SEASONAL INFLUENCE ON OHIO HARDWOOD STUMPAGE PRICE TRENDS

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Abstract.—The average annual percentage rates of change in real sawtimber stumpage prices from 1978 through 2012 (dollars per thousand board feet, Doyle) for the 10 commercial hardwood species of Ohio were determined. Each species was then further examined for differing trend lines between the spring and fall reporting periods. Annual real rates of change ranged from -1.10 percent for basswood to 2.13 percent for hard maple. Across species, 37 percent of the annual price highs occurred in spring; 59 percent of the annual highs occurred in fall. Approximately 75 percent of all price cycles lasted three seasons or less. However, no spring/fall seasonality effect in reported prices was observed for any of the 10 species. Although the relatively low rates of change suggest Ohio has historically been a buyer's market, the seasonal variation characteristic of a buyer's market was not present in Ohio's hardwood stumpage price trends.

INTRODUCTION

Stumpage price is the residual of lumber price less milling, harvesting, and hauling costs and the profits derived from each process. Stumpage prices are fundamentally driven by supply and demand, which can exhibit seasonal influences. Mead (1964) found demand for specific grades of lumber varied due to the seasonal needs of downstream purchasing sectors. Dahal and Mehmood (2005) stated one determinant of a timber tract's bid price was seasonality. For example, increasing procurement activities in fall before wetter and colder weather can help guard against potential emergency purchases in periods of low inventories (Gallagher 2003). Prudent supply management can also protect sawmills from competing against pulp mills for marginal quality sawtimber in times of reduced timber availabilities (Luppold 1996).

Price trends provide production forestry clientele with a measure of timber's economic performance. The Ohio Timber Price Report, which dates to 1960, has provided semiannual sawtimber price survey results for 10 hardwood species since 1978: ash (*Fraxinus americana*), basswood (*Tilia americana*), black cherry (*Prunus serotina*), hard and soft maples (*Acer saccharum* and *A. rubrum*), hickory (e.g., *Carya cordiformis*), black walnut (*Juglans nigra*), red and white oaks (*Quercus rubra* and *Q. alba*), and yellow-poplar (*Liriodendron tulipifera*). Participants in the surveys include foresters, loggers, mills, and timber buyers, with pricing data collected for the spring (May) and fall (November) seasons. Gathering prices from several sources helps provide an overall picture of the marketplace that reflects differing perspectives.

How the Ohio timber market has been affected by past seasonal influences has yet to be determined. The objective of this study was to determine the 1978 through 2012 sawtimber stumpage price trends of Ohio's commercial hardwood species. Price trends for the species were then evaluated for seasonality by using both descriptive statistics and regression models that contained seasonal indicator variables.

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METHODS

Statewide average sawtimber stumpage prices (dollars per thousand board feet, Doyle) reported for each species were used in this study. Nominal prices were adjusted for inflation to 2012 constant dollars by using the Producer Price Index for all commodities (U.S. Bureau of Labor Statistics 2013). Real prices for each species were averaged, with the amount of variation occurring about the means recorded.

Trend analyses were conducted for each species across their entire time series as well as for the spring and fall seasons from 1978 through 2012 at a significance level of $\alpha = 0.05$. Determining price trends first required transforming price data for each species to their natural logarithms. The following equation describes the simple linear regression model used in SAS version 9.2 (SAS Institute Inc., Cary, NC) to find the rate of price change:

$$Y = \beta_0 + \beta_1 X_t + \varepsilon$$

where

$Y = \ln(P_t)$, with P_t being the average price of a species paid at time t;

β_0 = the intercept of the line, represents the initial price in a series;

β_1 = the slope, or the continuous rate of change in price;

X_t = time t in a series, which was numbered sequentially (1978/spring = 1.25, 1978/fall = 1.75, 1979/spring = 2.25…2012/spring = 35.25, 2012/fall = 35.75); and

ε = the error of the model.

The average annual percentage rate of change (APR) was then found by using the following equation (Wagner and Sendak 2005):

$$APR = (e^{\beta_1} - 1) * 100$$

Time-series data are often autocorrelated, which means the residuals of the data are similar to adjacent points (Moineddin et al. 2003). Linear regression, though, requires residuals of observations to be independent of one another (Kutner et al. 2004). The Durbin-Watson test statistic, which tests the assumption of independence of the residuals of a linear regression (Albright et al. 1999), found significant autocorrelation existed across price data for each species.

Maximum Likelihood stepwise autoregression was used to account for the autocorrelation. Five lag variables were assigned by using a backward stepwise approach, and nonsignificant variables were removed one at a time. Any remaining variable(s) were those significantly contributing to the model. One lag variable accounted for the autocorrelated data of each price series. Autoregression model errors were reported as percent root mean square error (% RMSE) by using the equation below (Linehan et al. 2003):

$$\%RMSE = (e^{RMSE} - 1) * 100$$

Each species was then examined for seasonal price differences. First, annual price highs occurring in both spring and fall were counted for each species, with their frequency percentage determined. Price cycle lengths, which were defined here as the elapsed time between adjacent price peaks, were also established. A seasonality effect in the price trends of each species was then investigated by testing for trend line intercept (initial price) and slope (APR) differences. This was done by adding an indicator variable to a regression function to differentiate between seasons by using the following equation:

$$Y = \beta_0 + \beta_1 x_{1t} + \beta_2 x_{2t} + \beta_3 x_{1t} x_{2t} + \varepsilon$$

where

$Y = \ln(P_t)$, with P_t being the average price of a species paid at time t;

X_{1t} = time t in a series;

X_{2t} = the indicator variable (1 for spring, 0 for fall);

$X_{1t}X_{2t}$ = the interaction term;

β_0, β_1, β_2, and β_3 were model coefficients; and

ε = the error of the model.

The indicator variable coefficient, β_2, tested whether the initial prices between spring and fall were different. The interaction coefficient, β_3, tested for an APR difference between seasons. Autocorrelation was again examined and accounted for as described previously.

RESULTS

Overall Prices and Price Trends

The average real prices (constant 2012 dollars) for each species from 1978 through 2012 are provided in Figure 1. Average prices ranged from \$175 for hickory to \$769 for walnut. Variability about the means ranged from 19.7 percent to 44.7 percent. Overall, five species had price variations of less than 25.0 percent from their means, and five had greater than 25.0 percent. Prices of hickory were the most stable, varying 19.7 percent from its mean price. Cherry and hard maple each exhibited variations of at least 40.0 percent from their respective means.

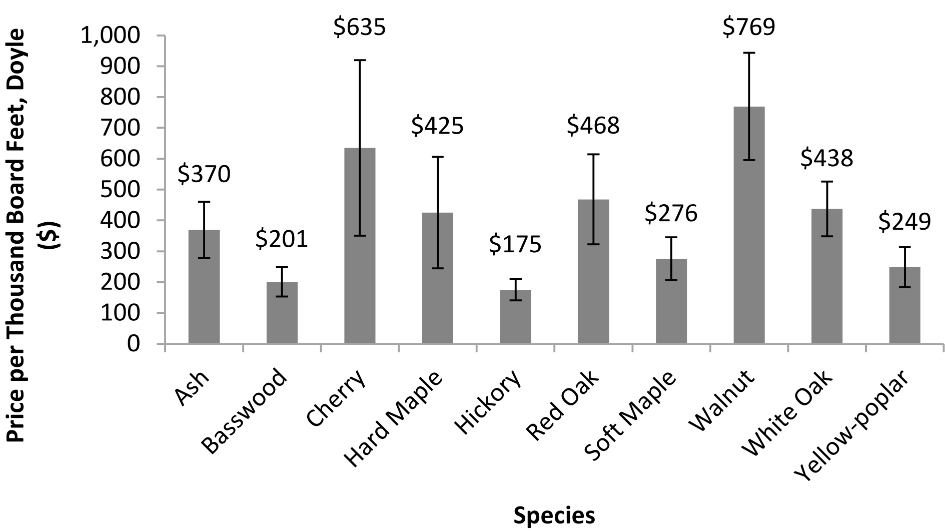

Figure 1.—Average real prices (constant 2012 dollars) from 1978 through 2012 for 10 Ohio hardwood species. Error bars are the standard deviation.

The APRs of real prices from 1978 through 2012 ranged from -1.10 percent for basswood to 2.13 percent for hard maple and are presented in Figure 2. Two species, ash and basswood, had overall negative APRs. Three species had APRs of at least 1 percent: hard maple, cherry, and white oak. Prices of only two species, though, were found to be changing at significant annual rates: basswood ($p = 0.05$) and white oak ($p = 0.04$).

Spring Price Trends

Real price APRs in spring from 1978 through 2012 ranged from -0.81 percent for basswood to 2.37 percent for hard maple (Fig. 3). Ash and basswood had negative APRs. Hard maple, cherry, and white oak showed price increases of at least 1 percent annually. Hard maple ($p = 0.04$) was the only species with a significant APR for the spring price series.

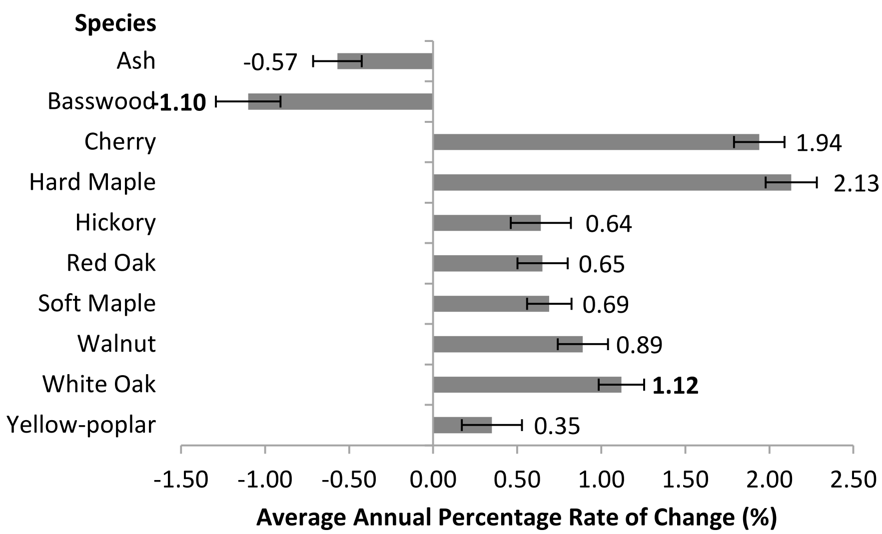

Figure 2.—Overall annual percentage rates of change (APR) in real prices from 1978 through 2012 for 10 Ohio hardwood species. Boldface APRs were significantly different from zero at $\alpha = 0.05$. Error bars are percent root mean square error.

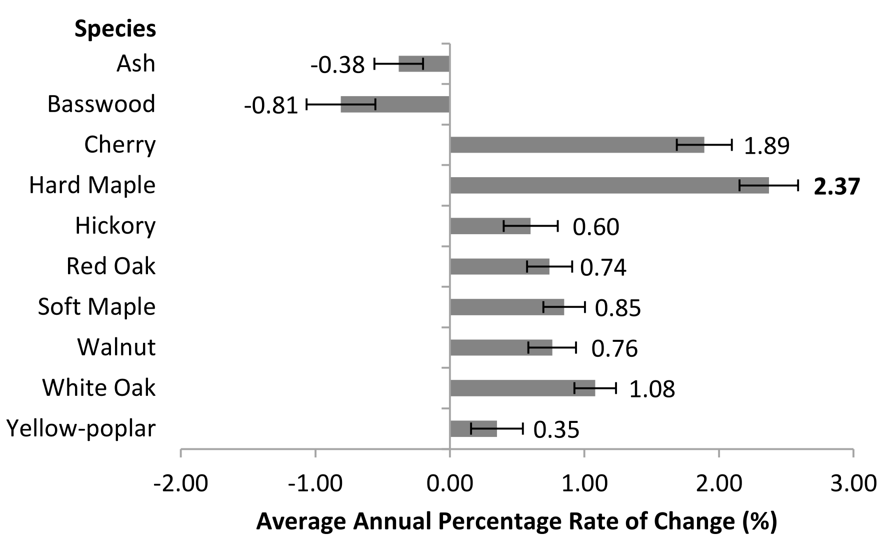

Figure 3.—Annual percentage rates of change (APR) in spring real prices from 1978 to 2012 for 10 Ohio hardwood species. Boldface APRs were significantly different from zero at $\alpha = 0.05$. Error bars are percent root mean square error.

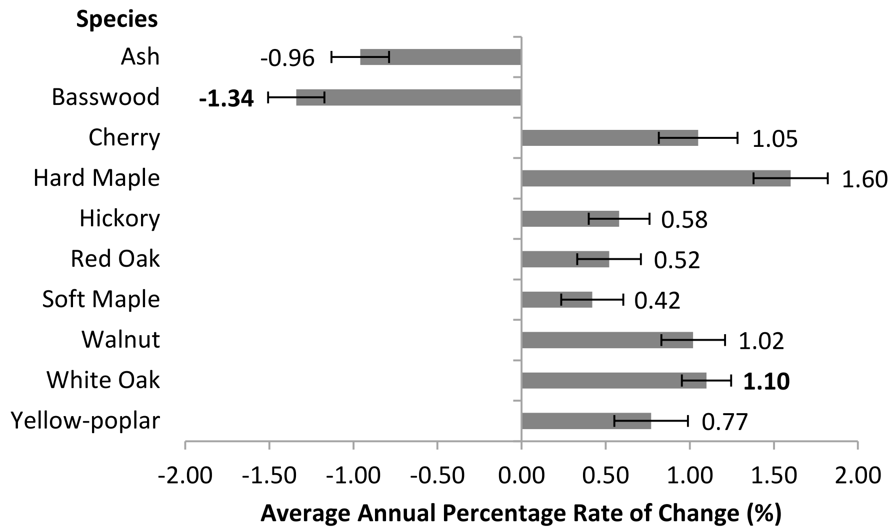

Figure 4.—Annual percentage rates of change (APR) in fall real prices from 1978 to 2012 for 10 Ohio hardwood species. Boldface APRs were significantly different from zero at α = 0.05. Error bars are percent root mean square error.

Fall Price Trends

Real prices in fall from 1978 through 2012 changed at annual rates of between -1.34 percent for basswood to 1.60 percent for hard maple (Fig. 4). Ash and basswood again had negative APRs. Hard maple, white oak, cherry, and walnut had fall APRs of at least 1 percent. For two species, basswood (p = 0.04) and white oak (p = 0.03), fall prices changed at significant annual rates.

Seasonality in Stumpage Price Trends

Tables 1 and 2 provide descriptions of any seasonal volatility occurring in hardwood stumpage prices from 1978 through 2012. Across species, 37.2 percent of the annual price highs occurred in spring (Table 1). No individual species had price highs occur in spring more than 50.0 percent of the time. Annual price highs occurred in fall at least 60.0 percent of the time for seven species. Overall, annual price highs occurred in fall 59.4 percent of the time.

Table 2 describes the price cycle lengths observed in Ohio hardwoods. The most common cycle observed in six species was the shortest possible, 1 year. Most of the cycle lengths for walnut, ash, hard maple, hickory, and yellow-poplar were only 1 year. Fifty percent of white oak's price cycles were intervals of at least 2 years. Across species, 44.3 percent of all price cycles lasted only 1 year, and 75.4 percent were three seasons or less in length.

Within each species, the seasonal trend lines were tested to determine if potential differences existed between the initial prices or APRs of each time series (Table 3). Initial prices did not differ between seasons ($0.37 \leq p \leq 0.94$), nor did APRs ($0.46 \leq p \leq 0.97$). Given the lack of intercept and slope differences, seasonal timber prices in Ohio have not historically exhibited any significant spreads between price levels, nor have the trends been diverging or converging.

Table 1.—Frequency of annual price highs occurring in spring and fall from 1978 through 2012 for 10 hardwood species in Ohio

Species	High price in spring	High price in fall	Prices equal
		Frequency, %	
Ash	34.4	65.6	0.0
Basswood	37.5	62.5	0.0
Cherry	28.1	71.9	0.0
Hard maple	50.0	46.9	3.1
Hickory	34.4	62.5	3.1
Red oak	31.3	65.6	3.1
Soft maple	31.3	68.8	0.0
Walnut	43.8	40.6	15.6
White oak	50.0	43.8	6.3
Yellow-poplar	31.3	65.6	3.1
All species	37.2	59.4	3.4

Table 2.—Frequency of cycle lengths between price highs for 10 Ohio hardwood species

	Cycle length (and equivalent number of seasons)				
	1 year (2 seasons)	1.5 years (3 seasons)	2 years (4 seasons)	2.5 years (5 seasons)	3 years (6 seasons)
Species			*Frequency, %*		
Ash	54.5	9.1	27.3	9.1	0.0
Basswood	20.0	50.0	30.0	0.0	0.0
Cherry	45.5	36.4	18.2	0.0	0.0
Hard maple	54.5	27.3	9.1	9.1	0.0
Hickory	54.5	18.2	9.1	9.1	9.1
Red oak	40.0	40.0	20.0	0.0	0.0
Soft maple	36.4	54.5	9.1	0.0	0.0
Walnut	58.3	25.0	16.7	0.0	0.0
White oak	12.5	37.5	37.5	12.5	0.0
Yellow-poplar	54.5	18.2	18.2	9.1	0.0
All species	44.3	31.1	18.9	4.7	1.0

Table 3.—Within-species seasonal price comparisons of trend line intercepts (initial price levels) and slopes (average annual percentage rates of change [APR]). Model errors are presented as percent root mean square error (%RMSE).

Species	Initial price, p-value	APR, p-value	%RMSE
Ash	0.50	0.56	17.41
Basswood	0.94	0.75	21.39
Cherry	0.37	0.46	21.67
Hard maple	0.40	0.56	21.80
Hickory	0.82	0.84	18.71
Red oak	0.58	0.72	17.09
Soft maple	0.62	0.65	16.97
Walnut	0.65	0.47	17.30
White oak	0.56	0.92	14.98
Yellow-poplar	0.77	0.97	18.71

DISCUSSION

Since 1978, real prices have not changed significantly across species. Overall price trends of only two species, white oak at 1.12 percent and basswood at -1.10 percent, were significantly different from zero. White oak is distributed widely throughout the Central Hardwood region and has a long-held preferred status in consumer and industrial products. Basswood has had limited demand in Ohio for some time. No species contained both significant spring and fall APRs. Though not overly encouraging, the rates of price change were at or near the average inflation rate.

Potential seasonality was first investigated by using descriptive methods. Measuring the variation about the means provided some measure of the volatility in prices. Five species had coefficients of variation (CVs) of at least 25.0 percent, and five others had CVs less than 25.0 percent. However, the presence of year-to-year variation may have masked any seasonal differences in the price data for the species. The frequency of seasonal price highs occurring in spring and fall were then determined. Annual prices were generally found to be lower in spring and higher in fall. Additionally, price cycle lengths were commonly three seasons or less, with 1 year being the most common. This pattern was similar to the volatility seen in Illinois's timber price trends (Campbell and White 1989).

By these criteria, Ohio timber market participants perhaps have attempted to purchase or market stumpage more aggressively in fall. For all species, though, the lack of trend line intercept and slope differences across the entire price ranges of both seasons indicated spring/fall seasonality was not a factor in determining sawtimber market price. A seasonal effect was also absent in Vermont's stumpage price trends (Sendak and McEvoy 1989).

However, the lack of seasonality found in Ohio may have been locally driven and not indicative of the greater timber market. Timber prices in the southern United States, for example, have been found to be higher in fall than other seasons in anticipation of weather-induced harvesting restrictions (Dahal and Mehmood 2005). Mead (1964) concluded a significant negative correlation existed between seasonal price variation and lumber grade, which in turn could indicate the potential for a seasonal effect within the price trends of one or more individual log or tree grades of a species. Future research should address this issue.

The relatively low rates of price change suggest a historical buyer's market for Ohio timber. A sale in this type of marketplace is typically one of a smaller private tract, where price is negotiated between the seller and an individual buyer. Formal bidding by multiple parties, which is advantageous to the landowner, is often the exception rather than the norm. An environment is thereby created where prices favorable to the buyer can endure (Campbell and White 1989). Another indicator of a buyer's market is price volatility, where local conditions can result in wider price fluctuations between reporting periods than those found in the greater region. Annual price highs occurred in Ohio more frequently in fall and cycle lengths often lasted no more than three seasons. However, the trend lines for Ohio's spring and fall price series were not distinct for any species. It was concluded Ohio's hardwood stumpage price trends were not exhibiting a significant seasonal effect.

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