipments and ranged from 45.9 percent in Ohio to 33.7 percent in Pennsylvania. The average value added in the south was 32.5 percent, ranging from 36 percent in Mississippi to 30 percent in Georgia. Such differences indicate higher material costs relative to prices received in the south and considerable variation in cost-price relations among states in both areas. On a product basis, the north averaged $153 per Mbf of value added compared with $109/Mbf in the south. Both compared favorably with the U.S. industry average of $108/Mbf.
FACTOR INPUTS

Labor Employment

Combined, the study area's sawmill industries directly employed over 41,000 people in 1982--27,200 in the southern industry and 14,000 in the north---and accounted for more than 31 percent of the Nation's total sawmill-industry employment. The southern labor force ranged from 2,900 in Louisiana to more than 6,900 in Georgia. In the north, employment ranged from 2,000 in Kentucky to about 3,300 in Pennsylvania. In contrast to nonproduction employees, who include managerial, technical, clerical, and other administrative workers, a majority of the labor force in both areas was composed of plant production workers--87 percent in the south and 84.5 percent in the north. However, the lumber industries in both areas were plant labor intensive compared with U.S. All Manufacturing (1.9:1 ratio). This indicates a much greater emphasis on managerial, technical, and transactional activities by general manufacturing.

<table>
<thead>
<tr>
<th>Area/Industry</th>
<th>Hours/Plant</th>
<th>Hours/Worker</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southern Area</td>
<td>46.1</td>
<td>1970</td>
</tr>
<tr>
<td>United States</td>
<td>34.8</td>
<td>1927</td>
</tr>
<tr>
<td>Northern Area</td>
<td>15.5</td>
<td>1866</td>
</tr>
</tbody>
</table>

Figure 5.--Production employment, lumber, 1982.

The typical southern area sawmill provided substantially more production worker employment than either the northern area or U.S. sawmills (Figure 5). It provided nearly one-third more hours of work than the average U.S. mill and almost 3 times that of the average plant in the north. More important from the production worker's perspective, southern mills provided a full year's employment while there were varying degrees of unemployment in U.S. and northern mills, and for U.S. All Manufacturing.

Labor Costs

In 1982, the total cost of sawmill industry labor ranged from more than $345 million in the south to about $155 million in the north. Due to a higher hourly wage, labor costs per hour worked were slightly greater in the south than in the north. But workers in both areas experienced a substantially lower total labor cost per hour than their counterparts in the U.S. lumber industry (Figure 6). The total hourly cost of labor includes wages paid and estimated legal and voluntary payments by employers attributable to labor. The average was $7.25 in the north, $7.79 in the south, and $9.97 in the U.S. lumber industry.
Material Costs

Materials constitute a major part of the total cost of producing grade hardwood and softwood lumber products. Broadly included are raw materials, contract logging and other production work, energy, operating supplies, and products bought and resold in the same condition. Within this scope, material costs in the 11-state area exceeded $1.7 billion--$1.35 and $0.37 billion in the southern and northern areas, respectively. Based on U.S. lumber industry expenditure patterns, raw materials and contract work accounted for an estimated 92 percent of total costs; energy accounted for 5 percent and resales nearly 3 percent. Due to site-specific price differences, material-cost composition would be expected to differ slightly among states and between areas.

As with lumber output, material costs per plant were widely divergent, ranging from an average of $1.3 million in the south to $0.32 million in the north. Expenditures ranged from a high of $392 million per year in Georgia to a low of $50 million in Ohio. But from a developmental perspective, there was less disparity in material costs when based on employment (Figure 7). For example, the mean expenditure for materials per employee in the south was $49,700 compared with $33,500 in the north; in the south, the range per employee was $42,000 (Louisiana) to $57,000 (Georgia); in the north, the range was $27,000 (West Virginia) to $41,000 (New York).

Figure 7.--Material costs, lumber, 1982.

Figure 8.--Capital investments, lumber, 1982.

Capital Input

The quantity and quality of capital inputs into the production process have become increasingly critical to a firm's effectiveness. This realization may be most evident in the southern lumber industry (Figure 8). In 1982, the southern sawmills invested more than $101 million in new machinery, equipment, plant structures, and other major alterations to plant capacity. An estimated additional $32 million were invested in used plant and equipment during this period. (These investments were over 18 percent higher per employee than those made by the U.S. lumber industry.) Given their emphasis on equipment as opposed to structures, these investments seemed to be substantially substitutions of capital for labor in the production process.
There were similar types of investments in the northern industry during 1982 but at substantially lower levels. Northern mills invested $34 million in both new and used plant and equipment, averaging about $2,421 per employee compared with more than $4,870 per worker in the south, where capital investment per employee ranged from $6,200 in Georgia to about $2,600 in Louisiana. In the north, the range was nearly $3,400 in Tennessee to $1,443 in West Virginia.

**Input Cost Perspective**

Figure 9 shows the relative cost of inputs into the lumber production process, each represented as a percentage of the production year's total value of shipments by area. As indicated earlier, material costs represented a larger proportion of the industry's total input cost in the south (70.2 percent) than in the north (66.2 percent). However, this margin widened (67.4 versus 60.4 percent) between the two areas when costs were measured against values received. This indicates a higher relative cost of materials (primarily, raw materials) in the south than in the north.

![Input Costs Composition](image)

Figure 9.—Input costs as percent of value received, lumber, 1982.

In direct contrast to material costs and irrespective of the southern area's higher wages, supplemental labor costs, and total hourly labor costs, labor commanded a significantly higher proportion (21 percent) of industry receipts in the north than in the south. This may be explained partially by the southern industry's traditional practice of substituting capital for labor in the production process. During the study year, firms in the south invested an amount equal to 6.6 percent of their value of shipments in new and used plant and equipment; this compares with 4.5 percent invested by northern firms.

Purchased services were estimated to provide a gross cost of operation, excluding debt service and unreported miscellaneous costs. The northern industry ended the production year with a larger percentage balance of unobligated receipts for debt service, taxes, and profit.

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PERFORMANCE

Productivity measures are standardized concepts that carry a common understanding. They measure the relationship between the quantity of resources used in the production process (inputs) and the quantity (or value in constant terms) of outputs. They are not precise measures of the efficiency of individual factors but are highly accepted and applied indicators of the efficiency of resource use.

Labor Productivity

Physical output per manhour (labor productivity) in the southern area's lumber industry was the highest of the two areas. At an average of 111.4 board feet per hour worked and assuming comparability, physical output was more than 56 percent greater than in the north but still was slightly below that of the U.S. industry average of 117.8 board feet (Figure 10). Stated another way, southern mills required about 9 manhours of labor to produce a 1,000 board feet of lumber products compared with 14 manhours in the north. Higher physical productivity combined with moderate wages also resulted in the south's sawmills attaining a lower unit payroll labor cost ($52.70) per Mbf of lumber produced than U.S. ($67.30) or northern ($82.27) mills.

<table>
<thead>
<tr>
<th>STATE</th>
<th>Labor Productivity</th>
<th>STATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern Area:</td>
<td>- - - bf/hr - -</td>
<td>Southern Area:</td>
</tr>
<tr>
<td>Ohio</td>
<td>86.6</td>
<td>Georgia</td>
</tr>
<tr>
<td>New York</td>
<td>82.1</td>
<td>Mississippi</td>
</tr>
<tr>
<td>Kentucky</td>
<td>77.4</td>
<td>Arkansas</td>
</tr>
<tr>
<td>W. Virginia</td>
<td>66.5</td>
<td>Alabama</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>66.2</td>
<td>Louisiana</td>
</tr>
<tr>
<td>Tennessee</td>
<td>60.0</td>
<td></td>
</tr>
<tr>
<td>Weighted Avg.</td>
<td>(71.2)</td>
<td>(111.4)</td>
</tr>
</tbody>
</table>

Figure 10.---Labor productivity in area and U.S. sawmills, 1982.

Capital Productivity

Returns to capital investments in machinery, equipment, and plant structures were greater in the south ($5.72 per manhour worked) than in the north ($4.99) and substantially higher than that for the U.S. industry at $4.78 per hour. However, returns to capital varied greatly among states within each area, ranging from $7.10 per manhour in Mississippi to $4.97 in both Alabama and Louisiana, and from $7.89 in Ohio to $3.81 in Tennessee. Although yet to be fully tested, it seems that in all of the states, returns to capital are highly correlated with their respective investments—or lack thereof—in new and used capital over the past 10 to 15 years as opposed to changes in labor and material costs.
THE TALLY

Value added, which is affected by output quality, provides a different insight into sawmill performance (Figure 11). In contrast to most other operating measures, the northern area's lumber industry had a higher average return to value added (37.5 percent) than the southern and U.S. lumber industries. This was due to materials in the north—particularly raw materials—being less costly relative to product values received than those in the south. However, due to labor intensity in the northern mills, this operational advantage was not sustained when measured by hours worked. Labor was relatively more costly in the northern sawmills. For example, a comparison of value added per hour worked shows that the northern mills averaged $10.88 per hour compared with $12.16 in the south. The deduction of hourly labor costs resulted in residuals for investment in labor or capital that were clearly to the south's advantage.

Figure 11.—Performance perspective by area and U.S. sawmills, 1982.

In sum, the 11-state area produced 26 percent of the Nation's output of lumber products in 1982, 76 percent of which originated in the southern area and 24 percent in the northern. Coincidental to its dominance in output, the southern sawmill industry was larger than that in the north in production capacity, plant size, productive factor inputs, and receipts. The south also led in the number and quality of employment—such as the provision of higher wages and full employment—and made higher capital investments per employee. Labor and capital productivity were higher in the south, probably due to a sustained, higher level of investments in capital and economies of scale. In the north, material inputs cost less relative to prices received. But this cost advantage could not be fully transformed into increased operating efficiency due, I believe, to undercapitalization of the hardwood industry.

LITERATURE CITED
