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## Journal of Forest Economics

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# Vertical price transmission in timber and lumber markets



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### ARTICLE INFO

*Article history:*

Received 4 December 2012

Accepted 10 July 2013

*JEL classification:*

C32

F15

Q23

*Keywords:*

Asymmetric price transmission

Error correction model

Market integration

Threshold cointegration

### ABSTRACT

Timber and lumber markets are linked and integrated through prices at several stages along timber supply chain. In this study, the degree of vertical integration and the presence of asymmetric price transmission are investigated for sawtimber and lumber products in the southern and western United States. The data utilized are quarterly stumpage price, delivered timber price, and lumber price of softwood between 1977 and 2011. Linear and threshold cointegration models are used for long-term price analyses, and symmetric and asymmetric error correction models are used for short-term price analyses. The integration in the early stage (i.e., stumpage/delivered timber price pair) is found to be stronger than that in the latter stage (i.e., delivered/lumber price pair). The South shows slightly stronger market cointegration than the West. Asymmetric price transmission is found along the timber supply chain. In the long term, prices are more responsive when the price margin is increased than decreased.

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### Introduction

Rich forest resources in the United States have supported large timber markets and related manufacturing activities. There are 751 million acres of forestlands in the United States, resulting in a forest coverage of 33% (Smith et al., 2009). These forests are owned and managed by a number of

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public agencies and over 10 million private forest landowners. Timber harvested from forests is an essential raw material for the forest products industry, which produces lumber products, paper and allied products, and furniture. In 2010, the value of shipments from the forest products industry was US\$298.7 billion, and its share in manufacturing was 6.1%; it has 1.01 million employees, or 9.6% of the total manufacturing employees (U.S. Bureau of Census, 2012). Given the importance of timber and the related industry to the economy, it is imperative to comprehend the integration among timber and lumber markets.

Analyses of linkage and integration among market prices are important research topics with a long history because prices drive resource allocation and output decisions and price transmission integrates markets vertically and horizontally (Meyer and von Cramon-Taubadel, 2004). Frey and Manera (2007) conduct a comprehensive literature review of both research issues in price transmission and the corresponding statistical models, which have evolved simultaneously. Early studies use simple correlation statistics or ordinary least square regressions to evaluate the relation between prices at different markets or processing stages. Since 1987, nonstationary properties of time series data have been explicitly modeled through cointegration and error correction models. In recent years, nonlinear behavior in price transmission and adjustment has attracted more attention and has been examined through nonlinear threshold models. In particular, research has been expanded to examine if price transmission is asymmetric and nonlinear among relevant prices (Meyer and von Cramon-Taubadel, 2004). Asymmetric price transmission can occur if one price reacts with a different speed or magnitude to an increase in another price than to a decrease. This can have important welfare and policy implications because a price change in one market under asymmetric transmission mechanism may not benefit a group of economic actors with the same magnitude or speed under symmetry conditions. Among the various sources of asymmetry, noncompetitive market structure and adjustment cost are among the most cited factors. Other causes include political intervention, inflation, or inventory management.

A number of studies have been conducted to evaluate price transmission or determination in timber and related product markets. Analyses of stumpage prices include Nagubadi et al. (2001), Haley and Paarsch (2004), and Daniels (2011). The number of studies on lumber market integration is much bigger, including Uri and Boyd (1990), Yin and Baek (2005), and Shahi and Kant (2009). There are also several studies on the integration of pulp, paper, or newsprint markets (e.g., Buongiorno and Uusivuori, 1992; Hänninen et al., 1997; Tang and Laaksonen-Craig, 2007). A review of this large literature reveals two features. One feature is that they usually assess the price linkage among spatially separated horizontal markets, either in timber or forest products markets. In general, vertical relation between factor and product markets has been an important issue in agriculture (Gardner, 1975). However, few studies have examined the vertical price linkage along timber supply chain in forestry; the few exceptions are a comparative static analysis on stumpage and lumber market (Haynes, 1977), analyses of hardwood stumpage and lumber prices in Ohio (Luppold and Baumgras, 1996; Luppold et al., 1998), a study of vertical price linkage in the lumber and paper markets in the southern United States (Zhou and Buongiorno, 2005), and the price transmission between sawnwood and sawlog markets in Europe (Hänninen et al., 2007). The other feature is that econometric models employed in those studies are usually linear, so any nonlinear behavior in market price adjustment is ignored. The exceptions are the analysis of asymmetric price transmission in the wood sector of Greece (Koutroumanidis et al., 2009) and in the import wooden bed market in the United States (Sun, 2011). Overall, there has been a critical need to pay more attention to vertical price transmission in forestry, and furthermore, to employ more recently developed econometric methods to assess possible nonlinear price adjustment.

The objective of this study is to inspect vertical price transmission in timber and lumber markets of softwood in the United States. Corresponding to several stages along timber supply chain, the analyses utilize three softwood prices: stumpage price, delivered timber price, and lumber price. These prices are separately defined for the southern and western United States, because these two regions are the major timber supplying regions and have different landownership patterns. The data are quarterly and cover the period between 1977 and 2011. The econometric methods employed are linear and threshold cointegration models for long-term price analyses, and additionally, corresponding error correction models for short-term price analyses. The main findings are that integration in the early stage is stronger than that in the latter stage along the timber supply chain. The South shows slightly

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