OHIO HARDWOOD SAWLOG PRICE TRENDS

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Abstract. We examined the 52-yr sawlog price trends for the 10 commercial hardwood tree species in Ohio. Data were compiled from the Ohio Timber Price Report for four log grades (Prime, #1, #2, Blocking) covering the years 1960–2011, and average annual percentage rates of change in both nominal and real sawlog prices were determined. We further compared real log grade price movements within each species. Nominal prices for all log grades of all species increased at significant annual rates. However, real price change rates varied with approximately two-thirds of the species–grade combinations not significantly differing from zero. Real Blocking log prices declined at significant annual rates for seven species. Only white oak contained log grades (Prime and #1 only) with significantly increasing real prices. Four groups were identified based on differences observed, or not observed, when comparing initial price levels of log grades and rates of change within each species. Initial price differences generally occurred between the higher (Prime and #1) and lower (#2 and Blocking) grade logs. Rate of price change differences were more a result of declining Blocking log prices than increasing high-grade log prices with the exception of white oak.

Keywords: Appalachian roundwood markets, hardwood log prices, Ohio forest industry, timber markets.

INTRODUCTION

Industrial product demand and new home construction are main drivers of forest products production and profits in the US (Barrett 2013). These influences have greatly affected wood use and manufacturing in recent times. The housing crash and recent great recession compounded an already decreasing economic performance. The more gradual decline can be partially attributed to furniture and pulp and paper manufacturers moving portions of their operations overseas during the past two decades and a subsequent overall

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rise in market share of imported forest-based products (Espinoza et al 2011).

The forest products industry has been experiencing significant change, however, 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 business arrangement has changed with time to a market-based model in which mills compete for stumpage directly (Hickman 2007). Likewise, the hardwood sector has seen technology set the pace for changes businesses have experienced from the 1970s to today, along with a 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 lower quality logs. Prices for zero clear face logs, for example, have recently become more competitive with higher quality logs because of 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 estimate historic price changes at a projected rate, as well as forecasting long-term and short-term trends in species popularity, can affect which species and/or log grades buyers may pursue. Purchasing decisions made without an understanding of possible future price changes can lead to production runs that 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 (Luppold and Baumgras 1995, 2007; Linehan et al 2003; Wagner and Sendak 2005). Price trends examined with time can provide information for future business decisions once a rate of price change is determined.

Ohio log prices in the past have provided a basis for investigating hardwood market trends (Luppold and Baumgras 1996; Luppold et al 1998). However, these studies encompassed price reporting periods of not more than 20 yr and investigated only particular species and markets. To date, no comprehensive study of sawlog prices has been performed for Ohio. Although recent research conducted in neighboring states and regions (Campbell and White 1989; Irland et al 2001; Linehan et al 2003; Linehan and Jacobson 2005; Hoover and Preston 2013) is useful for developing price trends on a broader scale, describing Ohio market activities requires analysis at a more local level. The Ohio Timber Price Report (Ohio DNR 2013; OSUE 2013), which has continually tracked graded log prices since 1960, provides a basis for determining average annual percentage rates of change (APR) in hardwood sawlog prices. The 52-yr APR are currently unknown and require further investigation.

The goal of this research was to describe the price trends from 1960-2011 for hardwood sawlogs of the commercial timber species reported in the Ohio Timber Price Report. Autoregressive functions were used to determine APR for the four log grades—Prime, #1, #2, and Blocking—reported within the 10 species. Price movements between grades for each species were then compared to determine if differences existed.

METHODOLOGY

Data

The data used here were compiled from biannual surveys sent to loggers, mills, and timber buyers in Ohio in May and November. Sawlog prices are reported for 10 species: 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*). Prices for four log grades were tracked within each species: Prime, #1, #2, and Blocking with Prime being the highest grade and Blocking the lowest. Average prices paid (dollars per thousand board feet, Doyle) are provided in each report.

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

Analyses

We used a simple linear regression model following a natural logarithm transformation of each species' log grade price data to evaluate price trends from 1960 to 2011. The rate of price change was found using Eq 1:

$$Y = \beta_0 + \beta_1 x_t + \varepsilon \qquad [1]$$

where $Y = \ln(P_t)$ with P_t being the average price of a log grade paid at time t; the intercept of the line, β_0, represented the initial price in a series; β_1 represented the slope, or the continuous rate of change in price; x_t was a price report at time t in a series; and ε represented the model's error. The continuous rate, β_1, was then converted to an annualized rate *i* using Eq 2 (Wagner and Sendak 2005):

$$i = \left(e^{\beta_1} - 1\right) * 100 \qquad [2]$$

One concern when analyzing time-series data was 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 et al 1999). We found that significant autocorrelation existed across each series of data with all testing conducted using SAS software Version 9.2 (SAS 2008) at a significance level of $\alpha = 0.05$.

We used maximum likelihood stepwise autoregression 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). Using a backward stepwise approach, a number of lag variables was assigned in a group and insignificant variables were removed one at a time. Any remaining variables were those significantly contributing to the model. Five lag variables were applied to our data, and we found a maximum of three was needed for an individual series to account for the autocorrelated data.

We determined the APR for nominal and real prices of each species' four log grades during the entire reporting period. All nominal prices were adjusted for inflation to a base year of 1982 using the producer price index for all commodities (US Department of Labor Bureau of Labor Statistics 2013). To give a sense of sawlog price changes relative to the general economy, the APR of both state and national gross domestic products (GDPs), which charted the values of final goods and services produced in Ohio from 1963 to 2011 and in the US from 1960 to 2011, were calculated (US Department of Commerce Bureau of Economic Analysis 2013a, 2013b, 2013c). Additionally, the APR of a 10-yr Treasury bond's annually aggregated constant maturity rate from 1962 to 2011 was determined to provide a comparison of an alternative investment (Federal Reserve 2013).

Real prices were then compared among 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 Eq 3:

$$Y_t = \beta_0 + \beta_1 x_{1t} + \beta_2 x_{2t} + \beta_3 x_{1t} x_{2t} + \varepsilon \qquad [3]$$

where $Y = \ln(P_t)$ with P_t being the average price of a log grade paid at time t; x_{1t} was a price report at time t in a 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 β_0, β_1, β_2, and β_3 were model coefficients with ε being the model's error. The indicator variable coefficient, β_2, tested if the initial prices between two grades were different. The interaction coefficient, β_3, tested for an APR difference among grades. Autocorrelation was again examined and accounted for as described previously. Autoregression model errors were reported as percentage root mean square error (%RMSE) using Eq 4 (Linehan et al 2003; Linehan and Jacobson 2005):

$$\%RMSE = \left(e^{RMSE} - 1\right) * 100 \qquad [4]$$

RESULTS

52-yr Trends by Log Grade

Prime. Nominal prices APR for Prime 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 had an APR of 1.37% ($p < 0.01$) (Fig 1).

#1. The #1 log APR using nominal prices were significant for all species hard maple having the highest APR at 4.31% ($p < 0.01$). 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% ($p = 0.03$) (Fig 2).

#2. 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% ($p = 0.02$) (Fig 3).

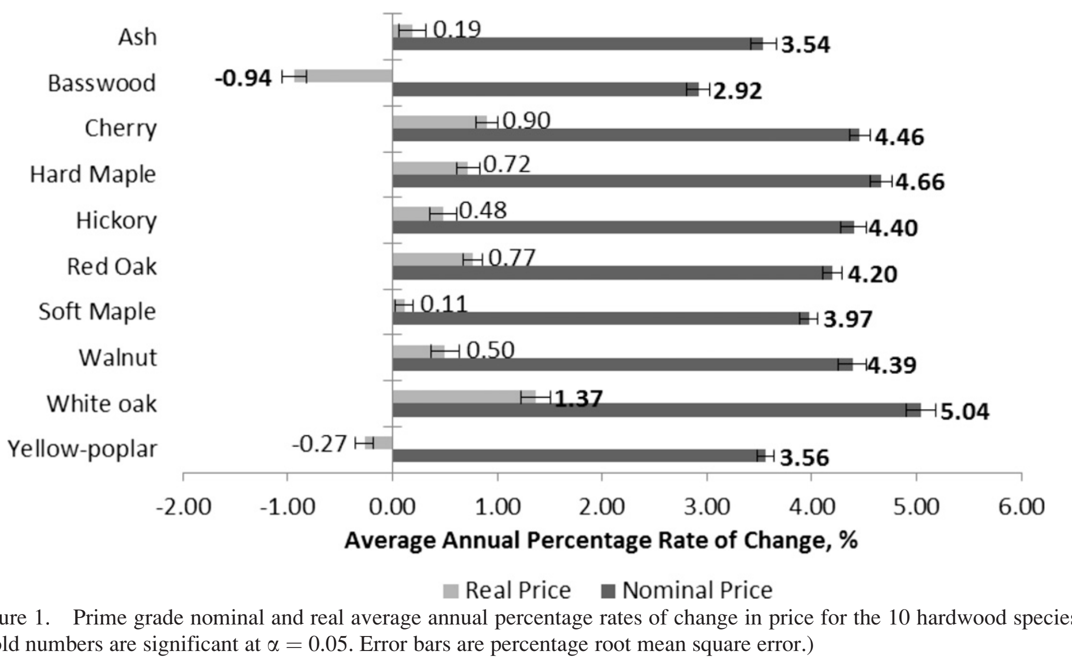

Figure 1. Prime grade nominal and real average annual percentage rates of change in price for the 10 hardwood species. (Bold numbers are significant at $\alpha = 0.05$. Error bars are percentage root mean square error.)

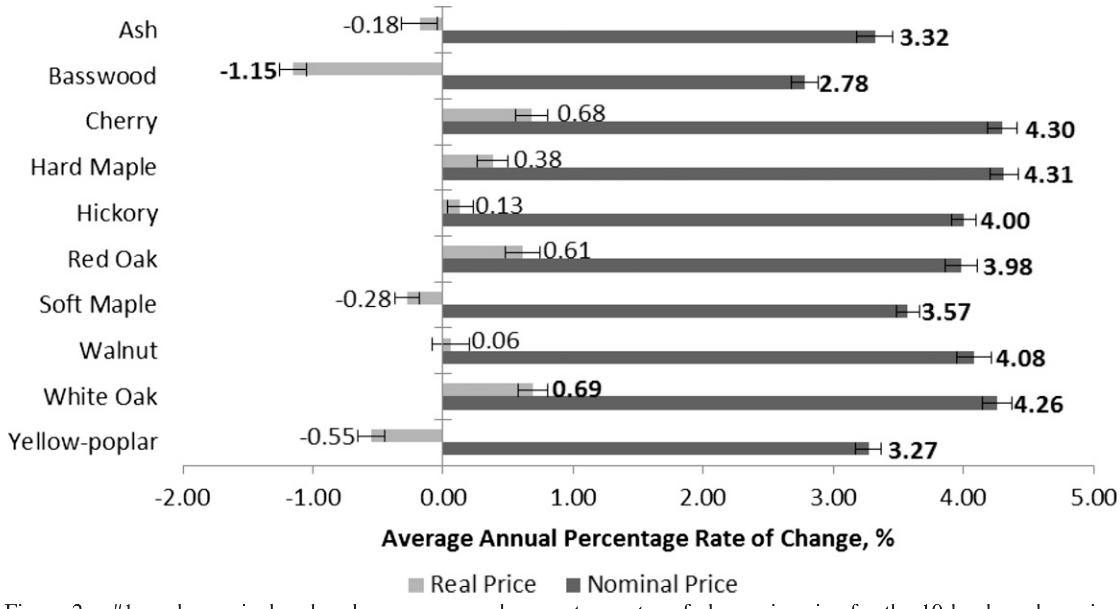

Figure 2. #1 grade nominal and real average annual percentage rates of change in price for the 10 hardwood species. (Bold numbers are significant at $\alpha = 0.05$. Error bars are percentage root mean square error.)

Blocking. Nominal price APR for all species of Blocking grade logs were significantly different from zero. Basswood again had the lowest APR at 3.17% ($p < 0.01$), whereas 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

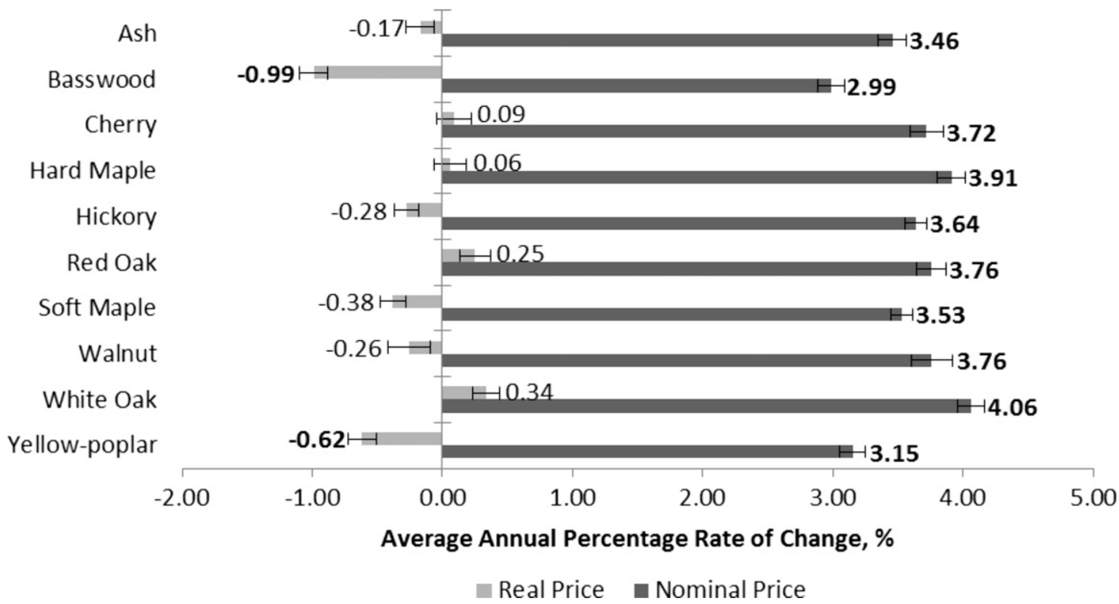

Figure 3. #2 grade nominal and real average annual percentage rates of change in price for the 10 hardwood species. (Bold numbers are significant at $\alpha = 0.05$. Error bars are percentage root mean square error).

highest real price APR at −0.44% ($p = 0.02$), whereas walnut had the lowest real price APR at −0.82% ($p = 0.04$) (Fig 4).

Gross Domestic Product and Treasury Trends

Nominal GDP APR were significant for both Ohio (5.78%, $p < 0.01$) and the US (6.82%, $p < 0.01$, Fig 5). Real GDP also significantly increased at APR of 1.86% for Ohio ($p < 0.01$) and 3.06% for the US ($p < 0.01$). Across grades, both nominal and real APR for Ohio's hardwood sawlogs were lower than those for GDP. The 10-yr Treasury bond's nominal maturity rate decreased at an APR of −0.74%, but this was not significantly different from zero. The real maturity rate, however, significantly decreased −4.53% ($p < 0.01$, Fig 5). All nominal and real species log grade APRs were higher than those of the 10-yr Treasury bonds.

Grade Comparisons within Species

Comparing initial price levels and price trends among grades for each hardwood species identified four separate groups. Group 1 was comprised of species containing grades in which both initial prices and APR differed. Species in Group 2 exhibited varying price levels among grades but no APR differences. Group 3 contained grades with differing APR only. In Group 4, neither APR nor initial prices significantly differed among grades (Table 1).

Group 1. Group 1 consisted of cherry, hard maple, and white oak. Differing initial prices and APR were found among 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 Blocking and between #1 and Blocking. White oak log initial prices and APR showed differences between Prime and #2, Prime and Blocking, and #1 and Blocking. Additionally, #2 and Blocking differed by APR only.

Group 2. Group 2 consisted of species with differing initial prices among grades but no differences in APR (ash, basswood, soft maple, walnut, and yellow-poplar). Given the lack of

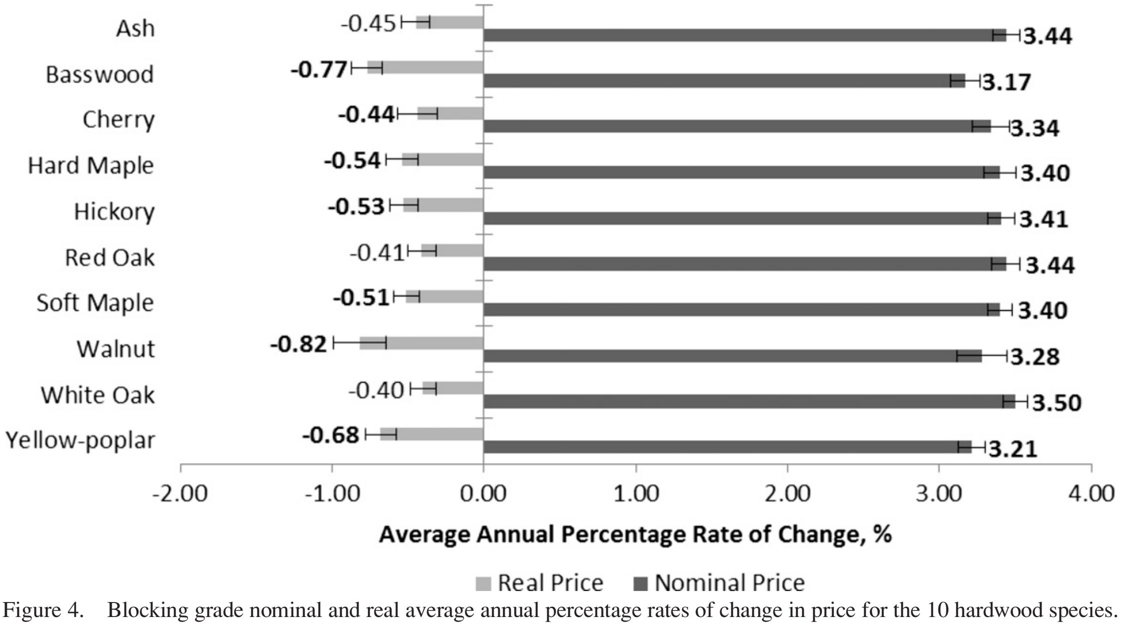

Figure 4. Blocking grade nominal and real average annual percentage rates of change in price for the 10 hardwood species. (Bold numbers are significant at $\alpha = 0.05$. Error bars are percentage root mean square error.)

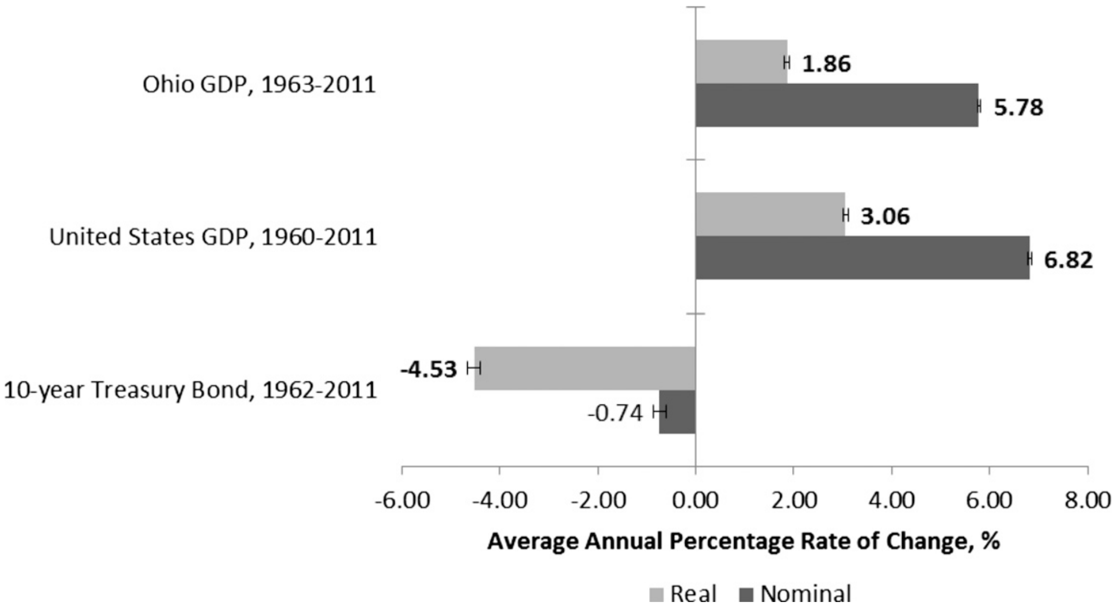

Figure 5. Nominal and real average annual percentage rates of change in Ohio gross domestic product (GDP) (1963–2011), national gross domestic product (GDP) (1960–2011), and the maturity rate of a 10-yr Treasury bond (1962–2011). (Bold numbers are significant at $\alpha = 0.05$. Error bars are percentage root mean square error.)

APR differences, these species' log prices have historically not been diverging or converging among grades. These significant price spreads have been maintained across the reporting period. Ash had initial price differences between Prime and Blocking and between #1 and Blocking. Basswood, soft maple, and yellow-poplar had initial price differences between the higher grade (Prime and #1) and lower grade (#2 and Blocking) logs but no differences between Prime and #1 or between #2 and Blocking. Walnut initial prices differed in all combinations containing #2 and Blocking logs.

Group 3. Red oak was found to have no differences in initial prices among log grades, but APR differences occurred. These were found between Prime and Blocking logs ($p = 0.03$) and between #1 and Blocking logs ($p = 0.04$). Red oak did not possess a log grade with an APR significantly different from zero (Figs 1–4). However, APR differences found in this study may be attributed to Blocking log prices changing at a level of significance greater than the other log grades (Blocking $p = 0.07$; Prime $p = 0.32$; #1 $p = 0.35$; #2 $p = 0.61$).

Group 4. Hickory was the only species with no significant differences found among grades in either initial prices or APR. Possibly, a combination of poorer tree quality and lack of markets locally were responsible for these absences.

DISCUSSION

Since 1960, nominal prices have been significantly increasing for all grades of all species. Real prices, however, have significantly changed for only one-third of the individual species–grade combinations and were at times negative. Of those, basswood was the only species with APR significantly different from zero across log grades, all of which were negative. Cherry, hard maple, hickory, soft maple, and walnut all had significantly negative APR for Blocking logs, and yellow-poplar had significantly negative APR for #2 and Blocking. White oak was the only species to show significantly positive real

Table 1. Within-species log grade price comparisons of initial price levels and average annual percentage rates of change (APR).[a]

Species	Comparison	Initial price, *p* value	APR, *p* value	%RMSE
Group 1				
Cherry	Prime: #1	0.99	0.49	11.38
	Prime: #2	0.24	0.24	12.05
	Prime: Blocking	**<0.01**	**0.01**	11.77
	#1: #2	0.38	0.32	13.09
	#1: Blocking	**<0.01**	**0.02**	12.58
	#2: Blocking	0.06	0.13	13.01
Hard maple	Prime: #1	0.69	0.52	11.44
	Prime: #2	0.08	0.25	11.86
	Prime: Blocking	**<0.01**	**0.02**	11.22
	#1: #2	0.37	0.51	12.00
	#1: Blocking	**0.01**	**0.04**	11.35
	#2: Blocking	0.21	0.13	11.43
White oak	Prime: #1	0.42	0.13	12.76
	Prime: #2	**<0.01**	**0.01**	12.42
	Prime: Blocking	**<0.01**	**<0.01**	11.56
	#1: #2	0.09	0.29	10.49
	#1: Blocking	**<0.01**	**<0.01**	9.67
	#2: Blocking	0.09	**0.02**	9.33
Group 2				
Ash	Prime: #1	0.90	0.38	12.88
	Prime: #2	0.16	0.38	11.50
	Prime: Blocking	**<0.01**	0.18	10.85
	#1: #2	0.36	0.61	12.24
	#1: Blocking	**0.01**	0.41	11.62
	#2: Blocking	0.20	0.39	10.08
Basswood	Prime: #1	0.29	0.51	10.94
	Prime: #2	**<0.01**	0.71	11.49
	Prime: Blocking	**<0.01**	0.61	34.89
	#1: #2	**0.04**	0.96	10.70
	#1: Blocking	**<0.01**	0.18	35.21
	#2: Blocking	0.06	0.63	34.61
Soft maple	Prime: #1	0.34	0.23	9.01
	Prime: #2	**<0.01**	0.13	9.08
	Prime: Blocking	**<0.01**	0.07	8.60
	#1: #2	**0.02**	0.51	9.36
	#1: Blocking	**<0.01**	0.28	8.92
	#2: Blocking	0.10	0.42	8.99
Walnut	Prime: #1	0.16	0.43	13.71
	Prime: #2	**<0.01**	0.18	14.95
	Prime: Blocking	**<0.01**	0.07	15.45
	#1: #2	**0.05**	0.39	14.99
	#1: Blocking	**<0.01**	0.25	9.47
	#2: Blocking	**0.03**	0.45	16.42
Yellow-poplar	Prime: #1	0.53	0.36	9.56
	Prime: #2	**0.01**	0.23	9.93
	Prime: Blocking	**<0.01**	0.25	9.47
	#1: #2	0.07	0.58	10.55
	#1: Blocking	**<0.01**	0.50	10.10
	#2: Blocking	0.16	0.62	10.33

Table 1. *Continued.*

Species	Comparison	Initial price, *p* value	APR, *p* value	%RMSE
Group 3				
Red oak	Prime: #1	0.87	0.33	11.47
	Prime: #2	0.40	0.16	10.91
	Prime: Blocking	0.07	**0.03**	9.51
	#1: #2	0.67	0.38	12.31
	#1: Blocking	0.07	**0.04**	11.28
	#2: Blocking	0.41	0.09	10.74
Group 4				
Hickory	Prime: #1	0.68	0.42	11.24
	Prime: #2	0.45	0.08	11.06
	Prime: Blocking	0.08	0.09	35.54
	#1: #2	0.86	0.36	9.54
	#1: Blocking	0.10	0.57	34.70
	#2: Blocking	0.11	0.68	34.61

[a] Bold *p* values are significant at $\alpha = 0.05$. Model errors are presented as percentage root mean square error (%RMSE).

APR, and this was only within the higher grades of Prime and #1. Neither red oak nor ash had significantly changing prices at any log grade.

Log prices have not moved at the levels of final goods as measured by state and national GDP, but they have outpaced the return of the 10-yr Treasury bond. Some caution should be exercised when comparing these returns to the Ohio hardwood sawlog price trends, however, because the historical time periods differed based on data availability. Additionally, comparing timber returns with those of 10-yr Treasury bonds, or other investments, should be done mindful of any potential differences in risk (Wagner and Sendak 2005).

Within the species-by-grade analyses, initial price differences between higher and lower grade logs were evident for eight species. No differences in APR or initial prices occurred between Prime logs and #1 logs for all species. Many of the differences in initial prices, APR, or both tended to occur between Prime and Blocking or #1 and Blocking logs. The results suggest the APR differences found in cherry and hard maple, and possibly red oak, were caused by the decreasing trends in prices for Blocking logs. Conversely, the APR differences found among white oak log grades were tied to the increasing prices of Prime and #1 logs. Although not significantly different in most cases among grades, APR decreased from Prime to Blocking across all species with the exception of basswood.

Grade differences in log price trends within a species are not unusual and are 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 (the supply of higher grade logs is less than that of lower grade logs). They also found log value was directly related to 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 and Baumgras (1996) also discovered that price spreads, or margins, between hardwood logs and lumber were increasing faster for lower grade logs than for higher grade logs and that margins increased as hardwood lumber prices increased. There has also been a long-term industry trend toward use 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 possibly log market growth (Luppold 1984).

More recently, however, Blocking log prices have outperformed #1 common lumber, Prime logs, and stumpage of the same species for cherry, hard maple, soft maple, red oak, white oak, and yellow-poplar (Luppold et al 2013). It was found that Blocking logs declined in price by the least amount from their respective price peaks of the mid-2000s to their lowest points in 2008-2009. Furthermore, Blocking log prices 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 more than 50%.

These findings were probably the result of hardwood mills increasing, or improving, their ability and willingness to change production goals from grade lumber to railroad ties, pallet cants, and other items generally made from low-grade logs (Anon 2012). For example, from December 2011 to December 2012, the Railway Tie Association (RTA) expected tie demand to be approximately 20 million ties. However, the RTA found the actual number of ties put into service for that 12-mo period was approximately 20% higher at 24 million ties (Barrett 2012), which helped increase the need for tie production. Also, pallet lumber demand has been experiencing growth because of increasing shipments of goods. This has paralleled the overall improving economy (Luppold et al 2013).

CONCLUSIONS

Nominal prices for all grades of hardwood logs in Ohio have increased at significant average annual rates since 1960. Real price trend analyses showed Prime log real price APR significantly increased for white oak only and significantly decreased only for basswood, whereas APR for all other species showed no significant differences from zero. Grade #1 log APR significantly increased for only white oak and significantly decreased for only basswood. No other #1 log APRs were significantly different from zero. APR for #2 logs did not significantly increase for any species, however both basswood and yellow-poplar had significantly decreasing APR. Blocking log APR showed no significant difference from zero for ash, red oak, and white oak, whereas all other species had significantly decreasing APR.

Basswood was the only species that showed significant changes in real price APR across all grades. APR ranged from a high of −0.77% for Blocking logs to a low of −1.15% for #2 logs, and no grades showed an increasing APR. Neither ash nor red oak had significant APR changes at any grade.

Species-by-grade analyses showed ash, basswood, soft maple, walnut, and yellow-poplar had only initial price differences between grades. Red oak had APR differences among Prime and Blocking logs and between #1 and Blocking logs but no initial price differences.

Cherry, hard maple, and white oak were the only species containing both significantly different initial prices and APR between specific grades. These differences were found for all three species between Prime and Blocking and between #1 and Blocking logs. White oak also showed this difference between Prime and #2 logs.

Across species, the initial price differences were largely between the higher (Prime and #1) and lower (#2 and Blocking) grade logs. APR differences within a species were more a result of declining lower grade log prices than increasing higher grade log prices. The exception to this conclusion was white oak.

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