The Annual Change in Ohio Stumpage and Sawlog Prices: 1960 to 2011

THESIS

Presented in Partial Fulfillment of the Requirements for the Degree Master of Science in
the Graduate School of The Ohio State University

by

Raymond Paul Duval

Graduate Program in Environment and Natural Resources

The Ohio State University

2013

Master’s Examination Committee

David M. Hix, Co-advisor

T. Eric McConnell, Co-advisor

Stephen N. Matthews

Roger A. Williams
Abstract

Timber price trends provide descriptive economic data for making land and business management decisions. Understanding historic price trends can also offer insights into possible future prices. These trends can and do influence such decisions as rotation age, harvest methods, silvicultural treatments, and wood procurement strategies. Providing information to better understand timber markets can lead to more efficient uses of land and business capital. We examined the 52-year price trends of ten commercial tree species in Ohio, both stumpage and delivered sawlogs, and determined the annual percentage rates of change in prices. Data were compiled from the Ohio Timber Price Report covering the years 1960-2011. For each study we used log-linear regression, which was adjusted for autocorrelation, with time as the explanatory variable and price as the response variable. We further tested whether the real stumpage price trends from 1960-1985 significantly differed from 1986-2011. Additionally, we compared real log grade prices within each species.

Results for stumpage prices indicate seven of ten species examined did not have significantly different annual percentage rates of change between the two eras. Results for sawlog price trends show that, in general, higher grade logs were increasing or holding value, while lower grade logs were decreasing in value in terms of real dollars. We also found that across the entire time period for both stumpage and sawlogs, real
prices that have been increasing have done so at relatively low rates, which is one indicator that Ohio has historically been a buyer's market for timber.
Acknowledgments

I would like to thank Dr. Eric McConnell, my graduate co-advisor, for his guidance and support throughout this entire process. Without him, none of this happens.

Thank you to Dr. David Hix, my co-advisor, who introduced me to silviculture and showed me where my future lies. You have inspired me.

Also, thanks to Dr. Roger Williams, for his great sense of humor, ability to make class fun and informative at the same time, and, with Dr. Steve Matthews, thank you for joining my thesis committee, providing advice and feedback when needed, and offering different perspectives from which to view my research.
Vita

June 1987 ..............................................................Mater Dei High School

Fields of Study

Major Field: Environment and Natural Resources
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Chapter 1. Introduction

Price trends for Ohio stumpage and sawlogs are localized tools that can improve the financial outcomes of growing, managing, harvesting, and milling the state’s commercial tree species. The Ohio Timber Price Report is one tool provided to forestry clientele to help them make more informed business decisions. Past studies of Ohio data, though, have provided insights into only a select few species as opposed to all of the commercially available hardwood species examined in the report. These studies also covered much shorter time periods than what the report is currently able to provide to clientele (Luppold and Baumgras 1995; Luppold and Baumgras 1996; Luppold, Prestemon, and Baumgras 1998). Regional studies of similar species are useful references (Hoover and Preston 2013; Linehan, Jacobson, and McDill 2003), but do not provide the Ohio forest owner, timber buyer, or mill operator a great deal of decision-making power due to timber markets being more local than regional.

This thesis is a two-part study that examined timber price trends from 1960-2011. Chapter 2 assesses stumpage price trends for the ten commercial hardwood species described in the Ohio Timber Price Report. Chapter 3 is an evaluation of sawlog price trends over the same 52-year period. Chapter 4 provides overall conclusions, recommendations, and limitations of the study.
Nominal and real stumpage prices in Ohio were examined and analyzed to determine annual percentage rates of change (APRs) over the entire period for each species. Real prices were adjusted to a constant year of 1982. Also, price movement between eras was evaluated for the periods 1960-1985 and 1986-2011 within each species to clarify how price changes during those two eras affected the overall trends.

Ohio sawlog price trends were examined and analyzed by log grade - Prime, #1, #2, and #3 - for each of the ten species over the 52-year period using both nominal and real prices, with the inflation adjustment again set to the base year 1982. Each species’ pricing was also examined individually between grades in order to discover what, if any, price level and/or trend differences were occurring among the different log grades.

**Objectives**

The specific objectives of this thesis research project were:

**Objective 1:** Determine the annual percentage rates of change in stumpage prices for the ten commercial timber species reported in the Ohio Timber Price Report from 1960 to 2011.

H₀: Each species’ APR was not significantly different from zero.

H₁: Each species’ APR significantly differed from zero.

**Objective 2:** Determine and compare the annual percentage rates of change and initial price points of two 26-year reporting eras, 1960 to 1985 and 1986 to 2011. This was conducted using real prices within each species.

H₀₁: Real initial prices were not significantly different between eras.

H₁₁: Real initial prices significantly differed between eras.

H₀₂: Real price APRs were not significantly different between eras.
H_{A,2}: Real price APRs significantly differed between eras.

**Objective 3:** Determine the annual percentage rates of change in sawlog prices for the ten commercial timber species reported in the Ohio Timber Price Report from 1960 to 2011. This was evaluated for the four log grades within each species.

H_0: The APR of a log grade within each species was not significantly different from zero.

H_{A}: The APR of a log grade within each species significantly differed from zero.

**Objective 4:** Compare the four log grades’ annual percentage rates of change and initial price points over the 52-year reporting period. This was also conducted using real prices within each species.

H_{0,1}: Real initial prices were not significantly different between grades.

H_{A,1}: Real initial prices significantly differed between grades.

H_{0,2}: Real price APRs were not significantly different between grades.

H_{A,2}: Real price APRs significantly differed between grades.
Chapter 2. The Annual Change in Ohio Stumpage Prices from 1960 to 2011

Introduction

Timber price trends provide information for making forest and business management decisions. Understanding price trends can offer insights into possible future prices. These prices, when adjusted to present value, can and do influence such decisions as rotation age, harvest methods, and silvicultural treatments (Guttenberg 1970). Management decisions made without an understanding of possible future price changes can lead to suboptimal harvest volume results, which could reduce the value of the harvest.

As early as 1849 there was a realization that an increase in future prices would drive longer rotation periods and a quest for greater stumpage volume (Faustman 1849). Faustman’s 1849 equation was developed so that rotation and harvest decisions could be applied using forecast prices (Dennis and Remington 1985). The forecast model included many of the variables that forest managers need to consider when planning timber harvests. Log-linear regression has been used to find the rates of change in stumpage, sawlog, and lumber prices in multiple states and regions (Linehan, Jacobson, and McDill 2003; Luppold and Baumgras 1995; Luppold and Bumgardner 2007; Wagner and Sendak 2005). Price trends examined over time could be projected into the future once the rate of change is determined.
The history of wood procurement is full of change. Perhaps the most influential movement was from manual to mechanized labor during the 20th century. Using the pulpwood market as an example, transport of timber changed from simple horse-pulled to rail transported and it became necessary for mills to offer increased prices at greater distances from the mill. Price zones were created to encourage direct delivery of timber, and to discourage cutting close to the mill in an effort at improved public perception. Mills drew timber from lower-priced, closer zones as well as higher-priced, more distant zones in order to maintain a channel of product should the less expensive feeder become unavailable. As the prices at delivery points fluctuate, the mid-sized producer may struggle to maintain a profit. For this reason, an ability to forecast price changes is beneficial to these producers. The larger producers are generally price insensitive, using volume to ensure profits. The smallest producers, individual landowners, are generally price insensitive due to the infrequency of their involvement (Guttenberg 1970).

Price expectations play a direct role in timber management decisions (Guttenberg 1970). Timber harvesting is recommended when the increase in volume becomes less than the potential gains earned from delaying harvest, which is when net present value is at its maximum. Forest managers need to be able to make a harvest decision that is best for the landowner’s stated goals. Possessing technical information that indicates prices have been historically increasing or decreasing at an estimated rate can affect when timber will be made available for bid. Long-term and short-term trends also influence silvicultural treatment decisions concerning thinning regimes and timing, as well as species selection (Dennis and Remington 1985).
Price trends have been examined for many regions, species, and aspects of the timber industry such as stumpage and lumber over many years. From Faustman’s 1849 equation relating future price changes to rotation periods, to more recent stumpage rate investigations, timber price change has been investigated for regions such as the Northeast and the South (Hunter 1982; Granskog and Crowther 1991; Wagner and Sendak 2005; Irland, Sendak, and Widmann 2001), as well as specific states such as Indiana, Pennsylvania and New Hampshire (Linehan and Jacobson 2005; Dennis 1989; Hoover and Preston 2013). These studies, while informative, provide only marginal utility to Ohio landowners and businesses due to the fact timber markets are more local in nature, given the overall economic feasibility of transporting roundwood. Thus, analyses should be conducted for specific geographical areas and product categories to provide maximum benefit to forest landowners, timber buyers, harvesters, and the industry. However, no comprehensive examination of Ohio timber price trend data, as reported since 1960 in the Ohio Timber Price Report, has been conducted to date to provide this essential information to forestry clientele.

**Objectives**

The goals of this research were to ask two basic questions. First, what were the average annual percentage rates of change (APR) of stumpage prices from 1960-2011 for the ten commercial hardwood species described in the Ohio Timber Price Report? Additionally, have the price trends changed over different time periods as species become more or less desirable?
Methods

Data

The data used here were compiled from semi-annual surveys sent to loggers, mills, and timber buyers in Ohio in May and November, respectively. Stumpage prices are reported for three regions: west, northeast, and southeast. There is also a statewide price for stumpage that is the grand mean of all prices reported.

From 1960 to 2001 the surveys were conducted by the Ohio Agricultural Statistics Service and the Ohio Department of Natural Resources (ODNR) (Ohio Department of Natural Resources 2013). From 2003 to the present, Ohio State University Extension has overseen the program (Ohio State University Extension 2013). During the transition year of 2002, no surveys were sent out. We treated these missing 2002 data as missing completely at random (MCAR). MCAR is the probability that observation $X_i$ missing is unrelated to the value of $X_i$ or other variables. The treatment applied for the missing data is simple listwise deletion, which is the omission of the missing cases and analyzing what remains (Howell 2012).

Completing the survey is voluntary, thus the number of responses can vary for any given period. The potential for sampling and/or non-sampling error is intrinsic with timber price reporting data (Irland, Sendak, and Widmann 2001; Wagner and Sendak 2005), and this should be considered when examining a single reporting period (Linehan, Jacobson, and McDill 2003). When analyzed over an extended period, though, the reported prices can give a reasonable trend indication for an individual species or product
Analyses

Ohio stumpage price trends were analyzed at the state level for ash (Fraxinus spp.), basswood (Tilia americana), black cherry (Prunus serotina), hard maples such as sugar maple (Acer saccharum), soft maples such as red maple (Acer rubrum), hickory (Carya spp.), black walnut (Juglans nigra), red oak (Quercus rubra), white oak (Quercus alba), and yellow-poplar (Liriodendron tulipifera).

The price trends, examined over a long enough period, can be projected into the future if the rate of change can be determined. In general for timber, the modified version for annually compounded interest is used, and if data are not available in that format a conversion factor from continuous compounding to annual is used. The rate of price change can be found using simple linear regression and can be converted from continuous to annual with a simple equation (Wagner and Sendak 2005). The rate can be estimated by determining the natural logarithm (ln) of prices for specific reporting periods and using log-linear modeling to evaluate the price trends over time. This process linearizes the data, where linear regression can then be performed to examine the price trends from 1960-2011. The continuous rate of price change was found using the model in equation [1]:

\[ Y = \beta_0 + \beta_1 x + \varepsilon \]  

[1]
where: \( Y = \ln(P_t) \), with \( P_t \) being the price at time \( t \); the intercept of the line, \( \beta_0 \), represents the initial price in a series; \( \beta_1 \) represents the slope, or continuous rate of change in price; \( x \) is a year in the time series; and \( \epsilon \) represents the model’s error. Finally, the continuous rate \( \beta_1 \) is converted to the annual rate \( i \) using equation [2] (Wagner and Sendak 2005):

\[
i = (e^{\beta_1} - 1) \times 100
\]  

[2]

The nominal prices reported for each period are the actual prices and are affected by inflationary pressures. This can potentially mask true price changes occurring over an extended period of time (Luppold, Prestemon, and Baumgras 1998; Linehan, Jacobson, and McDill 2003; Wagner and Sendak 2005). All nominal prices were adjusted for inflation to 1982 constant dollars using the Producer Price Index for all goods (Bureau of Labor and Statistics 2013). The year 1982 was chosen as it is a commonly used base year for inflation adjustment in timber price studies. SAS software version 9.3 for Windows was used for all statistical analyses. We applied equations [1] and [2] to the natural log of both state-level nominal and real prices for each species.

Autocorrelation is an underlying concern when analyzing time-series data (Moineddin et al. 2003). Autocorrelation is the tendency of time series data residuals to be similar to the residuals of adjacent points. This violates the assumption in linear regression that the residuals of each observation be independent (Linehan and Jacobson 2005). The presence of potential autocorrelation was detected by applying the Durbin-Watson test statistic, which tests the assumption of independence of a linear regression’s
residuals (Albright, Winston, and Zappe 1999). We found significant autocorrelation existed for all series of data at the $\alpha=0.05$ level of significance.

We used Maximum Likelihood (ML) stepwise autoregression to account for the autocorrelation (Zhou and Buongiorno 2006; Wagner and Sendak 2005; Mei, Clutter, and Harris 2010; Malaty, Toppinen, and Viitanen 2007; Luppold, Prestemon, and Baumgras 1998; Luppold and Bumgardner 2007; Linehan, Jacobson, and McDill 2003). Stepwise regression was used to assign a predictor, or explanatory variable, to the model to compare the new $R^2$ to the original. This variable is often called a ‘lag’ variable(s), as it is assigned to past data, thus lagging the current data in time. Using a backward stepwise approach, the variables are assigned in a group and the insignificant variable(s) are removed one at a time. The remaining variable(s) are those that significantly contribute to the model. We initially applied five lag variables to our data and found that a maximum of three was enough to account for autocorrelation, with the majority of data sets only needing one lag variable.

We determined the APRs for the nominal and real prices for each species over the entire reporting period. We also tested real prices for the two 26-year periods for uniformity and rate. For uniformity, we tested the intercepts to determine if the initial price points between the two eras were different. For rate, we examined the two eras’ APRs for differences. Both tests were conducted at a significance level of $\alpha = 0.05$. We split the reporting period into two eras, 1960 to 1985 and 1986 to 2011. We chose the 1985/1986 period for the break because it was approximately 1986 where Ohio timber prices were observed to become more volatile and begin an overall large increase and then decline.
Building on equation [1], we needed to allow the intercepts and slopes of the two periods to move independently. Equation [3] was used to do so (Luppold and Bumgardner 2007):

\[
\ln(P_t) = \beta_0 + \beta_1 + (\beta_F \times T_F) + (\beta_S \times T_S)
\]  

[3]

where: \(\ln(P_t)\) is the natural log of real price at time \(t\), \(\beta_0\) is the intercept of the first time period, \(\beta_1\) is the intercept shifter for the second period, \(\beta_F\) is the slope for the first period, \(T_F\) is the sequential, or indicator, time variable for the first time period (1 for 1961 to 1985, else 0), \(\beta_S\) is the slope for the second period, and \(T_S\) is the sequential, or indicator, time variable for the second time period (1 for 1986 to 2011, else 0).

Regression model errors were reported as percentage root mean square error (%RMSE) using equation [4] (Linehan and Jacobson 2005).

\[
\%RMSE = (e^{RMSE} - 1) \times 100
\]  

[4]

**Results and Discussion**

A summary of the statewide stumpage APRs are presented in Figure 2-1. Overall nominal gains were between 3.59% and 6.11%, and all nominal prices were found to be increasing at significant annual rates. Due to the lengthy rotation periods of northern hardwoods, i.e., greater than 15 years (Leak, Soloman, and DeBald 1987), and the need for forest managers to make best-possible predictions over the same time period, real prices were the focus of examining these price trends. When adjusted for inflation the gains were more modest, ranging from -0.26% to 2.17% annually. The APRs of three
species, ash (p = 0.17), yellow-poplar (p = 0.37), and basswood (p = 0.56), were found to not be significantly different from zero when adjusted for inflation.

Examination of the statewide two-era price trends found four groups of species based on similarities and differences between the APRs, and the initial price points of the two eras (Table 2-1). Group 1 had APRs and initial price points that significantly differed across the two eras. Group 2 consisted of species with significantly different APRs and initial price points which were not significantly different between the two eras. Species in group 3 had APRs not significantly different, and initial price points that were significantly different. A fourth group was comprised of species with APRs and initial prices not significantly different between eras.

**Group 1**

Ash and basswood both had differing APRs and initial price points between time periods. For the first era, the real initial price of ash was $96 in 1960 and was increasing at an APR of 2.99% (Table 2-2). Ash real price began at $181 for the second era but was increasing at a lower APR of 1.01% (p < 0.01). Basswood initial price differences were statistically significant (p = 0.02), yet were relatively comparable between the two eras, $95 in 1960 and $101 in 1986. Basswood had significantly different APRs for the two eras (p = 0.01), with a first era APR of 0.71% and a second era APR of -1.19%.

Basswood price peaked in 1995, with the Fall 2011 price 54% below the recorded high (Figure 2-2).

As the economy at large slowed dramatically beginning in 2000, ash prices began a decline that was likely hastened by the discovery of emerald ash borer (EAB) in Ohio in
2003. As a result of the discovery of 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.

The volume of basswood produced in Ohio is a possible driver of its low 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. Its use in interior designs, primarily blinds and shades, has been limited with the decline in home remodeling in recent years.

Basswood prices began a steady decline from $169/MBF in 1995 to its lowest historical price of $55/MBF in 2008, while ash peaked at $307/MBF in 1994 and declined to $102/MBF in 2007 (Figure 2-2).

**Group 2**

Table 2-2 shows that the price of hard maple at the beginning of each era did not significantly differ (p = 0.40), however, the APR between the two eras, 0.47% and 2.93%, respectively, did (p = 0.04). Hard maple and soft maple followed a similar price trend over both eras, though hard maple price shows a steeper increase over the period from 1991 to 2000, and has not returned to its initial price level as soft maple did (Figure 2-3). The greater increase from an identical price point in 1991, $99/MBF for both, to a peak of $414/MBF versus the soft maple peak of $227/MBF for soft maple may help to explain the significant APR difference for hard maple.
A potential cause for hard maple being more price resilient could be an overall increase in exports of maple, not including pulpwood (USDA FAS 2013), which peaked in 2002, followed by a steady decline to 2009, and then an increase through 2012 (Figure 2-4). Consumer preference for selected pieces from the clear portion of the outer sapwood generally provides a market advantage to hard maple over soft maple. It is possible that hard maple pricing reacted to the export quantity increase from 2009 to now, which slowed the price decline seen starting from around 2004. Also, Ohio 2012 export values of hard maple lumber have rebounded to surpass the 2008 level (USDA FAS 2013).

**Group 3**

The group with differing initial price points and similar APRs contained red oak and white oak. The initial real prices for red oak were $95 and $191 for eras one and two, respectively (p < 0.01), while white oak initial prices were $132 in 1960 and $176 in 1986 (p < 0.01). Red oak had APRs which were not significantly different (p = 0.73), 3.54% and 3.19% for eras one and two, respectively. White oak APRs of 1.95% and 2.30% for the two eras were also not significantly different (p = 0.39). The generally rising trends in red and white oak prices over the 52 year reporting period led to the initial price points of each era being significantly different (Table 2-2).

Prices for oak generally followed a pattern of steady increase from 1960 to 1991, then a large increase followed by an equally large decrease from 1991 to 2012 (Figure 2-5). The rapid escalation of oak prices, especially red oak, during the 1980s and 1990s can perhaps be attributed to the economic boom of the same period. Red oak prices started to
decline in 2004, possibly a result of the “anything but oak” backlash that occurred in the furniture and cabinetry industries around that time (Luppold and Bumgardner 2007).

Oak has been a popular export for the U.S., with China being a large buyer of the species for the past several years. From approximately 20 million board feet in 1998 to over 120 million board feet in 2011, the demand for exported U.S. oak has likely helped prices stay higher than other high-volume species (Meyer 2013).

**Group 4**

The next group consisted of cherry, hickory, soft maple, walnut and yellow-poplar. These species had neither APRs (cherry - p = 0.22, hickory - p = 0.53, soft maple - p = 0.39, walnut - p = 0.11, yellow-poplar - p = 0.78) nor initial price points (cherry - p = 0.66, hickory - p = 0.10, soft maple - p = 0.80, walnut - p = 0.99, yellow-poplar - p = 0.48) that were significantly different. Of these, yellow-poplar decreased in APR from the 1st to 2nd eras (Table 2-2).

Though some species showed reasonable gains in APR from era to era, none were significantly different. Cherry and walnut can be considered domestic exotic woods (Spieler 2011), but their prices do not generally act in concert (Figure 2-6). It appears that Ohio walnut has a real price support at approximately $300/MBF, and though it has moved below that point four times in the 2nd era, each time was for only a single season. It is possible that the quality of walnut for use in high-end furniture, as veneer, its durability (Frye 1996), and its relative scarcity in Ohio (Widmann et al. 2009), has helped it remain resistant to large price fluctuations.
Ohio cherry appears to have achieved a steadily increasing popularity starting in the 1980s and through the economic boom of the 1990s. This apparent increase in popularity is evidenced in the proportion of furniture showings at the High Point furniture market from 1962 to 2005. Cherry had a low of 3.5% of showings in 1974 with a steady increase to 21.0% of showings in 1998, and then a decline to 15.0% of showings in 2005 (Frye 1996; Luppold and Bumgardner 2007). As the popularity of, and demand for, the species changed, the generally poor tree quality of Ohio cherry likely holds it back from being a steady price performer similar to Ohio walnut. Cherry had 66% grade 3 trees or below in 2006 (Widmann et al. 2009).

During most of the 1st era, hickory, soft maple, and yellow-poplar showed relatively little movement in pricing. Soft maple and yellow-poplar had similar prices throughout most of both eras, with yellow-poplar pricing declining steadily from 1999 while soft maple held its value through 2004. The price of soft maple declined from its peak of $227/MBF in 2004 to $100/MBF in 2010, whereas yellow-poplar reached a similar peak of $239/MBF in 1999 and then declined to $82/MBF in 2010. Hickory reached a peak of $142/MBF in 2003 and then declined to $58/MBF in 2009, preceding the soft maple peak and nadir by one year, but declining from peak to bottom over the same duration (Figure 2-7).

In 2006, hickory had the 2nd lowest volume of sawlog harvest among commercial species in Ohio, accounting for 3% of sawlog harvest by major species group. While abundant in the forest, this species group is generally characterized as being of lower quality, with 61% of trees at tree grade 3 or below (Widmann et al. 2009). It is likely that the generally poor Ohio tree quality has kept hickory prices depressed.
Soft maple also had lower tree quality, with 81% of trees rated grade 3 or below (Widmann et al. 2009). Soft maple, though, has been utilized more recently in pulpwood and engineered products (Wiedenbeck and Sabula 2008). Therefore, tree grade in these markets likely affects its price less than in other markets, such as sawlog, veneer, or export. Also, maple in general has seen a recent increase in popularity with door and cabinet makers, with reports of over 50% of cabinet production and 36% of doors displayed at industry trade shows being maple, with soft maple use increasing as painted cabinetry becomes more popular (Johnson 2012a).

Yellow-poplar accounted for 13% of sawtimber harvest in 2006, and had the highest percentage of grade 1 trees at 34%, with only 35% graded at tree grade 3 or below. A tight supply of available softwood plywood, along with a diminished supply of western softwoods in the 1990s, helped to increase demand for yellow-poplar in engineered wood composite products (Luppold and Baumgras 1995), and the prices for Ohio yellow-poplar reflected that situation. The leveling off of the steep decline of yellow-poplar price seen in Figure 2-7, from 1999 into 2004, is likely the result of cost considerations and consumer tastes trending to darker finishes, making yellow-poplar a reasonable choice to replace more expensive woods, as it holds stain or paint and finishes well (Johnson 2012b).

**Overall observations**

Family forest owners generally lack knowledge regarding timber management and marketing (Widmann et al. 2009; Luppold, Prestemon, and Baumgras 1998; Luppold and Baumgras 1998; Luppold and Baumgras 1995). Only 8% of family-owned forest
land in Ohio has a written management plan, and just 13% of owners pursued management advice (Widmann et al. 2009).

The results of this study suggest Ohio stumpage prices tend to follow the greater lumber market, thus one aspect that should be investigated by owners considering a timber sale is industry trends. For example, Hardwood Review Weekly reported in August, 2011, that for several previous months oak demand nationwide was down, supplies were up, and overall prices were depressed. The future outlook was for a reversal as exports improved and demand accelerated (Johnson 2011). During the same period, Ohio oak stumpage prices were trending down, as seen by the moving average lines in Figure 2-8, yet white oak price had already begun moving up and red oak was maintaining its level. An examination of the other eight species shows similar reactions by Ohio stumpage prices to larger market forces.

Stumpage prices also tend to follow end user consumption. The desirability of a given product, or species, is determined by consumers’ willingness to pay. This cost determines the competitiveness of any forest product in the marketplace. This in turn defines the structure and economic sustainability of any forest products industrial sector. The mill’s participation in the marketplace influences the organization and viability of the wood supply system, which ultimately shapes the interest in investing in forest land for production purposes and the willingness to invest in forest management.

However, timber owners and mills do not coordinate (Luppold and Baumgras 1995). Due to this lack of coordination, an owner is largely at the mercy of his or her own knowledge. Generally, stumpage prices increase at a faster rate than lumber prices, as an increase in the worth of the end product accumulates at the source (Luppold and
Yet landowners still lack real control over the prices they receive for their timber (Luppold and Baumgras 1995). The number of sawmills in Ohio, for instance, has decreased from 219 in 1989 to 197 in 2006 (Widmann et al. 2009). This reduction in available delivery points results in increased hauling distances. As hauling distance to the mill increases, the price offered for a landowner’s timber will likely decrease (Guttenberg 1970).

Ohio’s stumpage market has historically performed differently than other states. Pennsylvania, a neighboring state with similar climate and forest compositions, experienced price increases generally greater than the APRs of Ohio stumpage for most species from 1984 to 2000 (Figure 2-9). Similarly, Maine prices generally outperformed Ohio prices for comparable commercial species during the years 1963-1990 (Figure 2-10). These changes could be attributable to a number of factors, including season of sale, tree quality, sale volume, and available markets and information, among many others (Brian and Chapman 2005).

If the rate of timber volume increase is lower than the rate of price increase, forest owners are not capturing the greatest possible profit from their timber (Heiligmann 2002). From this, it stands to reason that responsible management techniques leading to improved tree quality and increased volumes should be a goal of forest owners and managers in Ohio. Also, an improved understanding by owners of national and local market influences on stumpage prices could help to improve the rate of return for owners and investors alike.
Conclusions

Ohio stumpage price trends were investigated over the time period of 1960-2011. Nominal stumpage prices were all increasing at significant average annual rates dating to 1960. Real stumpage price trends have been mostly positive over the 52-year period examined. Only basswood had a negative APR, however it was not significantly different from zero. Seven of the 10 species had significant APR increases. Examined within the two-era parameters, 1960-1985 and 1986-2011, the ten species aggregated into four species groups depending upon changes in a species’ APR and initial price of the reporting period. The trends were reflective of wood markets in the eastern United States and the forces influencing them.
Table 2.1. Species groupings using two-era statewide coincidence test with %RMSE results. APR and initial price point coincidence tested at $p < 0.05$.

<table>
<thead>
<tr>
<th>Species</th>
<th>APR diff.</th>
<th>Init Price Diff.</th>
<th>%RMSE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group 1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ash</td>
<td>Significant</td>
<td>Significant</td>
<td>12.37</td>
</tr>
<tr>
<td>Basswood</td>
<td>Significant</td>
<td>Significant</td>
<td>14.81</td>
</tr>
<tr>
<td><strong>Group 2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hard Maple</td>
<td>Significant</td>
<td>Not Significant</td>
<td>13.18</td>
</tr>
<tr>
<td><strong>Group 3</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Red oak</td>
<td>Not Significant</td>
<td>Significant</td>
<td>12.75</td>
</tr>
<tr>
<td>White oak</td>
<td>Not Significant</td>
<td>Significant</td>
<td>11.94</td>
</tr>
<tr>
<td><strong>Group 4</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cherry</td>
<td>Not Significant</td>
<td>Not Significant</td>
<td>13.75</td>
</tr>
<tr>
<td>Hickory</td>
<td>Not Significant</td>
<td>Not Significant</td>
<td>12.37</td>
</tr>
<tr>
<td>Soft Maple</td>
<td>Not Significant</td>
<td>Not Significant</td>
<td>11.23</td>
</tr>
<tr>
<td>Walnut</td>
<td>Not Significant</td>
<td>Not Significant</td>
<td>13.68</td>
</tr>
<tr>
<td>Yellow-poplar</td>
<td>Not Significant</td>
<td>Not Significant</td>
<td>15.79</td>
</tr>
</tbody>
</table>
Table 2.2. Species two-era grouping and coincidence results, APR and initial price points are significantly different at $p < 0.05$.

<table>
<thead>
<tr>
<th>Species</th>
<th>Price diff p-value</th>
<th>1st era APR</th>
<th>2nd era APR</th>
<th>APR diff p-value</th>
<th>%RMSE</th>
</tr>
</thead>
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<tr>
<td>Group 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ash</td>
<td>$&lt;0.01$</td>
<td>2.99</td>
<td>1.01</td>
<td>$&lt;0.01$</td>
<td>12.37</td>
</tr>
<tr>
<td>Basswood</td>
<td>0.02</td>
<td>0.71</td>
<td>-1.19</td>
<td>0.01</td>
<td>14.81</td>
</tr>
<tr>
<td>Group 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hard maple</td>
<td>0.40</td>
<td>0.47</td>
<td>2.93</td>
<td>0.04</td>
<td>13.18</td>
</tr>
<tr>
<td>Group 3</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Red oak</td>
<td>$&lt;0.01$</td>
<td>3.54</td>
<td>3.19</td>
<td>0.73</td>
<td>12.75</td>
</tr>
<tr>
<td>White oak</td>
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<td>1.95</td>
<td>2.30</td>
<td>0.39</td>
<td>11.94</td>
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<tr>
<td>Group 4</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Cherry</td>
<td>0.66</td>
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<td>0.22</td>
<td>13.75</td>
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<td>Hickory</td>
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<td>0.53</td>
<td>12.37</td>
</tr>
<tr>
<td>Soft Maple</td>
<td>0.80</td>
<td>1.17</td>
<td>1.92</td>
<td>0.39</td>
<td>11.23</td>
</tr>
<tr>
<td>Walnut</td>
<td>0.99</td>
<td>2.04</td>
<td>3.43</td>
<td>0.11</td>
<td>13.68</td>
</tr>
<tr>
<td>Yellow-poplar</td>
<td>0.48</td>
<td>0.54</td>
<td>0.25</td>
<td>0.78</td>
<td>15.79</td>
</tr>
</tbody>
</table>
Figure 2.1. Comparison of stumpage state mean APRs using nominal and real prices over the 52-year period. **Bold** numbers indicate significance at $\alpha = 0.05$.

Figure 2.2. Ash and basswood prices over examined time period, two-era divider at 1985/1986.
Figure 2.3. Hard maple and soft maple prices over examined time period, two-era divider at 1985/1986.

Figure 2.4. Hard maple prices and exports over the second era.
Figure 2.5. Red oak and white oak prices over examined time period, two-era divider at 1985/1986.

Figure 2.6. Cherry and walnut prices over examined time period, two-era divider at 1985/1986.
Figure 2.7. Hickory, soft maple, and yellow-poplar prices over examined time period, two-era divider at 1985/1986.

Figure 2.8. Red oak and white oak second era, 4-period moving averages.
Figure 2.9. Comparison of stumpage APR by species 1984-2000 between Ohio and Pennsylvania.

Figure 2.10. Comparison of stumpage APR by species 1963-1990 between Ohio and Maine. (from Howard and Chase 1995)
Chapter 3. The Annual Change in Ohio Sawlog Prices from 1960 to 2011

Introduction

Industrial product demand and new home construction, among other economic forces, are the main drivers of forest products production and profits in the United States (Barrett 2013). These influences have greatly affected wood utilization and manufacturing in recent times. The housing crash and recent recession compounded an already decreasing economic performance. This more gradual decline can be partially attributed to furniture and pulp and paper manufacturers moving portions of their operations overseas, which has contributed to an overall rise in market share of imported forest-based products (Espinoza et al. 2011).

The forest products industry has been experiencing significant change, though, for quite some time. In the past, softwood-based producers generally owned mills and land that were used for maintaining a supply of stumpage. This vertical arrangement of the business of milling has changed over time to a market-based model where mills compete for stumpage directly (Hickman 2007). Likewise, the hardwood sector has seen technology pace the changes businesses have experienced from the 1970s to today, along with the shifting combination of end uses for hardwood products (Luppold and Baumgras 1996). Some of these technological advances have increased mills’ abilities to extract profitable lumber from suboptimal quality logs. Prices for zero clear face logs, for
example, have recently become more competitive with higher quality logs due to these advances in lumber recovery capabilities (Brian and Chapman 2005).

Price expectations play a direct role in mill purchasing decisions (Guttenberg 1970). Having the ability to predict historic price changes at an estimated rate, as well as knowing long-term and short-term trends in species popularity, can affect which species buyers may pursue. Purchasing decisions made without an understanding of possible future price changes can lead to production runs which fail to maximize profits or minimize losses. Log-linear regression has been used to describe the evolving trends in stumpage, sawlog, and lumber prices in multiple states and regions (Linehan, Jacobson, and McDill 2003; Luppold and Baumgras 1995; Luppold and Bumgardner 2007; Wagner and Sendak 2005). Price trends examined over time can provide information for future business decisions, once the rate of change is determined.

Ohio log prices have served as a proxy in past studies for investigating industry trends in the Appalachian region (Luppold and Baumgras 1996; Luppold, Prestemon, and Baumgras 1998; Wiedenbeck and Sabula 2008; Widmann et al. 2009). However, these studies encompassed price-reporting periods of not more than twenty years and investigated only particular species and markets. To date, no comprehensive study of sawlog prices has been performed for Ohio. While recent research conducted in neighboring Pennsylvania, Indiana, and the northeast region (Linehan and Jacobson 2005; Irland, Sendak, and Widmann 2001; Hoover and Preston 2013; Campbell and White 1989) is useful for developing regional trends, describing Ohio market activities requires analysis at a more local level. The Ohio Timber Price Report, which has continually tracked graded log prices dating to 1960, provides a basis for determining the
average annual percentage rate of change (APR) in hardwood species’ sawlog prices. The 52-year APRs are currently unknown and require further investigation.

The goal of this research was to determine the price trends from 1960-2011 for sawlogs of the commercial timber species reported in the Ohio Timber Price Report. Autoregressive functions were established for determining the APRs for the four log grades—prime, #1, #2, and #3—reported within the ten species. The trends between grades for each species were then compared to determine where price differences existed.

**Methods**

**Data**

The data used here were compiled from semi-annual surveys sent to loggers, mills, and timber buyers in Ohio in May and November, respectively. Sawlog prices are reported for ten species: ash (*Fraxinus* spp.), basswood (*Tilia americana*), black cherry (*Prunus serotina*), hard maples such as sugar maple (*Acer saccharum*), soft maples such as red maple (*Acer rubrum*), hickory (*Carya* spp.), black walnut (*Juglans nigra*), red oak (*Quercus rubra*), white oak (*Quercus alba*), and yellow-poplar (*Liriodendron tulipifera*). Prices for four log grades are tracked within each species: prime, #1, #2, and #3. Prime is the highest grade reported and #3 the lowest.

From 1960 to 2001 the surveys were conducted by the Ohio Agricultural Statistics Service and the Ohio Department of Natural Resources (Ohio Department of Natural Resources 2013). From 2003 to the present, Ohio State University Extension has overseen the program (Ohio State University Extension 2013). During the transition year of 2002, no surveys were sent out. We treated these missing 2002 data as missing
completely at random (MCAR). MCAR is the probability that observation \( X_i \) missing is unrelated to the value of \( X_i \) or other variables. The treatment applied for the missing data is simple listwise deletion, which is the omission of the missing cases and analyzing what remains (Howell 2012).

**Analyses**

We used a simple linear regression model following a natural logarithm transformation of each species’ price data to evaluate the price trends from 1960-2011. The rate of price change was found using equation [1]

\[
Y = \beta_0 + \beta_1 x + \varepsilon
\]

[ 1 ]

where: \( Y = \ln(P_t) \), with \( P_t \) being the price at time \( t \); the intercept of the line, \( \beta_0 \), represents the initial price in a series; \( \beta_1 \) represents the slope, or the continuous rate of change in price; \( x \) is a year in the time series; and \( \varepsilon \) represents the model’s error. The continuous rate, \( \beta_1 \), was then converted to the annualized rate \( i \) using equation [ 2 ] (Wagner and Sendak 2005):

\[
i = (e^{\beta_1} - 1) \times 100
\]

[ 2 ]

One concern when analyzing time-series data is autocorrelation, which describes the tendency of the data’s residuals to be similar to adjacent points (Moineddin et al.
2003). This disrupts the assumption in linear regression that the residuals of each observation are independent (Linehan and Jacobson 2005). The potential presence of autocorrelation was examined by applying the Durbin-Watson test statistic, which tests the assumption of independence of a linear regression’s residuals (Albright, Winston, and Zappe 1999). We found significant autocorrelation existed across all series of data at the $\alpha = 0.05$ level of significance.

We used Maximum Likelihood (ML) stepwise autoregression to account for the autocorrelation (Zhou and Buongiorno 2006; Wagner and Sendak 2005; Mei, Clutter, and Harris 2010; Malaty, Toppinen, and Viitanen 2007; Luppold, Prestemon, and Baumgras 1998; Luppold and Bumgardner 2007; Linehan, Jacobson, and McDill 2003). Using a backward stepwise approach, a number of lag variables were assigned in a group, and insignificant variables were removed one at a time. The remaining variable(s) were those significantly contributing to the model. Five lag variables were applied to our data, and we found a maximum of three were needed for an individual series to account for the autocorrelated data.

Nominal prices can hide inflationary pressures on prices (Luppold, Prestemon, and Baumgras 1998; Linehan, Jacobson, and McDill 2003; Wagner and Sendak 2005). Further, real prices are better indicators of price performance over long periods. All prices were therefore adjusted for inflation using the Producer Price Index for all goods with a base year of 1982 (Bureau of Labor and Statistics 2013). The year 1982 was chosen as it is a commonly used base year for inflation adjustment in timber price studies. SAS software version 9.3 for Windows was used for all statistical analyses.
We determined the APRs for the nominal and real prices of each species’ four log grades over the entire reporting period. Real prices were then compared between grades within each species for initial price and APR differences. This was done by adding an indicator variable to a regression function to differentiate between grades using equation [3]

\[ Y_t = \beta_0 + \beta_1 x_{1t} + \beta_2 x_{2t} + \beta_3 x_{1t} x_{2t} + \epsilon \]  

where \( x_{1t} \) was the year in the price series, \( x_{2t} \) was the indicator variable (1 for the grade of interest, 0 for the default grade), \( x_{1t} x_{2t} \) was the interaction term, and \( \beta_0, \beta_1, \beta_2, \) and \( \beta_3 \) were model coefficients, with \( \epsilon \) again being the model’s error. The indicator variable coefficient, \( \beta_2 \), was tested for whether the initial prices between the two grades were different. The interaction coefficient, \( \beta_3 \), was tested for an APR difference between grades. All testing of significance was conducted at \( \alpha = 0.05 \) level. Regression model errors were reported as percentage root mean square error (%RMSE) following the methods of Linehan and Jacobson (2005).

**Results and Discussion**

**52-year Trends by Grade**

*Prime Logs*

Nominal price APRs for prime grade logs were significantly different from zero for all species. White oak had the highest nominal APR of 5.04% (\( p < 0.01 \)). Basswood had the lowest nominal APR at 2.92% (\( p < 0.01 \)). Real price APRs were significant for
only two species. Basswood had an APR of -0.94% (p < 0.01), and white oak an APR of 1.37% (p < 0.01) (Figure 3-1).

*Grade #1 Logs*

The grade #1 log APRs using nominal prices were significant for all species, with cherry having the highest APR at 4.30% (p < 0.01). Basswood again had the lowest nominal APR at 2.78% (p < 0.01). Real price APRs were significantly different from zero for only basswood and white oak. Basswood real APR was -1.15% (p < 0.01), and white oak real APR was 0.69% (p = 0.03). Indications pointed to a potentially decreasing trend in real price of -0.55% for yellow-poplar (p = 0.10) (Figure 3-2).

*Grade #2 Logs*

Grade #2 logs had nominal price APRs that again were significant for all species. Basswood nominal APR was the lowest at 2.99% (p < 0.01), and white oak nominal APR was the highest at 4.06% (p < 0.01). Real price APRs were significantly different from zero for two species. Basswood real price APR was -0.99% (p < 0.01), and yellow-poplar real price APR was -0.62% (p = 0.02). (Figure 3-3)

*Grade #3 Logs*

Nominal price APR for all species of grade #3 logs were significantly different from zero. Basswood again had the lowest APR at 3.17% (p < 0.01), while white oak had the highest APR at 3.50 (p < 0.01). Real price APRs were significant for basswood, cherry, hard maple, hickory, soft maple, walnut, and yellow-poplar. Of these, cherry had the highest real price APR at -0.44% (p = 0.02), while walnut had the lowest real price APR at -0.82% (p=0.04). Ash (p = 0.07), red oak (p = 0.07), and white oak (p = 0.08)
also exhibited decreasing price trends, but these were only of moderate significance. (Figure 3-4)

**Grade Comparisons Within Species**

Comparing the initial price levels and price trends between grades for each hardwood species identified four separate groups. Group 1 was comprised of species containing grades with both initial prices and APRs differing. Species in group 2 exhibited varying price levels between grades but no APR differences. Group 3 had grades with differing APRs only. Group 4 had neither APRs nor initial prices that significantly differed across grades (Table 3-1).

**Group 1**

Group 1 consisted of cherry, hard maple, and white oak. Differing initial prices and APRs were found between some grades within each of these species. In general, these differences occurred between higher grade and lower grade logs. Both cherry and hard maple had initial price and APR differences between prime and #3, and between #1 and #3. White oak log initial prices and APRs showed differences between prime and #2 and #3 and between grade #1 and #3. Additionally, grade #2 and #3 differed by APR only.

**Group 2**

Group 2 consists of species with different initial prices between grades, but no differences in APRs - ash, basswood, soft maple, walnut, and yellow-poplar. Given the lack of APR differences, these species’ log prices have not been diverging or converging between grades through the examined period. Ash had initial price differences between
prime and #3, and between #1 and #3. Basswood, soft maple, and yellow-poplar had initial price differences between the higher grade (prime and #1) and lower grade (#2 and #3) logs, but no differences between prime and #1 or between #2 and #3. Walnut initial prices differed in all combinations containing grades #2 and #3 logs. These results indicate the price spreads present between these species’ higher and lower grade logs have been maintained over the life of the reporting period.

*Group 3*

Red oak showed no significant initial price differences between grades, but did have APR differences between prime and #3 logs (p = 0.03), as well as between #1 and #3 logs (p = 0.04). Red oak has been a popular species for flooring and cabinet makers, as well as exports, for many years, and as such high grade logs would be in greater demand than low grade for end user products such as hardwood floors and lightly stained cabinetry. While initial prices were not found to be different, the APR differences between #3 and prime/#1 possibly reflect the increase in demand for higher grade logs over the period examined (Meyer 2013).

*Group 4*

Hickory was the only species that showed no significant differences between grades in either initial prices or APRs. With neither initial prices nor APRs showing differences between log grades, it is possible a combination of poor tree quality and overall lack of markets was responsible for the lack of price differentiations. Approximately 88% of hickory trees are tree grade #2 and below (Widmann et al. 2009).
Discussion

Over the entire 52-year period, average log price trends exhibited similar behavior to the statewide stumpage price trends noted in chapter 2. Nominal prices showed significant increases for all species, while real price changes were less than their nominal counterparts, and at times negative.

Real prices were significantly changing for only approximately one-third of the individual species/grade combinations. Of those, basswood was the only species with APRs significantly different from zero for log grades prime through #3, all of which were negative. Cherry, hard maple, hickory, soft maple, and walnut all had significantly negative APRs for #3 logs, and yellow-poplar had significantly negative APRs for grades #2 and #3. White oak was the only species to show significantly positive APRs, and this was only within the higher grades of prime and #1.

Within the species-by-grade analyses, price spreads between higher and lower grade logs were evident for most species examined. Trend analyses found no differences in APRs or initial prices between prime logs and grade #1 logs for all species. Many of the differences due to initial price, APR, or both, tended to occur between prime and #3, or #1 and #3 logs. This tendency was most likely due to the significantly decreasing trend in prices for #3 logs for seven of 10 species. The differences found between white oak log grades, on the other hand, were possibly tied to the increasing price of prime logs. While not significant in most cases between grades, it is important to point out the general decreasing average annual change in prices as one moved from the higher to lower grade logs across these hardwood species.
The grade differences in log price trends within a species is not unusual, and is the result of many market factors that affect lumber, and thus log, pricing. Luppold and Baumgras (1995) found that prices for higher grade hardwood logs increased faster than prices for lower grade logs. This tendency was ascribed to increased demand by higher value markets such as exports (Luppold and Thomas 1991) and millwork (Luppold 1993), as well as supply considerations, where the supply of higher grade logs is less than that of lower grade logs. They also found that log value was directly related the value of the lumber that can be sawn from it, with technological upgrades in milling increasing the recovered amount and grade yield. The increased fixed costs associated with these upgrades were offset by increased high grade yield, but it was not apparent that low grade yield increases assisted in the same manner.

Luppold & Baumgras (1996) also discovered that price spreads, or margins, between logs and lumber were increasing faster for lower grade logs than for higher grade logs, and that margins increased as lumber prices increased. There has also been a long-term industry trend towards utilization of higher grade northern hardwoods, and away from lower grade southern hardwoods, for hardwood products (Luppold 1993). This shift, along with lower cost substitute products that continually enter the market, was believed to encumber lower grade lumber, and thus log, market growth (Luppold 1984).

More recently, though, #3 grade sawlog prices have outperformed #1 common lumber, prime sawlogs, and stumpage of the same species for cherry, hard maple, soft maple, red oak, white oak, and yellow-poplar (Unpublished data, Luppold et al. 2012). It was found #3 sawlogs declined in price by the least amount from their respective price
peaks of the mid-2000s to their lowest points in 2008-2009. Further, #3 grade sawlogs in Fall, 2011, had actually exceeded their previous peaks, some by as much as 20% and none by less than 6%. In contrast, lumber, prime logs, and stumpage of the same species had not yet reached their previous peaks, lagging those peaks by no less than 5%, and in the case of cherry by up to 58%.

These findings were likely the result of mills increasing, or improving, their ability and willingness to change production goals from grade lumber to railroad ties and pallet cants, among other items generally made from low-grade logs (Editor 2012). From December 2011 to December 2012, the Railroad Tie Association (RTA) expected tie demand to be approximately 20 million ties. However, the RTA found in Dec 2012 that actual ties used for the previous 12 months was approximately 20% higher at 24 million ties (Barrett 2012). Also, pallet lumber demand has been experiencing growth, which has paralleled the overall improving economy, to meet the need for increasing shipments of goods (Unpublished data, Luppold et al. 2012).

**Conclusions**

Price-trend analyses showed prime log real price APRs were significantly increasing for white oak only (1.37%), and were significantly decreasing only for basswood (-0.94%), while the APRs for all other species showed no significant differences from zero. Grade #1 log APRs were significantly increasing for only white oak (0.69%), and significantly decreasing for basswood only (-1.15%). No other #1 log APRs were significantly different from zero. The APRs for grade #2 logs were not significantly increasing for any species, however both basswood (-0.99%) and yellow-poplar (-0.62%) had significantly decreasing APRs. Grade #3 log APRs showed no
significant difference from zero for ash, red oak, and white oak, while all other species had significantly decreasing price trends.

Basswood was the only species that showed significant changes in APR across all grades. The APRs ranged from a high of -0.77% for #3 logs to a low of -1.15% for #2 logs, and no grades showed an increasing APR. Ash and red oak both had no significant changes at any grade.

Species-by-grade analyses showed that ash, basswood, soft maple, walnut, and yellow-poplar had only initial price differences, which were generally between higher grade (prime and #1) and lower grade (#2 and #3) logs. Red oak had APR, or price trend, differences between prime and #3 logs and between #1 and #3 logs, but not between initial price points at any grade.

Cherry, hard maple, and white oak were the only species containing distinct regression lines between grades. That is, these species had significantly different initial prices and significantly different APRs between specific grades. They showed differences between prime and #3, as well as between #1 and #3 grade logs. White oak also showed a difference between prime and #2 grade logs. The sawlog data indicated the overall price differences present were more a result of declining lower-grade prices than increasing higher-grade prices.
### Table 3.1. Grade within species comparison, examining the differences, or lack of same, in grades in initial price points and APRs by species. Bold is significant at $p = 0.05$. Percent RMSE calculated by $(\epsilon RMSE - 1) \times 100$.

<table>
<thead>
<tr>
<th>Species</th>
<th>Group 1 Comparison</th>
<th>Int. Price APR P-Value</th>
<th>APR %RMSE</th>
<th>$R^2$</th>
<th>Species</th>
<th>Group 2 cont'd</th>
<th>Int. Price APR P-Value</th>
<th>APR %RMSE</th>
<th>$R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cherry</td>
<td>PRIME : #1</td>
<td>0.99</td>
<td>0.49</td>
<td>11.38</td>
<td>Soft Maple</td>
<td>PRIME : #1</td>
<td>0.34</td>
<td>0.23</td>
<td>9.01</td>
</tr>
<tr>
<td></td>
<td>PRIME : #2</td>
<td>0.24</td>
<td>0.24</td>
<td>12.05</td>
<td>PRIME : #2</td>
<td>&lt; 0.01</td>
<td>0.13</td>
<td>0.07</td>
<td>9.08</td>
</tr>
<tr>
<td></td>
<td>PRIME : #3</td>
<td>&lt; 0.01</td>
<td>0.01</td>
<td>11.77</td>
<td>PRIME : #3</td>
<td>&lt; 0.01</td>
<td>0.07</td>
<td>0.07</td>
<td>8.60</td>
</tr>
<tr>
<td></td>
<td>#1 : #2</td>
<td>0.38</td>
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Figure 3.1. Prime grade nominal and real price average annual percentage rates of change for the ten hardwood species. *Bold* is significant at \( p = 0.05 \)

Figure 3.2. #1 grade nominal and real price average annual percentage rates of change for the ten hardwood species. *Bold* is significant at \( p = 0.05 \)
Figure 3.3. #2 grade nominal and real price average annual percentage rates of change for the ten hardwood species. **Bold** is significant at $p = 0.05$

Figure 3.4. #3 nominal and real price average annual percentage rates of change for the ten hardwood species. **Bold** is significant at $p = 0.05$
Chapter 4. Overall Conclusions

No comprehensive examination of Ohio timber price trends had been completed prior to this study. We: 1) determined the annual percentage rates of change (APR) in prices for the ten commercial hardwood species based upon data from the Ohio Timber Price Report, 2) conducted between-era comparisons of stumpage prices, and 3) conducted between grade comparisons of sawlog prices.

We found stumpage prices were generally appreciating over the 52 years, with prices for seven of 10 species increasing at annual rates that were significant (p < 0.05). However, dividing the data into two eras showed the APRs have been slowing for some species in more recent times.

The two-era examinations presented aggregations of species into four groups depending on initial price and APR behavior. Group 1 was ash and basswood, with APRs and initial price points that were significantly different. Group 2 consisted of hard maple, and had APRs differing between eras, but initial prices not significantly different between eras. Group 3 consisted of red oak and white oak. These species had APRs that did not significantly differ and initial price points that did differ across the two eras. Group 4 was comprised of cherry, hickory, soft maple, walnut and yellow-poplar. These species had neither APRs nor initial price points which significantly differed between the two eras.
In general, sawlog price APRs did not significantly differ from zero for log grades Prime, #1, and #2. Some exceptions, though, were noted. Basswood prices were declining significantly across all grades. Yellow-poplar #2 log price was also significantly declining. White oak Prime and #1 log prices were significantly increasing. Prices for #3 grade logs, though, were significantly declining for seven species. The other three species showed APRs not significantly different from zero.

While not significant (p > 0.05) in most cases between grades, a general trend was noted of decreasing APRs as one moved from the higher to lower grade logs across species. The between grade comparisons again revealed four distinct groups of species based on the presence, or absence, of significant differences. Group 1 consisted of cherry, hard maple, and white oak, and had both initial prices and APRs differing between grades. Group 2, containing ash, basswood, soft maple, walnut, and yellow-poplar, exhibited initial price points that differed between grades, but no APR differences. Group 3, with red oak, showed differing APRs, but not differing initial prices, between grades. Group 4, consisting of hickory, had APRs and initial price points that did not significantly differ across grades.

**Recommendations for future research:**

As was shown by Widmann et al. (2009), few Ohio forest owners have formalized management plans or seek professional assistance when conducting a timber sale. It may be beneficial to examine the relationship between stumpage prices attained by owners with formalized plans compared to those with no formal management plan in place. Within each group, it may be possible to break out subgroups of owners who hired foresters to oversee the timber sale and owners who did not. The results could then be
applied to outreach programs to discuss the benefits of having both a formal management plan and relationships with forestry professionals.

Luppold & Baumgras (1995) pointed out the lack of communication between the industry and landowners. We feel that it would be informative to discover how a formal or organized communication system or exchange would affect both stumpage and log prices in Ohio. This particular idea may fit well with the examination of formal management plans and professional relationships, in that it may be possible to discover whether “connected” owners with plans have significantly greater communication with harvesters and manufacturers than owners with no plans and/or relationships.

An examination of the correlation between larger market forces and local timber prices may yield useful results for both owners and industry in Ohio. There are some generalizations of a link between end-user preferences and lumber, and thus stumpage, prices (Frye 1996; Luppold and Bumgardner 2007). Further research into the furniture, flooring, and industrial products markets at the regional or national level may yield a greater understanding of price movements in Ohio timber markets.

Skog & Haynes (1987) and Skog et al. (1991) examined the potential impacts of timber industry research advances and how they may affect prices. These studies offered predictions that may be testable at this time, and an analysis of the research areas and their impacts on timber prices could be informative. Combined with an examination of larger market impact on local pricing, Ohio owners and industry may be able to more accurately predict pricing for their products.
**Limitations**

One limitation of this study, and any study containing survey data, was the variation in the number of responses for each price reporting period. The surveys of timber prices are voluntary, and it has been noted that the number of responses vary with prices (Linehan, Jacobson, and McDill 2003). That is, when prices are higher more responses are received, and when prices are lower fewer responses are obtained. Likely the most effective method for addressing this limitation is personal contact with potential survey respondents, and if that is not possible then phone contact should be considered.

Another limitation in the data utilized are possible outliers contained within individual price reports. Outliers can skew the means and distributions of the data, and should be identified. Further, depending on the study’s criteria, they should either be removed or reported in the study, or possibly both. This study was only able to utilize reported averages from 1960 to 2001, with no possibility of identifying outliers in that data subset. Even so, outliers in an individual report may or may not have an effect in a long-term trend analysis. Future research should address this issue.

The interval covered by the data is another minor concern, in that the 52-year period examined, while perhaps the most comprehensive of the eastern U.S. for an individual state (Luppold and Baumgras 1996), still represents an incomplete data set. It is likely that with more time we could have obtained archival information and uncovered pricing from earlier eras. This could have extended the timeline of each analysis through additional data points.
References


