Intermediaries in the U.S. Hardwood Lumber Market: Comparing and Contrasting Sawmills and Distributors

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The objective of this study was to better understand changes in the hardwood lumber supply chain from the perspective of lumber producers and distributors and to assess the degree of judgmental convergence between suppliers and buyers of hardwood lumber. Results from two nationwide surveys conducted in 2008 and 2009 were used for the analysis. Findings confirmed a decline in demand for red oak and an increase in species diversity in the market, although a majority of sales were dominated by five species. Results also showed an increasing importance of markets for lower grades of lumber, such as pallets, containers, and railroad ties, and a decline in demand for higher-value products such as furniture and kitchen cabinets. The importance of the lumber distributor role in the hardwood supply chain also has increased. Both sawmills and suppliers have increased their offerings of customized products and services in response to market demand. The customer base is changing, with smaller, more customized orders being sold to smaller businesses. Some of the trends and changes identified are structural and long-running in nature and are not expected to change in the short term.

Keywords: Hardwood lumber; Sawmill; Supply chain; Lumber yards; Distribution

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INTRODUCTION

The U.S. forest products industry has experienced significant challenges in recent years. Some of these challenges are structural and long in the making, such as the ongoing globalization of markets (Schuler and Buehlmann 2002; Buehlmann and Schuler 2009; Luppold and Bumgardner 2011; Hansen *et al.* 2013), the rise of electronic media and the ongoing shift in paper use (Woodall *et al.* 2011; Belz 2012; Dahal *et al.* 2013), and today's customer expectations toward mass customized products (Pine 1999; Schuler and Buehlmann 2002; Lihra *et al.* 2008; 2012). Other challenges are more immediate, involving shorter-term events that the industry has to cope with, such as the economic recession that began in 2007 (National Bureau of Economic Research 2010), which has cost the forest products industry more than a million jobs (Woodall *et al.* 2011) while temporarily reducing hardwood lumber demand by more than forty percent (Barford 2013; Johnson and Caldwell 2013; Luppold 2013).

Not all sub-segments of the wood products industry have shown the same ability to adapt to the changing global economy. The kitchen cabinet sub-segment, where import

market share rose from a relatively modest 1.5% in 1992 to 4.3% in 2008 (Buehlmann and Schuler 2009), has been successful in maintaining manufacturing capacity domestically. In contrast, imports for non-upholstered wood household furniture rose from 19% in 1992 to 64% in 2008 (Buehlmann and Schuler 2009). It has been suggested that the more favorable performance of the kitchen cabinet industry sub-segment is due, in part, to the mass-customized, made-to-order, modular products that are manufactured and sold, as well as improvements in operational capabilities and better management of their supply chain (Buehlmann 2004; Buehlmann *et al.* 2010). Because of its importance for business success, research has been conducted on the implementation of supply chain management practices in the wood products industry (Simpson and Wren 1997; Vlosky *et al.* 1998; Buehlmann 2004; D'Amours *et al.* 2004; Espinoza *et al.* 2010a; 2010b), while others have explored the improvement of operations management in forest products industries, particularly through the implementation of "just-in-time" and "lean management" practices (Motsenbocker *et al.* 2004; Cumbo *et al.* 2006; Fricke and Buehlmann 2012a). Also, customization as a competitive advantage in the wood products supply chain has been studied by a number of scholars (Kodzi 2006; Kodzi and Gazo 2007; Moreira *et al.* 2007; Walcher *et al.* 2007; Lihra *et al.* 2008). However, less attention has been paid to the ongoing changes to hardwood lumber manufacturers and distributors based on recent industry changes.

Lumber is the most valuable product derived from the U.S. hardwood forest resources (Luppold and Bumgardner 2008), and its trade provides income to landowners and loggers, as well as sawmills and lumber distributors. However, because of the ongoing changes in the U.S. forest products industry described above, hardwood lumber production has changed. According to the Hardwood Market Report (2014), U.S. hardwood lumber production peaked in 1999 at 12.9 billion board feet (bbf), decreased modestly until 2005 to 11.6 bbf, and then declined by almost 50% to 6.6 bbf in 2009 due to the recession, which represents a production level last seen in the early 1960s (Luppold 2013). By 2012, U.S. hardwood lumber production did increase to an estimated 7.3 bbf (Hardwood Market Report 2014), but was still 43% less than the 1999 peak.

The importance of demand segments for hardwood lumber also has changed. According to the Hardwood Market Report (2014), industrial uses of hardwood lumber in 1999 (*i.e.*, pallet lumber, cants, board road/mat timbers, and railways ties) collectively consumed 4.5 bbf, while graded or appearance-based uses (*i.e.*, furniture, flooring, millwork, cabinets, and exports) accounted for 7.7 bbf. By 2009, however, industrial uses accounted for 3.9 bbf, while appearance-based uses consumed 2.7 bbf (Hardwood Market Report 2014). Estimated consumption volumes for 2013 are 5.1 bbf for industrial uses and 3.5 bbf for appearance-based uses (Hardwood Market Report 2014). Thus, over the past 15 years, graded lumber demand has declined relative to industrial demand, potentially changing the economic equation for hardwood lumber producers and distributors. Because of the changing demand for hardwood lumber, prices have changed as well, with weak pricing when demand slumped, only to rise again recently with increasing demand. Appalachian 1 Common red oak, for example, was priced 30% lower in 2008 than in 2004 (Cochran 2009). Shifting consumer preferences also can affect markets for hardwood lumber species, such as the trend away from open-grained species like oak in the 2000s (Luppold and Bumgardner 2007).

With a number of large former customers of graded lumber (*e.g.*, a majority of the larger US non-upholstered wood household furniture manufacturers off-shore production over the past two decades) no longer buying large quantities of hardwood lumber, suppliers and distributors have faced pressure to offer Less-than-Truckload (LTL) loads of highly customized lumber shipments to satisfy smaller, more demanding clients expecting customized services. For example, because of the ongoing fractionation of hardwood lumber markets, distributors are playing an increasingly important role and have become important customers to sawmills (Buehlmann *et al.* 2010). Sawmills also are consolidating to maximize operational efficiencies and to be able to cope with necessary investments in technology, management, and distribution (Luppold 2005; Luppold and Bumgardner 2009; Manchester *et al.* 2009).

The objective of this study was to better understand changes in the hardwood lumber supply chain from the perspective of lumber producers and distributors and to assess the degree of judgmental convergence between suppliers and buyers of hardwood lumber. To accomplish this objective, results from two nation-wide surveys conducted in 2008 and 2009 were used. Specifically, firm and supply chain-related characteristics are compared and contrasted among sawmills and distributors. The results from these two original individual studies were published in Buehlmann *et al.* (2010) and Espinoza *et al.* (2011). Although the data collected correspond to the 5-year period ending in 2007 (for distributors) and 2008 (for sawmills), many of the trends and changes discussed here are somewhat structural in nature (*e.g.*, offshoring of wood furniture production) while others are likely more short-term and cyclical in nature (*e.g.*, housing markets).

EXPERIMENTAL

Two separate yet related mail-based surveys, one for hardwood lumber sawmills and one for hardwood lumber distributors, were conducted to inquire about trends in the hardwood lumber industry. Areas of focus included sales volume, species produced, customers and markets served, services provided, and perceptions of the business environment. The target population for the first survey was hardwood lumber distributors in the United States (which include North American Industry Classification System (NAICS) codes 423310 (Lumber, plywood, millwork, and wood panel merchant wholesalers) and 4441901 (Lumber retailing); see Espinoza *et al.* 2011). The target population for the second survey was hardwood lumber manufacturers in the United States (included in NAICS code 321113 (Sawmills); see Buehlmann *et al.* 2010). The surveys generally followed the guideline established in Dillman's Total Design Method (Dillman 2009).

A list of addresses was compiled using various sources. For lumber manufacturers, the Virginia Tech Center for Forest Products Business address database was used. For lumber distributors, the industry directories of the National Hardwood Lumber Association (NHLA), the North American Wholesale Lumber Association (NAWLA), and the Hardwood Distributors Association (HDA) were used. For the development of both surveys, common steps were followed: draft preparation according to study objectives, review by experts from industry and academia, and final version preparation. Both surveys'

questionnaires were tested using approximately 10 addressees from the survey population and was reviewed by academic colleagues. The final questionnaires, along with cover letters, were enclosed in envelopes with prepaid return postage and sent to their intended recipients. For each survey, two sets of questionnaires and reminder postcards were sent, with approximately two weeks between each mailing.

One concern in any survey study is to assess whether response bias is present. This can be determined by comparing selected characteristics of responding and non-responding firms. Two different methods were used to evaluate non-response bias in the surveys discussed in this paper. For the survey of lumber manufacturers, two firm characteristics were compared between early respondents and late respondents. This method assumes that there is a continuum in the probability to respond to the survey going from high for early respondents to low among late respondents, and that late respondents can be used as a proxy for non-respondents (Dalecki *et al.* 1993; Etter and Perneger 1997; Lahaut *et al.* 2003).

Non-response bias for the lumber distributor survey was carried out by contacting 31 companies that did not sent back responses and request their responses to four of the questions in the questionnaire (Malhotra 1996). For both studies, statistical tests were carried out to identify significant differences between respondents and non-respondents (Etter and Perneger 1997), including *z* test of proportions, chi-square tests, and *t* tests (all at 0.05 alpha level). No significant bias was detected in either survey.

Study Limitations

Survey research has some inherent limitations such as recall error, especially for numerical data, as well as coverage and sampling errors (Alreck and Settle 2004). Additionally, other limitations should be considered when drawing conclusions from the data collected for this study:

- Responses, coming from one individual in each company, may not reflect the views from other decision-makers within the same company.

- Certain bias may exist due to the fact that addresses were compiled using the industry directories of several associations, thus companies that do not belong to any of these organizations may be under-represented in the sample.

- Some of the trends discussed here may have been affected by the recession that began in late 2007 (National Bureau of Economic Research 2010), while the data corresponds to the five years before the recession.

The reader also must be aware that the surveys were conducted in sequential order; *e.g.*, mailing of the questionnaire began in August 2008 for distributors and in 2009 for sawmills. Accordingly, data was collected for 2007 and 2002 for distributors and for 2008 and 2003 for sawmills. This time difference, although minor, should be noted, as economic conditions may have changed slightly between the surveys.

RESULTS AND DISCUSSION

Response Analysis

A total of 137 and 69 usable responses were received from hardwood lumber manufacturers and distributors, respectively (Table 1). The response rates in the two surveys fall within the range achieved by similar research in the industry; for example similar studies have reported response rates of 9% (Espinoza *et al.* 2011) and 19.8% (Perkins 2009). The total lumber output for sawmills that responded to this survey represented 20% of the industry total (based on figures by Hardwood Market Report 2009). The geographic spread of responding sawmills and distribution firms is shown in Table 2. A great majority of respondents were located in the Northeast and South (65.4% of sawmills and 65.1% of distributors). This spread is consistent with the distribution of hardwood species in the standing stock in the country (74% hardwoods in the Eastern forests and 78% coniferous in the West; Smith *et al.* 2009). However, as a proportion of total respondents in each survey, there was a considerably higher number of sawmills compared to lumber distributors in the Midwest (30.0% *vs.* 13.3%); and a significantly higher number of distribution businesses compared to sawmills in the West (14.5% *vs.* 0.8%).

Table 1. Response Analysis

Response Characteristic	Hardwood Lumber Manufacturers	Hardwood Lumber Distributors
Sample size (count)	1,216	424
Usable responses (count)	137	77
Adjusted response rate (%)	13.9	17.8
Non-response bias assessment result	No significant bias detected	No significant bias detected
Average lumber output/volume (MMBF)	11.8 (2008)	12.8 (2007)

MMBF = million board feet

Table 2. Geographical Distribution of Respondents

Region	Hardwood Lumber Manufacturers Count (%)	Hardwood Lumber Distributors Count (%)
Midwest†	39 (30.0%)	5 (13.3%)
Northeast	29 (22.3%)	14 (26.5%)
South	56 (43.1%)	24 (38.6%)
West†	1 (0.8%)	8 (14.5%)
Multi-region*	5 (3.8%)	9 (7.2%)

† Denotes significant difference at 0.05 (z test of proportions)

Species Distribution of Sales

The species distribution of the respondents' lumber output/volume is listed in Table 3. Table 3 also displays the change in lumber species distribution for the five-year periods of the surveys. Red and white oak were still the most important species in terms of volume, representing 39.4% and 30.2% of sawmill and distributor output/volume in the last year of the survey, respectively. Yellow poplar followed, with 13.2% of sawmill output and 17.9% of distributor sales. Hard and soft maple accounted for 17.7% and 18.2% of output/volume for each group, respectively. A comparison was made between the share of each species

on the mix of both sawmills and distributors in 2008 and 2007, respectively (*t* test, α = 0.05). Significant differences in the volume of lumber by species were found for red oak and yellow-poplar for the sawmills versus the distributors for the last year of the surveys, suggesting differences in the customer base of hardwood lumber manufacturers and distributors. Also, for both groups, considerable decreases were noted in red oak and cherry, and increases for yellow poplar, hickory, and walnut (Table 3). This confirmed previous reports of declining demand for red oak for the period, especially by the kitchen cabinet and the furniture industry sub-segments (FDM 2008; Luppold and Bumgardner 2007). Increases in sales of hard and soft maple (+3.6% and +15.75%, respectively) were only reported by lumber manufacturers, while the share of these two species on distributor sales was almost flat during the reporting period. The share of "other" species has increased for both manufacturers and distributors, suggesting that demand for more product diversity, including imported species, is growing.

Table 3. Species Distribution of Respondents' Lumber Output/Volume (Board Foot Basis)

Species	Hardwood Lumber Manufacturers			Hardwood Lumber Distributors		
	2004	2008	Change 2004-2008	2003	2007	Change 2003-2007
	-- % of production --		-- % --	-- % of sales --		-- % --
Red oak†	27.6	24.7	-10.6	25.1	16.8	-33.1
White oak	15.0	14.7	-2.3	12.4	13.4	+7.7
Yellow-poplar†	11.6	13.2	+14.0	16.9	17.9	+5.7
Hard maple	10.5	10.8	+3.6	9.2	9.1	-0.4
Soft maple	5.9	6.9	+15.7	9.2	9.1	-1.7
Ash	4.5	4.5	+1.9	3.6	6.9	+88.4
Cherry	5.4	4.5	-17.0	6.3	6.1	-2.7
Hickory	3.5	3.9	+11.4	1.6	2.2	+36.7
Black walnut	2.0	2.6	+30.4	1.8	3.4	+88.0
Others*	13.4	14.6	+9.0	13.9	18.4	+32.4

† Denotes significant difference at 0.05 (t-test) for the 2007 and 2008 data
* Includes: birch, gum, basswood, birch, aspen, beech, cypress, alder, elm, and cottonwood

Market Distribution

The distribution of markets as a percent of total lumber output/volume as well as the percent change in market share is shown in Table 4. The market distribution in the last year reported for the study (*e.g.*, 2008 for sawmills and 2007 for distributors) was compared for both groups, and significant differences are indicated in Table 4. The most important manufacturing markets for hardwood sawmills were pallet, flooring, and railroad ties producers, all of which make use of lower grades of hardwood lumber (or ungraded lumber). Lumber distributors and retailers were also among the most important customers for hardwood sawmills with close to 20% of the hardwood lumber volume sold in 2008 by sawmills going to distributors. The most important markets for distributors were cabinet and millwork manufacturers as well as exports, making up a combined 63.7% of their total sales in 2007. Both sawmill and distribution merchants responding to the study indicated a decline in the importance of furniture and cabinet manufacturers as customers, with an increase in sales to flooring, pallets, railroad ties, and other industrial users of hardwood lumber.

Responses from sawmills showed a shift from direct sales to lumber users (secondary manufacturers) to sales heading for lumber distributors, as noted by the large decrease in sales to furniture, cabinet, and millwork manufacturers (-40.7%, -27.7%, and -11.3%, respectively) and increases in sales to distribution yards and retailers (+8.1% and +34.4%, respectively). The double digit decrease in sales to furniture manufacturers is explained in large part by the growing market share of low-cost imported furniture, a phenomenon that started in the 1990s and has continued to this day, resulting in more than 60% of the residential, non-upholstered wood household furniture purchased in the U.S. being manufactured overseas (Buehlmann and Schuler 2009), primarily in China, Vietnam, and Malasysia (Luppold and Bumgardner 2011). Industrial users of hardwood lumber have increased in importance, with sales to pallet and railroad ties manufacturers increasing in the time span reported by both sawmills and distributors (*e.g.*, sales to railroad ties manufacturers increased by 32.7% for sawmills and 103.3% for distributors). Similar to species distribution, sales to "other" markets increased considerably for both samwills and distributors (+122.7% and +23.%, respectively).

Table 4. Market Distribution of Respondents' Lumber Outputs (Board Foot Basis)

Market	Hardwood Lumber Manufacturers			Hardwood Lumber Distributors		
	2004	2008	Change	2003	2007	Change
	-- % of production --		-- % --	-- % of sales --		-- % --
Furniture	11.0	6.5	-40.7	15.33	9.6	-37.3
Cabinets†	9.9	7.1	-27.7	24.97	24.3	-2.5
Millwork†	5.9	5.3	-11.3	24.02	27.3	+13.6
Flooring†	14.0	14.3	+1.9	6.53	8.7	+33.7
Pallet & containers†	22.6	23.2	+2.6	2.02	2.1	+4.8
Exports	7.2	7.0	-3.3	9.37	12.1	+29.0
Railroad ties†	5.6	7.4	+32.7	0.25	0.5	+103.3
Dist. Yards	17.7	19.1	+8.1	n/a	n/a	n/a
Retail	2.2	2.9	+34.4	2.88	4.1	+40.5
Other*	2.9	6.5	+122.7	7.68	9.4	+23.0

† Denotes significant difference between hardwood lumber manufacturers and distributors at 0.05 (t-test)

* Includes: caskets, crane mats, industrial lumber, trailer flooring and pulp for sawmills, frame stock, blocking, and resale logs

Services Provided

Hardwood lumber manufacturers and distributors were asked about the services they offered and the importance of these services to their respective customer bases. Responses to this question are summarized in Table 5. The most common services offered by sawmills were quick delivery, double-end-trimming, and sorting boards according to width. The most common services offered by distributors were quick delivery, S2S (lumber surfaced on two sides, front and back), and break bundles. Quick delivery and just-in-time delivery were offered by most sawmills and distributors, which is consistent with the increasing interest of the wood products industry in implementing lean management principles as reported by previous studies (Fricke and Buehlmann 2012a, b). In general, a significantly ($\alpha = 0.05$) larger proportion of respondents in the lumber distribution business reported offering services such as S2S, S4S (lumber surfaced on 4 sides), break bundles,

environmentally-certified products, custom moulding, and custom flooring (*z* test of proportions), suggesting that diversity of services is an important source of differentiation between hardwood lumber producers and distributors. However, environmentally-certified lumber showed a large increase in importance for both lumber manufacturers and distributors (+196.4% and +262.5%, respectively). As reported by respondents, the volume of all services offered by sawmills and distributors grew, with very few expections (*i.e.*, width sorting for distributors and S2S for sawmills), in importance during the 5-year period of the survey. These results confirm the quest of the industry towards more customization and just-in-time delivery (Luppold 2009).

Table 5. Services Provided by Respondents and Change in Importance over the Last Five Years

Service	Hardwood Lumber Manufacturers		Hardwood Lumber Distributors	
	Services offered in 2008	Change in importance	Services offered in 2007	Change in importance
	-- % of respondents --	-- % --	-- % of respondents --	-- % --
Quick delivery	77.2	+50.7	73.1	+14.0
Double-end trim	71.7	-2.0	60.3	+20.5
Width sorting†	69.6	+47.7	51.3	-28.6
Just-in-time orders	58.7	+57.5	71.8	+9.8
Special grading	56.5	+54.8	62.8	+28.9
Color sorting	56.5	+23.6	59.0	+27.8
S2S†	48.9	-7.0	75.6	+5.4
Break bundles†	31.5	+26.9	71.8	+21.7
S4S†	20.7	+31.1	50.0	+34.5
Certified products†	19.6	+196.4	37.2	+262.5
Custom moulding†	12.0	+25.4	38.5	+100.0
Custom flooring†	12.0	+27.7	29.5	+91.7

† Denotes significant difference in services offered between manufacturers and distributors at 0.05 (z test of proportions)
Change in importance for lumber manufacturers measured by change in customer requests for the service, and for lumber distributors by change in number respondents offering service

Changes in the Customer Base

Respondents were asked about changes in the customer base, specifically about changes in the size of their customer orders and average size of the orders. It was assumed that as the industry moved towards customization and just-in-time delivery, orders were becoming smaller and more diverse (Schuler and Buehlmann 2002; Lihra *et al.* 2008). The results were consistent with this assumption (Table 6), with many sawmills and most

Table 6. Perceptions of Respondents (%) about Change in Order and Customer Size

Response	Order Size		Customer Size	
	Manufacturers	Distributors	Manufacturers	Distributors
	-- % of respondents --			
Decreased	45.4†	75.0†	40.8	47.1
Increased	4.6	11.8	12.3	11.8
About the same	46.2†	13.2†	41.5	39.7
Not sure	3.8	0.0	5.4	1.5

† Denotes significant difference at 0.05 (z test of proportions)

distributors reporting a decrease in average order size (45.4% of sawmills and 75.0% of distributors) and average customer size (40.8% of sawmills and 47.1% of distributors). These results, along with those presented in Table 5, constitute strong evidence of a shift towards more customization in the hardwood lumber industry.

Business Factors

The effect of a number of factors on the respondents business was evaluated using a scale ranging from 1 (anchored by "no effect on business") to 7 (anchored by "major effect on business"). The slowing housing market was the top concern among sawmills and distributors in 2009 (Table 7), which is not surprising given the recession just began as the surveys were conducted. The effect of production costs, including fuel, energy, and labor on respondents business were also rated highly by both lumber manufacturers and distributors. Furthermore, the changing nature of customer demand was rated among the top five business factors of concern by the respondents. Significant differences ($\alpha = 0.05$) were found in how sawmills and distributors rated factors, not only for energy costs but for production, labor costs, imports, and truck/driver availability (t tests).

Table 7. Respondents Perceptions on the Effect of Different Factors on Their Business (1 = No Effect, 7 = Major Effect)

Business Factor	Lumber Manufacturers	Lumber Distributors
Slowing housing market	6.2	6.0
Fuel costs	5.6	5.4
Energy costs for production†	5.2	4.6
Changing customer demand	5.1	4.7
Labor costs†	4.9	4.4
Globalization	4.4	4.4
Increasing lumber imports†	4.4	3.9
Changing raw material base	4.4	3.9
Interest rates	3.8	4.0
Lack of skilled workers	3.3	3.1
Certified hardwood lumber	3.2	3.4
Truck/driver availability†	3.1	3.7
Electronic-Commerce	3.0	3.3
Carrier required backhauls	2.6	2.5
Lumber branding	2.4	2.6

† Denotes significant difference between manufacturers and distributors at 0.05 (t test)

CONCLUSIONS

1. Regarding species distribution, both hardwood lumber manufacturers and distributors reported considerable decreases in the demand for red oak and increases in "other" species. This confirms a shift away from open-grain species reported in previous reports and suggests an increasing demand for more product diversity. For the last year reported, five species (*i.e.*, red oak, white oak, hard maple, soft maple, and yellow poplar) represented 70.3% of the total lumber output for hardwood lumber manufacturers (2008) and 66.3% of lumber distributor sales (2007).

2. The most important markets for hardwood lumber manufacturers in 2008 were pallet and flooring manufacturers and lumber distributors. The most important markets for distributors in 2007 on a board foot basis were cabinet and millwork manufacturers and exports. Both sawmill and distribution participants in the study indicated a decline in the importance of furniture and cabinet manufacturers as customers and an increase in sales for flooring, pallets, railroad ties, and other industrial uses of hardwood lumber. Over the period covered by the study, sawmills increased their sales to lumber intermediaries considerably (by 8.1% to distributors and by 34.3% to retailers), demonstrating the increasing importance of these businesses in the hardwood lumber distribution chain.
3. Results from both surveys show strong evidence of a move in the industry toward providing more and customized services. The most common services offered by both lumber manufacturers and distributors were quick delivery and end trimming. While still not offered by a majority of sawmills and distributors, environmental certification has increased considerably in importance among services provided by both sawmills and distributors.
4. A large proportion of respondents in both the lumber manufacturing and distribution groups reported that orders have become smaller, with a similar trend for the size of their customers. This suggests a shift towards a more fragmented industry and may imply a need for more customization.
5. Major factors for both sawmills and distributors were the slowing housing market and production costs, including fuel, energy, and labor. Changing customer demand was also rated highly among business factors. Electronic commerce, carrier-required backhauls, and lumber branding were rated as having a low effect on respondents' business.

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