

Patterns of hardwood sawmill industry concentration: Tennessee case study, 1979 to 2005

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Abstract

This paper examines changes in sawmill concentration and hardwood lumber production for Tennessee between 1979 and 2005. In 1979, only 2 percent of the lumber manufactured in Tennessee was produced by very large mills with capacities of 10 million board feet (MMBF) or more annually. By 2005, such mills produced more than 43 percent of the lumber, generally following an “expand or exit” model of industry concentration. The greatest change in sawmill concentration, however, occurred in the eastern region of Tennessee, where very large mills accounted for 61 percent of the production in 2005 compared to 0 percent in 1979. Construction of mills in eastern Tennessee seems to have been facilitated by relatively low delivered log prices and improved highway systems. Such changes seem to follow a different model of industry concentration, one that occurred during the timber boom of the early 20th century – if timber can be economically transported it will be “severed and sawn.” Since 2005 there has been a decline in demand for higher grades of hardwood lumber and large increases in energy costs. This combination could influence the future size, location, operational objectives, and the industrial concentration of sawmills in Tennessee and other eastern hardwood states.

The forest products industry is important to the Tennessee economy (Young et al. 2007). This industry is dynamic as demonstrated by changes in the hardwood sawmill sector and hardwood lumber production. In 1979, Tennessee was home to more than 600 hardwood sawmills with an annual combined production of more than 660 million board feet (MMBF) of lumber. Most of this lumber was manufactured by mills producing less than 3 MMBF per year (Table 1). In 2005, fewer than 325 hardwood sawmills produced in excess of 850 MMBF of lumber, of which 43 percent was produced by very large mills defined as having annual capacities of 10 MMBF or more.¹ The greatest change occurred in the eastern region where more than 60 percent of the lumber was manufactured by very large mills by 2005.

Concurrent with regional changes in Tennessee’s sawmill concentration has been differing rates of growth in regional lumber production. In 1979, the western, central, and eastern regions (Fig. 1) produced 202, 348, and 114 MMBF, respectively (Table 2). Twenty-six years later, production in the western region had declined to 187 MMBF, while production

in the central and eastern regions had increased to 569 and 195 MMBF, respectively. These production increases were facilitated in part by a doubling of sawtimber inventories in the central and eastern regions during this 26-year period (Table 3), but economic factors have also played a role in regional changes in hardwood lumber production and sawmill size.

Theoretically, the optimal location and size of a plant or mill is where the combined costs of production, collection (timber procurement), and distribution (cost of shipping to secondary processors or yards) are minimized (Bressler and King 1970). While this theory is conceptually simple, its implications for the hardwood sawmilling industry are affected by several factors including: preexisting capital investments; changes in sawing technology that change economies

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¹ In this paper sawmills are classified into five size groups: very small mills producing less than 1 MMBF annually; small mills producing 1 to 2.99 MMBF; medium mills producing 3 to 4.99 MMBF; large mills producing 5 to 9.99 MMBF; and very large mills producing 10 MMBF or greater.

Table 1. — Percent of total annual production for Tennessee hardwood sawmills by mill size and year for each region and entire state, 1979 to 2005.

	Mill size				
	Very small (< 0.99 MMBF)	Small (1 to 2.9 MMBF)	Medium (3 to 4.9 MMBF)	Large (5 to 9.9 MMBF)	Very large (10 MMBF+)
------(%)-----					
Western region					
1979 ^a	7	52	20	21	0
1984 ^b	7	43	27	23	0
1989 ^c	4	32	21	18	24
1999 ^d	4	18	16	41	20
2005 ^e	4	13	25	27	32
Central region					
1979 ^a	16	37	16	27	3
1984 ^b	11	32	25	16	16
1989 ^c	6	19	25	20	31
1999 ^d	6	15	18	18	43
2005 ^e	6	13	17	24	39
Eastern region					
1979 ^a	28	49	17	6	0
1984 ^b	21	50	24	5	0
1989 ^c	15	36	27	11	12
1999 ^d	8	9	8	20	55
2005 ^e	6	8	10	14	61
Entire state					
1979 ^a	15	44	17	22	2
1984 ^b	12	37	25	16	10
1989 ^c	7	24	24	18	27
1999 ^d	6	15	16	23	41
2005 ^e	6	12	17	23	43

^a Developed from TN Dept. Conserv. (1980) using procedures described in Luppold (1996).

^b Developed from TN Dept. Conserv. (1986) using procedures described in Luppold (1996).

^c Developed from TN Dept. Ag. (1991) using procedures described in Luppold (1996).

^d Developed from TN Dept. Ag. (2001).

^e Developed from TN Dept. Ag. (2006).

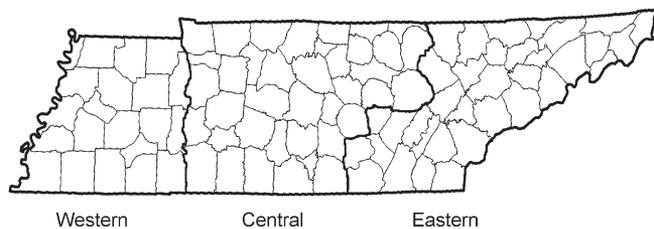


Figure 1. — Tennessee's hardwood production regions.

of scale; improvement in transportation infrastructure; and the growth or decline of available hardwood sawtimber. As a result of these factors, there appears to be two generalized models that explain most of the changes in the size and concentration of hardwood sawmills in the eastern United States. In the case of existing mills, increased economies of scale, reduced transportation costs, and expanding sawtimber inventories have allowed innovative firms to expand production and ultimately force smaller—less cost efficient—firms out of the market (“expand or exit”). In areas where there was a sharp improvement in transportation infrastructure or large increases in sawtimber supplies, new mills have been constructed and the size of these mills has been predicated on

Table 2. — Regional and statewide hardwood lumber production in Tennessee in 1979, 1984, 1989, 1999, and 2005 in MMBF and regional percentage market share.

Year	Western		Central		Eastern		State
	(MMBF)	(%)	(MMBF)	(%)	(MMBF)	(%)	
1979 ^a	202	30	348	52	114	17 ^f	664
1984 ^b	146	22	397	61	104	16 ^f	647
1989 ^c	186	22	536	63	126	15	848
1999 ^d	192	21	535	60	176	20 ^f	903
2005 ^e	187	22	469	55	195	23	851

^a Developed from TN Dept. Conserv. (1980) using procedures described in Luppold (1996).

^b Developed from TN Dept. Conserv. (1986) using procedures described in Luppold (1996).

^c Developed from TN Dept. Ag. (1991) using procedures described in Luppold (1996).

^d Developed from TN Dept. Ag. (2001).

^e Developed from TN Dept. Ag. (2006).

^f Does not sum to 100 percent due to rounding error.

the minimization of production, collection, and distribution costs, i.e., if timber can be economically transported and processed it will be “severed and sawn.”

Table 3. — Regional hardwood sawtimber inventories and rates of relative utilization in Tennessee in 1980, 1989, and 1999.

Year	Sawtimber volume			Relative utilization		
	Western	Central	Eastern	Western	Central	Eastern
	----- (MMBF) -----			----- (years) -----		
1980	7,410	12,178	11,624	44	32	98
1989	8,946	17,509	16,419	48	33	130
1999	11,249	24,212	23,030	61	45	131

The objective of this paper is to discuss changes in the location and concentration of the hardwood sawmill industry in Tennessee and to describe how changes in sawtimber inventories, lumber and timber prices, and localized market conditions have influenced these changes. The results delineate the market conditions that trigger changes in sawmill capacity and to what extent the two general models of hardwood sawmill concentration apply to Tennessee's hardwood lumber industry.

Production regions and sawtimber inventory

The three regions defined in the Tennessee Forest Products Bulletin are shown in **Figure 1** (TN Dept. Conserv. 1980, TN Dept. Ag. 1991). The western region is comprised primarily of timberland under 1,000 feet in elevation with flat to moderate slope (USDA 2007). The major components of the forest in this region are red and white oak species, sweetgum, yellow-poplar, and hickory. In 1979, this region had major hardwood flooring operations in Shelby and Madison counties and several sawmills producing cross ties and flooring lumber. At the same time, this region produced more than 200 MMBF of hardwood lumber with small mills accounting for 52 percent of this volume (**Tables 1 and 2**). The ratio of hardwood sawtimber volume to annual log production (relative utilization coefficient) was 44 in 1980. This ratio indicates the number of years it would take to cut the existing sawtimber inventory at current levels of lumber production. While this ratio can be difficult to interpret in absolute terms, any value below the number of years that it takes a tree to reach harvestable size (50 to 60 years in the south) is indicative of a relatively high rate of timber utilization (**Table 3**).

The central region of Tennessee is primarily comprised of timberland under 2,000 feet in elevation with slopes ranging from 0 to 40 percent. Red and white oak species, yellow-poplar, and hickory comprise the forest in this region with select white oak species accounting for nearly 20 percent of sawtimber volume in 1989. Whereas 31 percent of the 348 MMBF of lumber produced in this region in 1979 was manufactured by larger mills, small and very small mills (production under 1 MMBF) accounted for 50 percent of sawmill capacity during this year. This region contained 39 percent of the state's sawtimber volume in 1980. The relative utilization of the sawtimber inventory was 32 years, indicating a very high timber utilization rate (**Table 3**).

Nearly 60 percent of the timberland in the eastern region of Tennessee is at elevations greater than 1,000 feet and nearly one-third of this land has slope in excess of 40 percent (USDA 2007). Topography is the primary reason why the interstate system was not completed in this region until the late 1970s. The major components of the forest are red and white

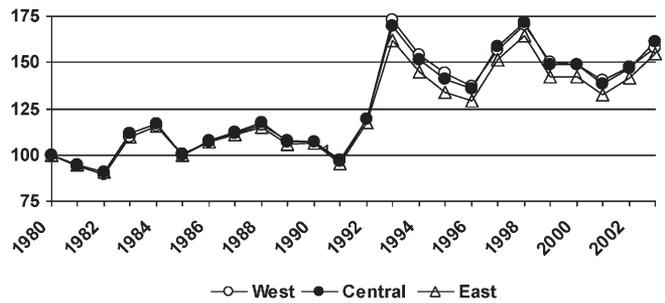


Figure 2. — Index (1980 = 100) of hardwood lumber prices weighted for sawtimber composition and quality for the eastern, central, and western regions of Tennessee, 1980 to 2003.

oak species, yellow-poplar, and hickory. In 1979, 75 percent of the lumber manufactured in this region was produced by small and very small mills. In 1980 the relative utilization of the sawtimber inventory was 98 years indicating low sawtimber utilization.

Changes in lumber and sawlog prices

Regional differences in lumber production within a state can be influenced by the relative value of the regional sawtimber (Luppold and Bumgardner 2006). Tennessee's forest composition is relatively uniform across regions with the majority of land being in the oak-hickory forest-type group. But, there are considerable differences in the type of oak among these regions, with the eastern region having a high volume of less desirable chestnut oak. In an effort to examine the dual impact of inflation-adjusted (real) lumber prices, as reported in the Hardwood Market Report (1979–2004), and forest composition in 1989 (USDA 2007) on regional production, a relative timber value index was developed adjusting for yield by species and log grade using data developed by Hanks et al. (1980). An examination of this index indicates no discernible long-term difference in value trends between regions between 1979 and 2005; even though the index seemed to have trended lower in the eastern region in recent years, the regional indexes have moved in the same direction (**Fig. 2**).

Over all of the regions of Tennessee, there has been a trend of increasing real prices of delivered logs (TN Dept. Conserv. 1980 to 1991, TN Dept. Ag. 1991 to 2003), but considerable variations exist. In the early 1980s, prices in the western region remained high while prices in the central and eastern region declined (**Fig. 3**). During the mid- and late-1980s, log prices fell and rose erratically but prices in the eastern region were clearly lower. Between 1989 and 1999, log prices increased erratically among the regions with the greatest growth occurring in the central region. Since 1999 log prices have decreased in the western and eastern regions while remaining high in the central region.

Trends in regional production and concentration

Nearly all of the sawmilling firms operating in Tennessee are either single mill operations or individual mills owned by firms that operate mills in other states. Therefore, industry concentration can be examined by analyzing changes in mill size. In 1979, nearly 60 percent of the lumber produced in Tennessee

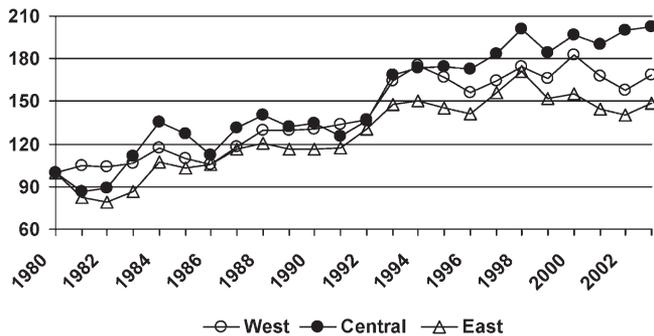


Figure 3. — Index (1980 = 100) of hardwood log prices weighted for sawtimber composition and quality for the eastern, central, and western regions of Tennessee, 1980 to 2003.

was manufactured by small and very small operations producing less than 3 MMBF per year. Fifty-nine percent of the production in the western region and 77 percent of the production in the eastern region was manufactured by these smaller mills. The central region had the largest mills in the State, while the eastern region and western region did not have any mills producing 10 MMBF or more (Table 1).

In 2005, 32 percent of the production in the western region was manufactured by very large sawmills. This increase in concentration in the western region typically was from existing mills that had increased their capacity over time, following the “expand or exit” explanation of industrial concentration: the relatively low volume of sawtimber relative to hardwood lumber production and higher log prices forced mills to either increase their efficiency by becoming larger or exit the market.

While sawtimber inventory may have influenced the prices of delivered logs in the central region, the relatively low initial relative utilization coefficient in this region did not inhibit increased lumber production. In fact, the relative utilization coefficient increased in all three regions between 1980 and 2005. Nearly all of the increase in production in the central region was due to existing mills increasing in size, which again follows the “expand or exit” explanation of industrial concentration.

In 1979, eastern Tennessee contained 37 percent of the sawtimber volume in the State but was responsible for only 17 percent of the lumber produced. This low level of production might be partially explained by the result of the large volume of less desirable species, but was primarily the result of rough topography and an undeveloped highway system. In 1979, the interstate system of highways was completed and other highways were upgraded in subsequent years. By 2005, 61 percent of the production in the eastern region was manufactured in large or very large mills. Of the eight very large mills in this region in 2005, seven were built as large or very large mills which fit the “severed and sawn” explanation of mill construction.

Beyond 2005 — A multimill model?

Since 2005 the downturn in home construction has resulted in reduced demand for hardwood lumber. Further, increases in energy prices have resulted in higher transportation costs. This combination of factors has caused the hardwood industry

to examine cost and profitability issues. The solutions that emerge from this examination could potentially affect the size, location, operational objectives, and industrial concentration of the Tennessee sawmilling industry.

Over the last several decades, hardwood sawmills have increased in size as production and transportation technology allowed increased economies of scale in production. These increases, however, occurred in a period of stable, if not declining, fuel costs. Increases in fuel costs increase collection and distribution costs, thus effectively reducing economically viable production levels in existing mills even when lumber prices remain stable or slightly increase. If fuel costs remain high, then new capital will be spent on increasing lumber recovery from the logs available over a smaller procurement region. Some examples of such capital expenditures are curve sawing equipment that is capable of increasing yield from mid- and lower quality logs and thin kerf headsaws and resaws.

Continual high fuel costs also may result in new mills being located closer to the timber resource. In areas where collection costs are especially high, portable mills may become economical to operate because the cost of transporting a thousand board feet of lumber is less than transporting the same quantity of logs.

While it is relatively easy to project the extended impact of current market conditions on mill size and potential capital equipment expenditures, it is more difficult to project changes in industry concentration because this measure is at the firm level. Currently, most of the sawmills operating in Tennessee are single mill operations. If the efficient size of mills declines, or if a large number of portable mills are put in service, firms may opt to have several mills that feed lumber into a concentration yard and dry kiln operation. While such multimill operations will have higher fuel-related distribution costs, other cost and revenue advantages associated with the ability to maintain robust inventories and move high volumes of lumber could offset increased distribution costs. Multimill systems thus potentially could dominate the industry and increase market concentration, although management of multimill systems is more complex than single mill operations.

Conclusion

Over the past quarter-century, hardwood lumber production has increased in Tennessee, but there is no unifying reason for increases among regions. The western and central regions have relatively high levels of timber utilization resulting in greater increases in log costs over the 25-year period examined. As a result of escalating log costs, improved production and transportation technology, and moderate fuel costs, mills in these regions have expanded production following the “expand or exit” model of industry concentration. In contrast, eastern Tennessee was populated by small mills in 1979 but an improved transportation structure resulted in the construction of several large and very large mills to process the relatively less expensive and more abundant timber resource in this region. Therefore, the increase in concentration of the hardwood sawmills industry in eastern Tennessee followed the “severed and sawn” model. Just as the Shay locomotive allowed timber to be harvested and then converted into lumber by large sawmills in West Virginia in the early 20th century (Clarkson 1964), the improvement of transportation

systems allowed large mills to be built in eastern Tennessee in the late 20th century.

While this analysis provides an explanation of past market behavior of Tennessee's hardwood lumber industry, it must be tempered with the changes in lumber demand and energy costs that have occurred since 2005. The same underlying economic principles that influenced the industry in the past will guide it in the future. To what extent the hardwood industry in Tennessee and elsewhere will change will be predicated on energy and lumber market conditions, which are difficult to predict.

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