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The Determinants of Hardwood Lumber Price

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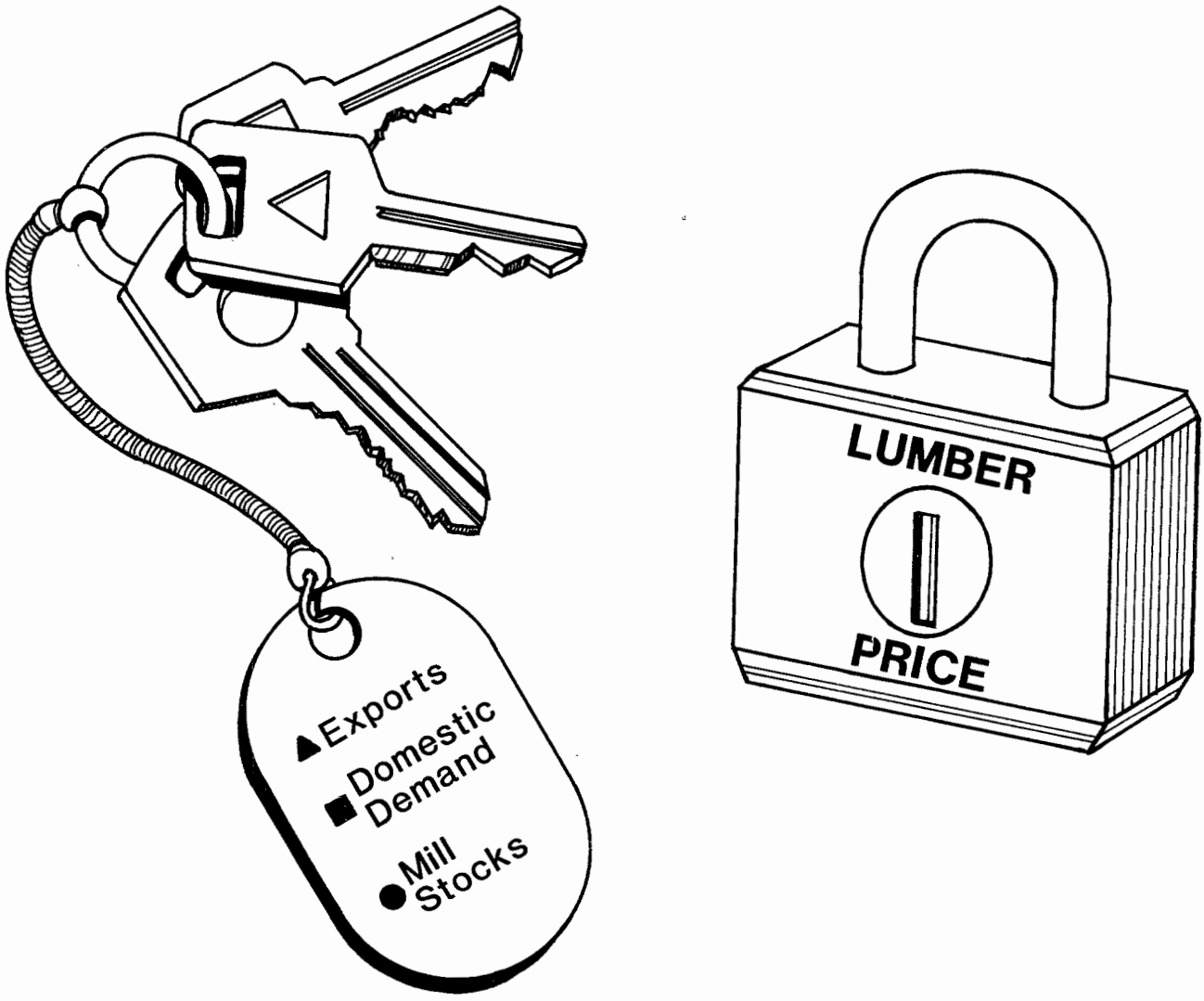

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Abstract

Increased export activity in the hardwood and oak lumber markets coincided with rising prices of these commodities, which also coincided with an increase in the overall price level of all commodities. To determine the effect that exports have on the prices of hardwood and oak lumber, relative price models for these commodities were developed. Relative, rather than actual or nominal, price models were used to remove the effects of inflation. The models indicated that exports to Europe have had and will have an influence on hardwood lumber prices. Oak price seems to be more sensitive to changes in exports than overall hardwood lumber price. However, the main determinants of hardwood lumber and oak lumber prices were found to be domestic demand and millstock levels.

Introduction

Before 1973, exports of hardwood lumber were a minor part of the U.S. hardwood lumber market. Except for a temporary intrusion of Japanese buyers into the hard maple market in the early 1970's, there was little export activity in the hardwood lumber market until European buyers started to increase their purchases of oak lumber. In 1973, European demands accounted for only 5 percent of hardwood lumber exports; by 1980, exports to Europe accounted for 34 percent of the domestic hardwood lumber exported (Fig. 1). More significantly, the European share of oak exports increased from less than 6 percent in 1973 to more than 45 percent in 1980. These increases occurred during a period when total hardwood exports increased 91 percent and oak lumber exports increased 182 percent.

The export boom in the hardwood lumber market brought greater profits to producers and distributors of hardwood lumber, and to a small extent, improved the balance of payments with Western Europe. One suspected drawback of increased exports was increased lumber price, especially for oak.

The allegation that increased exports lead to increased hardwood lumber price results from the strong correlation between increased exports (Fig. 1) and increased nominal[1] lumber price (Fig. 2). The movement of hardwood lumber and No. 1 Common oak lumber prices seems to parallel exports to Europe, even though exports are primarily composed of grades Firsts and Seconds. Exports of higher grades indirectly affect overall prices of hardwood lumber because increasing the price of higher grade lumber increases the domestic demand pressures for lower grade lumber.

The trends exhibited in Figure 2 must be interpreted with some skepticism since inflation and expectations of further inflation were also prevalent during the period when exports increased. From 1973 to 1980, when oak price increased 116 percent, the general price index for all commodities rose by 100 percent. To assess the true effect of exports on the hardwood lumber market, the effects of inflation should be accounted for.

The prices of oak and hardwood lumber relative to the price of all commodities are shown in Figure 3. Although the relative price of oak has fluctuated above the 1967-100 baseline, these fluctuations are not nearly as dramatic as the increase in nominal oak price. The relative price of hardwood lumber has also tended to fluctuate above the baseline, but not to the same degree as oak lumber price. These fluctuations may indicate that exports did have some effect on domestic hardwood lumber prices; however, other factors such as demand and supply

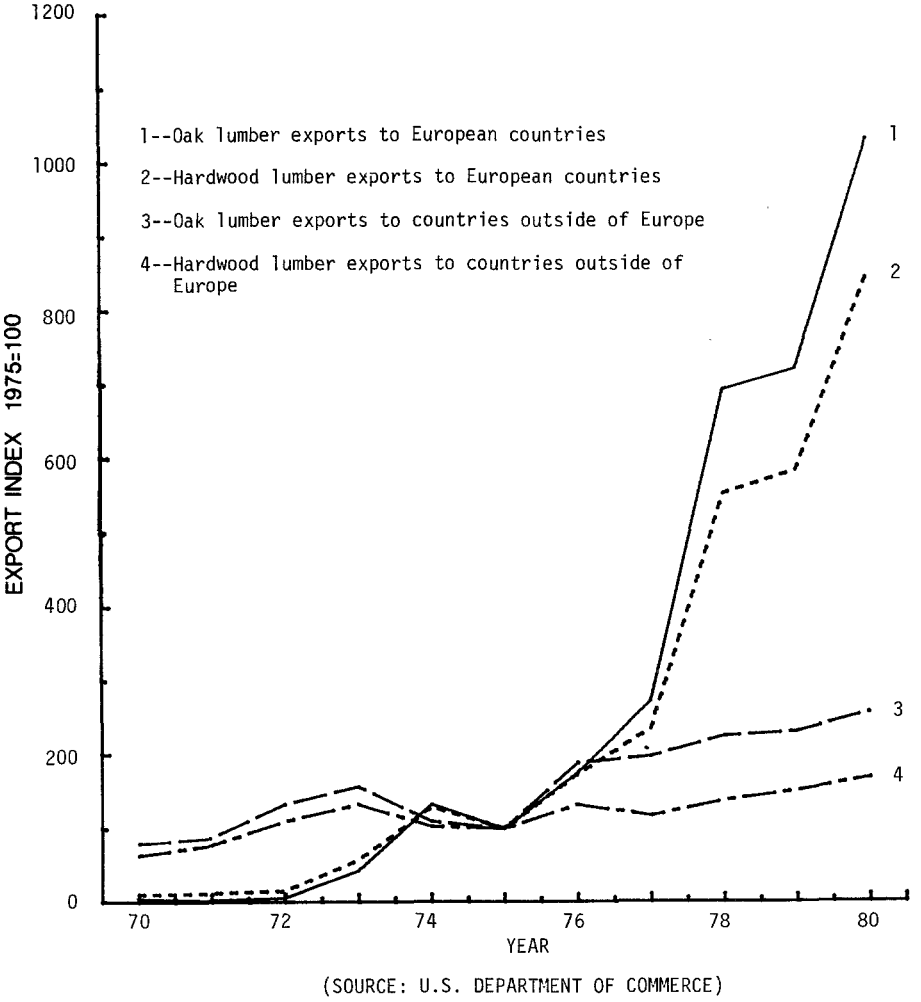

Figure 1.—Indexes of quantities of oak and hardwood lumber exported to European and non-European countries. (Source: U.S. Department of Commerce)

[1] Nominal price is the price that exists in the marketplace. Real price is the nominal price divided by the true rate of inflation. Relative price is nominal price divided by a nominal price of another commodity or commodity group. Relative price may be a reasonable measure of real price if the adjusting index is based on a broad composite of commodities.

Model Development

forces within the domestic hardwood lumber market could also have contributed to these fluctuations. The objective of this paper is to isolate and measure the determinants of oak and hardwood lumber price to assess the impact of exports on prices of oak and hardwood lumber.

Luppold (1982) developed an equation for nominal hardwood lumber price as part of a system of equations depicting hardwood lumber demand, supply, and price. The price equation was estimated using ordinary least squares (OLS) procedures because the hardwood lumber market was assumed to be recursive, with quantity of hardwood lumber demanded being a function of past lumber price, and because the error term associated with the estimated equations was found to be uncorrelated.

The specification of Luppold's (1982) price equation included variables representing past lumber price, quantity of lumber demanded domestically, quantity of lumber exported, and millstocks. Past price was included as a measure of price expectations, domestic demand and exports were included to account for the effects of these demands on price, and millstocks were included to determine the effects of changes in inventories. In this type of model specification, supply does not enter directly into the price equation; but the effects of supply are reflected in changes in inventories. Therefore, the inclusion of the domestic demand and millstock variables accounted for the demand and

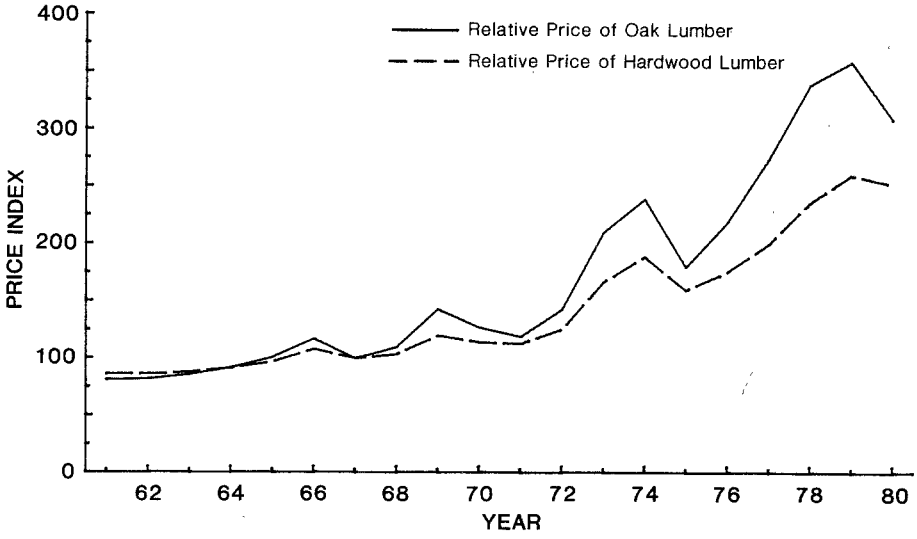

Figure 2.—Indexes of oak and hardwood lumber prices.

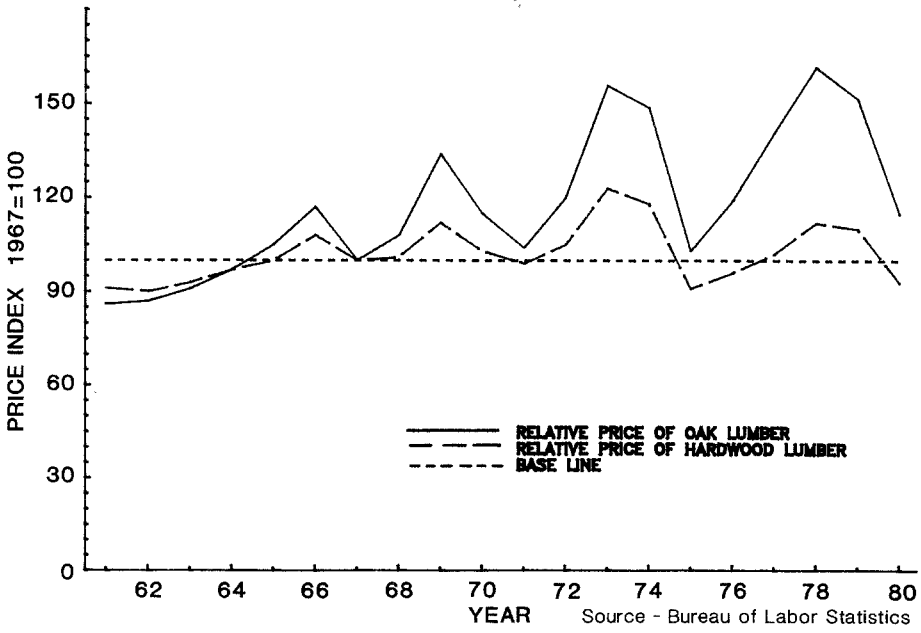

Figure 3.—Indexes of relative prices of oak and hardwood lumber (relative to the price index for all commodities).

supply forces in the domestic hardwood market, while the export variable accounted for the demand forces outside the domestic market.

The weakness in Luppold's specification is that one cannot separate the influence of exports from the influence of inflation and expectations of inflation since all followed similar paths. Therefore, the influence of exports could have been over- or underestimated in Luppold's specification. A real-price model or its operational proxy, a relative price model, would resolve this problem. The models to be presented in this paper are relative price models with the price expectation variable.

Another difference between the specification of the current price equations and Luppold's (1982) specification is that European and non-European exports are represented by separate variables. This allows us to separate the effects of European exports from those of exports in general and also to test whether European exports affect domestic lumber price differently from non-European exports. The specific definition of the variable to be included in the hardwood lumber and oak lumber relative price equations is outlined in Table 1.

Table 1.—Dependent variables for the hardwood lumber and oak lumber price equations

Variable	Actual variable used in hardwood lumber price model	Actual variable used in oak lumber price model
Quantity demanded domestically	Quantity of hardwood lumber domestically consumed in current year	Quantity of hardwood lumber domestically consumed multiplied by the proportion of oak lumber produced
Exports to Western Europe	Quantity of hardwood lumber exported to Western European countries	Quantity of oak lumber exported to Western European countries
Exports outside of Western Europe	Quantity of hardwood lumber exported to other than Western European countries	Quantity of oak lumber exported to other than Western European countries
Millstocks (inventories)	Average level of millstocks of hardwood lumber at end of current year and past year	Average level of millstocks of hardwood lumber multiplied by the proportion of oak lumber produced in current year and past year.

Data Base

The data base used in the estimation of the hardwood lumber price equation and the oak lumber price equation extended from 1960 through 1980. All data were obtained or derived from secondary sources.

Indexes for hardwood lumber price, oak lumber price, and the producer price index of all commodities were obtained from U.S. Department of Labor, *Producer Price and Price Indexes.* Since no aggregate oak price representing all grades and species was available through the time period under study, the price of No. 1 Common red oak was used as the dependent variable in the oak price equation.

Quantities of hardwood lumber and of oak lumber exported were obtained from *U.S. Exports, Schedule B, Commodity by Country.* Millstock and lumber production figures were obtained from U.S. Department of Commerce, Bureau of the Census, *Current Industrial Reports: Lumber Production and Mill Stocks.* Quantity of hardwood lumber demanded domestically was derived by subtracting exports and changes in millstocks from production figures.

The quantity of oak lumber demanded and the millstocks of oak lumber were estimated by multiplying the proportion of oak lumber produced by domestic quantity demanded and by millstocks, respectively. The proportion of oak lumber produced was calculated by dividing oak lumber production by total hardwood lumber production.

Model Estimation

The statistically estimated price equations for hardwood lumber and oak lumber are presented in Table 2. Both equations fitted the data relatively well, as indicated by the R^2's and the "t" statistics. The non-intercept variables representing exports to Europe, millstocks, and domestic demand were significant at the 0.10 level or better. The variable representing non-European exports was insignificant in both equations. The Durbin Watson (DW) statistics of both equations fell into the inconclusive range, so the hypothesis of autocorrelation could not be accepted or rejected.

The price equations were estimated by taking the natural logarithms of the independent and dependent variables, then estimating their relationships by OLS procedures. The equations resulting from the transform data are in multiplicative form, and the resulting parameter estimates can be directly interpreted as price flexibilities.[2]

[2] Flexibilities are used in interpreting price equations as elasticities are used to analyze demand and supply equations. Mathematically, a flexibility is the (aP/aQ) (Q/P) where Q represents a quantity and P represents commodity price. This contrasts with the elasticity formula of $\frac{\alpha Q}{\alpha P}\frac{P}{Q}$. Given the multiplicative form, $P = Q^b$, where b is the estimated parameter, (aP/aQ), $(Q/P) = b\ Q^{b-1}$ $(Q/Q^b) = b$.

Table 2.—Ordinary least squares estimates for hardwood and oak lumber price equations (t statistics in parentheses)

Item	Hardwood lumber	Oak lumber
Intercept	4.06*	− 0.066
	(2.32)	(0.141)
Quantity demanded domestically	0.610**	1.44[a]
	(3.50)	(2.51)
Exports to Western Europe	0.017*	0.074**
	(1.52)	(3.41)
Exports outside of Western Europe	− 0.046	− 0.119
	(0.815)	(0.942)
Millstocks	− 0.662**	− 0.931**
	(6.47)	(4.78)
R^2	0.822	0.819
DW	1.31	0.90

** = Significant at the 0.01 level
* = Significant at the 0.05 level
[a] = Significant at the 0.10 level

Analysis

"Price flexibility" is the percentage change in price resulting from a 1-percent change in an independent variable (Tomek and Robinson 1972). Flexibilities have been widely used to analyze agricultural markets in which demand and supply forces are buffered by the existence of a large fluctuating inventory. Although hardwood lumber does not exhibit the seasonal inventory extremes common in the soybean, corn, and wheat markets, millstocks of lumber account for as much as 17 percent of the annual production and can vary by 45 percent in a single year.

Flexibilities can be viewed as inverse elasticities to the extent that the more elastic a demand for a commodity is, the lower its flexibility. Luppold (1984) found that the European demand for oak lumber was quite elastic, and Luppold (1982) found domestic hardwood lumber demand to be near unitary elasticity. These results are supported by the current study, since export demand flexibilities are much smaller than domestic demand flexibilities. Since the non-European export coefficient was insignificant, future use of the term "price flexibility of exports" refers to exports to Western Europe.

The estimated price flexibilities indicate that oak lumber price is affected by changes in domestic demand, millstocks, and exports to a greater degree than is hardwood lumber price. This finding may explain why oak price tended to fluctuate more than hardwood lumber price even during the pre-1973 period when exports were a minor part of the market. The increased divergence between oak lumber and hardwood lumber price fluctuations since 1973 (Figs. 2 and 3) probably results from the facts that (1) changes in oak exports affect oak price more than changes in hardwood exports affect hardwood price, and (2) changes in oak exports to Europe have been greater than changes in hardwood lumber exports.

Another interesting fact demonstrated by the estimated price flexibilities is that a 1-percent change in domestic demand or millstocks has a much larger influence on hardwood lumber and oak lumber prices than a 1-percent change in exports. In the case of oak lumber price, exports would have to increase by 19.5 percent to have the same impact as a 1-percent change in domestic demand and by 12.6 percent to have the same impact as a 1-percent change in millstocks. During the 1972-to-1980 period, yearly changes in domestic demand averaged 6 percent, yearly changes in millstocks averaged 12 percent, and yearly changes in exports averaged 50 percent. Analysis based on these 1972-1980 average yearly changes shows that changes in domestic demand affected oak lumber price 2.3 times as much as changes in exports and changes in millstocks affected oak lumber price 3 times as much as changes in exports. Similarly, changes in domestic demand affected hardwood lumber price 5.2 times as much as changes in exports, and changes in millstocks affected price 10.1 times as much as changes in exports.

The above analysis should not be interpreted as indicating that exports have little discernible effect on oak and hardwood lumber prices. During the late 1970's, when domestic demand was increasing and millstocks were decreasing, increased levels of exports helped push lumber prices up even further. On the other hand, during 1979 and 1980, when domestic demand was decreasing and inventories were increasing, increases in exports helped moderate the drops in hardwood lumber and oak lumber prices. However, since 1980, changes in export demand have moderated; therefore, the effect of exports on hardwood lumber prices has moderated.

Conclusions

Increases in exports of hardwood and oak lumber to Europe did contribute to the increases in the nominal and relative prices of these commodities during the 1970's. Exports affected oak lumber price more than hardwood lumber price because: (1) The increase in oak exports to Europe was 20 percent greater than the exports of all hardwood lumber to Europe, and (2) a 1-percent change in exports affects oak price 3.3 times as much as a 1-percent change in hardwood lumber affects hardwood lumber price. However, changes in domestic demand and millstocks have had more influence on hardwood lumber and oak lumber prices than changes in exports. Furthermore, changes in exports of hardwood lumber have leveled during the last 5 years. Therefore, exports of hardwood and oak lumber can be thought of as contributing to the formation of hardwood lumber prices, but domestic demand and level of millstocks have been and will be the major factors that influence domestic hardwood lumber prices.

Literature Cited

Luppold, William G. **An econometric model of the hardwood lumber market.** Res. Pap. NE-512. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1982. 15 p.

Luppold, William G. **An analysis of European demand for oak lumber.** Res. Pap. NE-538. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1984. 7 p.

Tomek, William G.; Robinson, Kenneth L. **Agricultural product prices.** Ithaca, NY: Cornell University Press; 1972. 378 p.

U.S. Department of Commerce, Bureau of the Census. **Current industrial reports: lumber production and mill stocks.** Washington, DC: U.S. Department of Commerce; 1961-1980.

U.S. Department of Commerce, Bureau of the Census. **U.S. exports, Schedule B. commodity by country.** Washington, DC: U.S. Department of Commerce; 1961-1979.

U.S. Department of Labor. **Producer prices and price indexes.** Washington, DC: U.S. Department of Labor, 1961-1980.

Luppold, William G.; Jacobsen, Jennifer M. **The determinants of hardwood lumber price.** Res. Pap. NE-558. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station; 1985. 6 p.

Econometric equations were estimated to determine the effects of domestic foreign hardwood lumber demands on oak and hardwood lumber prices. Oak price seemed to be more sensitive to changes in exports than overall hardwood lumber price. However, the main determinants of hardwood lumber and oak lumber prices were found to be domestic demand and millstock levels.

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