AN EXAMINATION OF CHANGES IN SAWMILL CONCENTRATION IN
THE CENTRAL APPALACHIAN REGION

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Abstract: The central Appalachian hardwood sawmilling industry has undergone considerable
change over the past two decades. Production and average sawmill capacity have increased while the
number of sawmills has decreased. This paper examines changes in the central Appalachian region by
analyzing changes in sawmill concentration. Historic cumulative concentration curves were estimated
using seemingly unrelated regression techniques for each state in the region. Although the sawmill
industry has become more concentrated over time, the degree of concentration varies. Simple
measures, such as average mill capacity and the proportion of production capacity in large sawmills,
are not necessarily indicative of the degree of sawmill concentration.

Introduction

The central Appalachian region (Figure 1) contains 45 percent of eastern hardwood sawtimber
inventories (Powell et al. 1993) and supplied 50 percent of eastern hardwood lumber in 1991 (Luppold
and Dempsey 1994). Although there has been an increased demand for hardwood timber by the pulp
and oriented-strandboard industries, the hardwood lumber industry remains the dominant user of
hardwood timber in this region except for North Carolina (Hutchins 1992, Johnson 1994, Wharton and
Widmann and Murriner 1990).

In the early 1980s, the central Appalachian region contained approximately 3,000 hardwood sawmills
that produced more than 100,000 board feet (bf) of lumber per year (Luppold 1996). Total production
of these mills was approximately 5 billion board feet of lumber. By the early 1990s, the number of
sawmills in this region had decreased by 20 percent while hardwood lumber production had increased
by 14 percent. However, the rate of sawmill decline varied by state. In this paper I examine changes
in the hardwood sawmilling industry by contrasting changes in sawmill concentration.

Data Development

The major source of information on the number and production levels of hardwood sawmills is
primary wood-processing directories published between the 1970s and the early 1990s for each state.
Usable directories for this period were obtained for West Virginia, Tennessee, Kentucky, Pennsylvania,
and New York. The earliest usable directory obtained for Ohio was 1980. The directories used in this
study are listed in the References section by state and agency.

The directories published by North Carolina and Virginia reported mill size in range categories that
place hardwood mills into two groups, as a result, these directories were unusable for this study.
However, frequent timber output studies for these states provided detailed data on sawlog consumption
by individual mills every 2 to 3 years (USDA Forest Service 1994). Therefore, log-consumption data

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Figure 1. Central Appalachian hardwood sawmill region.

were used rather than sawmill directory information. The combination of directories and log-consumption information allowed for historic sawmill industry databases to be compiled for each state.

After the directories were examined, it was decided to begin the analysis for the years closest to 1975. Additional information was collected from directories every 3 to 5 years from the initial year. The format used to report mill capacity differs among states and has changed over time within most states. Although many recent directories of primary wood processors provide actual production data for the larger sawmills, the capacities of most mills are provided in capacity ranges. Mills with production capacities of less than 100 thousand board feet (Mbf) per year were excluded from the analysis because they produce a relatively small amount of hardwood lumber and are not reported uniformly by all states.

Estimates of hardwood lumber production capacity for specific ranges were developed by summing the number of hardwood sawmills in each range and multiplying this sum by the range's midpoint. Information on the production capacity of larger sawmills was provided by forest product utilization specialists in individual states. This information was used to develop volume and mill numbers in six range categories representing annual capacities of 100 to 499 Mbf, 500 to 999 Mbf, and 1 to 2 million, 2 to 5 million, 5 to 10 million, and greater than 10 million board feet.
Estimation of Cumulative Concentration Curves

The cumulative concentration curve (CC curve), as defined by Kluender et al. (1993), ranks firms from largest to smallest and plots the cumulative proportion of industry production against the firm's rank. In a perfectly competitive industry where all firms have the same capacity, the CC curve is a diagonal line. The CC curve, as defined in this study, differs from that of Kluender et al. (1993) in that cumulative proportion of industry production is plotted against cumulative proportion of firms for a specific state and year from largest to smallest mill.

It is difficult to estimate CC curves for the hardwood sawmilling industry because of limited information on the industry in most central Appalachian states. In most cases, there were only six observations for a given state and year. This restriction requires that CC curves be estimated using a functional form that requires a minimum number of independent variables.

The selection of a CC curve functional form began by examining the actual CC curve for Virginia in 1992 (Figure 2). This examination indicated that a usable function must initially rise rapidly or increase at a decreasing rate. The limits of the function's range and domain should be 0 and 1 with the range equal to 0 when the domain is 0 and 1 when the domain is 1. These criteria led to the development of the following functional form:

\[
\ln(CPP_{ij}) = B_{o,ij} + B_{1,ij}(\ln(CPS_{ij}) - CPS_{ij})
\]

Subject to \(B_{o,ij} = B_{1,ij}\)

Where: \(CPP_{ij} = \) Cumulative proportion of production capacity in state \(i, i = 1 \text{ to } 8 \) in year \(j \) (range of CPP is 0 to 1),

\(CPS_{ij} = \) Cumulative proportion of sawmills in state \(i, \) in year \(j \) (range of CPS is 0 to 1)

\(B_{o,ij} = \) Intercept coefficient for equation representing state \(i \) in year \(j\)

\(B_{1,ij} = \) Slope coefficient for equation representing state \(i \) in year \(j\)

Given that \(B_{o,ij} = B_{1,ij} = B\), equation 1 can be written as:

\[
CPP = CPS^B e^{(B-B(CPS))}
\]

The restriction forcing the intercept and slope coefficient to be equal ensures the required range and domain properties. This restriction also provided a single coefficient \(B\) that provides a relative measure of concentration across all states and years. The higher the value of \(B\), the lower the degree of sawmill concentration. Higher values of \(B\) also indicate that the CC curve is flatter (closer to a diagonal line).

The CC curves were estimated in four equation systems (one system for each state) using seemingly unrelated regression techniques developed by Zellner (1962). Estimations were completed using SHAZAM 7.0 econometric computer program (Shazam 1993). The Zellner estimation technique was used because it pooled observations (increasing the degrees of freedom), allowed direct comparison of coefficients in specific states across years, and reduced variance by adjusting estimates for contemporaneously correlated error. The statistical fits of the estimated CC curves were excellent for most states and years. The \(R^2\) associated with these curves exceeded 0.99 in most cases and was 0.9999 in many of the equations. The exceptions were the equations for New York.
Figure 2. Actual and predicted cumulative concentration curves for Virginia's hardwood sawmilling industry in 1992.

Changes in Sawmill Concentration

The estimated CC curve for the states and years in this study are presented in Table 1. This table also includes estimates of hardwood lumber production by the top 10 percent of mills in the various states and years. The information in this table indicates that the sawmilling industry in five of the eight states has become more concentrated over time. North Carolina's sawmill industry has actually become less concentrated in recent years while concentration levels in Virginia and New York have remained stable.

West Virginia has the greatest degree and largest change in sawmill concentration. This high degree of concentration is reflected in the concavity of West Virginia's CC curve (Figure 3). In recent years, many West Virginia sawmills have expanded production and several new sawmills have been built because of increased volumes of sawtimber in this state.

Although Virginia and North Carolina have a high proportion of capacity in larger sawmills (Luppold 1995), both states have relatively low levels of sawmill concentration. Virginia also had a higher
Table 1. Estimates of the cumulative concentration curve B coefficients for states in the central Appalachian region between 1974 and 1992 (equation estimated using seemingly unrelated regression).

<table>
<thead>
<tr>
<th>State</th>
<th>Year</th>
<th>B Coefficient</th>
<th>Standard Error</th>
<th>R²</th>
<th>Production by Top 10 Percent of Mills (in percent)</th>
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<tr>
<td>West Virginia</td>
<td>1976</td>
<td>0.624</td>
<td>0.0246</td>
<td>98.6</td>
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<td>45.3</td>
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<td>0.612</td>
<td>0.0011</td>
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<td></td>
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<td>0.0010</td>
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<tr>
<td>Tennessee</td>
<td>1974</td>
<td>0.712</td>
<td>0.0056</td>
<td>99.9</td>
<td>36.8</td>
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</tr>
<tr>
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<tr>
<td>Kentucky</td>
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<td>0.0032</td>
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<td>0.0019</td>
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<td>38.7</td>
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<tr>
<td></td>
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<tr>
<td></td>
<td>1990</td>
<td>0.608</td>
<td>0.0015</td>
<td>99.9</td>
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<tr>
<td>Virginia</td>
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<td>0.0055</td>
<td>99.9</td>
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<td>New York</td>
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<tr>
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<tr>
<td></td>
<td>1990</td>
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<td>Pennsylvania</td>
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<td>99.9</td>
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<td></td>
<td>1982</td>
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<td>0.598</td>
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<td>43.4</td>
</tr>
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</table>

* Significant increases in sawmill concentration over the data period.

* Significant decreases in sawmill concentration over the data period.
average capacity than Ohio or West Virginia. Yet Virginia had the lowest concentration levels while Ohio and West Virginia had two of the highest levels (Figure 3).

Tennessee and Kentucky have similar hardwood sawmilling industries (Luppold 1995) and have followed similar increases in concentration. Pennsylvania and Ohio also have similar degrees of concentration and have followed similar concentration paths. However, the average size sawmill in Ohio is considerably larger than in Pennsylvania (Luppold 1995). This finding indicates that average sawmill size is not a good indicator of market concentration.

The hardwood sawmilling industry has become more concentrated over time. Still, the impact of this change is difficult to assess. One can argue that large hardwood sawmills are spatial monopsonists that will exercise market power to keep stumpage prices low. However, this behavior cannot be observed in the marketplace. An analysis of stumpage and log markets in Ohio (a state with a relatively high degree of concentration) indicated that stumpage prices have increased faster than log prices, and that log prices have increased faster than lumber prices (Luppold and Baumgras 1995). Luppold and Baumgras also found similar trends for Pennsylvania. These trends indicate that
increasing capacity is correlated with increased competition in the stumpage market because larger mills must expand their procurement area.

Summary and Conclusion

Although the central Appalachian hardwood industry has shown considerable changes across all states, there is no indication that these changes have occurred in a consistent manner. Although some of this divergence may be attributed to errors or inconsistencies in state directories, most result from the diverse nature of the hardwood timber resource and lumber industry.

West Virginia has shown the greatest increase in sawmill concentration of the eight states examined. This state also has had the greatest increase in sawtimber volume over the last 20 years (Powell et al. 1993). This increase has allowed existing mills to expand and new mills to be constructed. North Carolina's sawmilling industry has become less concentrated since the late 1980s. This drop in concentration coincides with decreased National Forest timber sales in western North Carolina.

The change in hardwood sawmill concentration does not seem to have increased the market power that sawmills can exercise in the stumpage market. Previous analysis indicates that hardwood stumpage prices have increased faster than hardwood lumber prices. This trend indicates the transfer of any short-term excess profits gained by the lumber industry to the hardwood resources.

Literature Cited


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