EFFECT OF THE HARDWOOD RESOURCE ON THE SAWMILL INDUSTRY IN THE CENTRAL AND APPALACHIAN REGIONS

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Abstract: The Central and Appalachian hardwood regions contain a diverse and valuable timber resource. The regions are important to the hardwood industry because they contain 68 percent of the eastern hardwood sawtimber. Furthermore, more than 70 percent of the hardwood lumber produced in the United States is manufactured at mills located in 16 of the states in the regions. This paper examines the hardwood sawmill industry and its relationship to the hardwood resource in the Central and Appalachian Regions. The major conclusion is that there is considerable regional variation in the size and concentration of the sawmill industry. This variation is affected by the differences in the volume and density of the hardwood resource in different states in the regions.

INTRODUCTION

The hardwood forests within the 16 Central and Appalachian states (Figure 1) are a valuable natural resource. These forests contain 68 percent of the hardwood sawtimber volume in the United States (Powell and others 1993). A high proportion of this sawtimber is in the more desired species such as the select red and white oaks (Luppold and Dempsey 1994). Furthermore, virtually the entire United State's supply of black cherry, black walnut, and sugar maple exists in these states (Powell and others 1993). The large volume and high value of this timber base allow these regions to be a major source of hardwood lumber.

The large variety of climates and growing conditions in the Central and Appalachian states has caused the hardwood resource in these states to be extremely diverse. The four principal hardwood forest types existing in the regions are: aspen-birch, maple-beech-birch, oak-hickory, and oak-pine. There also is considerable local and regional variation in species mix between hardwood stands of similar forest types.

The hardwood industry adapts to local conditions such as volume, quality and type of resource, and transportation costs. Analysis by Luppold (in press) found regional differences in the average size and market concentration within the hardwood sawmill industry. This finding suggests that regional characteristics of the resource may be the cause. The objectives of this paper are to examine the hardwood industry in the Central and Appalachian Regions and to determine how differences in the resource base contribute to long term regional differences in the industry.

THE HARDWOOD LUMBER INDUSTRY

Information concerning the hardwood lumber industry has been incomplete or in error. For instance, U.S. Department of Commerce estimates of hardwood lumber production underestimates the size of the industry by more than 40 percent (Luppold and Dempsey 1994). However, detailed information about the industry is available from primary wood processing directories published by individual states. In this study, the data on the number of mills and average size of mills were primarily developed from these directories and USDA Forest Service records. The specific procedures used to develop the sawmill information presented in this study are outlined in Luppold (in press).

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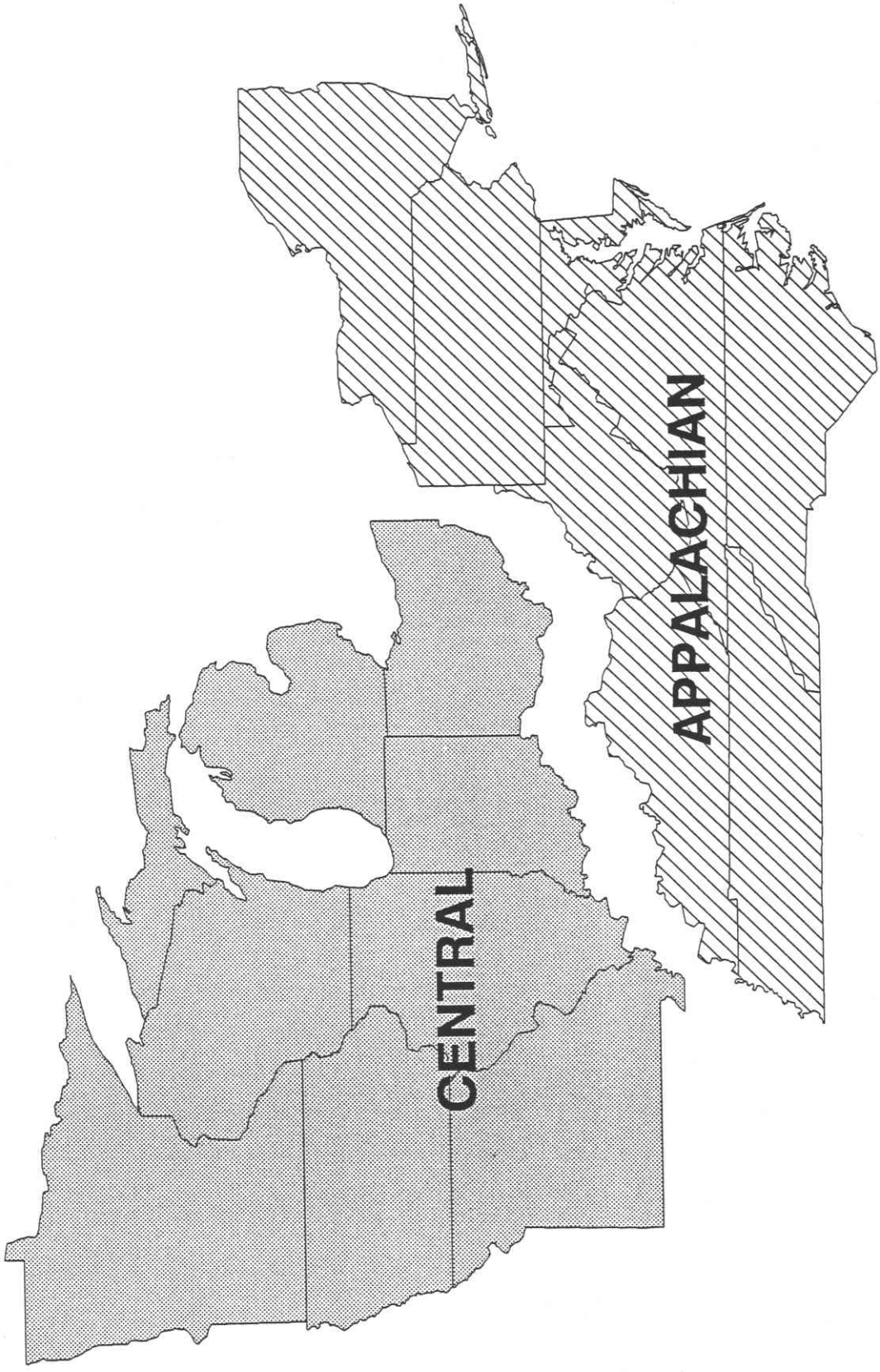

Figure 1. Central and Appalachian hardwood production regions.

Estimates of the hardwood lumber production capacity and average size of sawmills in the 16 Central and Appalachian states are summarized in Table 1.

Table 1. Estimated hardwood sawmill capacity, number of sawmills, and average capacity of sawmills in states in the Central and Appalachian Regions.

Region	State	Year	Estimated capacity of mills (mmbf)	Number	Average production (mmbf)
Central	Wisconsin	92	528	201	2.63
	Ohio	92	524	207	2.53
	Michigan	91	559	247	2.26
	Indiana	93	393	191	2.06
	Iowa	90	70	38	1.97
	Missouri	92	636	375	1.70
	Illinois	93	117	70	1.67
	Minnesota	90	244	240	1.02
	Total region		3,071	1,569	1.96
Appalachian	Maryland	94	179	46	3.90
	Virginia	92	717	239	2.98
	N Carolina	92	616	208	2.96
	W Virginia	92	581	226	2.57
	Tennessee	89	890	353	2.60
	Kentucky	90	936	395	2.37
	New York	91	511	221	2.31
	Pennsylvania	91	1,028	578	1.81
	Total region		5,458	2,266	2.41

In 1991, the sawmills in the states listed in Table 1 produced nearly 8.4 billion board feet of hardwood lumber (Luppold and Dempsey 1994). This volume represents 70 percent of the total United States production in 1991. The state with the largest sawmill capacity is Pennsylvania. Other states with considerable capacity include North Carolina, Virginia, Tennessee, and Kentucky. Relatively little lumber was produced in Iowa, Illinois, and Minnesota.

The 16 states listed in Table 1 contain over 3,800 hardwood sawmills that produce at least 100,000 board feet of hardwood lumber per year. In addition to these mills, there are at least 1,000 mills that produce less than 100,000 board feet per year in the states listed in Table 1. In Minnesota alone there are more than 425 small sawmills that had a combined total production of 11.4 million board feet in 1993. However, the total output of these smaller mills seems to be less than 5 percent of total production in the 16 state area.

The average size of hardwood sawmills varies considerably by state. However, there are some geographic similarities. Virginia and North Carolina have similar hardwood lumber industries when considering the level of production, the number of mills, and the average size of the mill. Average capacities of sawmills in Tennessee, West Virginia, Ohio, and Kentucky are similar. For the most part, sawmill size decreases the farther north and west a state is located in the 16 state area.

The small size of the average sawmills in Pennsylvania masked the fact that some of the largest mills in the 16 state area are in this state. Pennsylvania also has the largest number of hardwood sawmills producing more than 5 million board feet annually. One reason for the low statewide average sawmill size is the large number of Amish sawmills. Another reason is the large number of mills that specialize in railroad crosstie production. Both Amish-owned sawmills and sawmills that produce rail ties tend to produce between 100,000 and 1 million board feet of lumber annually. In 1991, 470 sawmills in Pennsylvania fell in this range of production.

LUMBER PRODUCTION RELATIVE TO THE HARDWOOD RESOURCE

Variation in the size, density, and quality of the hardwood resource between states may help explain regional differences in the hardwood sawmill industry. To understand the relationship between the hardwood sawmill industry and the resource, a comparison of the resource in the 16 states is presented in Table 2.

Table 2. Hardwood sawtimber inventories, timber density, and percent of resource in select species in states in the Central and Appalachian Regions.

Region	State	Sawtimber inventory (mmbf)	Timber density [a] (Million bdf/acre)
Central	Wisconsin	30,394	2.91
	Ohio	28,926	4.00
	Michigan	39,451	3.38
	Indiana	18,946	4.56
	Iowa	5,767	2.98
	Missouri	23,064	1.93
	Illinois	17,782	4.50
	Minnesota	22,693	2.36
Appalachian	Maryland	11,384	5.65
	Virginia	58,295	5.09
	N Carolina	62,541	5.70
	W Virginia	53,886	4.84
	Tennessee	42,963	4.04
	Kentucky	43,996	3.70
	New York	37,991	3.23
	Pennsylvania	59,421	4.20

a/ Since inventory statistics do not separate hardwood timberland from softwood timberland, the timber ratios are based on both hardwood and softwood inventories.

As would be expected, the volume of hardwood lumber produced is correlated with the size of the resource in a specific state. The states within the Appalachian Region have large volumes of hardwood sawtimber and the greatest sawmilling capacities. The states of Iowa, Illinois, and Minnesota have small inventories of hardwood timber and produce small quantities of hardwood lumber. Indiana and Missouri have relatively small inventories of hardwood sawtimber but produce high volumes of hardwood lumber. However, both these states were net importers of hardwood sawtimber during the early 1990's (Hackett and Mayer 1993; Hackett and others 1993). Another state that is a net importer of hardwood sawtimber is Ohio (Widmann and Long 1992).

To measure the relationship between standing timber volume and lumber production capacity, the following equation was estimated using ordinary least squares:

$$\text{Ln(Capacity)}_i = b_0 + b1\ \text{Ln(Inventory)}_i + b_2\ \text{Importer} \quad (1)$$

Where: Ln(Capacity)_i = the natural log of sawmilling capacity for state i,
Ln(Inventory)_i = the natural log of sawtimber inventory for state i,
Importer = a zero one variable that shifts the slope for the states of Missouri, Indiana, and Ohio (equals 1 if net importer)

The double log or multiplicative functional form was used for this equation because it provided a better statistical fit than a linear or other log linear forms. The ordinary least square results presented in Table 3 indicate that a 1 percent increase in sawtimber inventory will, on average, result in a 1.08 percent increase in sawmilling capacity. Because equation 1 was estimated using cross sectional data, the estimated results indicate a long run adjustment by the hardwood lumber industry in a particular state to the resource of that state. Short term increase in capacity due to incremental increases in inventory could be considerably lower than estimated.

Table 3. Ordinary least squares estimates of the relationship between hardwood sawmill capacity and the volume of the hardwood resource and average sawmill capacity and timber density for states in the Central and Appalachian Regions.

Equation[a]	Explanatory variable	Regression coefficient	Student's "t"[b]
(1) Capacity of sawmilling industry:			
Capacity	Intercept	-5.17	3.89
	Inventory	1.08	8.45
	Importer	0.51	2.45
R^2 = .848			
(2) Average capacity of sawmilling industry:			
Avercap	Intercept	0.07	.37
	Density	0.62	4.66
	INIL	-0.45	4.45
R^2 = .772			

a Equations described in text.
b Critical "t" value for P level of 0.05, 1.782.

The significance and sign of the importer slope shifter indicate that the estimated relationship between sawmill capacity and inventory is slightly higher for importing states. The relatively high R^2 and significance of all independent variables indicate that the relationship between sawmill capacity and sawtimber inventory is quite significant.

The size of a sawmill may be affected by the density of the forests on timberlands. This relationship exists because procurement costs increase with distance or as greater quantities of timber are demanded from a finite resource. In states where the resource is spread out over a large area, one would expect to find large numbers of small and intermediate sized mills. In regions where large volumes of timber exist in relatively small areas, one would expect to find large sawmills. As indicated in Tables 1 and 2, the average size of hardwood sawmills is correlated with timber density.

The major exceptions to the correlation between average mill size and timber density are Illinois, Indiana, and Pennsylvania. Both Illinois and Indiana have large agricultural industries that use much of the land base in these states. The timber resource in these states is often located in small patches of land that are unsuitable for farming. Although the densities of these stands are high, the spatial separation of these patches increases procurement costs. As previously mentioned, the small average size of sawmills in Pennsylvania is, in part, the result of Amish ownership and the rail tie industry.

To measure the relationship between average capacity of sawmills in a state and timber density, the following equation was estimated using ordinary least squares:

$$\text{Ln(Avercap)}_i = b_0 + b_1 \text{Ln(Density)}_i + b_2 \text{INIL} \quad (2)$$

Where: Ln(Avercap)_i = the natural log of average capacity of sawmills in state i,
Ln(Density)_i = the natural log of density of the sawtimber inventory for state i,
INIL = a zero one variable that shifts the slope for the states of Indiana and Illinois (equals 1 for IN and IL)

The double log or multiplicative functional form also was used in this equation. The ordinary least square results presented in Table 3 indicate that a 1 percent increase in sawtimber density will, on average, result in a 0.62 percent increase in average sawmilling capacity over the long run. The significance and sign of the INIL slope shifter indicate that average sawmilling capacity in Illinois and Indiana seems to be lower because of the scattered but highly dense hardwood resource in these states. The relatively high R^2 and significance of all independent variables indicate that the relationship between timber density and average sawmill capacity is significant.

SUMMARY AND CONCLUSIONS

The hardwood sawmill industry in the Central and Appalachian Regions is a diffuse group of manufacturers who are dependent on and affected by the diverse forest resource in these regions. Analysis presented in this paper found that the hardwood sawmill industry varies considerably from state to state. Most of the differences in the size of a sawmill industry between states are related to the volume of sawtimber that exists in the state. Furthermore, the size of the average sawmill is dependent on the density of the timber resource in the state.

The relationship between the hardwood resource and the hardwood sawmill industry aids in understanding how the constantly changing hardwood resource will affect future lumber production. In areas of an expanding resource, one can expect greater lumber production. If the resource is allowed to mature to a high density, one can expect larger and possibly more efficient sawmills. However, changes in demand for this timber resource by the pulp and engineered building products industries may change the relationship estimated in this paper. If these alternative users start consuming large volumes of hardwood sawtimber, there is a potential for a structural change within the hardwood industry.

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