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Variations in Productivity and Performance in Grade Lumber Industries in Kentucky, Pennsylvania, and West Virginia—1982

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Abstract

Hardwood sawmills are the basic link between a valuable and growing resource and the domestic and foreign users of fine hardwood lumber products. Their effectiveness is crucial to the growth and development of wood industries among locales, states, regions, and countries. Productivity ratios, structural factors, and other indicators of economic performance were used to measure the relative productive efficiency of the grade hardwood lumber industries (sawmills and planing mills) in Kentucky, Pennsylvania, and West Virginia. Their economic performance was high compared to the predominantly softwood U.S. lumber industry in 1982. Among the states, labor productivity was greatest in Kentucky; product prices received were highest in Pennsylvania; but West Virginia's sawmills were the most economically efficient. Despite undercapitalization, the industries' latent capacity and efficiency potential provide the base and make the prospect for socially desirable economic development a highly viable option in all three states.

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Introduction

The hardwood sawmill industry[1] is the basic link between a valuable and growing resource and domestic and foreign users of hardwood lumber products. The hardwood lumber industry is competitive, allowing cost-reducing efficiencies attained by the lumber industry to flow backward and forward in the distribution system: backward to loggers and landowners and their suppliers, forward to secondary manufacturers and ultimately the consumer. To a significant degree, the economic value and development potential of the resource, as well as the operating margins and competitiveness of industrial users of lumber products, are affected directly by the efficiency of supply from the primary timber breakdown process—the sawmill. Therefore, a better understanding of the factors that influence sawmill efficiency will improve the competitiveness of sawmill operations and indirectly benefit local communities, landowners, and consumers of hardwood products.

This paper presents an analysis of the current operating and financial structure, performance, and productivity of the lumber industries in Kentucky, Pennsylvania, and West Virginia—three of the Nation's more important Appalachian and northern hardwood-producing states. These states do not produce a significant amount of softwood lumber, which allows direct examination of the hardwood industry when using secondary data. With some exceptions, the natural resource bases of the three states are similar; but they differ in labor markets, product markets, levels of secondary wood product manufacturing, and other factors that influence sawmill structure and performance. This paper provides baseline information and findings to support specific actions for economic improvement.

The Data

The primary data source for the study was the most recent (1982) Census of Manufactures—the Industry and Geographic Series, which is both the major and most complete and consistent source of facts about the structure and functioning of the Nation's manufacturing establishments. These sources were supplemented with data from the U.S. Department of Commerce, Current Industrial Reports; U.S. Department of Labor, Bureau of Labor Statistics; state and USDA Forest Service documents; the general literature, knowledgeable industry personnel; and my own knowledge of lumbering in each of the three states gained over the many years of association with the industry. However, as with any secondary information, there were data limitations.

A major criticism of Census data is that production figures for hardwood lumber appear to underreport actual production levels. Lumber consumption figures developed by Cardellichio and Binkley (1984) suggest that hardwood lumber production was underreported by approximately 20 percent in 1979. And state forestry personnel generally estimate an even larger difference. I agree with this criticism but contend that changes in production as reported by the Census do reflect changes in actual production levels.

Too, the reader must be aware that 1982 was an economic recessionary year for the general economy. The primary overt effect of the economic recession on the lumber industries in the three states was a decrease in demand, which resulted in relatively lower than normal quantities of inputs, outputs, and prices of outputs. And, quite probably, the recession was a partial cause of fewer mills operating in each of the states in 1982 than in 1977. Even though each state's lumber industry may have been affected differently by the recession, the comparability of the operational and performance measures is not compromised. In fact, this comparison may provide additional insight into the relative strengths of the lumber industry in each of the three states in terms of their response to the recession.

Economic Setting

Lumber was one of the earliest and most important manufacturing industries in Kentucky, Pennsylvania, and West Virgina. But with the onset of the Industrial Revolution, other manufacturing segments within each state began to surpass the lumber industry in economic importance (Brown 1958). Today, the grade lumber industry that has evolved remains a positive economic force in its predominately rural localities; it is of prime importance to the sustenance and development of timbering as well as secondary wood and related manufacturing within its respective and neighboring states.

For example, Pennsylvania's lumber industry produced more than 481 MM bf (million board feet) of primary products in 1984 (U.S. Department of Commerce 1985a,b). A conservative estimate of the first-sale contribution of this output to the State's rural economies was about $279 million (U.S. Department of Labor 1983, 1985). These receipts averaged over $744,000 for each of the 375 operating establishments surveyed.

To the extent that these monies were spent within Pennsylvania's local economies for products and services, and lumber products were further manufactured within the State, the turnover or multiplier effect of this income was

[1] The lumber-producing sawmill industry (SIC 2421, Sawmills and Planing Mills, General), as defined by the 1982 Census of Manufactures, comprises operating manufacturing establishments primarily engaged in the sawing of lumber from logs and bolts or the resawing of cants and flitches into lumber and cut stock, and establishments that saw railroad ties, lath, and miscellaneous lumber-like products.

substantial. This is especially true of sawmills since a large proportion of the industry's value received for products sold is expended for raw materials, supplies, labor, and capital— most of which are locally supplied (91 percent of Pennsylvania's lumber mills' value of shipments is spent for these required inputs). For example, with a multiplier effect of 3 in 1984, Pennsylvania's lumber industry would have generated expenditures of $837 million worth of economic activity at the state level, averaging $2,232,000 per sawmill.

Physical Plant

The Census of Manufactures' survey of the industry provides data on 751 commercial lumber-producing sawmills and planing mills operating in the three states during 1982—375 in Pennsylvania, 195 in Kentucky, and 181 in West Virginia. Included in the survey population were all establishments of multi-unit companies and all single-unit companies in the industry with five or more employees. Further, the Bureau, recognizing that there are many smaller mills within the industry, developed data for these establishments from administrative records and other institutional sources.

The significance of the small lumber mill in these states is evident by the fact that state forest product industry directories report 1,892 operational sawmills located within the tristate area in 1984 (Table 1). Although not necessarily full-time operations, small hardwood sawmills produce a considerable amount of lumber, especially during periods of high demand. And, theoretically, assuming market accessibility and land, labor, and capital resources, these mills could contribute significantly to production given the proper stimulant; for example, substantial and stable price increases for lumber products and/or national emergencies, as occurred in 1941.

Although the Census recognizes the existence of small sawmills within the industry, many of these are family-owned and operated and may not be listed in administrative records. The production at these small mills is, therefore, the most likely source of the underreporting since the industry in each of these states changes slowly. Further, the count and patterns of operations for several years prior to 1982 were essentially the same as those shown in 1984.

Productive Factor Outputs and Performance

The hardwood lumber industry's performance is influenced by many social and economic conditions (Ellefson and Stone 1984). But given access to economic resources and markets, and a viable framework within which to conduct

Table 1.—Number and annual production class of operational sawmills in Pennsylvania, Kentucky, and West Virginia, 1984[a]

Production class (MM bf)	Mills		
	Pennsylvania	Kentucky	West Virginia
		Number	
10 or more	5	5	4
5 to 10	53	17	20
2 to 5	101	73	36
1 to 2	116	83[b]	40
1 MM bf >	275	178	100
500 M bf to 1 MM bf	265	66	45
< 500 M bf + custom mills	428	256	279
All mills	968	500	424

[a]Assumed operational, but may or may not have been in operation during survey year.

[b]Estimate based on Kentucky wood industry directories for prior years and patterns evidenced in Pennsylvania and West Virginia.

Source: Lohr 1985; Thorpe 1984; Warder 1984.

business, the cost structure and output of the industry (firm) are fundamental to its productivity and overall performance. Three of the principal and most useful outputs for measuring the effectiveness of the industry in terms of 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.

Lumber Products Output

Total reported U.S. hardwood lumber production in 1982 amounted to 5.1 billion board feet, of which about 17.9 percent was produced in Kentucky, Pennsylvania, and West Virginia. However, compared with the previous 5 years, hardwood lumber production was lower in 1982 for all three states, as well as for the United States.

In 1982, the tristate sawmill industry produced 938 MM bf of lumber products, of which 96.7 percent was hardwoods (Table 2). This output relationship was almost the opposite of that for the U.S. lumber industry, which was 83.1 percent softwoods and 16.9 percent hardwoods in 1982. Total hardwood lumber production per establishment averaged 1.249 MM bf, or about one-fourth as much per establishment as the predominantly softwood U.S. lumber industry. This reflects the effect of the traditionally larger capacity of output of softwood mills due to both the type of product—principally construction lumber of the less dense coniferous species versus grade lumber of the denser deciduous species—and differences in quantity and quality of the inputs, especially capital and technology.

Among the states. In 1982, Pennsylvania's sawmills led the tristate area in total lumber production with 416 MM bf, 96.6 percent of which was hardwoods. Kentucky's lumber output was the second largest at 270 MM bf, but less than two-thirds that of Pennsylvania. And West Virginia's lumber output, normally higher than Kentucky's, was only three-fifths that of Pennsylvania, or 252 MM bf in 1982. Like Pennsylvania, most of the lumber output in both Kentucky and West Virginia was composed of hardwoods—95.9 percent in Kentucky and 97.6 percent in West Virginia.

Kentucky's lumber industry had the second largest average volume of output of lumber per mill per year at 1.385 MM bf, but it had the highest average output per employee and production hour worked—significantly higher than Pennsylvania and West Virginia. Kentucky's average output per employee was 135.0 M bf (thousand board feet), 12.5 percent higher than West Virginia's and 7.1 percent more than Pennsylvania's.

Data are not available to explain conclusively the large differences in gross physical output per employee between Kentucky's sawmill industry and those of West Virginia and Pennsylvania. However, the most probable partial explanations are:

1. Nature of output: Kentucky ranked sixth among the Nation's top 10 users of hardwood lumber for pallet production in 1984 and held that approximate position in 1982. It also had a strong treating industry. Consequently, compared with Pennsylvania and West Virginia, Kentucky's lumber mills likely produced a higher proportion of industrial products. Such stocks require somewhat less time to process than grade lumber outputs.

2. Nature of physical plant: Based on output, Kentucky's lumber industry has shown signs of expanding over the past 10 to 15 years (Schallau et al. 1985); thus, its

Table 2.—Lumber products output by tristate and U.S. lumber industries, by area (SIC 2421), 1982

Area	Total lumber output by:		Average lumber output by:	
	Hardwood	Softwood	Establishment	Employee
	MM bf		*MM bf*	M bf
Pennsylvania	402	14	1.109	126.1
West Virginia	246	6	1.392	120.0
Kentucky	259	11	1.385	135.0
Total/mean	907	31	< > 1.249	126.8
United States	5,061	24,949	4.751	227.5

Source: U.S. Department of Commerce, Bureau of the Census 1984a,b,c,d, 1985 a,b.

lumber mills may have a lower ratio of labor to undepreciated capital assets than either Pennsylvania or West Virginia. This would indicate the operation of newer and perhaps more productive capital plant, machinery, and equipment mixes.

Value of Products Sold

The tristate sawmill industry received $382.8 million from lumber products sold in 1982; this represents about 3.8 percent of the total value of lumber shipped by the U.S. lumber industry (Table 3). Receipts averaged $510,000 per establishment, or about 32 percent of that received by the average U.S. sawmilling establishment. More telling, however, is that tristate industry receipts per unit of product sold averaged $408 per M bf of product—only 21.8 percent higher than that received by the predominantly softwood U.S. sawmill industry. Although the difference in receipts reflects a higher unit value for the hardwood output, it is less than might be expected given the prevailing market prices of that period.

Among the states. Pennsylvania's sawmills, with the largest output and highest prices received per unit, led in total value of shipments with $193.1 million in 1982—over twice that of West Virginia's shipments, valued at $95.5 million, and Kentucky's, $94.2 million. West Virginia mills, due to a smaller number but larger average output per mill, led in value of shipments with $528,000 per establishment. This was only slightly higher than Pennsylvania's $515,000 receipts per establishment, but 9.3 percent greater than Kentucky's $483,000 per unit.

In all other breakdowns of values received, however, Pennsylvania's sawmill industry led those in West Virginia and Kentucky: Pennsylvania's firms received an average of $464 per M bf for their lumber products sold and shipped compared to West Virginia's $379 per M bf and Kentucky's $349 per M bf. This tends to support earlier evidence that Pennsylvania is milling higher valued logs, the probable result of a larger proportion of higher valued species such as red oak. Other viable explanations for the higher output prices received by Pennsylvania sawmillers could be: (1) the innate strength of the State's internal market for lumber products; (2) a higher proportion of unmodified lumber resales; (3) more direct marketing; (4) more specialized services being provided by the industry, such as planing, drying, and milling-to-order; and, perhaps, (5) more vertical integration in the industry, thus allowing cost-center financial accounting adjustments.

The differences in prices received between West Virginia's and Kentucky's industries were small and probably can be explained more by log size, quality, and species than by either specialized or secondary processing. A larger proportion of Kentucky's lumber products is thought to be moving into the growing industrial product markets—such as the treating and pallet stock industries, which use the mixed hardwoods and require less processing than grade lumber.

Value Added by Manufacture

The value added by manufacturing measure is considered the best general indicator of a firm's or industry's economic performance (Ellefson and Stone 1984). The dollar value added by manufacture is that portion of the value of shipments (total value received for products sold or otherwise transferred) that remains after deducting total material costs inputed into the production process. It is this portion of the receipts for products sold that is available for payments to labor, capital, rents, and profits.

Table 3.—Value received from lumber shipments by tristate and U.S. lumber industries, by area (SIC 2421), 1982

Area	Total	Value of shipments by: Plant	Employee	Thousand board foot
		Dollars		
Pennsylvania	193,100,000	515,000	58,500	464
West Virginia	95,500,000	528,000	45,500	379
Kentucky	94,200,000	483,000	47,100	349
Total/mean	382,800,000	510,000	51,700	408
United States	10,065,200,000	1,593,600	76,300	335

Source: U.S. Department of Commerce, Bureau of the Census 1984a,b,c,d, 1985a,b, 1986.

In 1982, the Kentucky, Pennsylvania, and West Virginia sawmill industries earned $139 million over and above the cost of materials, or about 4.3 percent of the total value added by the U.S. lumber industry (Table 4). Value added by tristate mills averaged 36.3 percent of their total value of shipments compared to 32.2 percent for the United States—which indicates a relatively lower cost for materials than that experienced by the softwood-dominated U.S. lumber industry.

Value added for the tristate lumber industry averaged $148 per M bf compared to $108 per M bf for the Nation's sawmills, indicating a more effective performance per unit of output. However, due to the differences in physical output, the tristate average value added per employee, production worker, and production worker hour were below that of the U.S. industry by 23.5, 23.6, and 18.8 percent, respectively.

Among the states. West Virginia's lumber industry earned the highest average value added among the three states, which, at $157 per M bf, was 23.6 percent higher than Kentucky's earnings but only 0.6 percent higher than Pennsylvania's. As a consequence of having the highest value added per M bf combined with the largest average output per mill, West Virginia had the largest dollar volume of value added per mill at $219,000, 24.4 percent greater than Kentucky's average sawmill, and 26.6 percent larger than that earned by Pennsylvania's mills.

However, Pennsylvania, due primarily to its substantially higher value of shipments per unit of product, led both West Vriginia and Kentucky in value added returns per employee by at least 5.9 percent. Overall, though, West Virginia's sawmill industry had the best performance in terms of value added—41.5 percent of its value of shipments compared to 36.5 percent for Kentucky and 33.7 percent for Pennsylvania.

Productive Factor Inputs and Performance

A statement of inputs is necessary not only to measure but to understand an industry's operating cost structure and performance. More important, this statement provides an insight into the general economy in which the industry operates and the magnitude of its relationships within and to various segments of that economy. For example, lumber-producing operations affect and are affected by resource and product markets, labor and capital markets, and institutional and other factors both within and well beyond their own immediate operating area. In turn, occurrences in any of these factors that negatively affect inputs also affect output and supply, demand for the product, and ultimately the viability of the firm and industry and all segments of the economy that depend on the industry's output. The factor inputs on which we concentrate are labor, capital, and materials.

Employment

The combined employment in the tristate sawmill industry totaled about 7,400 full-time persons in 1982—3,300 in Pennsylvania, 2,100 in Kentucky, and 2,000 in West Virginia (Table 5). Nationally, this work force represented about 5.6 percent of the lumber industry's total employment but only 3.1 percent of the total lumber product's output in 1982. Assuming similar coefficients of specialization in primary product manufacture, this most likely reflects the relatively higher degree of labor intensity in the production of hardwoods versus softwoods.

Since the demise of the region's virgin timber resources, the small- to medium-size mills have been predominant in the hardwood industry (Simmons 1960). This situation is evident in the tristate hardwood industry and is reflected partially in plant employment. Of the 751 sawmills in Penn-

Table 4.—Value added in lumber production by tristate and U.S. lumber industries, by area (SIC 2421), 1982

Area	Total	Value added by: Plant	Employee	Thousand board foot	Value of shipments
	Dollars				*Percent*
West Virginia	39,600,000	219,000	18,900	157	41.5
Pennsylvania	65,000,000	173,000	19,700	156	33.7
Kentucky	34,400,000	176,000	17,200	119	36.5
Total/mean	139,000,000	185,000	18,800	148	36.3
United States	3,237,500,000	513,000	24,500	108	32.2

Source: U.S. Department of Commerce, Bureau of the Census 1985a,b, 1986.

sylvania, Kentucky, and West Virginia, only 112, or 14.9 percent, employed 20 or more persons per plant in the manufacture of lumber products.

This proportion is substantially below the average for the U.S. lumber industry (24.7 percent) and that for all U.S. manufacturing, where 34.4 percent of the firms employed 20 or more persons. But it is typical in the hardwood lumber industry, where mills tend to be smaller in both physical capacity and output than their counterparts in softwoods. This is due partly to the type of outputs, e.g., emphasis on grade versus construction lumber; the physical differences in breaking down the physiologically denser hardwoods; and lower technology and automation in the smaller hardwood mills.

Too, tristate hardwood lumber mills are smaller than establishments in U.S. "All Manufacturing" due much to the limits imposed by raw material orientation (located close to resource); traditional orientation to one-shift operations, (which may be totally rational due to the cyclic nature of demand for lumber); and the cyclic nature of the market for output (mills must be of a size to minimize risk of a rapidly fluctuating market demand and still maintain stability of operations—especially labor and capital use).

Among the states. West Virginia's industry averaged the most workers per plant and had the largest proportion of total mills employing 20 or more persons (20.1 percent), followed by Kentucky (13.8 percent), and Pennsylvania (12.8 percent). In absolute terms, Pennsylvania had the largest number of mills (48) employing 20 or more people, but the lowest proportion of such plants to its total industry among the three states. This latter measure reflects the disproportionately large number of very small sawmills in Pennsylvania compared to Kentucky or West Virginia.

Fundamentally, the differences in the structure of the industries among the three states are due largely to the structure of the markets for lumber products in each. For example: (1) Pennsylvania has a variety of well-developed but growing internal markets for the full range of hardwood lumber products. Such markets would provide substantially greater market opportunities for mills with smaller than a medium-size output and specialty mills; (2) West Virginia has a limited secondary wood industry and thus must sell most of its output to external markets—and probably more through brokers or other middlemen; (3) Kentucky has a growing internal market for lumber products but still must market most of its production externally. Consequently, both West Virginia and Kentucky would tend to move larger, more homogeneous shipments of lumber products than Pennsylvania.

Labor Force Composition

Table 6 presents the composition of the tristate work force in terms of (1) production workers, or those plant employees (up through the line-supervisor level) engaged in all plant, direct production-related activities; and (2) "nonproduction" employees, or managers above the line-supervisor level and other production support workers, including sales, clerical, technical, professional, and other administrative personnel.

In 1982, the tristate lumber industry employed 7,400 full-time workers, 6,400 (86.5 percent) of whom were production employees. The industry had about the same percentage of production workers as the U.S. lumber industry

Table 5.—Plant employment in tristate and U.S. lumber industries and U.S. All Manufacturing, by area (SIC 2421), 1982

Area	Total employment	Plants with 20 or more employees	Employees per plant
		Number	
Pennsylvania	3,300	48	8.8
West Virginia	2,100	37	11.6
Kentucky	2,000	27	10.3
Total/mean	7,400	112	9.9
United States	131,900	1,557	20.9
U.S. all manufacturing	19,094,100	123,163	53.3

Source: U.S. Department of Commerce, Bureau of the Census 1985a,b, 1986.

but higher percentages than the U.S. lumber and wood products sector (83.2 percent) and U.S. "All Manufacturing" (64.9 percent). This reflects a high production labor intensiveness for both the hardwood and softwood sawmilling firms compared to manufacturing in general, and underlines the relative dearth of nonproduction personnel expertise in the lumber industries compared with most other types of manufacturing.

Among the states. West Virginia's sawmill industry had the highest percentage of total employees (90.4) in the production category—a 9.5 to 1 ratio of production to nonproduction personnel—or about one administrative employee for every 9.5 production line workers. Kentucky and Pennsylvania both had about 85 percent of their total work force in a production worker capacity, and production to nonproduction worker ratios of 5.7 to 1 and 5.6 to 1, respectively.

Even considering the vagaries caused by the rounding of data, West Virginia's ratio of production to nonproduction personnel is quite different from those of Kentucky, Pennsylvania, or the United States. Probable reasons for the difference are: (1) less on-site emphasis on marketing, market development, technical development, and indirect production management activities by individual mills; and (2) a greater reliance on outside establishments for these services.

West Virginia had the lowest ratio of management to labor within the tristate lumber industry and was about 50 percent lower than the ratio for the U.S. lumber industry. Under such circumstances, the mill manager could pay only fleeting attention to the firm's transactional requirements. And since there is no indication that the cost of purchased services in West Virginia's sawmills are disproportionate to that of the other two states or the U.S. lumber industry, it suggests that these services, if being received, come from outside the establishment from other firms either within or outside of the State.

In fact, both situations probably are applicable; that is, medium to larger mills that are owned by corporations or other entities located elsewhere probably receive the more critical administrative support services from their respective headquarters rather than having support personnel at the production site. In such circumstances, the mill personnel on the production site can give their full attention to the production process. Too, many of the smaller independent mills probably are receiving much of the more critical nonproduction services such as market information, technical information, and other professional advice from outside (nonowned) vested-interest sources such as brokers, other middlemen, and suppliers.

The differences in the ratios of production to nonproduction personnel employed by tristate sawmills suggest that, compared to West Virginia, the mills in Kentucky and Pennsylvania probably: (1) had more administrative and/or technical expertise within their on-site staffs; and (2) had greater flexibility (and, possibly, autonomy) in making production, marketing, and development decisions; and, thus, (3) placed less reliance on outside sources for critical, nonproduction services. Such differences in operational characteristics have important implications for the development of both private and institutional efforts and strategies to effect structural changes, growth, and development in the industry.

Table 6.—Composition of labor force in tristate and U.S. lumber industries, by area (SIC 2421) and U.S. All Manufacturing, 1982

Area	Employees		
	Production	Nonproduction	Ratio
	Number		
Pennsylvania	2,800	500	5.6 to 1
West Virginia	1,900	200	9.5 to 1
Kentucky	1,700	300	5.7 to 1
Total/mean	6,400	1,000	6.4 to 1
United States	113,900	18,000	6.3 to 1
U.S. all manufacturing	12,400,600	6,693,500	1.9 to 1

Source: U.S. Department of Commerce, Bureau of the Census 1985a,b, 1986.

Production Worker Employment

The number of plant hours worked by production personnel[2] varied significantly between the lumber industries of two of the three states and among all three states and the Nation's industry. The 6,400 production personnel worked 11.6 million plant-hours in the direct production of lumber products in 1982 (Table 7). They averaged 15,400 work-hours per mill, or less than one-half that of the average (34,800) worked in the higher capacity U.S. lumber industry.

As a group, the tristate mills averaged operating 7.86 man-years, or 92.5 percent of the production worker man-years available based on the current full-time manpower employed. This represented about 1,294 man-hours per plant less than capacity. Using a conservative estimate of plant production hours (1,960)[3] available per worker-year, the tristate lumber industry was underemployed by almost 1 million production hours in 1982. Downtime could have been due to sickness, accidents, lack of demand, weather, and many other factors. Assuming that downtime could have been prevented, and an average output per production worker hour, the tristate industry could have produced additional lumber products valued at nearly $33 million with the unused 1 million production man-hours.

The typical tristate sawmill production worker was employed 1,813 hours—all less than full-time even when excluding paid lumber-industry holidays and vacation time. Workers averaged about 145 hours less than a full work year per production worker, and 114 hours per person less than the average for the U.S. lumber industry in 1982. The lack of full-time employment over an extended time would be expected to contribute to employee turnover and other labor-related problems within the industry (Wolf 1977).

Among the states. The sawmill production hours worked by individual states were: Pennsylvania, 5.3 million; West Virginia, 3.4 million; Kentucky, 2.9 million—all of which excluded paid vacation time, holidays, and sick leave. Pennsylvania mills operated closest to a full work year by providing an average of 1,893 hours of work per worker, or about 96.6 percent of full-time employment. This was about the same as the "All Manufacturing" average but still less than that provided by the U.S. lumber industry. Pennsylvania averaged 7.19 work man-years per establishment of an available 7.47 man-years—or 96.3 percent of the labor force capacity. With the available labor, Pennsylvania industry lost about 0.19 million production hours of operating time, or about 507 hours per plant.

Kentucky and West Virginia mills operated at an annual average rate substantially less than that of Pennsylvania or the U.S. lumber industry. These states provided 1,706 and 1,790 annual hours of work per production worker, or 254 and 170 hours each less than full-time work. Based on their available production man-hours and current labor force, the Kentucky and West Virginia lumber industries lost about 0.430 million hours of work (2,205 hours per plant) and 0.320 million hours (1,768 per plant) based on their available production hours and current labor force. The industry in Kentucky averaged working 7.6 man-years per establishment of an available 8.71 man-years, or 87.3 percent of capacity of the labor force. The West Virginia lumber industry averaged working 9.59 man-years per plant of an available 10.48 man-years, or 91.5 percent of labor force capacity.

The lack of full-time employment over an extended period could lead to undesirable consequences in the tristate lumber industry, especially in Kentucky and West Virginia. Unless the labor market is of such a nature as to condone the situation, underemployment would be expected to: (1) result in higher than normal labor turnover (Wolf 1973, 1977); (2) lessen a firm's competitive hiring ability in the labor market, especially in employing the desired quality of labor; (3) cause higher overhead costs; and (4) the latter, when combined with the initial lower productivity and higher accident potential of new employees (Wolf and Dempsey 1978), would bring about higher marginal costs per unit of output.

Payroll and Wages

Total employee payroll for the tristate sawmill industry in 1982 was $78.4 million, of which $65.2 million (83.2 percent) went for wages for production workers (Table 8). This included total payments made directly to employees for all plant hours worked, including paid sick leave, holidays, and vacation time.

The proportion of total payroll devoted to production workers was slightly higher than that for U.S. lumber industry (81.8 percent), but substantially higher than that for U.S. lumber and wood products sector (76.3 percent) and U.S. "All Manufacturing" (53.9 percent). Such relatives further reflect the tristate hardwood lumber industry's direct production labor intensiveness, and probable lack of emphasis on transactional activities—marketing, for example.

[2] Production-worker hours are those hours actually worked or paid for at the plant, including actual overtime hours.

[3] A conservative estimate of production worker man-year is 1,960 plant hours per worker.

Table 7.—Production worker employment in tristate and U.S. lumber industries, by area (SIC 2421) and U.S. All Manufacturing, 1982

Area/industry	Hours of production worked	Average hours/ plant	Average hours/ worker
		Number	
Pennsylvania	5,300,000	14,100	1,893
West Virginia	3,400,000	18,800	1,790
Kentucky	2,900,000	14,900	1,706
Total/mean	11,600,000	15,400	1,813
United States	219,500,000	34,800	1,927
U.S. all manufacturing	23,538,300,000	65,700	1,898

Source: U.S. Department of Commerce, Bureau of the Census 1985a,b, 1986.

Table 8.—Labor costs in tristate and U.S. lumber industries, by area (SIC 2421) and U.S. All Manufacturing, 1982

Area	Total payroll	Total wages	Labor cost		Percent wages
			Supplemental[a]	Total	
		Million dollars			
Pennsylvania	38.0	31.0	8.8	46.8	66.2
West Virginia	20.7	17.9	5.5	26.2	68.3
Kentucky	19.7	16.3	4.7	24.4	66.8
Total/mean	78.4	65.2	19.0	97.4	66.9
United States	2,020.2	1,651.7	468.7	2,488.9	66.4
U.S. all manufacturing	379,626.5	204,787.2	80,993.4	460,619.9	44.5

[a] A firm's estimated legal and voluntary costs attributable to all employees and expressed as percent of total payroll.

Source: U.S. Department of Commerce, Bureau of the Census 1984a,b,c,d, 1986.

These factors differed substantially among the three states. Pennsylvania and Kentucky had similar proportions of total payroll going to wages—81.6 and 82.8 percent. But West Virginia had 86.5 percent of its payroll devoted to wages, which is consistent with its greater percentage of production versus nonproduction employees.

Supplemental labor costs. In addition to payroll costs, supplemental labor costs, or those costs attributable to the employment of all human capital in addition to wages and salaries, were estimated for the tristate lumber industry for 1982.[4] These costs include (1) *legally required payments*—those required by state or Federal statutes such as Social Security, Unemployment Compensation, and Workmen's Compensation; and (2) *payments for voluntary programs* not specifically required by legislation—such as life insurance premiums, premiums for supplemental accident and sickness insurance, pension plans, supplemental unemployment compensation, welfare plans, stock purchase plans, and deferred profit-sharing plans. They exclude such company-sponsored perquisites such as cafeterias, in-plant medical services, free parking, employee uniforms, etc.

Supplemental labor costs for the tristate sawmill industry totaled $19 million in 1982, or 24.2 percent of the total payroll compared with 23.2 percent for the U.S. industry. Assuming that the distribution of these costs was similar to the average for the U.S. lumber industry, legally required costs amounted to 48.9 percent and voluntary costs to 51.1 percent of the total supplementary labor costs.[5]

Among the individual states, Pennsylvania and Kentucky had similar proportions of total payroll devoted to supplemental labor costs, 23.2 and 23.7 percent. In effect, these added labor charges increased the average cost per employee over payroll by $2,667 in Pennsylvania and $2,350 in Kentucky. Pennsylvania's total dollar cost was higher due to a higher annual wage per employee. West Virginia had an estimated 26.7 percent of its lumber industry payroll paid out in supplemental labor costs; this was substantially higher than in Pennsylvania, Kentucky, or the U.S. industry average. West Virginia's added cost per employee was $2,619, or about the same as the total contribution per employee in Pennsylvania, which was based on a much higher wage.

The West Virginia lumber industry's supplemental labor cost rate was 15.1 percent higher than that of Pennsylvania or the U.S. sawmill industry. This difference resulted in a relatively higher total labor cost, $333 per employee per year. Effectively, this additional cost reduced the industry's net income by $699,300. Had the "extra cost" not been incurred, an additional $699,300 could have been added to total payroll, which would have remained in the local economies. Or another $0.7 million could have been used for capital improvements to increase productivity—which might have resulted in longer term improvements in wages.

Among possible legal and voluntary factors affecting supplemental labor costs are required Federal and state programs, collective bargaining, additional insurance, and labor profit and welfare plans of various types. Although explanatory data are inconclusive, the West Virginia lumber industry may have had higher supplemental labor costs in 1982 due to: (1) Insuring more heavily than operators in Pennsylvania or Kentucky to minimize potentially uninsured liabilities resulting from accidents and sickness. (2) The effective (loaded, based on firm experience) rates for both Workmen's Compensation and Unemployment Compensation may be higher in West Virginia than in Pennsylvania or Kentucky. Either of these explanations would indicate (1) inadequacies in legislation governing the respective social programs; and (2) possible operational inadequacies that discourage stability in the labor force and adequate working conditions. The result of either would be to reduce the funds available and, thus, the flexibility of the State's firms and industry to invest in more effective human and physical capital and operating modes to increase productivity.

Total Labor Costs

With the addition of supplemental labor expenditures to develop total labor costs, the manpower cost relationship among the Pennsylvania, Kentucky, and U.S. industries remained essentially the same. West Virginia showed a disproportionate increase in total labor costs due to its higher percentage of payroll going to legal and voluntary labor costs.

The tristate industry's total expenditures for all employees amounted to about $97.4 million in 1982, with wages to production workers representing 66.9 percent of that amount. This was comparable to the average of 66.4 percent for wages paid by the U.S. sawmill industry during the same period. However, due to lower wages and fewer hours worked, the total annual labor costs per employee for the tristate lumber industry was substantially lower than "All Manufacturing" in each respective state. Viewed as earnings, sawmill labor received 52.9 percent less than "All Manufacturing" in West Virginia, 47.6 percent less in Kentucky, and 41.7 percent less in Pennsylvania.

Among the states. Pennsylvania's total expenditures for labor—including employee salaries, wages, and supplemental costs—were the highest among the three states at $46.8 million in 1982, but it had the lowest proportion going to wages (66.2 percent). The latter was due mostly to the

[4] Estimates based on "All Manufacturing" average within each respective state.

[5] Estimates based on U.S. lumber industry average.

higher relative earnings of nonproduction workers and the lower ratio of production to nonproduction workers in Pennsylvania. Kentucky's total expenditures for labor were slightly more than one-half that of Pennsylvania for 1982, but the percentage going to wages was essentially the same (66.8 percent). West Virginia's total expenditures for labor were slightly higher than Kentucky's, due not to higher average earnings but to a greater number of persons employed.

However, West Virginia's lumber industry had 68.3 pecent of its total expenditures for labor being paid as wages, which was noticeably higher—from 2.2 percent to 3.2 percent higher—than the proportions paid by Kentucky, Pennsylvania, and the United States. The difference is explained by: (1) the higher ratio of production to nonproduction workers employed in West Virginia's lumber industry compared to the other states; and (2) a higher percent of total payroll devoted to supplemental labor costs—15.1 percent higher than Pennsylvania, for example. Still, due to higher wages and salaries, Pennsylvania's mills averaged the highest total labor cost per employee at $14,182 per year, or about 13.7 percent greater than that for West Virginia and 16.2 percent higher than that for Kentucky.

From the employee's perspective, most of the differences in total labor costs per employee between the sawmill industries and "All Manufacturing" in Kentucky, Pennsylvania, and West Virginia were derived from lower earnings per worker. Consequently, on wages alone, general manufacturing in each state had a substantial comparative advantage when competing for labor in the external labor market; and this does not include working conditions, upward mobility potential, and other factors critical to a firm's ability to employ and retain highly productive labor. Thus, assuming the existence of a dual labor market and a mobile labor force, such differences in earnings suggest that the lumber industries of all three states may be bidding in a secondary labor market wherein the training, skills, and work (job) behavior of the labor force is less than ideal for optimum firm efficiency (White 1980).

Capital Expenditures

In recent years, the quantity and quality of capital investments in the production process have become increasingly critical to the firm's efficiency. Table 9 shows the industry's expenditures in 1982 for both new and used machinery, equipment, buildings, and other permanent physical additions and major alterations to plant capacity. Because a limited amount of industry data has been published on the capital structure and expenditures of the tristate sawmill industries, only new and used capital expenditures are presented; the latter were estimated using the U.S. lumber industry average as a proxy.

For the tristate lumber industry, capital expenditures for new and used machinery, equipment, buildings, and other structures totaled $14.22 million in 1982, or 2.6 percent of the total expended by the Nation's lumber industry. Assuming that tristate mills purchased used capital goods at the same rate as the Nation, a ratio of 0.316 to 1, then 75.9 percent (or $10.8 million) of the tristate sawmill industry's total capital expenditures were investments in new physical plant and equipment. The remaining 24.1 percent of total expenditures were for used plant and equipment. If true, this would have been a substantially greater percentage of total expenditures for used machinery, equipment, and physical structures than occurred in each state's "All Manufacturing" sector, as well as in most other segments of their respective lumber and wood products sectors. Further, it opens the question of the occurrence of consolidation in the tristate lumber industry.

The tristate sawmill industry's investments in new capital equipment and physical plant accounted for 28.1 percent of the total new investments made by the area's lumber and wood products sector in 1982. More significantly, however, these industries had investments in new capital plant per employee substantially below the average for the Nation's sawmills: Pennsylvania invested 45.1 percent less; Kentucky, 55.5 percent less; and West Virginia, 65.2 percent less, indicating a much greater reliance on capital by the Nation's predominantly softwood sawmill industry and the relative undercapitalization in the hardwood lumber industries. Further, the lack of adequate capital is thought to be especially prevalent in the "middle-size" hardwood mills.

Pennsylvania, with the largest sawmill industry, led in total expenditures for new and used capital plant and equipment with a $7,500,000 investment in 1982—over twice that of Kentucky ($3.69 million) and West Virginia ($3.03 million). Total expenditures per lumber mill in Pennsylvania averaged $20,000, which was about equal to the average investment per plant for "All Manufacturing" in the state. And although Kentucky's and West Virginia's lumber mills were larger than Pennsylvania's in terms of physical output, they made less investment per mill ($18,897 in Kentucky and $16,724 in West Virginia), both significantly below that of Pennsylvania mills, and substantially below each respective state's average for "All Manufacturing" plants.

However, investment in new capital plant and equipment is a more relevant indicator of technical innovation in the tristate lumber industry. In two of the states, new capital investment per employee averaged more than that for each state's total lumber and wood products industry: 28.8 percent greater in Pennsylvania and 7.1 percent more in Kentucky. West Virginia's sawmills had the lowest new capital expenditure per employee, at $1,095; this figure was 22.1 percent less than the average expenditure by the State's

Table 9.—Capital expenditures in tristate lumber and lumber and wood products sectors, and All Manufacturing, by area, 1982

Area and sector	Investments in: New capital per employee	Used capital per employee[a]	Capital expenditures by employee	Total
		-Dollars-		
Pennsylvania				
Lumber[b]	1,727	545	2,273	7,500,000
Lumber/wood products[c]	1,341	152	1,493	25,380,000
All manufacturing	2,873	203	3,076	3,630,500,000
Kentucky				
Lumber[b]	1,400	445	1,845	3,690,000
Lumber/wood products[c]	1,307	148	1,456	10,910,000
All manufacturing	4,042	858	4,900	1,208,500,000
West Virginia				
Lumber[b]	1,095	348	1,443	3,030,000
Lumber/wood products[c]	1,405	160	1,564	6,570,000
All manufacturing	4,110	276	4,386	420,100,000
United States				
Lumber[b]	3,145	995	4,139	546,000,000
Lumber/wood products[c]	2,498	282	2,780	1,602,400,000

Note: Data may not total due to rounding.

[a] Estimated for lumber industry in three states based on U.S. lumber industry (SIC 2421) average.

[b] SIC 2421.

[c] SIC 24.

Source: U.S. Department of Commerce, Bureau of the Census 1985a,b, 1986.

total lumber and wood products sector. This occurred despite the sawmill industry's prominence in the state lumber and wood products sector, accounting for 39 percent of that sector's total capital investment in 1982.

Material Costs

Materials constitute a major part of the total cost of producing grade hardwood lumber. Material costs represent, in this context, all physical items put into production during the year by the firm and industry. Based on the Census of Manufactures definition, the "materials costs" classification broadly includes: raw materials, parts, containers, production and operating supplies, energy, production contract work, and products bought and resold in the same condition.

In 1982, material costs for lumber production in Pennsylvania, Kentucky, and West Virginia totaled $234 million (Table 10), or about 3.5 percent of that for the U.S. lumber industry. This represented about 23.6 percent of the total cost of materials used by the tristate's entire lumber and wood products sector, but only about 0.29 percent of the area's total material inputs for "All Manufacturing." However, it should be of interest to suppliers and developers to note that in Pennsylvania, for example, annual materials costs alone (locally purchased timber and supplies) in the sawmill industry averaged $317,067 per establishment and $36,030 per person employed. From an economic development perspective, this compared quite favorably with a materials cost expenditure of $37,647 per employee by Pennsylvania's total lumber and wood products sector and with the average expenditure of $47,896 per employee by the State's "All Manufacturing" sector.

Among the states, Pennsylvania's sawmill industry was the leading user of materials, totaling $118.9 million in 1982. This was 3 percent more than the total of the combined industries of Kentucky and West Virginia, and represented

Table 10.—Material costs in tristate lumber and lumber and wood products sectors, by area, and U.S. lumber sector, 1982

Area and sector	Material costs by:		
	Total	Plant	Employee
	----------Dollars----------		
Pennsylvania			
Lumber	118,900,000	317,100	36,030
Lumber/wood products	640,000,000	530,000	37,647
West Virginia			
Lumber	56,900,000	314,400	27,095
Lumber/wood products	122,600,000	326,600	29,190
Kentucky			
Lumber	58,200,000	298,500	29,100
Lumber/wood products	228,200,000	457,300	30,427
United States			
Lumber	6,674,200,000	1,056,700	50,600

Source: U.S. Department of Commerce, Bureau of the Census 1984a,b,c,d, 1985a,b.

18.6 percent of the toal materials purchased by Pennsylvania's solid wood industry. Expenditures for materials averaged $317,067 per mill, which was slightly greater than that for West Virginia (0.9 percent) and moderately higher than that for Kentucky (6.2 percent). Since the sawmills in both Kentucky and West Virginia had a larger average volume of lumber output, Pennsylvania's higher material input costs are thought to reflect a higher degree of competition for available raw materials, and perhaps a larger proportion of high-quality timber—either in terms of species or grade, or both.

The total material cost for Kentucky sawmills was $58.2 million and represented about 25.5 percent of the $228.2 million used by the State's entire lumber and wood products industry. West Virginia's material costs were the lowest among the three states, but it had the lowest volume of output. However, its materials cost of $56.9 million represented about 46.4 percent of the total used by the State's lumber and wood products sector, making it by far the dominant purchasing segment of West Virginia's solid wood sector. West Virginia's expenditures per employee for materials also were the least among the three states—$27,095 per employee versus $29,100 for Kentucky and $36,030 for Pennsylvania. Relative to Kentucky, this was due primarily to a lower volume processed per employee, and to Pennsylvania, due to a combination of smaller volume processed and lower price per unit.

Summary of Factor Inputs

The total cost of producing grade lumber in Kentucky, Pennsylvania, and West Virginia in 1982 was about $350,100,000 (Table 11). Materials and labor were the major inputs into the production process—accounting for 94.6 percent (66.8 and 27.8 percent) of the total cost of production. The balance of the costs included expenditures for new and used capital plant and equipment (4.1 percent) and purchased services (1.3 percent).

Materials—including contract timber logging, energy, resales, and supplies—was the predominant cost in producing lumber. Material costs ranged from 67.7 percent of total production cost in Pennsylvania—which was significantly influenced by higher prices paid per unit of higher value raw material—to 65.2 percent in West Virginia, which was affected by the lowest prices paid for high value raw material. The lumber industries in all three states had a lower proportion of total costs in materials than the U.S. lumber industry, though this was not a situation favorable to relative efficiency in the tristate hardwood industry. Rather, it was a result of: (1) the lower physical output per unit of labor (and higher unit cost of labor) in the hardwood industries compared with the predominantly softwood U.S. lumber industry; and (2) the proportionately larger volumes of materials purchased and processed by the U.S. industry due to its higher physical productivity.

As suggested, labor—as a proportion of total costs—was higher in the tristate lumber industry than in the United States by about 10 percent. West Virginia's industry—which had the lowest material cost—averaged the highest cost of labor input at 30.0 percent of total production cost. This was due mostly to the lower physical output per man-hour and significantly higher supplemental labor costs in West Virginia's lumber industry. Of the three states, Pennsylvania's labor input accounted for the smallest proportion of the total cost of lumber production.

Capital expenditures, the third major cost item in the production process, ranged from 4.3 percent of total cost in Pennsylvania to 3.4 percent in West Virginia. In all three hardwood lumber-producing states, however, capital expenditures were a less significant item of total cost than was evidenced in the U.S. lumber industry (23.2 to 39.3 percent lower). This may further reflect undercapitalization in the tristate hardwood lumber industry.

Summary and Conclusions

In an economy where increasing efficiency is stressed, improvements in productivity and performance among all economic factors of production—such as land, labor, capital, management, and entrepreneurship—are necessary for an industry to remain competitive in the marketplace. In the following tabulations and tables are measures that are useful in the management of operations to evaluate performance. Used collectively and in conjunction with the earlier displays and discussions, they provide insight into the operational status and productive differences among the tristate hardwood lumber industry. Combined with forthcoming performance trends analyses and current, site-specific data, these measures provide the foundation for improved efficiency, development, and policy initiatives by the firm, industry, and concerned institutions.

Measures of Productivity and Performance

Productivity measures are standardized concepts that carry a common understanding. They measure the relationship between quantity of resources used and quantity (or value in constant terms) of outputs. They are not precise measures of individual factor efficiency, but are highly accepted and applied indicators of the efficiency with which a resource is used. For example, the ratio of output per employee hour (labor or capital productivity) does not measure a specific contribution, such as labor or capital. Rather, it reflects the joint effect of these factors and others such as changes in technology, capacity utilization, plant design and layout, skill and effort of the work force, managerial ability, and labor-management relations.

The following tabulation provides 1982 measures of productivity for the tristate and U.S. lumber industries (SIC 2421). In the tabulation, ratios involving hours represent all employee plant hours worked; also, capital productivity equals value added minus payroll (VAMP) divided by all employee plant hours worked (Schallau et al. 1985).

Area	Labor productivity bf/hour	Unit Labor cost/payroll Dollars/bf	Capital productivity Dollars/hr	Value added as percent of shipments	Value added per hour Dollars
Kentucky	77.4	.0730	4.21	36.5	10.15
West Virginia	66.5	.0821	4.98	41.5	10.44
Pennsylvania	66.2	.0913	4.30	33.7	10.35
U.S.	117.8	.0673	4.78	32.2	12.71

Table 11.—Input cost distribution of major operational factors in tristate and U.S. lumber industries by area (SIC 2421), 1982[a]

Area	Total costs	Material costs	Labor costs	Capital expenditures	Purchased services
	Million dollars			*Percent*	
Pennsylvania	175.5	67.7	26.7	4.3	1.3
Kentucky	87.4	66.6	27.9	4.2	1.3
West Virginia	87.2	65.2	30.0	3.4	1.3
United States	9,829.0	67.9	25.3	5.6	1.2

[a] Costs are necessarily conservative due to lack of cost information on undepreciated assets; labor includes estimated supplemental costs; purchased services are based on U.S. lumber industry (SIC 2421) average (data may not total due to rounding).
Source: U.S. Department of Commerce, Bureau of the Census 1985a,b.

Table 12.—Supplemental measures of performance in tristate and U.S. lumber industries, by area (SIC 2421), 1982

Ratio	West Virginia	Kentucky	Penn-sylvania	United States
Cost: input/output (percent)				
Materials/value of shipments	59.6	61.8	61.6	66.3
Materials and payroll/shipment value	86.0	87.7	85.8	91.0
Payroll/value added	52.3	57.3	58.4	62.4
Total labor cost/value added[a]	66.2	70.8	72.0	76.9
New capital plant/value added	5.8	8.1	8.8	12.8
Payroll/man-hour worked (dollars)	5.46	5.65	6.05	7.83
Total labor cost/ man-hour worked[a] (dollars)	6.92	6.99	7.46	9.77

[a] Includes estimated supplemental labor costs.

Labor Productivity

The physical output per man-hour (labor productivity) in Kentucky's lumber industry was the highest among the three states, at least 10.6 percent higher than in West Virginia or Pennsylvania in 1982. Stated another way, Kentucky's sawmills required only 12.55 man-hours of labor to produce a thousand board feet of lumber. In West Virginia and Pennsylvania, it took 15.05 and 15.10 hours of labor, respectively, to manufacture the same volume of products. Also, high physical productivity combined with moderately low wages (Table 12) resulted in Kentucky's sawmills attaining the lowest payroll labor cost (7.3 cents) per board foot of lumber produced. West Virginia's sawmill industry had the second lowest unit labor cost (8.2 cents/board foot) and Pennsylvania's had the highest (9.1 cents/board foot). Still, the industries of all three states experienced lower physical productivity and higher unit labor costs than the Nation's predominately softwood lumber industry. Given the relative nature of the inputs, outputs, and breakdown processes between the hardwood and softwood industries, this general relationship is to be expected.

Economic Performance

Upon changing from a physical to an economic perspective, which introduces output quality, a substantially different insight into the hardwood sawmill industry's performance is gained by considering the total costs of inputs relative to the values received for products sold, especially the value added. Value added (value of shipments minus all material costs) in the manufacture of goods is a major indicator of overall economic performance for both the firm and industry.

In overall economic performance, the lumber industries in all three states achieved relatively high productivity rates compared to the U.S. lumber industry. However, West Virginia's lumber industry was substantially more productive than that of Kentucky or Pennsylvania. In West Virginia, the monetary value added by the lumber manufacturing process represented 41.5 percent of the total value of products sold in 1982. This was substantially higher (13.7 percent) than the value added earned (36.5 percent) by the lumber industry in Kentucky, and 23.1 percent higher than that received (33.7 percent) by Pennsylvania's sawmill industry. The West Virginia industry's higher productivity was primarily due to its lower ratio (59.6 percent) of nonwage costs to value of shipments; that is, compared to the prices received for final products, the industry paid relatively lower prices for its raw materials, energy, supplies, and other material inputs than the Kentucky, Pennsylvania, or U.S. sawmill industries (Table 13).

West Virginia's lumber industry also achieved (1) the lowest labor cost relative to value added; and (2) the highest rate of dollar value added per man-hour worked by all employees, or $10.44 per hour. Sawmills in Pennsylvania ranked second with $10.35 value added per hour worked, and Kentucky's industry ranked third at $10.15 per hour. Although West Virginia's industry remained the most productive among the three states in value added per man-hour worked, its position was compromised somewhat because the full effect of the industry's lower relative material costs was not realized due to: (1) its lower physical output per man-hour compared to Kentucky's sawmills; and (2) the industry's lower output prices received compared to Pennsylvania's industry. The industries in all three states produced at least 17.9 percent less value added per man-hour than the U.S. lumber industry. This was primarily due to the latter's substantially higher labor productivity, which partially reflects the softwood lumber sector's higher capital intensity and technological innovations.

Capital Productivity

The performance of capital expenditures on investments in machinery, equipment, and plant structures was greater in the lumber industry of West Virginia than that of Kentucky, Pennsylvania, or the United States. Capital productivity, measured in terms of dollar returns per man-hours worked, was $4.98 per hour in West Virginia—or at least 15.8 percent greater than the $4.30 return in Pennsylvania and the $4.21 return in Kentucky. Also, West Virginia's capital investments were more productive than those of the Nation's lumber industry.

Since sawmills in West Virginia reportedly invested less per employee in 1982 than the other industries compared, a situation that has been prevalent since at least 1972 (Jones and Zinn 1986), the higher productivity experienced by the industry represents a phenomenon that defies simple explanation given the data at hand. However, several possible explanations come to mind, the most plausible of which are: (1) It is possible that the West Virginia lumber industry's emphasis on production as contrasted with trans-

Table 13.—Inputs as a proportion of value of shipments by tristate and U.S. lumber industries, by area (SIC 2421), 1982[a]

Area	Total value of shipments	Material costs	Labor costs[b]	Capital expenditures[c]	Purchased services	Total inputs
	Million dollars			*Percent*		
Pennsylvania	193.1	61.6	24.2	3.9	1.2	90.9
Kentucky	94.2	61.8	25.9	3.9	1.2	92.8
West Virginia	95.5	59.6	27.4	3.1	1.2	91.3
Total	382.8	61.1	25.4	3.7	1.2	91.5
United States	10,065.2	66.3	24.7	5.4	1.2	97.7

[a] See qualifications in Table 11 (data may not add due to rounding).
[b] Includes supplemental labor costs.
[c] Includes used capital expenditures.

actional activities (as evidenced by the almost 10 to 1 ratio of production workers to nonproduction workers) is especially conducive to enhancing the overall productivity of the firm and industry; (2) Since the West Virginia lumber industry produces a more homogeneous product output than either Pennsylvania or Kentucky, the invested capital may be more concentrated and, thus, more productive due to specialization; (3) Unreported investments in used capital could be of such a magnitude as to maintain or increase productivity and offset expenditures that otherwise would have been required for new capital plant.

Contributing to this situation are the following: (1) It is possible that the sawmill industry's undepreciated capital assets are disproportionately greater in West Virginia than in Kentucky or Pennsylvania; that is, the industry has newer productive assets in operation. Since data on these assets are not available, the question cannot be resolved; (2) It is possible that the larger size sawmills in the State account for the predominance of the new capital expenditures and perhaps operating at peak efficiency, and/or the combined output and efficiency of these mills is of such proportion as to distort the productivity ratio. Conclusive answers cannot be developed without further study.

Performance Relative to Social Objectives

On the basis of the measures cited, in 1982 the West Virginia lumber industry was the most productive in terms of economic efficiency; that is, the industry generated the highest total economic output relative to inputs among the three states studied. But West Virginia's lumber industry was not as efficient as the U.S. lumber industry in 1982. The U.S. lumber industry was more productive, I believe, due to its higher multifactor productivity of labor and capital combined in the production process with its homogeneity of product output.

Assuming this hypothesis concerning the U.S. lumber industry is correct, it appears that, as a whole, the tristate lumber industry is undercapitalized to the point of being unable to optimize output efficiency. This is not to deny that there are many highly efficient medium- to large-size mills operating within all three states. Other factors detrimental to the overall performance of tristate operations were:

1. The industries operated well below their reported normal (and probably preferred) capacities.

2. The Kentucky and West Virginia lumber industries operated substantially less than a full work-year, which resulted in the underemployment of labor and capital.

3. Both wages and total earnings in the sawmill industries of all three states were lower in all occupations than those in each respective state's other lumber and wood products industries and "All Manufacturing" averages, thus lessening their competitiveness for the most productive labor.

4. Material costs (predominantly raw materials) in Pennsylvania were substantially higher, even when considering a probable higher quality of raw materials in terms of species and grade, than in West Virginia or Kentucky. Thus, the question is raised of the adequacy of the performance of the markets for raw materials (values received) in the latter two states.

The demand for hardwood lumber products has increased since 1982 and is expected to continue to increase substantially in the years ahead (Phelps 1984). Since the tristate area is blessed with extensive and valuable forest resources—the economic potential of which are not being fully realized—and large, high capacity sawmill industries, the prospect for socially desirable economic development is a highly viable option. This is especially true in West Virginia, where a secondary wood-using industry remains seriously underdeveloped, but where efforts are underway to correct the situation (Dempsey and Price 1984; Zinn and Jones 1986).

The prominence of the tristate lumber industry as an optimum performing and economically competitive supplier in the years ahead will depend on: (1) the policies and strategies developed to use the resource in a socially desirable manner; (2) improving the creativity and productivity of management, especially in fostering technological innovations, more effective marketing and other transactional activities (Dempsey 1973); (3) ". . .improving the utilization of all inputs into the production and use of hardwood lumber. . ." as Luppold (1982) reported in an econometric study of the hardwood lumber market; and (4) the character and resolve of the entrepreneural actions taken by the firm, industry, and supporting institutions.

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Sawmill effectiveness is crucial to the growth and development of wood industries among locales, states, regions, and countries. Productivity ratios, structural factors, and other indicators of economic performance were used to measure the relative productive efficiency of the grade hardwood lumber industries in Kentucky, Pennsylvania, and West Virginia. Despite undercapitalization, the industries' latent capacity and efficiency potential provide the base and make the prospect for socially desirable economic development a highly viable option in all three states.

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