

US HARDWOOD LUMBER CONSUMPTION AND INTERNATIONAL TRADE FROM 1991 TO 2014¹

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Abstract. Apparent US hardwood lumber consumption (developed from production, import, and export data) was contrasted with estimated consumption based on employment data and lumber utilization coefficients. The two methods of measuring domestic consumption provided similar results, but the use of employment data allowed for a comparison of appearance lumber vs industrial lumber use. Consumption of both appearance and industrial lumber increased between 1991 and 2000 as imported lumber augmented domestic lumber production. Exports increased during the 1990s but at a lower rate than domestic consumption. Beginning in 2000, consumption of appearance lumber started to decrease because of globalization of the furniture industry followed by a decline in US home construction. The 2008-2009 recession was associated with declines for all segments of domestic consumption and a decline in exports. Domestic consumption of appearance lumber continued at depressed levels until 2012. Exports and industrial consumption increased after 2009. In 2014, industrial users accounted for 51% of domestic lumber consumption, and exports represented 37% of consumption of appearance lumber.

Keywords: Hardwood lumber use, hardwood consumption trends, hardwood industry groupings, appearance-based uses, industrial uses, US hardwood trade.

INTRODUCTION

Hardwood lumber continues to be the major product derived from the higher-value hardwood sawtimber resource. In the current century, hardwood lumber consumption patterns have changed considerably. Many of the changes began in the early 2000s (Luppold and Bumgardner 2008a), driven by changes in the global and US economy. Understanding current and historical consumption of hardwood lumber can help analysts examine the potential effects of market forces on past and future hardwood sawtimber removals.

Hardwood lumber consumption is difficult to measure. Estimates of consumption for individual industries exist for specific years based on survey data (Sinclair et al 1990; Meyer et al 1992; Forbes et al 1993), but these estimates are snapshots. There also are estimates based on information from the Census of Manufacturers (Luppold 1988; Luppold and Bumgardner 2008a), but these are available only every 5 yr and are based on value rather than volume.

In general terms, consumption of any commodity is equal to domestic production, minus exports, plus imports, and the net change in inventories (Labys 1975). Changes in inventories of hardwood lumber are exceedingly difficult to measure because they can occur at the

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mill, in the distribution chain, and at secondary processor levels. An alternative measure of domestic hardwood lumber consumption is “apparent” consumption, which can be developed by adding imports to domestic production and subtracting exports. Another useful measure is total domestic consumption plus exports, which is consumption by all domestic uses plus the amount exported. Domestic consumption plus exports is of particular interest to domestic hardwood lumber distributors and can be developed from apparent or estimated hardwood lumber consumption.

US hardwood lumber production was estimated by the US Department of Commerce, Census Bureau (USDC) as early as 1947 (USDC 1952). Analysis by Cardellichio and Binkley (1984) found that estimates of hardwood lumber production by USDC were considerably lower than their corresponding estimates of hardwood lumber consumption. A reexamination of USDC estimates by Luppold and Dempsey (1994) confirmed that Cardellichio and Binkley’s (1984) conclusions were valid; therefore, hardwood lumber production was reestimated (Luppold and Dempsey 1994). Continued discrepancies in USDC data, although smaller than for previous decades, led Luppold and Bumgardner (2008c) to provide an updated series of hardwood lumber production estimates from 1963 to 2005. In 2012, the USDC discontinued Current Industrial Reports, Lumber Production and Mill Stocks; the last reported year was 2010.

In contrast to domestic consumption or production data for hardwood lumber, accurate international hardwood lumber trade data are easily accessible after 1991 (Luppold 1995). International trade data are initially collected by the US Customs Service and compiled by the US Census Bureau, Foreign Trade Division and are available from a variety of sources including the US Department of Agriculture (USDA), Foreign Agricultural Service (USDA 2015).

This study first examined apparent US hardwood lumber consumption from 1991 through 2010 (the last year for which data were published by USDC, as previously mentioned). Sec-

ond, yearly estimates of domestic hardwood lumber consumption were developed by using data reported in the work of Luppold and Bumgardner (2008a) and methods presented in the work of Luppold and Bumgardner (2008b) in combination with the US Department of Labor (USDL) employment and productivity data. Then, these estimates were compared with apparent consumption, and estimated consumption was divided among major hardwood consumption groups. The last objective of this study was to examine the role of hardwood lumber imports in domestic consumption and compare domestic consumption with exports.

METHODS

Apparent Consumption

Apparent US hardwood lumber consumption was based on estimates of eastern US hardwood lumber production as presented in the work of Luppold and Bumgardner (2008b) and extended to 2006 through 2008 by using procedures discussed in that study and USDC (1995-2009). Official USDC estimates of eastern hardwood lumber production for 2009 and 2010 excluded estimates for eastern hardwood lumber production not specified by kind (n.s.k.), which accounted for production in smaller mills that were not sampled but that were known or assumed to exist (USDC 2010, 2011). However, estimates of eastern hardwood lumber production for 2008 were provided with and without the n.s.k. category. When the n.s.k. category was excluded, 2008 production was 32% lower than initial estimates reported in USDC (1995-2009). Because the official estimates for 2009 and 2010 were low as the n.s.k. category was not counted, alternative production estimates were calculated based on the percentage change from the revised estimates for 2009 and 2010, and the original 2008 estimate was adjusted upward using procedures from the work of Luppold and Bumgardner (2008c).

In addition to the eastern US production, western US hardwood lumber production was included in the development of apparent consumption to estimate national consumption. Unlike eastern production, western production estimates by

USDC appeared to be accurate, primarily because of the larger size of western hardwood sawmills. Census estimates of western production as reported in Current Industrial Reports, Lumber Production and Mill Stocks data from 1993 to 2010 were added to the Luppold and Bumgardner's (2008c) eastern production estimates. The beginning year of 1991 was selected because this was the first year that reliable export data were again available after resolution of a series of data issues, which were most acute during the mid- and late-1980s (Luppold 1995).

Estimated Consumption

Employment and productivity data were used to develop estimated consumption. Luppold and Bumgardner (2008a) provided consumption estimates for 10 different industry groups. Under the North America Industrial Classification System (NAICS) adopted in 1990; USDL employment data were directly available for only six of these groups: millwork, which has combined millwork and flooring since 1990 (NAICS 321910), pallets and containers (NAICS 321920), kitchen cabinets (NAICS 337110), upholstered household furniture (NAICS 337121), nonupholstered wood household furniture (NAICS 337122), and office and institutional furniture (sum of NAICS 337127 and 337212). Other hardwood building products were assumed to be associated with all other plywood and engineered wood products (NAICS 321214), and miscellaneous wood products were included in all other product manufacturing (NAICS 321990). These two groups are used as proxies for employment in these two categories. Crosstie production is included in the category sawmills and wood preservation (NAICS 321100). Because crosstie production has remained fairly constant since 2006 and crosstie treaters are a relatively small portion of NAICS 321100, it was decided to use Johnson's (2015, unpublished data) estimates of lumber use in crossties. This estimate is based on the statistics developed by the Railroad Tie Association.

Domestic consumption was estimated for the eight NAICS groupings by multiplying estimates of wood consumption from employment data as

reported by USDL (2015a), adjusted for labor productivity, times employment (USDL 2015b):

$$\text{Estimated domestic consumption in year } j (EC_j) = \sum CC_{ij}E_{ij}$$

where CC_{ij} is the consumption coefficient for NAICS code i ($i = 1-8$) in year j ($j = 1992-2014$) and E_{ij} is employment in NAICS code i in year j adjusted for productivity. The consumption coefficients were developed through a three-step process. The first step was to develop employment adjusted for the productivity vector for each NAICS code by multiplying employment data for a specific code (reported in thousands of employees) by the annual productivity index ($2007 = 100$) for that code divided by 100. The second step was to develop a consumption coefficient for the NAICS codes for 1992, 1997, and 2002 by dividing lumber consumption estimates for those years reported in the work of Luppold and Bumgardner (2008a) by the corresponding productivity-adjusted employment estimates for those years. Estimates of hardwood lumber consumption for 2007 and 2012 were developed using the procedure discussed in the work of Luppold and Bumgardner (2008b), and consumption coefficients for that year were developed by dividing those volumes by the corresponding estimate of employment adjusted for productivity.

The resulting coefficients (consumption adjusted for labor productivity) for 1992, 1997, 2002, 2007, and 2012 are shown in Table 1. The coefficient for 1991 was assumed to be the same as 1992, and the coefficients for 2013 and 2014 were assumed to be the same as 2012. Coefficients for the intervening years between the 5-yr periods shown in Table 1 were developed in a stepwise manner by first finding the difference between two 5-yr periods, then dividing this difference by five, and incrementally adding the results to each subsequent year.

RESULTS AND DISCUSSION

Changes in Apparent Consumption

Apparent hardwood lumber consumption (Fig 1) grew by 21% (5.2 million m^3) between 1991

Table 1. Wood consumption coefficients by the North America Industrial Classification System (NAICS) group (in thousand m³ consumed per thousand employees, adjusted for productivity) and classification of these groups.

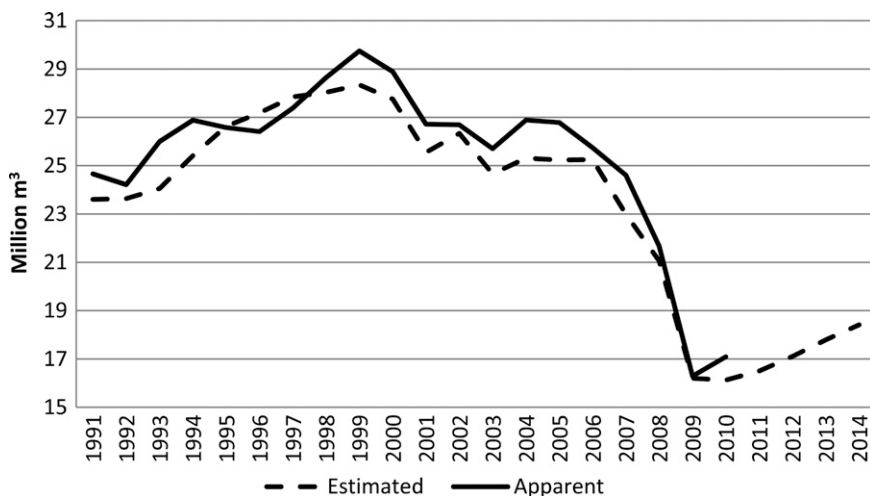
Industry	NAICS code	1992	1997	2002	2007	2012	Classification
Other building products	321214	22.18	24.10	23.67	13.69	10.12	Other
Millwork and flooring	321910	32.71	41.70	39.22	29.55	34.81	Appearance
Pallets and containers	321920	215.09	229.58	186.63	147.43	124.21	Industrial
Miscellaneous wood products	321990	30.56	17.02	14.28	17.06	30.54	Other
Kitchen cabinets	337110	29.92	31.67	24.05	16.85	17.18	Appearance
Upholstered furniture	337121	27.21	17.91	13.43	5.52	2.88	Appearance
Nonupholstered wood furniture	337122	31.58	29.59	25.42	21.55	12.18	Appearance
Office and institutional furniture	337127 and 337212	17.63	17.06	10.36	7.84	10.57	Appearance

and 1999 before decreasing by 45% (13.5 million m³) between 1999 and 2009. The size of this decrease is noteworthy. It is almost equal to the total national hardwood production in 1957 (13.7 million m³) (USDC 1961). The decline in US consumption was the result of three market shocks.

The first shock was the loss of the domestic wood household furniture industry to international competition (Luppold and Bumgardner 2011). As a result, this dominant user of lumber graded for appearance attributes (appearance lumber) decreased consumption sharply (Luppold et al 2014). The impact of the furniture industry's decreased consumption of appearance lumber was counteracted by an increase in lumber consumption by the millwork industry (which includes

hardwood flooring) and the kitchen cabinet industry. Additionally, an increase in home construction between 2001 and 2006 muted the downward trend in hardwood lumber consumption during this period.

The second shock affecting domestic hardwood lumber consumption was a decline in home construction starting in mid-2006, which was quickly followed by the third shock, the economic recession from December 2007 to June 2009. Apparent domestic hardwood lumber consumption and production dropped by more than 9.4 million m³ between 2006 and 2009. Previously, the largest decline in hardwood lumber production in the last 50 yr was 3.5 million m³ between 1973 and 1975. Although initial decreases in hardwood lumber consumption after 2006 could be linked to the

Figure 1. Apparent domestic consumption of hardwood lumber (1991-2010) and estimated domestic consumption of hardwood lumber (1991-2014), in million m³.

decline in home construction and the continued lower levels of furniture production, data indicated that employment in all major hardwood-consuming industries other than crossties declined in 2008 and 2009.

Changes in Estimated Domestic Consumption

Figure 1 shows estimated domestic consumption relative to apparent consumption for 1991 through 2010. Estimated consumption was then extended to 2014. Apparent and estimated consumption values were highly correlated ($r = 0.98$). This high correlation both statistically and technically increased the likelihood that an analysis of the major components of estimated consumption was valid. For most years, apparent consumption was greater than estimated consumption. Both apparent and estimated consumption for the period 2000-2011 were greater than or similar to consumption estimates developed by industry sources (Johnson 2015, unpublished data). However, estimated domestic consumption here includes consumption groups not directly counted by Johnson (2015, unpublished data).

The hardwood-lumber-consuming industries examined in the work of Luppold and Bumgardner (2008a) can be broadly classified as appearance,

industrial, or other. Although some industrial products may be exported, the imputed prices of exported items as reported by USDA (2015) were considerably higher than domestic industrial products during the period examined. The appearance lumber classification includes most industries that consume graded hardwood lumber (listed in Table 1). Industrial users include the pallet and container industry (listed in Table 1) and crossties. The “other” classification consists of other building and miscellaneous products. Some of these “other” products contain higher-value sawn hardwood materials such as handle blanks, staves, and laminated architectural beams, but these categories as a group are too heterogeneous to classify as appearance or industrial. The volume of hardwood lumber consumed by appearance, industrial, and other users between 1991 and 2014 is given in Fig 2.

In 1991, estimated domestic consumption was 23.6 million m^3 : 48% was for appearance-based products, 40% was industrial, and the remainder was consumed in other products (Table 2). Between 1991 and 1999, estimated consumption increased by 4.7 million m^3 (20%), which equaled the increase in apparent lumber consumption (Fig 1). During this period, growth in consumption of appearance lumber in industries other than wood household furniture increased the

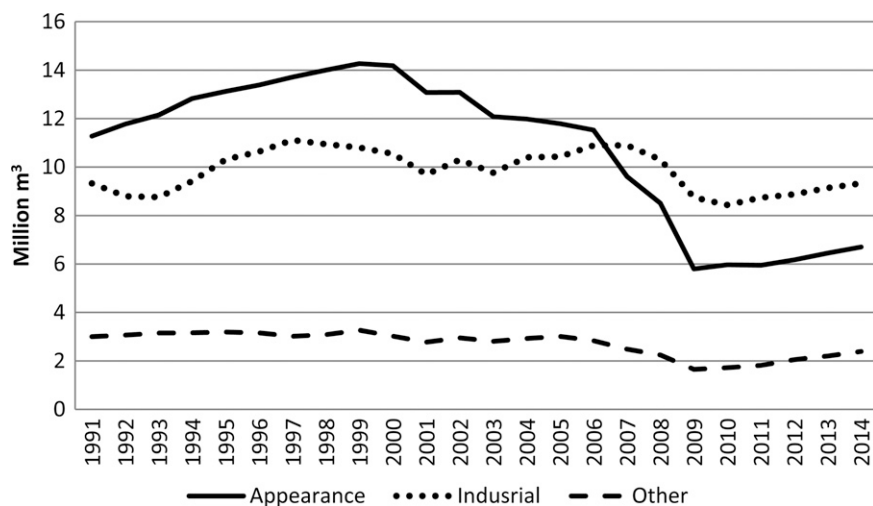


Figure 2. Hardwood lumber consumption for appearance, industrial, and other groupings 1991-2014, in million m^3 .

Table 2. Estimated domestic hardwood lumber consumption and the percentage of this consumption by major consumption groupings.

Year	Domestic consumption (thousand m ³)	Proportional appearance consumption	Proportional industrial consumption	Proportional other consumption
		Percentage ^a		
1991	23,602	48	40	13
1999	28,346	50	38	12
2002 ^b	26,335	50	39	11
2006	25,254	46	43	11
2009	16,199	36	54	10
2014	18,415	36	51	13

^a Percentages may not add to 100 by year because of rounding error.

proportion of lumber used by appearance-lumber-consuming industries to 50%.

Despite the steep decline in total hardwood lumber consumption, proportional consumption within the three categories remained fairly constant between 2000 and 2002 (Table 2). After 2002, the share of consumption for appearance-based uses started to decrease, and all of this decrease was initially attributable to decreased consumption by the furniture industries (especially the wood household furniture industry). In contrast, industrial consumption increased between 2002 and 2006 as overall consumption remained nearly constant. By 2006, proportional appearance-based consumption had declined to 46%, whereas proportional industrial consumption had increased to 43%.

Appearance-based consumption declined steeply between 2006 and 2009, whereas industrial consumption remained relatively constant in 2006 and 2007 before declining in 2008 and 2009 (Fig 2). Consumption for the other hardwood products category also began a decline in 2006 that lasted through 2009. As a result of these changes, the proportion of hardwood lumber consumed by industrial uses climbed to 54% in 2009, whereas the proportion consumed by appearance and other consumers declined to 36% and 10%, respectively (Table 2). Estimated hardwood lumber consumption by appearance users remained at low levels between 2009 and 2011 before tracking upward starting in 2012.

Hardwood Lumber Imports and Exports

Imports. Since 1995, the United States has been a major exporter of hardwood lumber and, at times, also one of the top five importers of hardwood lumber (Luppold and Bumgardner 2015). In 1991, the United States exported 2082 thousand m³ and imported 496 thousand m³ for roughly a ratio of 4.2 to 1.0. The change in hardwood lumber exports relative to imports is shown in terms of indices (1991 = 100) in Fig 3.

Imports of hardwood lumber increased between 1991 and 2000 by nearly 240% or 1180 thousand m³ (USDA 2015). This volume represents nearly 28% of the increase in apparent demand during this period. The greatest part (80%) of this increase was imports of temperate species from Canada, and imports from South America accounted for another 8% of this increase. In 2000, shipments from Canada accounted for 72% of imports of hardwood lumber by the United States. More than half of these shipments (53%) were low-value cottonwood/aspen (*Populus*) species (USDA 2015), which are typically used in industrial and other applications rather than appearance applications. For example, the average price of these products was \$116/m³ (cost, insurance, and freight) for rough and dressed lumber (poplar, aspen, and cottonwood, excluding yellow poplar). The remainder of the shipments appeared to be lumber for appearance applications, with an average value of \$329/m³.

Although impossible to quantify, some of the lumber imported from Canada could have been processed from logs originating in the United States. Logs that originated in Canada also could have been processed in the United States. In addition, there is a high probability that some of the lumber imported into the United States was originally purchased from US mills in green form by Canadian distributors, kiln-dried or otherwise processed, and then resold to US customers. The unique relationship between the United States and Canadian hardwood lumber industries perhaps is best explained by the fact that mills in both countries belong to the National Hardwood Lumber Association. This

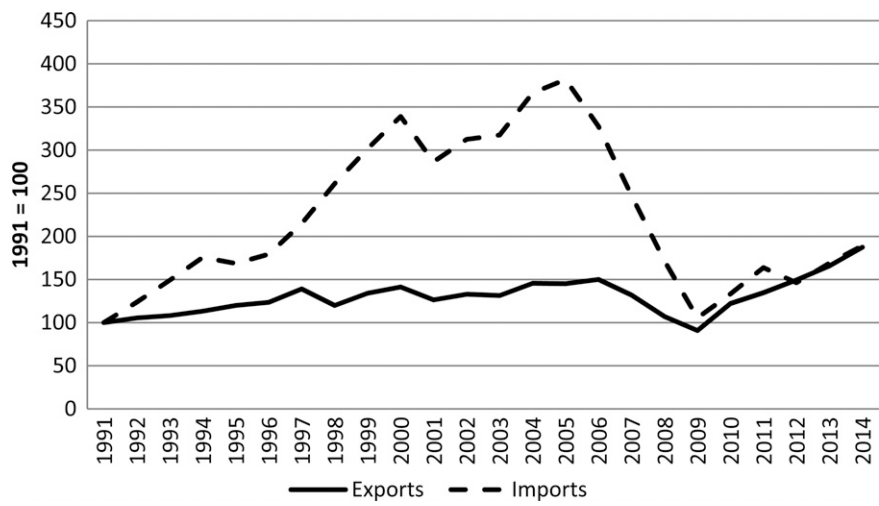


Figure 3. Index of hardwood lumber exports and imports 1991-2014 (Data for 2014 imports were adjusted for apparent errors in volume of lumber imported from Bolivia. Between 2013 and 2014, lumber imports from Bolivia increased by 4000% and the average unit value was \$39/m³. Volume for Bolivia was reestimated by dividing unit value in 2013 into value of exports in 2014. Source of original data was USDA [2015]).

association establishes hardwood lumber grading rules and arbitrates in trade disputes regarding these rules.

Between 2000 and 2006, hardwood lumber imports fluctuated but remained high (Fig 3) even as domestic consumption trended downward. During this period, imports from Canada declined and imports from South America, especially from Brazil, increased. In 2005, imports peaked at 1895 thousand m³ and represented 7.1% of apparent domestic consumption. Between 2006 and 2009, total imports declined by 68% and imports from Canada declined by 74%. During the same period, total apparent consumption declined by 37% and estimated consumption of lumber for appearance-based uses declined by 50%. During the same period, imports from Canada declined by 74%. Since 2009, hardwood lumber imports have increased at the same rate as exports but exports are again about four times higher than imports (Table 3).

Exports. Hardwood lumber exports started to emerge as a major market for hardwood lumber after the adoption of the floating exchange rates in the early 1970s and have grown to be an important market for US lumber (Luppold and

Bumgardner 2013). In 1991, exports were 8% of estimated domestic consumption plus exports (Table 3). Assuming that exports are primarily appearance-based lumber, the percentage of exports of appearance consumption plus exports was 16% in 1991. Between 1991 and 1999, exports increased but so did domestic production; therefore, the relationship between exports and domestic consumption was nearly constant.

Between 1999 and 2002, exports remained stable, whereas estimated domestic consumption declined by 2011 thousand m³, resulting in a small increase in the percentage of domestic

Table 3. Hardwood lumber exports, exports relative to imports, exports relative to total estimated lumber consumption plus exports, and exports relative to total estimated appearance-based lumber consumption plus exports.

Year	US hardwood lumber exports (thousand m ³)	Ratio of export to import volume	Proportion of exports to total estimated consumption plus exports	Proportion of exports to appearance consumption plus exports
			Percentage	
1991	2082	4.2	8	16
1999	2792	1.9	9	16
2002	2766	1.8	10	17
2006	3122	1.9	11	21
2009	1890	3.6	10	25
2014	3901	4.2	17	37

consumption plus exports attributable to exports (Table 3). Between 2002 and 2006, the proportion of total consumption attributable to exports increased to 11%. However, because the consumption of appearance lumber decreased and the demand for industrial lumber and exports increased, the proportion of exports relative to appearance consumption plus exports rose to 21%. The decline in hardwood lumber consumption between 2006 and 2009 reached across all sectors but affected domestic demand for appearance-based material the most. Exports retracted to 10% of total consumption but increased to 25% of appearance consumption plus exports.

The economic recovery that occurred after the 2009 recession had little initial impact on estimated consumption, and by 2014, total hardwood lumber consumption had increased by 2.2 million m³ (15%). In contrast, exports more than doubled during this period, causing the proportion of exports relative to total consumption plus exports to increase to 17% and the proportion of exports relative to appearance consumption plus exports to increase to 37%. Still, even the 37% figure underrepresents the importance of exports in the markets for higher grades of hardwood lumber; exports account for an even larger share of the higher grades (grades: No. 1 Common, 1Face, Selects, and Firsts and Seconds). More importantly, although consumption of hardwood products for home construction (combined millwork and kitchen cabinet consumption) was still greater than exports in 2014, exports were the largest individual market for appearance-based hardwood lumber that year.

SUMMARY AND CONCLUSIONS

Since 1991, US hardwood lumber consumption has varied considerably. During the 1990s, estimated domestic hardwood lumber consumption and exports grew by 20% and 34%, respectively, sustained by a 4.8 million m³ (19%) increase in domestic production and a 1.0 million m³ (200%) increase in hardwood lumber imports. The growth in domestic demand occurred in both appearance and industrial applications.

Apparent and estimated hardwood lumber consumption peaked in 1999 and then started to decline. This decline occurred as the result of three changes in the market. After apparently augmenting domestic production with imported furniture, the US furniture industry started to move offshore in earnest after 2000 (Luppold and Bumgardner 2011). The decline in domestic hardwood lumber consumption was initially offset by increased consumption of lumber by users associated with the housing industry, but once housing construction started to rapidly decline after 2006, consumption of lumber for appearance applications dropped abruptly. Although industrial lumber consumption was not as apparently affected by the decline in the housing market, it was affected by the great recession, which began in 2008. In 2009, estimated domestic hardwood lumber consumption was 16.2 million m³, a 43% decline from 1999 levels.

International trade of hardwood lumber by the United States also changed during the 2000-2009 period. After increasing in the previous decade, hardwood lumber imports continued at high levels, hitting a high point in 2005, but declined sharply after 2006. Exports also fluctuated during this period but were strong relative to domestic demand for appearance lumber. Proportional consumption of exports relative to appearance lumber plus exports increased from 16% in 1999 to 25% in 2009.

Industrial demand for hardwood lumber started to return to prerecession levels beginning in 2009, but demand for appearance lumber remained at low levels. In contrast, exports doubled between 2009 and 2014. As a result of the divergent patterns of domestic consumption of appearance lumber and exports, the proportion of exports relative to appearance consumption plus exports increased to 37% in 2014. This proportion for exports probably was even higher if considering only the higher grades (No. 1 Common and Better) of appearance-based lumber.

The hardwood market that existed between 2006 and 2014 is an anomaly compared with the market conditions that can be documented at any

previous time in the last 50 yr. In 2014, industrial users accounted for 51% of domestic consumption, whereas appearance consumers accounted for 36%; other users accounted for the remaining volume. In the years before 2006, industrial users remained at or below 43% of domestic consumption. The extent to which the market might return to a more historical pattern in the near-term depends largely on construction-related markets (including remodeling) in North America and continued strength in global demand for US hardwoods.

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