Annual Change in Ohio Hardwood Stumpage Prices, 1960 to 2011

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Abstract

Timber price trends provide economic information for forest management and wood utilization decision making, yet to our knowledge, no comprehensive examination of Ohio timber price data has been conducted. Stumpage prices reported biannually from 1960 to 2011 (dollars per thousand board feet, Doyle) for the 10 commercial hardwood species of Ohio were obtained from the Ohio Timber Price Report. Average annual percentage rates of change were determined using log-linear modeling, which included testing and accounting for serial correlation of the residuals. The real price data of each species (1982 dollars) were further examined for differing trend lines between the periods 1960 to 1985 and 1986 to 2011. Nominal prices have been increasing annually between 3.57 percent for basswood (*Tilia americana*) and 6.13 percent for cherry (*Prunus serotina*). Real price rates of change were lowest for basswood, –0.25 percent, and highest for cherry, 2.19 percent. The species separated into three groups based on trend line intercept (initial price) and/or slope (rate of price change) differences between the two eras. No differences were observed between eras for cherry, hard and soft maple (*Acer* spp), hickory (*Carya* spp.), walnut (*Juglans nigra*), and yellow-poplar (*Liriodendron tulipifera*). Basswood prices in the second era were changing at a significantly lower rate than in the first era. Distinct trend lines were found between eras for ash (*Fraxinus* spp.), and red and white oak (*Quercus* spp.). Initial prices for the three were significantly higher in the second era, while rates of price change were significantly lower in the second era.

Timber price trends provide information for making forest and business management decisions because price expectations play a key role in timber management. When prices are adjusted to present value, decisions such as rotation age, harvest methods, and silvicultural treatments are directly influenced (Guttenberg 1970). Management decisions made without an understanding of past price trends and expectations of future prices can lead to a suboptimal harvest that could reduce a landowner's revenues and affect long-term management goals.

Dennis and Remington (1985) described a modification of Faustman's formula in which they incorporated stumpage price trends into the procedure for reaching rotation and harvest decisions. Timber harvesting was recommended at the point when the increase in value no longer was greater than the potential gains earned from delaying harvest, which was when marginal revenue equaled marginal cost. The long-term effect of a price trend influenced the opportunity cost, which lengthened the optimal rotation period with increasing prices or shortened it with decreasing prices.

Production forestry's adoption of timber and log conversion technologies has had its effects on timber prices, because stumpage price itself is the residual once milling, harvesting, and hauling costs, and the profits derived from each process, have been subtracted from lumber price. Perhaps the most influential movements were from manual to mechanized labor and the transport of timber from simple horse-pulled to truck and rail during the 20th century. More recent times have seen a growing presence of computerized equipment in sawmills, such as log scanners and the associated programs designed to optimize lumber recovery and grade yield. Likewise, the move to more fully mechanized and higher output harvesting operations, including the shift from chainsaw tree felling to feller bunchers or even the increasing use of higher payload forwarders over rubber-tired skidders, has led to dramatic increases in productivity and technical efficiency. The resulting improvements in conversion efficiencies through

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these and other technological advances have accrued to hardwood stumpage prices (Luppold and Baumgras 1995).

The US Forest Service and university state Extension services have provided timber buyers and sellers a wealth of price trend literature. Some recent examples include Linehan et al. (2003) and Linehan and Jacobson (2005) examining Pennsylvania stumpage price trends for eight species groups. Prices for Indiana's trend report date to 1957 for timber stands of both average and high quality (Hoover and Preston 2013). Wagner and Sendak (2005) determined the annual change in timber prices from 1961 to 2002 using price data from a nine state region of the northeastern United States. These and other studies, while informative, cannot completely and accurately describe Ohio timber market activities, given the overall economic feasibility of transporting roundwood (Cubbage and Davis 1986). No comprehensive examination of local timber price data, as reported since 1960 in the Ohio Timber Price Report (Ohio Department of Natural Resources, Division of Forestry [ODNR] 1960–2001; Ohio State University Extension [OSUE] 2003–2011), has been conducted to date to provide this trend information to Ohio forestry clientele.

Further, industry shifts over the past two decades (Luppold and Bumgardner 2007, Espinoza et al. 2011) and the more recent Great Recession have had significant impacts on the forest products industry. For example, real gross domestic product of Ohio's wood products manufacturing sectors from 2001 to 2010 declined $146 million (US Department of Commerce Bureau of Economic Analysis 2013). A survey of Ohio primary processors estimated a 15 percent loss in the number of businesses from 2003 to 2011 (McConnell 2011). Luppold et al. (in press) noted stumpage price declines of at least 30 percent for six Ohio hardwood species from their most recent mid-2000s price peaks to their low points in 2008 and 2009. These local market activities support the recommendation of Wagner and Sendak (2005) to both publish and then periodically update timber price trend analyses.

The goals of this research were to determine the average annual percentage rates of change (APR) in nominal and real stumpage prices from 1960 to 2011 for the 10 commercial hardwood species described in the Ohio Timber Price Report. Real price movements between the periods 1960 to 1985 (Era 1) and 1986 to 2011 (Era 2) were then further evaluated to determine how price trends in the second era differed from trends in the first era.

Methodology

Data

The stumpage data used here were statewide average prices (dollars per thousand board feet [$/MBF], Doyle, by species) compiled from biannual surveys sent to loggers, mills, and timber buyers in Ohio in May (spring) and November (fall). From 1960 to 2001 the surveys were conducted by the Ohio Agricultural Statistics Service and ODNR (ODNR 1960–2001). From 2003 to the present, OSUE has overseen the program (OSUE 2003–2011). During the transition year of 2002, no surveys were sent out. The 2002 data were considered missing completely at random, which is the probability that missing observation X_i is unrelated to the value of X_i or to the value of any other variables. Simple listwise deletion was used to omit the missing case and analyze the remaining data points (Howell 2012).

Nominal stumpage price APRs were reported for ash (*Fraxinus* spp.), basswood (*Tilia americana*), black cherry (*Prunus serotina*), hard and soft maples (*Acer* spp.), hickory (*Carya* spp.), black walnut (*Juglans nigra*), red and white oaks (*Quercus* spp.), and yellow-poplar (*Liriodendron tulipifera*). Nominal prices were then adjusted for inflation to 1982 constant dollars using the Producer Price Index for all commodities (US Department of Labor Bureau of Labor Statistics 2013), with the associated real price APRs subsequently determined.

Approach

All analyses were conducted at the $\alpha = 0.05$ significance level. The nominal and real price APRs for each species were determined by initially transforming the prices for a reporting period to their natural logarithms (ln) followed by log-linear modeling using SAS software version 9.2 (SAS 2008). A continuous rate of price change from 1960 to 2011 was estimated using Equation 1:

$$Y = \beta_0 + \beta_1 X + \varepsilon \tag{1}$$

where $Y = \ln(P_t)$, with P_t being the average price paid at time t (year/season); the intercept of the line, β_0, represents the initial price in a series; β_1 represents the slope, or continuous rate of change in price; X is time (year/season) in a series, which in this case is numbered sequentially (1960/spring = 1.25, 1960/fall = 1.75, 1961/spring = 2.25 … 2011/spring = 52.25, 2011/fall = 52.75); and ε is the model's error. The continuous rate β_1 is then converted to an APR using Equation 2 (Wagner and Sendak 2005)

$$\text{APR} = (e^{\beta_1} - 1) \times 100 \tag{2}$$

Autocorrelation, or serial correlation of residuals, is an underlying concern when analyzing time-series data (Moineddin et al. 2003). The presence of autocorrelation violates the assumption of residual independence in linear regression (Linehan and Jacobson 2005). The independence of each species's residuals was tested using the Durbin-Watson test statistic (Albright et al. 1999). Significant autocorrelation was present for all species.

Maximum Likelihood stepwise autoregression was used to account for the autocorrelation (Luppold et al. 1998, Linehan et al. 2003, Wagner and Sendak 2005, Zhou and Buongiorno 2006, Luppold and Bumgardner 2007, Malaty et al. 2007, Mei et al. 2010). A backward stepwise approach was used to assign five explanatory variables to the model to compare the new R^2 to the original. These variables are often called ''lag'' variables because they are assigned to past data and thus are lagging the current data in time. The variables were assigned in a group, and insignificant variables were removed individually. The remaining variables were those significantly contributing to the model. A maximum of three lag variables accounted for autocorrelation in a series, with many requiring only one lag variable.

Real prices for the entire reporting period were split into two 26-year eras, 1960 to 1985 and 1986 to 2011, with the trend lines compared for intercept (initial price) and slope (APR) differences. The 1985/1986 point was chosen for the break for two reasons. First, hardwood production was at a historical low in 1985 (Luppold and Bumgardner 2007).

Second, the mid- to late 1980s was just prior to when Ohio stumpage prices for many species were observed to become more volatile, beginning an overall large increase and then decline.

Equation 3 was used to compare these two eras by adding an indicator variable to allow the intercepts and slopes of the two periods to move independently (Luppold and Bumgardner 2007)

$$Y = \beta_0 + \beta_1 + (\beta_F \times T_F) + (\beta_S \times T_S) + \varepsilon \qquad (3)$$

where $Y = \ln(P_t)$, with P_t being the average price paid at time t; β_0 is the intercept of the first time period; β_1 is the intercept shifter for the second period; β_F is the slope for the first period; T_F is the indicator time variable for the first time period (1 for 1961 to 1985, else 0); β_S is the slope for the second period; T_S is the indicator time variable for the second time period (1 for 1986 to 2011, else 0); and ε is the model's error. Autocorrelation was again present in each series and accounted for as described previously. Autoregression model errors were reported as percent root mean square error (%RMSE) using Equation 4 (Linehan et al. 2003, Linehan and Jacobson 2005)

$$\%\text{RMSE} = (e^{\text{RMSE}} - 1) \times 100 \qquad (4)$$

Results and Discussion

A summary of the species' APRs are presented in Figure 1. Overall nominal changes were between 3.57 percent for basswood and 6.13 percent for cherry, and all nominal prices were found to be increasing at significant average annual rates ($P < 0.01$ in all cases). We focused our analysis on real price trends because of the need for forest landowners and managers to take the long-term view in their decisions. For example, northern hardwoods managed under an evenage system typically have rotation periods of 100 to 120 years (Leak et al. 1987). When adjusted for inflation, the gains were more modest, ranging from –0.25 percent for basswood to 2.19 percent annually for cherry. The APRs of three species, ash ($P = 0.17$), yellow-poplar ($P = 0.37$), and basswood ($P = 0.55$), were found to not be significantly different from zero when adjusted for inflation.

Three groups of species were identified based on the presence or absence of differences between the initial prices and/or APRs of the two eras (Table 1). Group 1 was composed of species with APRs and initial prices not significantly different between eras. Group 2 had only significantly different APRs between the two eras. Group 3 species had both initial price levels and APRs that significantly differed across the two eras.

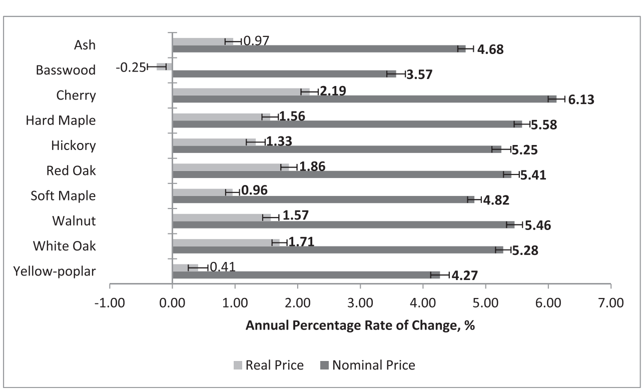

Figure 1.—Nominal and real average annual percentage rates of change in Ohio stumpage prices for the 10 hardwood species, 1960 to 2011. Bold values are significant at $\alpha = 0.05$. Error bars are percent root mean square error.

Table 1.—Two era comparisons of real Ohio stumpage price movements within each species, grouped according to differences or lack of differences in initial prices, annual percentage rates (APRs), or both.[a]

Species	Initial price difference, *P* value	APR (%) Era 1	APR (%) Era 2	APR difference, *P* value	%RMSE
Group 1: no differences in initial prices or APRs					
Cherry	0.70	1.79	1.66	0.95	13.73
Hard maple	0.39	0.45	2.49	0.32	13.17
Hickory	0.10	2.16	0.40	0.08	15.01
Soft maple	0.86	1.13	0.83	0.84	11.21
Walnut	0.95	2.02	1.41	0.66	13.67
Yellow-poplar	0.49	0.53	−0.27	0.63	15.79
Group 2: difference in APRs only					
Basswood	0.07	0.72	−1.91	**0.03**	14.80
Group 3: differences in both initial prices and APRs					
Ash	**<0.01**	2.99	−1.91	**<0.01**	12.38
Red oak	**0.01**	3.51	−0.28	**0.02**	12.76
White oak	**<0.01**	1.95	0.36	**0.01**	11.94

[a] Era 1 = 1960 to 1985; Era 2 = 1986 to 2011. Model errors reported as percent root mean square error (%RMSE). Bold *P* values are significant at $\alpha = 0.05$.

Group 1

Group 1 consisted of cherry, hard maple, hickory, soft maple, walnut, and yellow-poplar. These species had neither initial price levels nor APRs that were significantly different between eras (Table 1).

Cherry and walnut can be considered domestic exotic woods (Spieler 2011), but their prices in Ohio do not generally act in concert (Fig. 2). It appears walnut has a real price support in Ohio at approximately \$300/MBF, and although it has moved below that point four times in the second era, each time was for only a single season. It is possible the demand for walnut veneer and sawlogs in higher-valued furniture, paneling, and cabinetry, and its

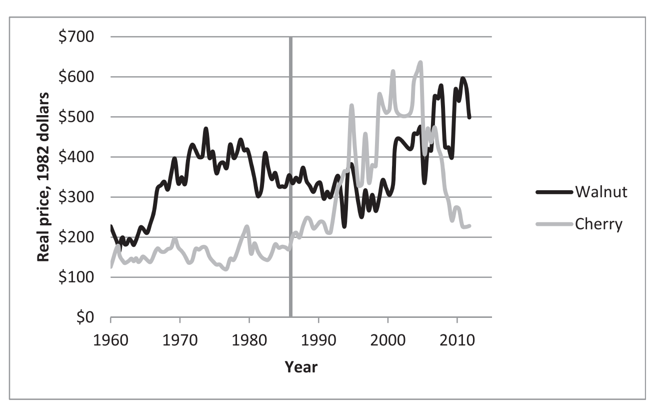

Figure 2.—Ohio walnut and cherry real stumpage prices (1982 dollars), 1960 to 2011. Two era divider at 1985/1986.

relative scarcity in Ohio has helped it remain resistant to large price fluctuations (Frye 1996, Widmann et al. 2009).

Cherry experienced a steady increase in popularity starting in the 1980s and through the economic boom of the 1990s. This increase was evident in the proportion of furniture showings at the High Point, North Carolina, furniture market from 1962 to 2005. Cherry had a low of 3.5 percent of showings in 1974 with a steady increase to 21.0 percent of showings in 1998, and then a decline to 15.0 percent of showings in 2005 (Frye 1996, Luppold and Bumgardner 2007). Ohio cherry stumpage prices declined 64 percent from fall 2004 to fall 2011.

Hickory reached a peak of $142/MBF in 2003 and then declined to $58/MBF in 2009 (Fig. 3). In 2006, hickory had the second lowest volume of sawlogs harvested among commercial species in Ohio, accounting for only 3 percent of the state's total hardwood sawlog harvest. While abundant in the forest, this species group is generally characterized as being of lower quality, with 61 percent of trees at tree Grade 3 or below (Widmann et al. 2009). Tree quality coupled with a lack of local markets has likely kept hickory prices historically depressed.

Yellow-poplar stumpage reached a peak of $239/MBF in 1999 and then declined to $82/MBF in 2010. The geographic shift in production away from the western states' softwood timber supplies contributed to a shortage in softwood plywood in the 1990s, which helped to increase demand for Appalachian yellow-poplar in wood composite products (Luppold and Baumgras 1995). However, soft hardwoods have been poorer performers in the lumber market, where greater stumpage prices can be obtained for some time, and the diminished need for core stock by domestic furniture manufacturers has affected yellow-poplar sawtimber pricing. The leveling off of the steep price decline of yellow-poplar from 1999 into 2004 (shown in Fig. 3) is likely the result of cost considerations and consumer tastes trending to darker finishes and painted cabinetry, making yellow-poplar a reasonable choice to replace more expensive woods because it holds stain or paint and finishes well (Johnson 2012a). Recent increases in shipments of yellow-poplar lumber for export have been noted regionally (Luppold and Bumgardner 2007) and locally by Ohio sawmills (Anonymous, personal communication, 2012).

Hard maple and soft maple followed a similar price trend over both eras. Hard maple price, though, showed a steeper increase over the period from 1991 to 2000 as the hardwood industry shifted from oak to maple in the late 1980s (Luppold and Bumgardner 2007). Both species were at an identical price of $99/MBF in 1991, while hard maple peaked at $414/MBF in 2000 and soft maple peaked at $227/MBF in 2004 (Fig. 4). Consumer preference for selected pieces from the clear portion of the outer sapwood generally provides a market advantage to hard maple over soft maple.

Maple in general has seen a recent increase in popularity with door and cabinet makers. Over 50 percent of cabinet production and 36 percent of doors displayed at industry trade shows were reported to be maple, with soft maple use increasing as painted cabinetry becomes more popular (Johnson 2012b). Soft maple use has also increased more recently in pulpwood and engineered products (Wiedenbeck and Sabula 2008), which favors use of lower quality logs. An overall increase in Ohio maple exports, which is supported by higher quality logs and lumber, could be playing a role in recent maple pricing. State exports of hard maple lumber, for example, have recently rebounded to surpass the 2008 level (US Department of Agriculture Foreign Agricultural Service Global Agricultural Trade System 2013).

Group 2

Group 2 contained basswood only, which had differing APRs between time periods. The two eras' initial prices, $95 in 1960 and $101 in 1986, were not significantly different (Table 1). Basswood price peaked in 1995, with the fall 2011 price 54 percent below the recorded high (Fig. 5). Basswood prices began a steady decline from $169/MBF in 1995 to its lowest historical price of $55/MBF in 2008.

The volume of basswood produced in Ohio is a possible driver of its lower prices. Low volumes and/or tree densities within a stand make it more difficult for landowners to market a particular species when conducting a timber sale (Bruton 2004). Basswood has not been a popular timber species in Ohio for some time. More recently, the increased substitution of nonwood alternatives and the decline in home remodeling (Luppold et al., in press) has limited its use in interior designs.

Group 3

The group with both initial prices and APRs differing significantly between eras contained ash, red oak, and white

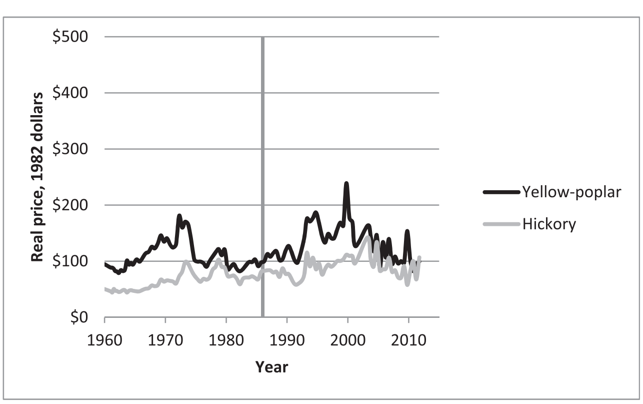

Figure 3.—Ohio yellow-poplar and hickory real stumpage prices (1982 dollars), 1960 to 2011. Two era divider at 1985/1986.

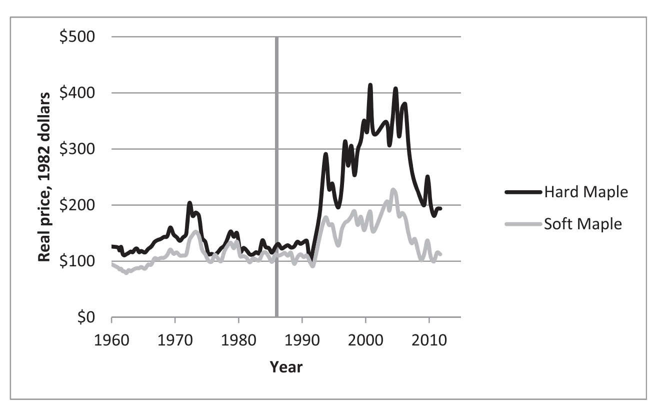

Figure 4.—Ohio hard and soft maple real stumpage prices (1982 dollars), 1960 to 2011. Two era divider at 1985/1986.

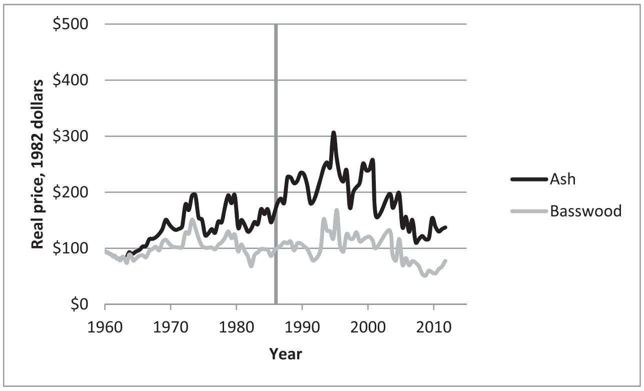

Figure 5.—Ohio ash and basswood real stumpage prices (1982 dollars), 1960 to 2011. Two era divider at 1985/1986.

oak (Table 1). The initial price at the start of the second era in 1986 was significantly higher than the 1960 price for each species. Additionally, prices for all three species in the second era have been changing at significantly lower rates than in the first era.

The price of ash peaked at $307/MBF in 1994 and declined to $102/MBF in 2007. A steady fall in ash price began in 2000 and was likely hastened by the discovery of the emerald ash borer (EAB; *Agrilus planipennis*) in Ohio in 2003 (Fig. 5). As a result of the discovery of the EAB, Ohio imposed a quarantine on ash movement out of the state (Widmann et al. 2009), which may have moved prices lower through a lack of competitive bid situations. An increasing lack of healthy trees available for harvest on a tract likely affected offers as well.

Prices for oak stumpage generally followed a pattern of steady increase from 1960 to 1991, then a large increase followed by an equally large decrease from 1991 to 2011 (Fig. 6). Three peaks in red oak price occurred in the second era, one in 1994 ($368) and two nearly identical peaks in 1998 ($390) and 2004 ($389). White oak stumpage reached an all-time high of $309 in 1996 and was almost equaled in 2004 ($302). Prices fell rapidly for red oak following 2004 and less so for white oak. A second era low price of $159 was reached for red oak in 2009. White oak reached its second era low price in 2005 ($172) and then recovered briefly up to 2007 before declining again. Stumpage prices for each at the end of 2011 had rebounded 15 percent from their lows in the most recent 5-year cycle.

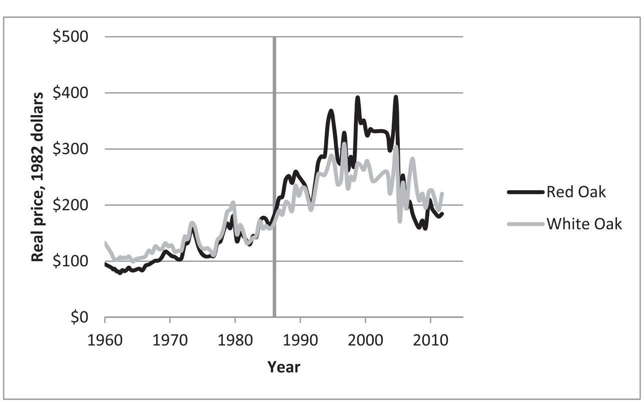

Figure 6.—Ohio red and white oak real stumpage prices (1982 dollars), 1960 to 2011. Two era divider at 1985/1986.

The escalation of oak prices, especially red oak, during the 1980s and 1990s can be partially attributed to increased demand for red oak lumber by secondary processors in the mid- to late 1980s followed by the economic boom of the mid- to late 1990s, which caused hardwood lumber consumption to increase in those time periods. Red oak prices started to decline in 2004 due to the overall decrease in Appalachian hardwood lumber consumption by the wood furniture industry and escalated following the rapid drop in home construction (Luppold et al., in press). Additionally, an ''anything but oak'' backlash occurred in the furniture and cabinetry industries around that time (Luppold and Bumgardner 2007). Exports have been helping buoy Ohio oak prices in recent years because total log exports have increased by $6 million and lumber exports by $235 million since 2009 (US Department of Agriculture Foreign Agricultural Service Global Agricultural Trade System 2013).

Discussion

Nominal stumpage prices have been increasing at significant APRs of at least 3.57 percent for all species over the past 52 years. Real trends were the focus of this study, and those price changes have varied. Seven species were increasing in real price APRs while three—ash, basswood, and yellow-poplar—were not. The long-term trends for ash, basswood, red oak, and white oak have been slowing since 1986.

Ohio stumpage prices were largely steady in the first era. Price declines beginning from the mid-1990s to mid-2000s prevented any significant APR increases across species in the second era. In many cases real prices at the end of 2011 were similar to those at the beginning of the second era in 1986. Prices have largely stabilized and for some species improved since 2009. Red and white oak prices have fared better than other species from 2009 to 2011 (OSUE 2003–2011), likely due to the wide species distributions and their historic preference for use in consumer and industrial products.

While final consumption is a fundamental driver, hardwood sawmills are the primary purchasers of Ohio roundwood. Even though spatially dependent factors, such as harvest and haul costs, can affect timber prices in defined local areas, Ohio's stumpage prices have historically followed trends similar to the greater Appalachian region's hardwood lumber market (Kingsley and DeBald 1987). Campbell and White's (1989) conclusion that Illinois stumpage prices were driven by more than strictly local market activities parallels these findings. Linehan and Jacobson (2005) found real stumpage price APRs in Pennsylvania from 1984 to 2003 were as much as 2.4 percent lower than those from 1984 to 2000. They concluded a 5-year decrease in the state's hardwood lumber production, which was believed to be driven nationally by a decline in wood furniture manufacturing and the national economic downturn in the early 2000s, contributed to the 2001 to 2003 decreases in stumpage prices. More recent price declines in Ohio stumpage prices related to the Great Recession have also correlated with Appalachian hardwood lumber prices (Luppold et al., in press).

Ohio timber supplies have grown, with growing stock and sawtimber volumes having both increased more than threefold since 1952 (McConnell 2012). Increasing tree size has improved the sawtimber quality, and this has greatly enhanced stands' earnings potential (Trimble et al. 1974). Red and white oaks predominate in the sawtimber size diameter classes. These species have historically been of higher quality and played leading roles in Ohio's forest products industry. The more tolerant and quality-inferior maples occupy 25 percent of the total volume in the sapling and poletimber classes and a growing percentage of the total sawtimber volume (Widmann and Balser 2011). Continued removal of ash and oak, which is due more to mortality in the first case and harvesting in the second, will likely maintain the recent trend of maple growth in sawtimber trees surpassing that of the other commercial hardwood species (Widmann and Balser 2011).

Landowners considering a timber sale would be judicious in their planning to study industrial trends. However, landowners and industry have historically not worked in concert (Luppold and Baumgras 1995). Owing to this lack of coordination, an owner depends on an understanding of timber management, marketing, and procurement that is commonly lacking (Luppold and Baumgras 1995, 1998; Luppold et al. 1998; Widmann et al. 2009). A certified professional forester, who can prudently mark trees for harvest and is knowledgeable of the local markets and buyers, can be a helpful resource when organizing a timber sale and for long-range planning. Landowners seeking this assistance frequently receive higher prices for their timber through competitive bidding than the average prices found in timber market reports. The competitive bid process also provides the seller more power to negotiate other aspects of a sale (Campbell and White 1989). The sale's terms—particularly its value, how payment is to be made, and at what time—should be clearly spelled out in a written timber sale contract.

Encouraging responsible forest management in favor of crop trees from the more economically and ecologically valued species, such as oak where applicable, can capitalize in the short term on sawtimber growth (Dennis and Remington 1985), forest products industry demand (Luppold 1997), and the environmental and financial capacity of the land (Campbell and White 1989). The limited active management of Ohio's forest lands (Widmann et al. 2009) may constrain the practice of this prescription, because only a small percentage of Ohio forest landowners pursue professional management or timber marketing advice (Widmann et al. 2009). This trend mirrors the Northeast in general (Wagner and Sendak 2005). Long-term implications of a hardwood sawtimber supply shift could be far reaching for forest ecosystems, the forest products industry, and its economic contributions to communities.

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