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Regional Changes in the Timber Resources of and Lumber Production in Pennsylvania

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Abstract

In this study we examine regional differences in the hardwood timber resources of Pennsylvania and explain how the combined changes in this resource and in lumber prices have influenced regional lumber production. Isolation of these relationships is important because shifts in lumber production affect harvesting levels and harvesting activity influences long-term forest composition and structure. We define three hardwood regions in Pennsylvania based on forest composition and present a chronology of regional changes in sawtimber volumes, sawtimber composition, and lumber production. Regional changes in hardwood lumber production are related to fluctuation in the inflation-adjusted price of lumber from 1970 to1999. We found that regional changes in lumber production are influenced by a combination of variations in interspecies price and regional changes in species composition.

Key Words – Hardwood, sawmill, sawtimber

Introduction

In 2002, Pennsylvania contained nearly 78 billion board feet of hardwood sawtimber (McWilliams et al. 2003) or approximately 7 percent of the estimated eastern U.S. inventory (Smith et al. 2001). More than 30 percent of this timber consists of three species with high current market values: black cherry, hard maple, and northern red oak. Pennsylvania's forests also contain large quantities of other commercially important species such as white oak, black oak, ash, red maple, and yellow-poplar. Still, the composition of this forest varies considerably when the state is examined from east to west and north to south (Alerich 1993).

Pennsylvania's timber resource has been dynamic with respect to volume and composition. Sawtimber volume has tripled since 1965, but the rate of growth has been greatest in the northern and western portions of the state (Table 1). The composition of Pennsylvania's forest also has been changing as selective cutting over the last 70 years has contributed to increased relative volumes of shade tolerant species such as red and sugar maple (Table 2).

Table 1 – Changes in sawtimber inventory (hardwood and softwood) in Pennsylvania by survey unit, 1965 to 200

Survey Unit	1965[a]	1978[b]	1989[b]	2002[c]	Percent Change[d]
	-----million board feet (International log scale)------				
Western	3,378	6,770	10,024	11,583	243
Southwestern	2,627	4,401	5,358	7,152	172
North-central	4,503	8,362	11,093	15,307	240
Allegheny	6,700	12,123	18,247	24,753	269
Northeastern	1,397	3,304	5,121	5,817	316
South-central	3,345	5,377	6,175	8,608	157
Pocono	2,193	3,273	5,164	6,362	190

Southeastern	2,126	4,476	5,536	6,651	213
Total[e]	26,269	48,087	66,718	86,235	228

[a] Developed from Ferguson (1968)
[b] Developed from Alerich (1993)
[c] Developed using USDA Forest Service (2004)
[d] For years 1965 to 2002
[e] May not be the sum of units due to of rounding error.

With its large volume of quality timber, the Keystone State has consistently been the nation's largest producer of hardwood lumber with production in excess of 1.1 billion board feet (U.S. Census Bur. 2001). Lumber production also has more than doubled between 1970 and 1999 (U.S. Census Bur. 1971, 2001). Luppold (1996) and Smith et al. (2003) reported that census data has consistently underestimated lumber production, though these alternative estimates and census indicate a similar rate of growth over the last 3 decades.

While hardwood lumber production has increased, the variation in value and growth of timber resources within Pennsylvania leads one to question whether changes in lumber production have been uniform across the state. Further, regional differences in species composition and the changing relative value of different hardwood species (interspecies pricing) over the last 30 to 50 years (Luppold and Prestemon 2003) may have influenced the amount of lumber produced in a given area or region. Understanding the interaction between the hardwood lumber market, the timber resource, and the timing and magnitude of harvesting is important since the latter can influence long-term forest composition and structure in a particular region.

Table 2 – Percent composition of Pennsylvania's sawtimber inventory by region, 1965 and 2002.[a]

Species	Northern[b]		Western[c]		Eastern[d]	
	1965[e]	2002[f]	1965	2002	1965	2002
Oaks						
Northern red oak	14.5	9.3	21.2	13.3	13.2	13.9
Other red oaks[g]	2.2	1.5	9.3	4.5	14.1	11.7
White oak	5.0	2.1	10.0	7.1	9.9	8.1
Chestnut oak	1.9	1.2	7.9	5.5	16.1	14.3
All oaks	**23.6**	**14.1**	**48.5**	**30.4**	**53.3**	**48.0**

Northern hardwoods						
Sugar maple	9.9	11.9	4.7	5.7	0.7	1.6
Red maple	14.1	23.8	8.6	15.6	5.4	7.8
Cherry	19.6	18.6	8.3	12.9	0.6	2.4
Birch	0.7	3.1	0.6	2.4	nr[h]	3.6
Beech	7.2	4.6	2.8	3.1	0.9	1.0
Basswood	2.7	2.0	0.6	2.0	nr	0.7
All northern hardwoods	**54.2**	**64.0**	**25.6**	**41.7**	**7.6**[i]	**17.1**
Other species						
Ash	5.9	7.1	2.1	3.0	3.0	5.9
Yellow-poplar	nr	2.0	3.3	6.0	8.9	10.7
Hickory	0.3	0.9	2.7	2.2	4.0	3.8
Softwoods	14.7	9.9	9.9	10.2	17.1	10.1

[a] Not all species are reported (i.e. percentages do not add to 100).
[b] Includes the Allegheny and northeastern FIA survey-units.
[c] Includes the western, southwestern, and north-central FIA survey-units.
[d] Includes the Pocono, south-central, and southeastern FIA survey-units.
[e] Developed from Ferguson (1968).
[f] Developed from USDA For. Serv. (2004).
[g] Includes black, scarlet, pin, and shingle oaks.
[h] Estimate not reported.
[i] Underestimates northern hardwood because many of these species were not reported in detail for survey-units in this region in 1965.

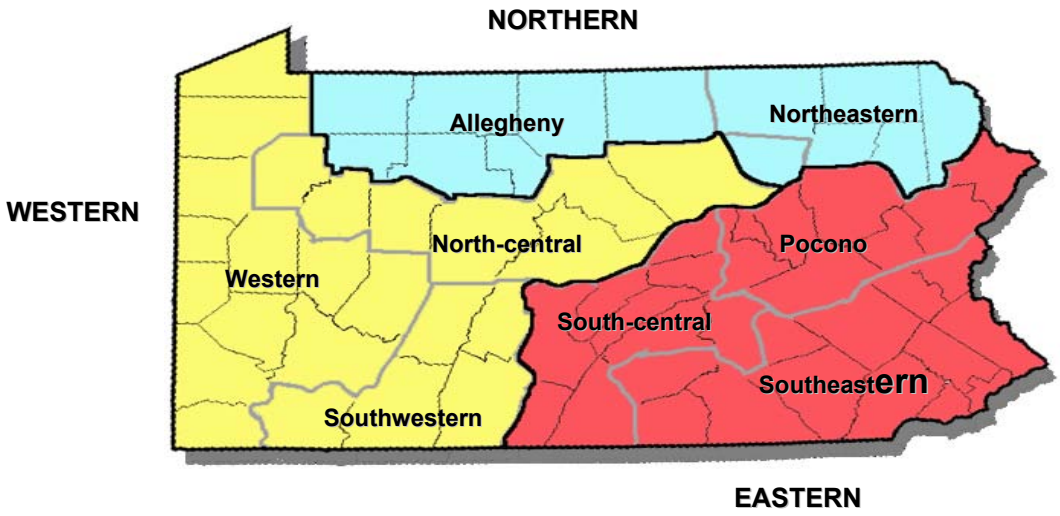
In this study we compare regional changes in Pennsylvania's timber resources to regional changes in lumber production and examine the influence of changing interspecies price, weighted for changing composition, on lumber production. Specifically, we group USDA Forest Service, Forest Inventory and Analysis (FIA) survey units into larger and more manageable regions, examine changes in lumber production between regions, and relate relative changes in lumber production to changes in regional price indexes weighted for changes in forest composition.

Defining Hardwood Regions for Pennsylvania

Pennsylvania contains eight FIA survey units. These units originally were defined in terms of physiographic features and county boundaries, but neighboring units often contain sawtimber resources with similar composition. The relatively large number but small size of many of these units made it impractical to examine the long-term relationship between the resource and the hardwood lumber industry at the survey unit level, so we combined them for this study using cluster analysis. This analysis was based on three variables: proportional sawtimber volumes of black cherry, all maples (red and sugar maple combined), and all oaks (chestnut, northern red, select white, and other oaks combined) for each survey unit in 1989

(Alerich 1993). Three readily identifiable clusters (northern, western, and eastern) emerged based on the average linkage method (Fig. 1). Other methods yielded identical clusters.

Figure 1. -- Regions of Pennsylvania analyzed and the Forest Service survey units aggregated to form these regions.



Regional Changes in Pennsylvania's Lumber Production

The earliest available estimates of hardwood lumber production for Pennsylvania were derived from a 1970 survey of the state's sawmill industry (Pennsylvania Dep. of Environ. Resour. 1971). Subsequent surveys of Pennsylvania's sawmilling industry were conducted in 1975, 1982, and 1986. The most recent production estimates were developed from a sawmill database developed by Smith et al. (2003). However, between 1970 and 1999 there have been two major swings in interspecies pricing associated with changing market preferences. In the 1970s and 1980s, the price of red and white oak surged while the price of maple declined. This corresponds to a period of increasing popularity of oak in furniture styles (Frye 1996). In the late 1980s, the price of red oak remained high while that of white oak began to decline relative to red oak. At the same time, the price of maple and cherry began to increase as styles incorporating closed-grain species increased in popularity. As a result, we decided to examine changes in Pennsylvania's lumber production for two periods: 1970 to 1986 (the red and white oak period) and 1986 to 1999 (the cherry, maple, and red oak period).

Table 3 presents a modified shift-share analysis for lumber production in the three regions of Pennsylvania for the two periods being examined. This analysis contrasts actual changes against expected changes assuming a consistent rate of growth in lumber production across all regions. A negative percentage difference indicates less than expected growth while a positive percentage indicates a greater than expected growth. The formulas are:

$$EC_{i,\,t,t+n} = (V_{t+n} - V_t) * P_{it}$$

and

$PD_{i,\,t,t+n} = (AC_{i,\,t,,t+n} - EC_{i,\,t,,t+n}) / AC_{i,\,t,,t+n}$

Where:

$EC_{i,\,t,t+n}$ = Expected change in lumber production in region i between periods t and t+n

V_{t+n} = Lumber production in all regions in period t+n

V_t = Lumber production in all regions in period t

P_{it} = Proportion production volume in region i in period t

$PD_{i,\,t,\,t+n}$ = Percentage difference between actual and expected change in region i between periods t and t+n

$AC_{i,\,t,\,t+n}$ = Actual change in lumber production in region i between periods t and t+n

Table 3 – Shift-share analysis of regional lumber production (mmbf) in Pennsylvania 1970 to 1986 and 1986 to 1999.

Region	Northern	Western	Eastern	All regions
		1970 to 1986		
Production 1970[a]	143	329	134	606
Production 1986[b]	232	479	290	1001
Expected change	93	214	87	
Actual change	89	150	156	
Percentage difference	-4.3	-29.9	79.3	
		1986 to 1999		
Production 1986	232	479	290	1001
Production 1999[c]	375	618	318	1311
Expected change	72	148	90	
Actual change	143	139	28	
Percentage difference	98.6	-6.1	-68.9	

[a] Pennsylvania Department of Environmental Resources (1971); procedures developed by Luppold (1996).

[b] Pennsylvania Department of Environmental Resources (1986); procedures developed by Luppold (1996).

[c] Smith, et al. (2003).

In 1970, more than 54 percent of the lumber was produced in the western region, while the northern and eastern regions contained 24 percent and 22 percent of production, respectively (Table 3). Between 1970 and 1986, production increased by nearly 400 million board feet. However, the relative production in the western region decreased to 48 percent with most of the increased proportion shift accruing in the eastern region. In percentage difference, production in the northern region grew slightly less than expected, production in the western region was 30 percent less than expected, and production in the eastern region was 79 percent more than expected.

Between 1986 and 1999 lumber production increased by an additional 300 million board feet, mostly in the northern and western regions. In percentage difference, production in the western region grew slightly less than expected, production in the eastern region was 69 percent less than expected, and production in the northern region was 99 percent more than expected (Table 3).

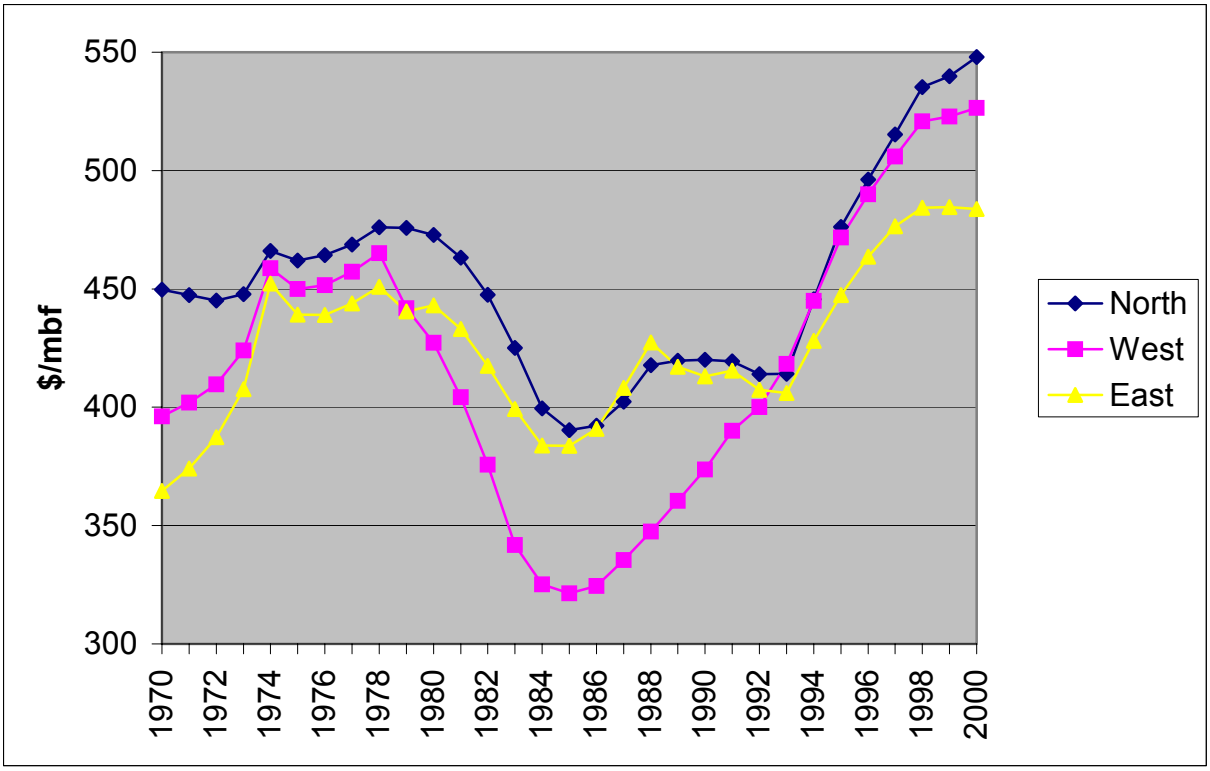
Influence of Lumber Prices on Regional Lumber Production

When examining the hardwood resource for the three timber regions of Pennsylvania, it was noted that the eastern region had the lowest rate of growth in sawtimber but the highest relative rate of growth in lumber production between 1970 and 1986. These two trends seem inconsistent given that the eastern region also contained the lowest percentage of select species as defined by Araman (1987). However, changes in relative lumber production also are influenced by changes in the relative interspecies price.

Figure 2 presents a 5-year moving average of deflated regional price series based on the composite prices of No. 1 Common (1C) lumber for the species in each region. A 5-year moving average was selected to reduce cyclical variation in lumber prices that could confound the analysis and because changes in lumber production are the result of both current and past prices (Luppold 1984). The price of 1C lumber was obtained for the Appalachian region for the first week in January from 1966 to 2000 (Hardwood Mar. Rep.1966 to 2000). Prices were deflated using the Producer's Price Index for all industrial commodities (U.S. Dep. of Labor 2003). Because regional forest composition has changed over time (Table 2), the price series for each region reflects changes in lumber prices for relative volumes of species in the regions and changes in relative composition of these species over time. These variable weights were developed yearly by extrapolating the proportional volumes of the hardwood species reported in Ferguson (1968), Alerich (1993), and USDA Forest Service (2004) for the inventory years 1965, 1978, 1989, and 2002, respectively.

Figure 2 reveals that lumber prices faced by sawmills in each region followed distinctly different trends. The northern region consistently had the highest or near highest price for the 30-year period. By contrast, prices in the western region began between those in the other regions, declined in the mid-1980s, and then increased steadily. Prices in the eastern region increased in the 1970s, and remained relatively high until the early 1990s, but have since lagged behind those in the other regions.

Figure 2. Five year moving average of deflated 1Common hardwood lumber price in the northern, western, and eastern regions of Pennsylvania weighted for changing sawtimber composition.



Changes in relative prices between 1970 and 1986 are reflected in the actual versus expected changes in the shift-share values in Table 3. During this period, the price of species increased in the eastern region, decreased in the western region, and showed the least variability in the northern region (Fig. 2). The large increase in relative prices in the eastern region resulted from an increase in the price of red and white oak (the most common species in this region). The large drop in relative price in the western region reflected declining prices for hard and soft maple and increased proportions of these species (Table 2). Compared to the western region, relative prices in the northern region remained high during this period due to continued high price for black cherry, a smaller decrease in relative oak volumes, and a smaller increase in relative maple volume. The smaller changes in composition in the northern region resulted in virtually no change in relative production.

In the late 1980s the price of red oak remained high, the price of white oak began to decline relative to red oak, and the price of maple and cherry began to increase. This caused relative production in the northern region to increase, virtually no change in relative production in the western region, and a decrease in relative production in the eastern region.

SUMMARY AND CONCLUSIONS

The hardwood sawtimber inventory in Pennsylvania more than tripled in volume between 1965 and 2002. Coincident with this increase has been a change in forest composition as proportional volumes of maples have increased. However, changes in sawtimber volume and forest composition have not been uniform across the state. The northern region has had the greatest increase in sawtimber volume and the largest proportional change from oaks to maples. By contrast, the eastern region has had the smallest increase in inventory and the smallest shift in forest composition.

Pennsylvania's sawmilling industry also has grown over the last 35 years as timber inventories have increased and prices for most species of hardwood lumber have cycled upward. However, the rate of growth in regional lumber production has not strictly coincided with increases in inventories, nor has it coincided with expectations with respect to timber quality. Between 1970 and 1986, lumber production more than doubled in the eastern region, even though this region had the least relative increase in sawtimber inventory and the lowest proportion of select species. However, after 1986, production in the northern and western regions grew while production in the eastern region remained nearly constant. The reason for this is that lumber production is influenced not only by changes in interspecies pricing but also by changes in forest composition.

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