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The Global Position of the U.S. Forest Products Industry

Jeffrey P. Prestemon, David N. Wear, and Michaela O. Foster

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Cover: Oriented strand board (OSB) modified with map of the world. OSB photo courtesy of Wikipedia.

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KEY FINDINGS

1. The U.S. share of global wood products output peaked in 1998 at about 28 percent, declined to about 24 percent in 2006, and then fell with the 2007–2009 recession to an unprecedented low of about 17 percent, where it remained through 2013.

2. A combination of cyclical and long-term trend factors largely drove the decline in share observed since the late 1990s.

3. The paper sector is strongly linked to the manufacturing sector: U.S. paper and paperboard production and manufacturing activity both peaked in 1998 and have since trended downward. In addition, the composition of U.S. manufacturing has recently shifted away from sectors that utilize more consumer packaging per unit of output.

4. Paper demands for writing, newsprint, and advertising have declined precipitously since 2000, as electronic media have partially supplanted paper media.

5. Technology has influenced solidwood product composition, with particleboard and other engineered wood products (e.g., glulam beams and I-joists), allowing a shift toward utilization of smaller trees, particularly trees grown in plantations.

6. Housing construction defines the strongest demand for solidwood products, and its most recent fluctuations reveal its effect on the U.S. global share of industrial roundwood production. Between 2007 and 2009, housing starts fell to their lowest levels since World War II. By 2013, housing starts had still not returned to previous, post-war levels. U.S. construction, heavily reliant on wood products, was affected more than most other countries' construction sectors, and this largely explains the record low U.S. market share in forest products.

7. Ongoing population growth combined with economic growth should raise demands for housing construction, and a return to start levels approximating the 1960 to 2000 average (1.5 million per year) would likely bring the U.S. share of global wood products markets to prerecession levels (in the range of 22–24 percent). However, long-term trends in the paper sector and in technology indicate downward pressure on this share over the long run.

8. Long-term trends in paper use, trade, and U.S. manufacturing activity indicate that market share in the foreseeable future is unlikely to return to the peak levels (28 percent) observed in the late 1990s.

9. While domestic economic activity dominates U.S. forest product output, global markets are increasing in importance. Most notably, growth in manufacturing output in China has shifted paper and paperboard production toward Asia.

KEY UNKNOWNS

1. Wood products market futures over the next 10 years will depend not only on the level of housing demands but also on the composition of new housing (single versus multi-unit). Potential effects of altered income distribution on housing demand are unclear.

2. Tightening resource supplies outside of the United States and especially in Asia might increase U.S. comparative advantage in the long run, based on its sustainable plantation production model.

3. Unknown effects of inventory/supply shocks (related to the mountain pine beetle epidemic) in Canada, a dominant source of U.S. imports, could potentially increase demand for U.S. production.

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The Global Position of the U.S. Forest Products Industry

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Abstract

The United States' share of global industrial roundwood production has declined since the 1990s. We reviewed data from 1961-2013 to evaluate the extent of this decline for industrial roundwood and derived secondary forest products compared to other major producing countries. We find that the U.S. global share of industrial roundwood peaked at 28 percent in 1999 but then declined to 17 percent by 2012. We attribute the decline to a combination of cyclical factors, most notably the decline in U.S. construction, and long-term decline in U.S. paper manufacture that is connected to a reduction in the size of the U.S. manufacturing sector and waning demand for paper used in media. Prospects are for increased use of wood in construction as the housing market returns to long-run averages in the coming years, which should push the U.S. share to over 20 percent. However, the use of wood by the paper sector is not likely to experience a significant recovery, implying that it is unlikely that the United States will return to its 1990s levels of global market share in industrial roundwood production. Timber demands—not timber supplies—currently limit production growth in the United States. Increased wood demand by the construction sector might occur with changes in building codes, allowing for taller and larger wood-frame construction. The growth in wood use by the energy sector is another emerging prospect.

Keywords: Forest sector, industrial roundwood, market share, timber products.

INTRODUCTION

Forests and forest products have long represented a substantial resource endowment in the United States. The United States has long been among the top consuming countries for industrial roundwood on a per capita basis (1.39 m^3/person in 2006, 0.99 in 2012) (Food and Agricultural Organization of the United Nations 2014a, U.S. Census Bureau 2014a, 2014b, 2014c). The Nation consumes and produces (aggregated across product categories) more forest products than any other country. However, the size and organization of the forest products industry has changed over the past decade, reflecting multiple cyclical and long-term phenomena occurring domestically and internationally. Decisionmakers in both the public and private sectors want to know what these phenomena are and how they might shape future development of the sector. For this reason, this paper examines the long-term and the most recent changes in the sector and identifies the underlying forces for the changes, including developments in policies, programs, technologies, and consumer preferences. The analysis therefore provides an explanation for why the U.S. forest products sector's global position has changed and offers insights into how it might change in the future.

Solidwood products and pulp and paper make up the vast majority of the U.S. forest products sector, and both have been affected by a combination of trends and cyclical factors. The solidwood products sector serves demands from manufacturing, housing upkeep and repair, and most strongly, new construction. Paper and paperboard output is strongly correlated with manufacturing output in the United States. Fluctuations in both the manufacturing and the housing sectors over the past decade (cyclical effects) have affected markets for U.S. forest products, especially during the recent recession, which ran from the fourth quarter of 2007 to the second quarter of 2009 (National Bureau of Economic Research 2015). However, underlying these fluctuations are longer term trends attributable to technology change and shifts in consumer preferences. Beyond these domestic demands for forest products, changes in the distribution of economic activity around the globe hold implications for the forest products sector.

DOMESTIC MARKETS

First, we examine how consumption, production, and net trade of U.S. forest products have changed between 1961 and 2013 (our most recent data). For continuity with later discussions of international markets, we utilize international definitions of products and units.

Industrial Roundwood

Industrial roundwood is the primary wood product that feeds the solidwood product and the pulp and paper sector. Consumption and production of industrial roundwood provides an overall picture of total size of the sector in terms of fiber volume. Volumes and values of secondary products (e.g., pulp, paper, lumber, and panels) and tertiary or final product categories (e.g., furniture, books, packaging components of consumer products) are

not added to these figures because they would represent double-counting. We expand the discussion to examine trends in secondary products in the next section.

Consumption—The United States exhibited a steady expansion in the consumption of industrial roundwood from 1965 to 2005, with only slight dips in output associated with economic downturns (fig. 1). This growth aligned with a growth in production of manufactured goods in the United States, which demands paper, especially for packaging. But this growth ceased in 1999 and has since dropped along with the U.S. manufacturing sector (fig. 2). Consumption growth also aligned with growth in the U.S. population, which needed wood to build residences and businesses (figs. 3 and 4). The recession of 2007–2009, which was led by a strong contraction of the housing market, brought roundwood consumption in the United States to its lowest level since the early 1960s. In per capita terms, consumption levels had dropped 40 percent by 2007, from 1.46 to 0.88 m^3/person/yr, compared to average levels sustained from 1990 through 2007 (fig. 5). The slow recovery in housing starts has had no apparent effect on this rate.

Production—Industrial roundwood production growth strongly paralleled expansion in consumption from 1961 through 1990, and total production was roughly 95 percent of total consumption over this time span (fig. 1). From the early 1990s to 2005, consumption growth was fed by rapidly expanding imports of industrial roundwood; thus, consumption began to expand at a greater rate than production. Production fell substantially with the recession and housing market contraction, and some production recovery has occurred since 2009. Production declines also align with the shrinkage in consumption and production of paper in the United States. These declines are generally attributable to a shrinking manufacturing sector and the emergence of electronic media, and reflected in the closure of 98 paper mills in the United States between 1998 and 2003 (American Forest and Paper Association 2007).

Trade—Imports of industrial roundwood averaged 34 million m^3 from 1965 to 1997 (Howard and Westby 2013). The housing market expansion from 1998 through 2007 required import quantities that were more than triple that number, up to 118 million m^3. Since 2007, imports have declined to near parity with exports. The housing market contraction in the United States from 2006 to 2009 corresponded with an import contraction, particularly in wood products from Canada, the largest foreign supplier. So, although current domestic U.S. production and consumption are at quantities not observed since before 1965, the gap between imports and exports had shrunk by 2011 to its lowest level since before 1965. Between 2005 and 2011, imports declined by 57 percent, and exports increased by 27 percent. In other words, the United States, which in 2011 produced 314 million m^3 and consumed 326 million m^3 of industrial roundwood, was within 12 million m^3 of balanced trade (roughly equivalent to 3 percent of production in roundwood).

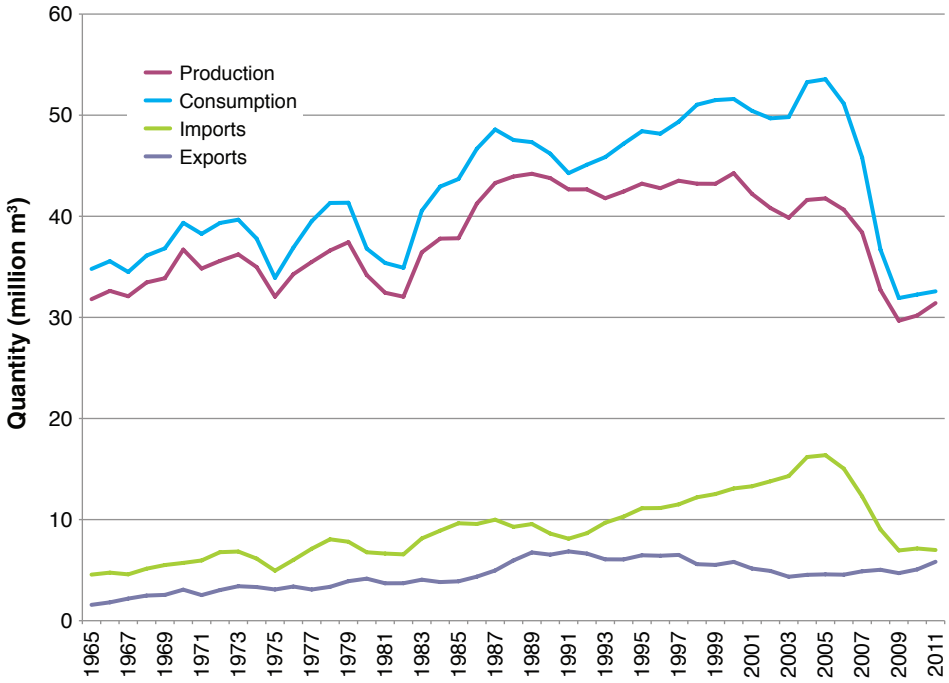

Figure 1—Production, consumption, imports, and exports of roundwood-equivalent timber products (million m^3) in the United States, 1965-2011 (Source: Howard and Westby 2013).

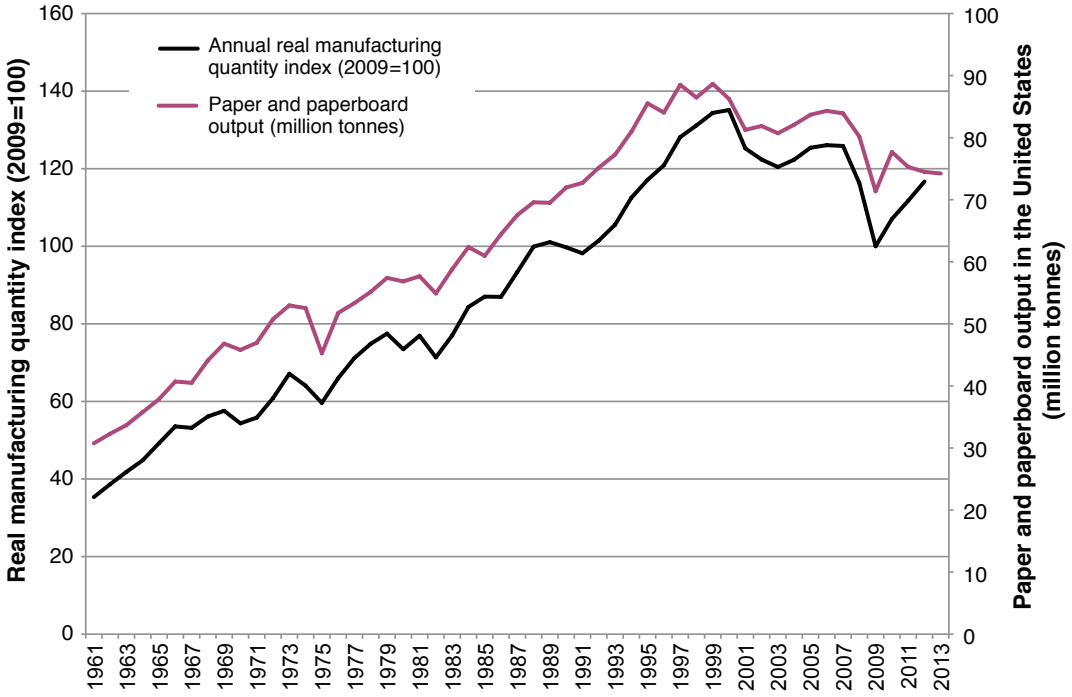

Figure 2—Real manufacturing output quantity index (2009=100), 1961-2012, and paper and paperboard output (million tonnes) 1961-2013 (Sources: Food and Agricultural Organization of the United Nations 2014a, U.S. Department of Commerce 2014a, 2014b).

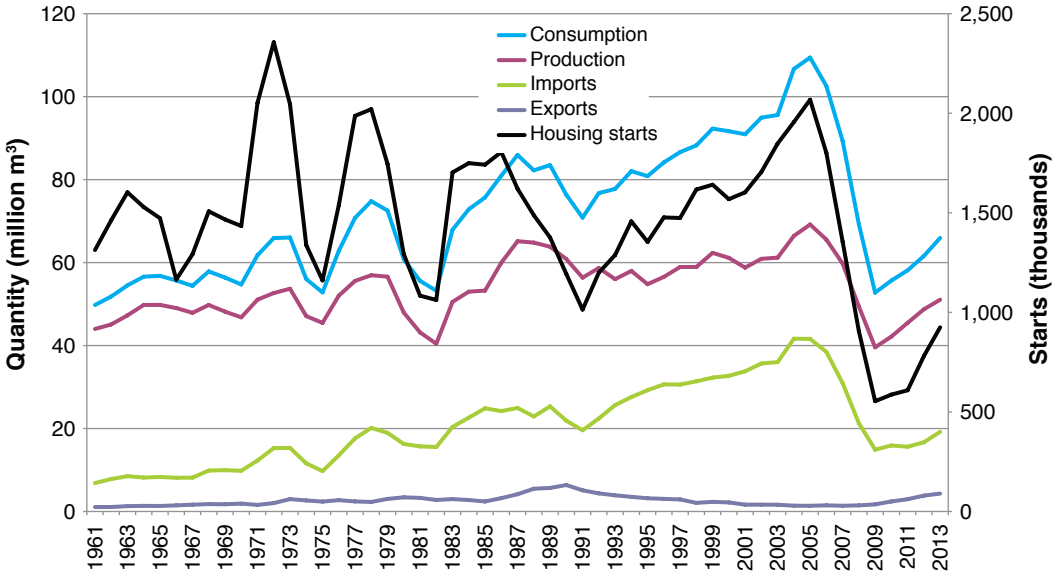

Figure 3—Housing starts and the consumption, production, imports, and exports of coniferous sawnwood (million m³) in the United States, 1961-2013 (Sources: Food and Agricultural Organization of the United Nations 2014a, U.S. Census Bureau 2014d).

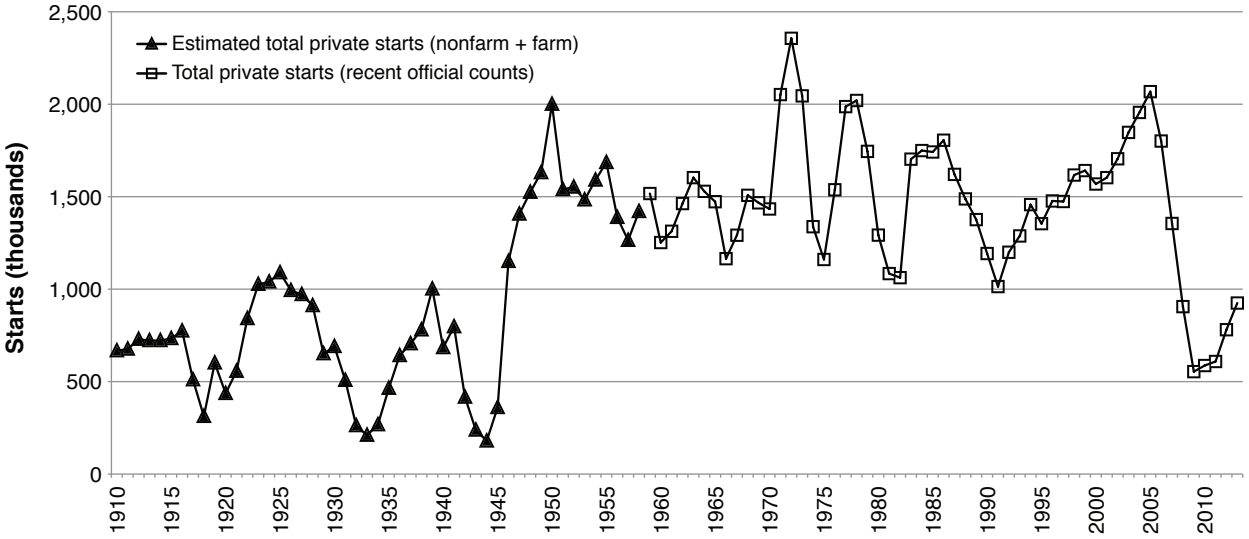

Figure 4—Total United States housing starts, 1910-2013 (Sources: 1910-1958: Siskind 1979, p. 16; 1959-2013: U.S. Census Bureau 2014d).

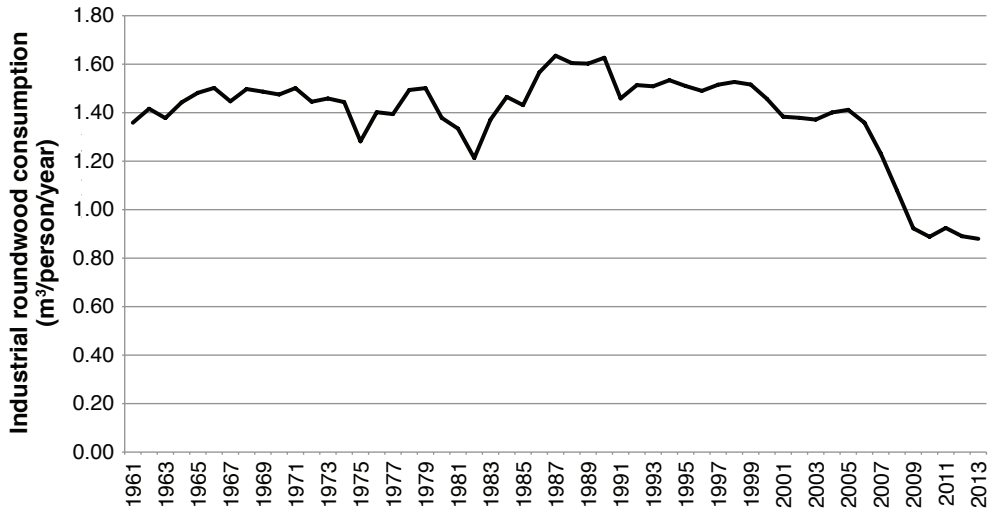

Figure 5—Annual consumption per capita of industrial roundwood in the United States, 1961-2013 (Sources: Food and Agricultural Organization of the United Nations 2014a, U.S. Census Bureau 2014a, 2014b, 2014c).

Derivative Industrial Forest Products

Industrial roundwood is used to make a variety of secondary forest products, especially lumber, panels, and paper. Understanding variations and the most recent decline in industrial roundwood production in the United States requires insights into the factors affecting the production and consumption of these secondary products. Solidwood products generally follow the construction industry and paper the manufacturing industry, and long-term trends or more permanent shifts in markets for these products affect the long-run future for timber production.

Coniferous sawnwood—Consistent with the historical fluctuations in consumption, production, and imports linked to the construction sector in the United States (fig. 3), the most recent recovery of the U.S. housing market is pulling all of these variables higher. As of 2013, coniferous sawnwood production had increased by 10 million m^3, or 25 percent, from its 2009 nadir. The housing market expansion up to 2006 induced a decline in exports and a rise in the rate of domestic wood consumption. However, as the housing market contracted, exports increased. Between 2007 and 2013, the quantity of exports of coniferous sawnwood increased by 193 percent, from 1.47 to 4.31 million m^3. Imports, especially from Canada, play a strong role in U.S. markets for coniferous sawnwood. Up until the early 1990s, imports made up about 25 percent of consumption, but subsequent consumption growth, including the housing boom of the early 2000s, was provided by expanded imports, reaching as high as 29 percent in 2005. The growth in import market share coincided with the withdrawal of most Federal timber from the market beginning in 1992.

Nonconiferous sawnwood—Because much nonconiferous sawnwood is used to make furniture, flooring, cabinets, and other interior products for new houses, markets for these products also followed trends similar to the housing market (fig. 6). However, total production and consumption of this wood product category peaked in 1999, at 30.2 million and 29.0 million m^3, respectively, 6 years before the previous housing cycle peak. This pre-recession peak is partly explained by the offshoring of the hardwood furniture sector during the 1990s and early 2000s, especially to China, Viet Nam, and other Asian destinations (Schuler and Lawser 2007). Exports in nonconiferous sawnwood have exceeded imports for over three decades and are now at record levels. Production and consumption have increased since the most recent recession to levels observed before 1990, and they continue to rise. The positive net trade position is partly attributable to the offshoring of the furniture sector, as Asian importers, in particular, demand U.S. hardwood to make many furniture products that are subsequently marketed in the United States (Luppold and Bumgardner 2013, 2014).

Plywood—Plywood production and consumption in the United States peaked in the late 1980s (fig. 7), and cycles in production are correlated with housing construction. The United States has been a net importer of plywood, mainly from Canada; the most recent housing cycle greatly increased the level of imports, and since 2000, the United States has become even more dependent on imports. Although plywood production and consumption levels have recovered since 2009, the recovery is weak, and it reveals the effects of the oriented strand board (OSB) industry, which emerged in the mid-1980s and continues to take a progressively larger share of the structural panel market in the United States (fig. 8).

Particleboard—This product category includes nonstructural and structural panels made from wood particles, including OSB (which has strength and other properties comparable to plywood), waferboard, and flaxboard (fig. 9). However, data from 1995 to present for the United States are strictly for OSB (Food and Agricultural Organization of the United Nations 2014b) because production of waferboard stopped in the United States by the 1990s (Dick 2009) and flaxboard is a minor product in the United States. Hence, most of the quadrupling of production and consumption since the early 1980s is due to the emergence of OSB. The housing market cycle also has a strong effect on this product category. The use of OSB in housing construction has increased faster than growth in domestic OSB production, however, so imports of this category have generally risen since the early 1990s, while exports represent < 5 percent of total production.

Fiberboard—Fiberboard is a nonstructural panel used in buildings, especially interior applications such as wall systems. Low- and medium-density fiberboard is often used as an insulator, while high-density fiberboard (i.e., hardboard) is demanded for any number of applications requiring solid exterior faces of indoor walls and furniture. Like plywood and particleboard, imports of fiberboard rose steeply from the early 1990s to the peak of the most recent housing cycle and then dropped precipitously with the housing market contraction (fig. 10). However, production and consumption remained high, even through the 2007–2009 recession, and today are near their historical peaks in the United States, indicating strong demands outside of housing construction. Although fiberboard production and consumption fall short of those of plywood and particleboard, resilient demand for repair and renovation applications has meant that fiberboard continues to retain its market share in spite of swings in new construction.

Newsprint—Production and consumption of newsprint is unrelated to the size of the manufacturing sector in the United States, but it is tied to consumer demands for reading material and print advertising. Newsprint is

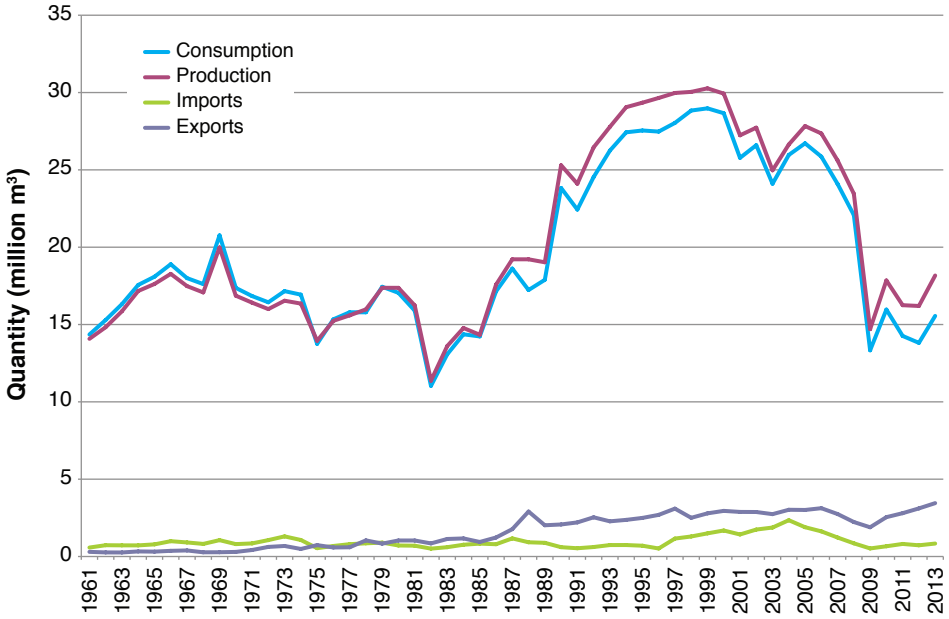

Figure 6—Consumption, production, imports, and exports of nonconiferous sawnwood (million m³) in the United States, 1961-2013 (Source: Food and Agricultural Organization of the United Nations 2014a).

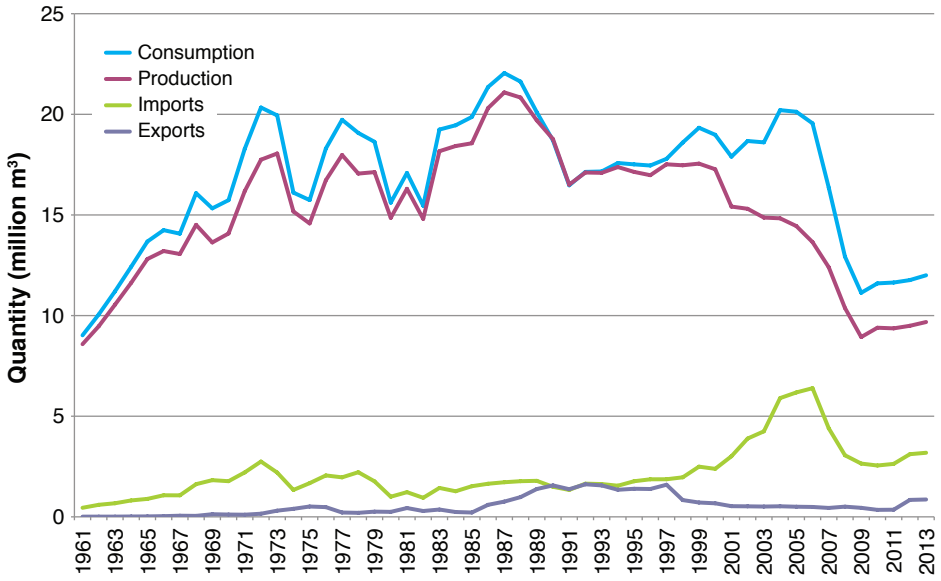

Figure 7—Consumption, production, imports, and exports of plywood (million m³) in the United States, 1961-2013 (Source: Food and Agricultural Organization of the United Nations 2014a).

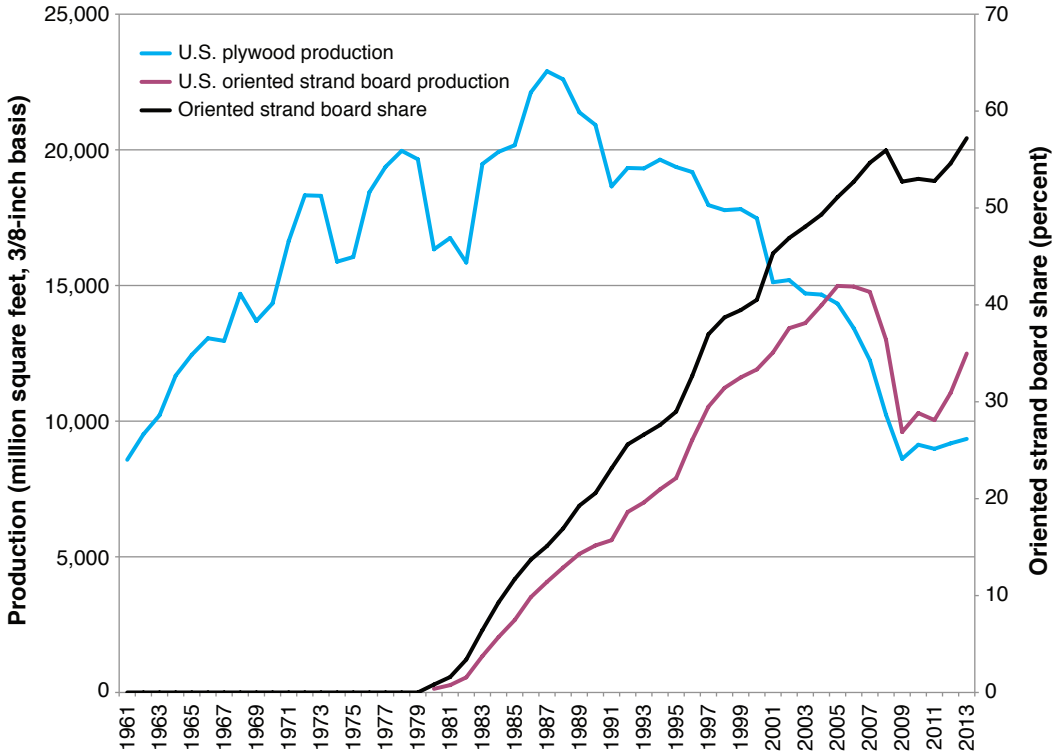

Figure 8—Production of plywood and oriented strand board in the United States, 1961-2013 (Sources: Adair 2010, APA 2014).

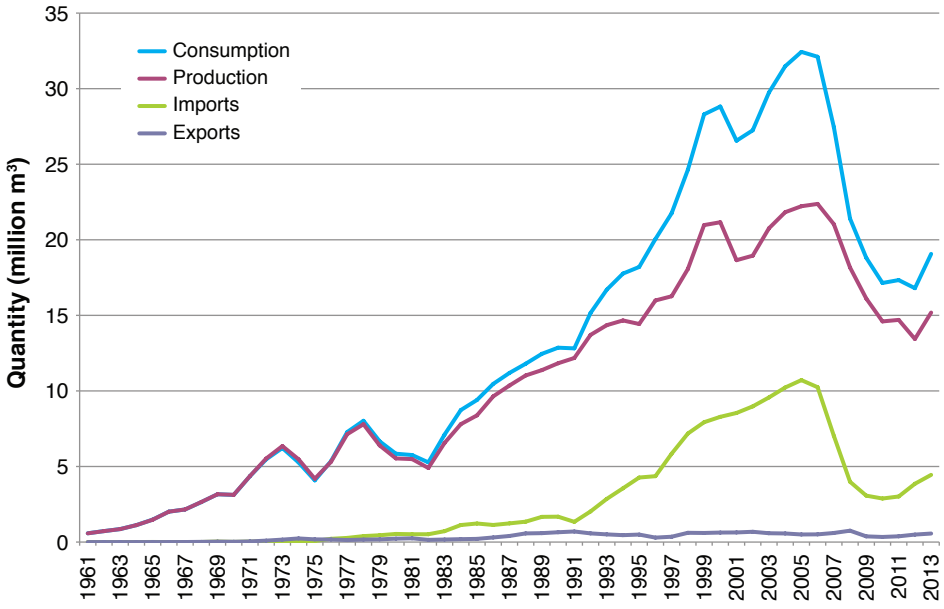

Figure 9—Consumption, production, imports, and exports of particleboard (million m^3) in the United States, 1961-2013 (Source: Food and Agricultural Organization of the United Nations 2014a).

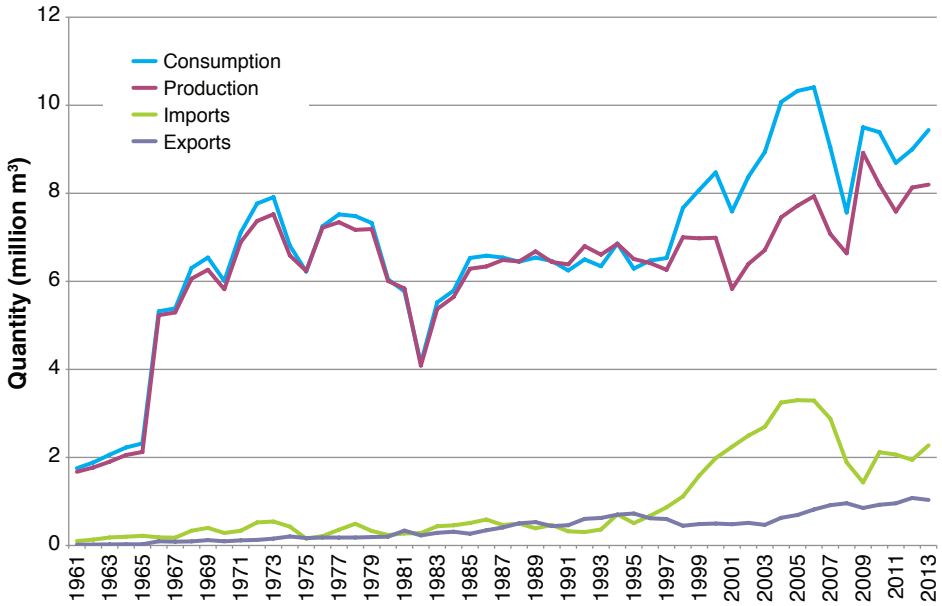

Figure 10—Consumption, production, imports, and exports of fiberboard (million m³) in the United States, 1961-2013 (Source: Food and Agricultural Organization of the United Nations 2014a).

the primary input to the newspaper sector in the United States, and newsprint consumption declined by 70 percent between 2000 and 2013 (fig. 11). Analysts attribute most of the decline to the burgeoning growth in the use of electronic media and associated declines in newspaper consumption and use of paper in advertising (Skog and others 2012). Such trends are beginning to be observed in Europe, as well (Hetemäki and Hurmekoski 2014). The data also indicate that manufacturers of newsprint have reduced production capacity. Consumption of newsprint peaked in 1987, wavered until 2000, and then declined. Imports, primarily from Canada, provided nearly 50 percent of newsprint consumed in the United States and fell in similar fashion over this period. The small amount of newsprint exports have changed little since 1995, although in the face of the consumption decline, they make up a rising share of domestic U.S. production, comprising a third of U.S. output.

Printing and writing paper—Like newsprint, printing and writing paper production and consumption in the United States fell precipitously beginning in the early 2000s (fig. 12). While 2004 marked the most recent high-water mark for consumption, the decline since that year has been steep, falling by 28 percent since 2004 and continuing to fall post-2007–2009 recession, in spite of economic recovery. Analysts (Skog and others 2012) attribute much of the decline to the same forces affecting the newsprint sector: a shrinkage in advertising and media use of paper in favor of electronic modes of information delivery.

Other paper and paperboard—This product category includes all forms of paper besides newsprint and printing and writing paper: paperboard, wrapping paper, packaging paper, and household and sanitary papers. The wrapping, packaging, and board component are closely tied to the demands of the manufacturing sector, accounting for 82 percent of the other paper and paperboard category from 2010 to 2013 (Food and Agricultural Organization of the United Nations 2014a). The remaining share comprises products (e.g., tissues and sanitary papers) that are more closely tied to income and population. U.S. production of other paper and paperboard increased rather steadily from the early 1960s through 1999 but has generally stagnated since then (fig. 13). In contrast to newsprint and printing and writing paper, the United States has maintained a trade surplus (positive net exports) in volume terms since at least 1961, and this surplus continued through 2013.

Wood pulp—Wood pulp is an intermediate product and input to all kinds of paper produced in the United States and globally. The United States has maintained nearly balanced production and consumption, so net exports have been near zero (fig. 14). In recent years, production has exceeded consumption, as foreign demand has increased—notably in China. Hence, wood pulp not used directly for domestic paper manufacture has a ready export market.

Recovered paper—Recovered paper is used primarily in the paper industry as the recycled fiber input, which

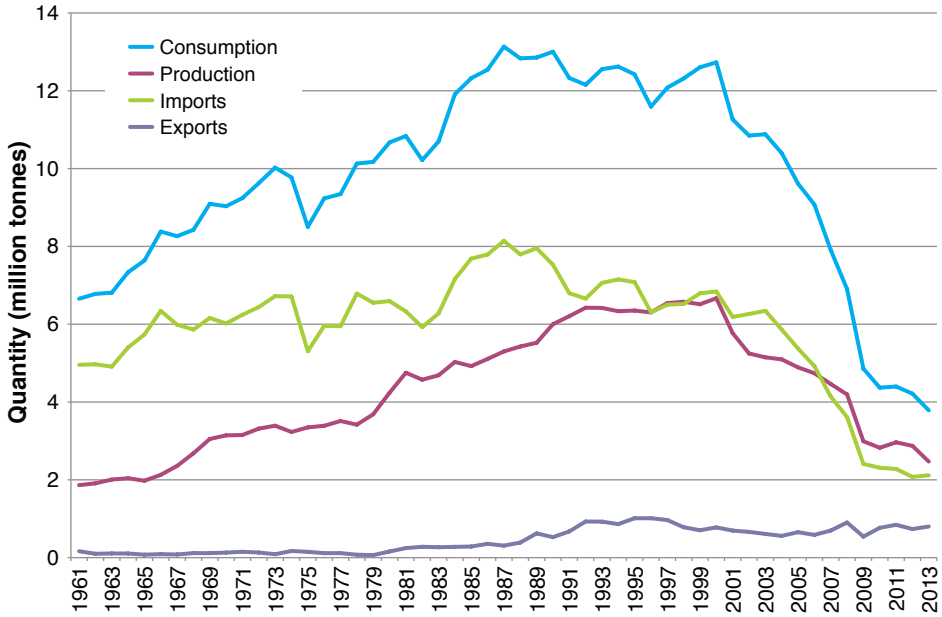

Figure 11—Consumption, production, imports, and exports of newsprint (million tonnes) in the United States, 1961-2013 (Source: Food and Agricultural Organization of the United Nations 2014a).

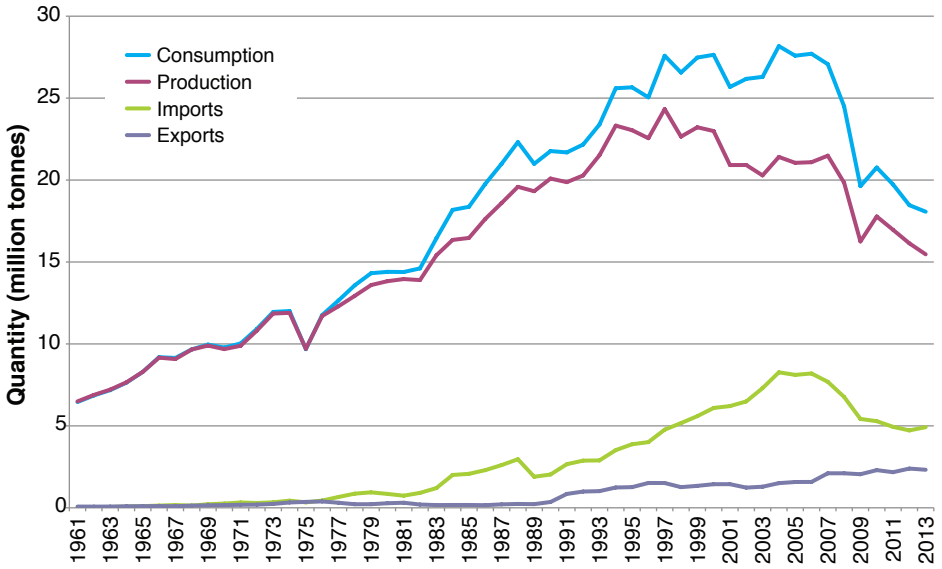

Figure 12—Consumption, production, imports, and exports of printing and writing paper (million tonnes) in the United States, 1961-2013 (Source: Food and Agricultural Organization of the United Nations 2014a).

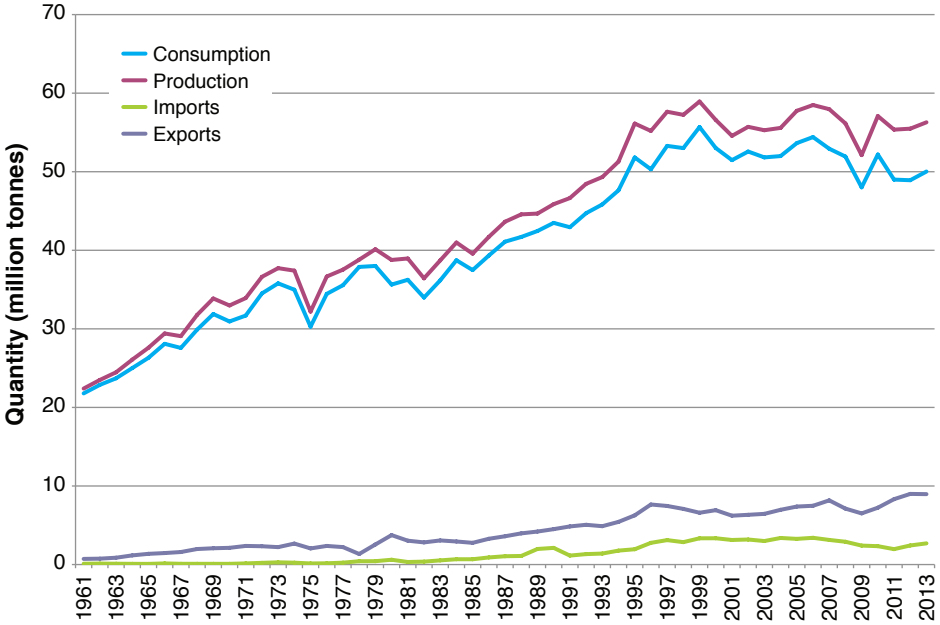

Figure 13—Consumption, production, imports, and exports of other paper and paperboard (million tonnes) in the United States, 1961-2013 (Source: Food and Agricultural Organization of the United Nations 2014a).

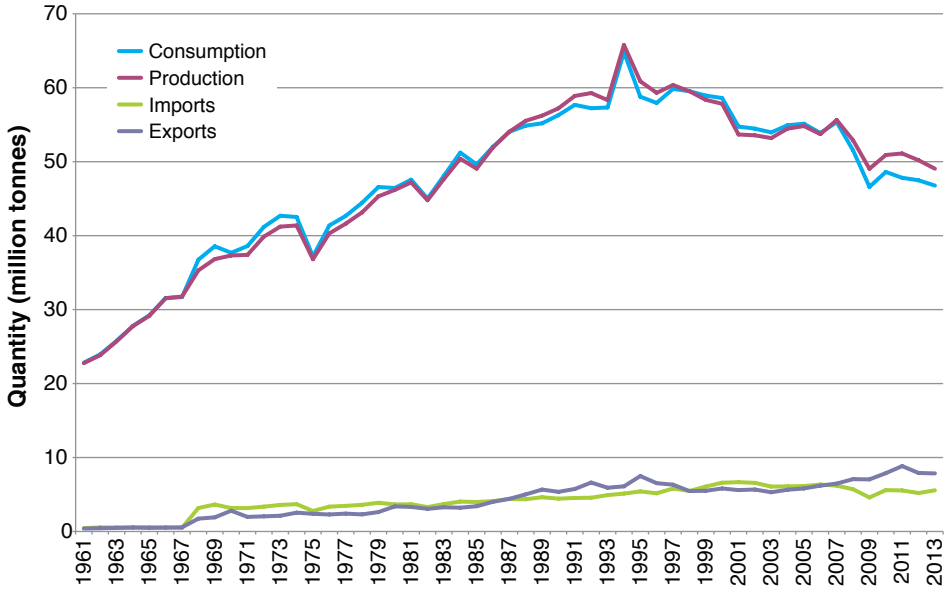

Figure 14—Consumption, production, imports, and exports of total wood pulp (million tonnes) in the United States, 1961-2013 (Source: Food and Agricultural Organization of the United Nations 2014a).

commands a growing share of the fiber used by the paper industry in the United States and abroad (fig. 15). In other words, recovered paper is a partial substitute for industrial roundwood in the paper industry. Historically, the United States has produced large quantities of recovered paper, consistent with its large paper sector and a large number of domestic paper consumers. Production of recovered paper has increased faster than paper consumption, partly as a result of the decline in U.S. production of paper and paperboard, and exports have increased. Since 2005, production exceeded 45 million tonnes/yr, and exports grew by nearly a third. Destination markets for these exports include China, whose imports from all sources increased from 1.8 million tonnes in 1993 to over 30 million tonnes by 2013. Skog and others (2012) report that in 2009, 37 percent of fiber furnish in the paper sector in the United States was recycled (recovered), an increase from 25 percent in 1965. Rising rates of recycling, therefore, have defined a small but perceptible decline in consumption of industrial roundwood by the paper sector.

Summary of Causative Factors

A combination of trends related to preferences, technology, and macroeconomic shifts in economic activity and business cycles have driven changes in the U.S. forest products sector. Housing construction activity (housing starts) has long been linked to the business cycle through the income/savings preferences of consumers. However, commencing in 2007, the latest recession was led by a housing market contraction in the United States, and housing starts fell in unprecedented fashion, thereby amplifying the implications of the downturn for the wood products sector. Between 2006 and 2009, housing starts fell to levels not observed in the United States since the World War II years, and the trough in housing starts continued for longer than in any previous post-war business cycle (fig. 4). While demand for wood in upkeep and repair has grown, housing construction remains the strongest source of demand for solidwood products in the United States, especially for softwood and hardwood sawnwood (figs. 3 and 5) and structural and nonstructural wood panels (figs. 7 through 10).

Future solidwood demands depend strongly on the course of housing demand. However, the mix and composition of housing types influence total wood demands. Nonetheless, it should be noted that much of the most recent rise in housing starts has occurred in the multifamily dwelling category (5 or more families per unit), which has increased its share of the total number of housing starts since the peak of the previous cycle. This share averaged 18 percent between January 1998 and December of 2006 and has averaged 32 percent since January of 2012 (U.S. Census Bureau 2014d). Multifamily dwellings use less wood per person. According to the U.S. Census Bureau (2014e), multifamily dwellings completed in 2013 averaged 1,082 square feet, compared to 2,598 square feet for the average single-family house completed that year (Howard and Jones 2015). Therefore, new housing in the United States between 2009 and 2013 provided about 9 percent less square footage per family compared to 1998–2006. Further, data (Skog and others 2012) indicate that wood use per unit of installed square footage has declined by about 10 percent over the past 50 years, a slight negative trend. And while the average square

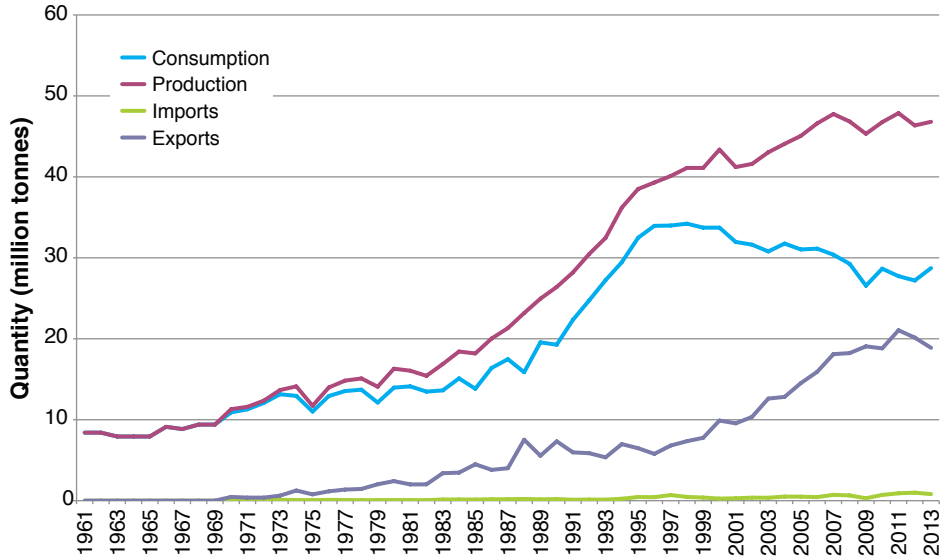

Figure 15—Consumption, production, imports, and exports of recovered paper (million tonnes) in the United States, 1961-2013 (Source: Food and Agricultural Organization of the United Nations 2014a).

footage of multifamily units has been declining since 2007, the average square footage of single-family units in 2013 was the highest ever recorded, rising along a trend of an additional 23 square feet per year (Howard and Jones 2015; U.S. Census Bureau 2014d, 2014e) (fig. 16). It is not clear whether these divergent trends will continue into the future.

The history of panel markets demonstrates how technological change can affect change in wood product markets. Overall panel output is tightly coupled to housing starts, but panel output has steadily shifted from plywood (using relatively large trees) to OSB (using any sized trees) (fig. 8). OSB provides a cost-competitive approach to manufacturing panels for most applications and has allowed for a strong shift, not only in market share of the product, but also in the location of domestic U.S. production from the West to the East. While plywood will continue to have preferred uses, OSB provides a lower cost option in many applications and may be an indicator of how technology could change other product segments of the market—i.e., a shift from scarce large tree inputs to relatively plentiful and plantation-grown smaller trees. Since 2006, Western and Southern U.S. plywood mill prices have averaged 45 percent higher than OSB mill prices for comparable products ($ per square foot on a 3/8-inch basis) (Random Lengths 2014); this price differential provides an important explanation for the shift toward OSB, which has gained an average of 1.6 percent in market share each year since 1990 and commanded 57 percent of the U.S. structural panel market in 2013 (APA 2014). Production of glulam beams, I-joists, and laminated veneer lumber (LVL) also have trended upward since 1980 (fig. 17); these products are increasingly being substituted for large timbers in roofing and flooring systems in residential and nonresidential applications. For example, I-joists were used in about 31 percent of new single-family home raised floors built in 1998, but use grew to 50 percent in 2009 (Adair 2010). Such engineered products allow for less overall wood use in many applications, so their expanded use can partially explain a net reduction in the amount of wood being used per unit of installed square footage; it could be inferred that these trends will continue into the future.

Technological changes have also influenced the pulp and paper sector in the United States and abroad. Paper-making technology has evolved to allow a broader range of hardwood-softwood mixtures, thereby allowing producers more ability to adjust their inputs to available raw material supplies. More broadly, technological advances in the entire forest products sector have favored capital versus labor in its development (Ince and others 2007, Stier and Bengston 1982) (figs. 18 and 19), resulting in a strong reduction in the labor used to produce forest products (i.e., allowing a substitution of capital in the form of machinery, computers, and other equipment for labor in production). With capital costs (interest rates)

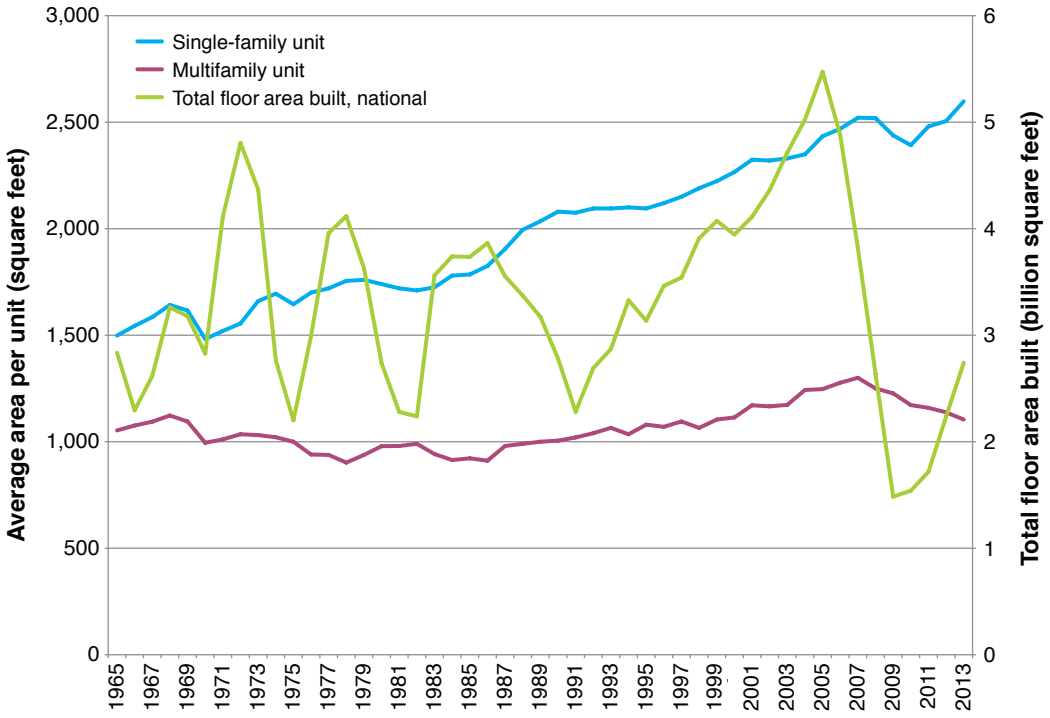

Figure 16—Average square footage per unit and total square footage of residential units built in the United States, 1965-2013 (Sources: Howard and Jones 2015; U.S. Census Bureau 2014d, 2014e).

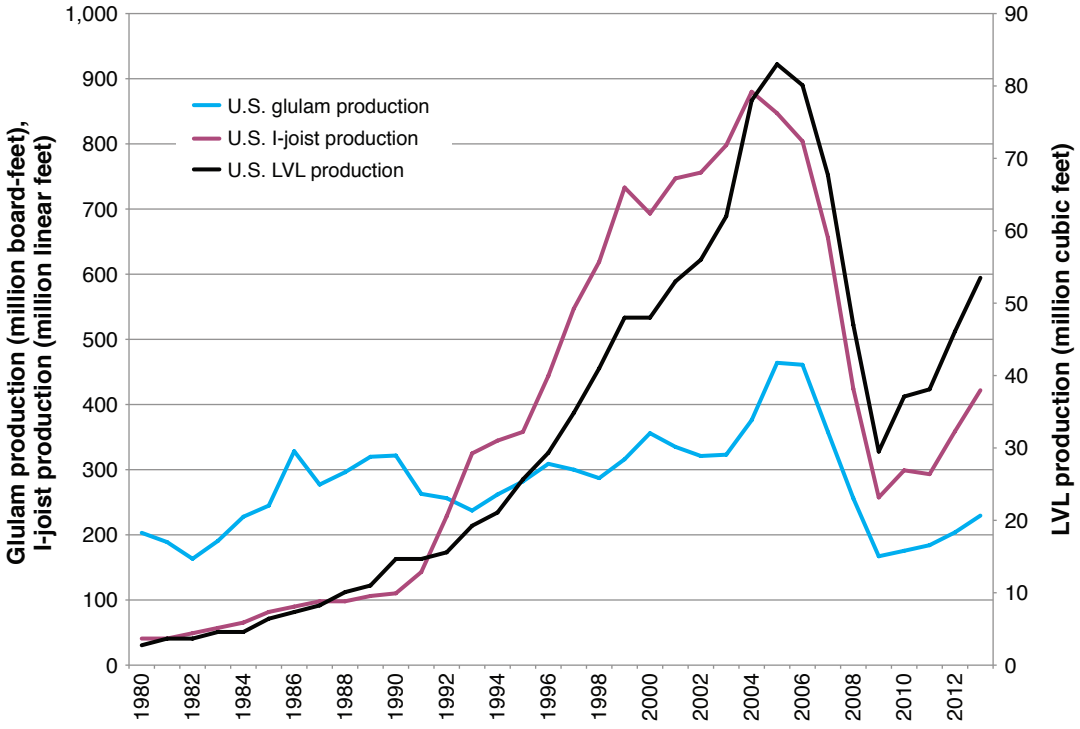

Figure 17—Production of glulam beams, I-joists, and laminated veneer lumber (LVL) in the United States, 1980-2013 (Sources: Adair 2010, APA 2014).

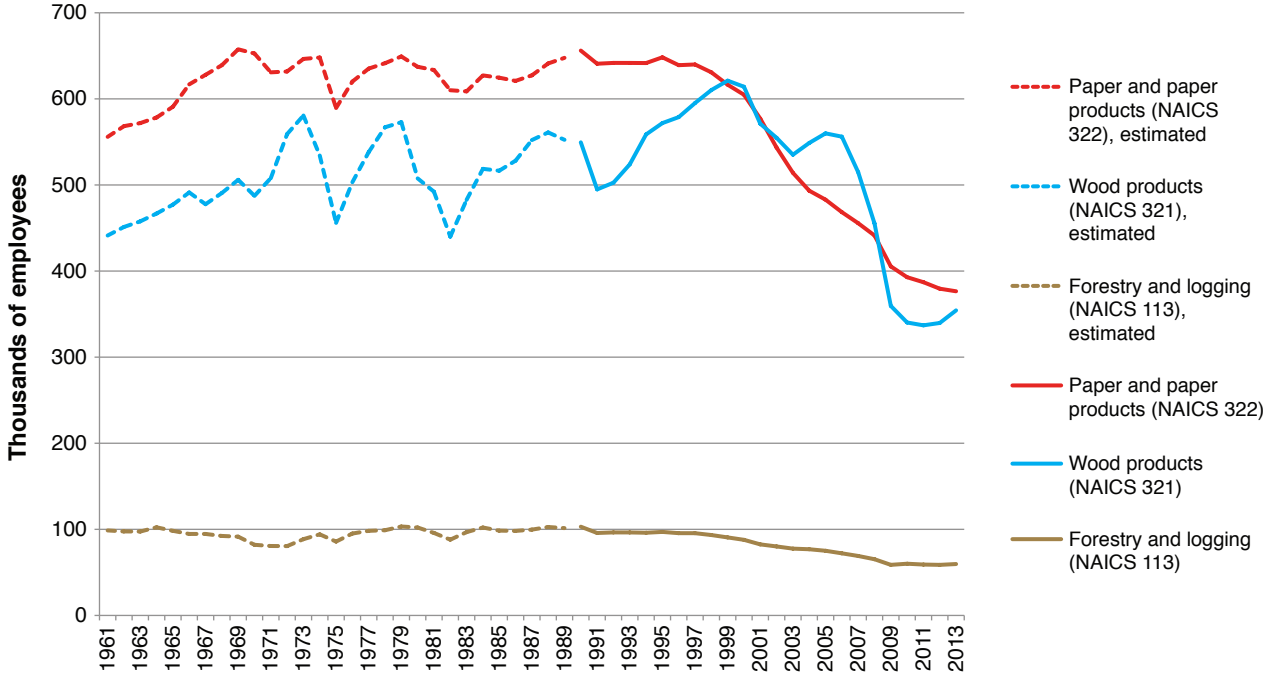

Figure 18—Employment in the forest products sector in the United States, 1961-2013 (Source: U.S. Bureau of Labor Statistics 2014a, 2014b, 2014c).

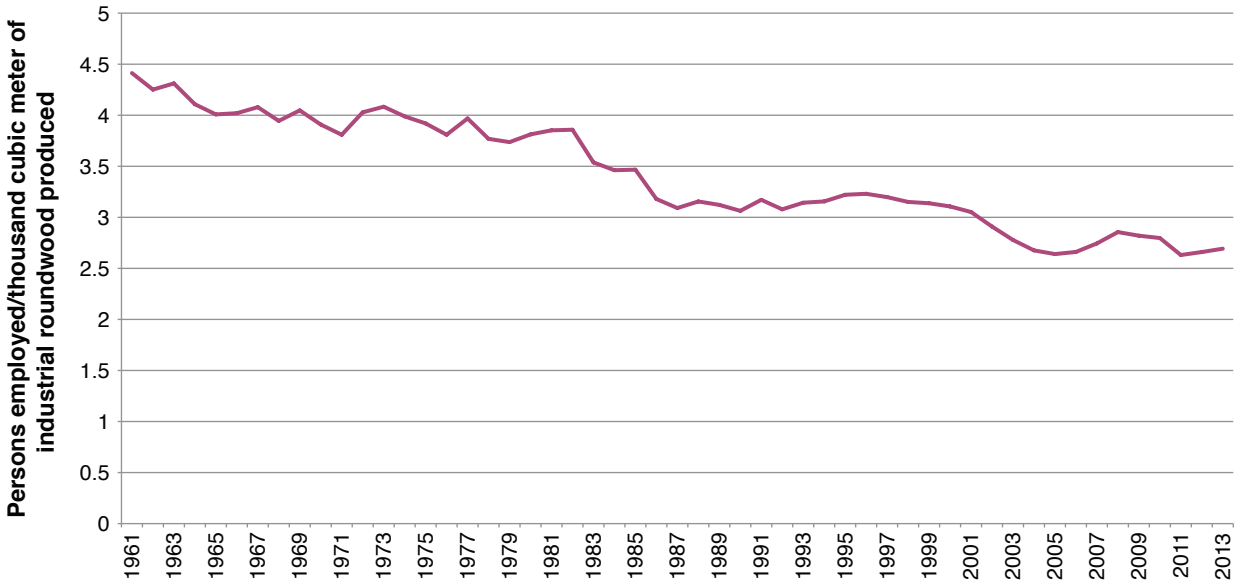

Figure 19—Labor intensity in the forest products sector in the United States, 1961-2013 (Sources: Food and Agricultural Organization of the United Nations 2014a, U.S. Bureau of Labor Statistics 2014a, 2014b, 2014c).

remaining low, we should expect this trend to continue, regardless of technological advances.

The paper and paperboard sector is most strongly influenced by total manufacturing output in the United States, which responds to business cycles, although less dramatically than does housing starts. The tight correlation of paper and paperboard output and overall manufacturing output is revealed in figure 2 and has been confirmed in similar analyses for Europe (Hetemäki and Hurmekoski 2014). Between 1961 and 1998, manufacturing output grew rather steadily, with downticks marking recessions. After reaching a maximum level in 1998, manufacturing output in the United States began to fall just as steadily, with a deep trough coincident with the latest recession and an increase back to meet its 2000–2007 trendline decline of 1 percent per year between 2009 and 2013. Paper and paperboard output follows the same trend with the exception of the recent recovery, and this is at least partially attributable to the steep declines in production and consumption of newsprint (fig. 11) and printing and writing paper (fig. 12). A more detailed look at the subcomponents of the manufacturing sector reveals the apparent connections between manufacturing levels and paper and paperboard demands. Some sectors most highly correlated with the output of the paper and paperboard industry are associated with subcomponents that have declined with the paper sector: printing, support activities for printing, food processing, cereal manufacturing, small electrics and tool manufacture, office equipment, photocopiers, paper bag manufacture, and machinery for packaging. At the same time, subcomponents with recent increases in output (e.g., the petroleum, aircraft and vehicle manufacturing, and pharmaceuticals and chemical industries) are not intensive users of paper and paperboard. This change in the composition of manufacturing outputs is at least a partial explanation for why pulp and paperboard output fell while manufacturing activity increased from 2009 to 2013.

In summary, U.S. forest products consumption and production are heavily correlated with U.S. economic activity. Solidwood products output correlates most strongly with housing construction. Paper and paperboard production correlates very strongly with total manufacturing output. Product mix, raw material (timber) harvest, and labor demand have all been strongly affected by technological changes through this time period. We observe a change in the relationship between U.S. consumption and production levels in 1992 for softwood lumber, when the United States substantially reduced timber harvesting from its Federal lands, thereby reducing available timber supply. As Haynes (2003) indicates, in 1986 the Pacific Northwest accounted for 26 percent of total timber harvests, but by 1996 had dropped to 15 percent. The effect of this reduction in Federal harvests was significant and negative for most wood processors, forest sector employment, income, and Federal revenue sharing with counties based on commercial receipts from timber harvesting in the Pacific Northwest and other parts of the West touched by the Federal harvest decline. It also had implications for prices and imports. The decline in Federal timber production led to increased domestic prices and increased demand for imports, largely from Canada, as well as greater reliance on private Southern U.S. timber to meet domestic demands (Wear and Murray 2004). We observe a change from paper and paperboard

output growth to output decline in 1998, correlated with the same pattern for overall manufacturing activity, and the most recent production declines are coupled with negative consumption trends that began in the 1980s for newsprint and the 2000s for printing and writing.

INTERNATIONAL MARKETS

The strong link between manufacturing activity and paper and paperboard output demonstrates how global markets influence the position of the U.S. forest products sector. Figure 20 shows total output of industrial roundwood (wood used in all marketed products) by country from 1961 to 2013.[1] Throughout this period, the United States has led the world in industrial roundwood production, though its share of global production has declined from a peak of 28 percent in 1998 to <17 percent by 2013. Part of the decline is attributable to growth of industrial roundwood production in Russia and New Zealand. Since 1995, Russia has had the greatest net export of wood in the world: their net exports reached a peak at 50 million m^3 in 2006 before declining rapidly to 21.6 million m^3 in 2009. The growth in some countries contrasts with shrinkage in others. For example, Japan's production has declined by 90 percent since 1973. While economies throughout the world were affected by the global recession—changes are especially evident in Canada and several European countries—these data demonstrate that the wood products sectors in the United States and Canada were affected to a greater extent than major producers in the rest of the world. As well as being the largest producer, the United States has been the world's largest consumer of industrial roundwood throughout the 53-year span of data from 1961 to 2013, and the recent recession had a disproportionate impact on U.S. wood consumption. After growing steadily from about 248 million m^3/yr in 1961 to 423 million m^3 in 2005, U.S. consumption receded with the housing market to 284 million m^3 by 2010 and subsequently recovered to 294 million m^3 by 2013 (Food and Agricultural Organization

[1] 2013 data are preliminary and for some countries are estimated by analysts (Food and Agricultural Organization of the United Nations 2014b).

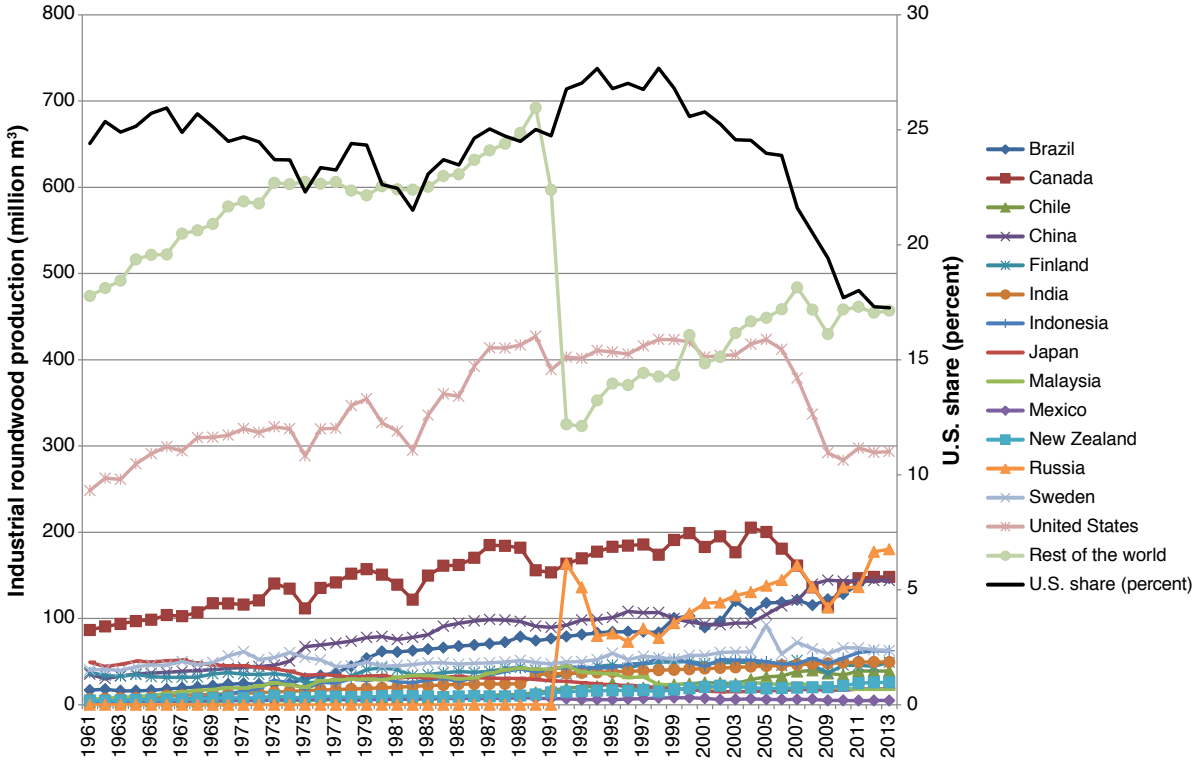

Figure 20—Industrial roundwood production by country and rest of the world with U.S. share of global output, 1961-2013. Note that 2013 data are preliminary and estimated by analysts (Food and Agricultural Organization of the United Nations 2014b). (Source: Food and Agricultural Organization of the United Nations 2014a). The discontinuity in the rest of the world output reflects the separate reporting of the Russian Federation States and remaining former Soviet States beginning in 1992.

of the United Nations 2014a)[2]. At the same time, the United States has been a world leader in industrial roundwood exports and since 1963 has had positive net exports. In 2013, the United States had net exports >15 million m³. These overall consumption and net export trends are important to keep in mind as we decompose changes in global production share of the United States.

Coniferous Sawnwood Production Share

The United States has led the world in production of coniferous sawnwood (lumber) since 1961 (as shown in figure 21) and even before then; it has also been a long-term net importer of coniferous sawnwood largely from Canada. The United States' dominance in production has narrowed since the late 1990s. The decline from the late 1990s, when global production share was over 22 percent, can be attributed not just to declining domestic production but also to increased production in Russia, China, and other countries with significant coniferous resources. The most recent recovery in U.S. share from the 2010 low of 15.6 percent to the 2013 share of about 17.2 percent is consistent with the partial construction market recovery; a continuing construction recovery is likely to bring this share closer to its 1961–2012 average of 18.5 percent. However, countries with significant comparative advantage in coniferous sawnwood—Canada, Finland, Sweden, and now Russia—are exporting far more than they import. The United States, on the other hand, has historically depended on Canada to satisfy a large share of domestic demand for this product category, and this dependence continues today, even after reduced imports from Canada since 2005 and increased exports from the United States to global markets. Expanded plantation resources in the Southern United States and the continued increase in average square footage of single-family homes (fig. 16) both point to underlying long-run strength in U.S. production of coniferous sawnwood.

[2] Data on U.S. industrial roundwood production shown in figure 20 from the Food and Agricultural Organization of the United Nations (2014a) (FAO) do not exactly match data from Howard and Westby (2013) shown in figure 1 because: (1) the Howard and Westby (2013) data are calculated based on the volume of derivative products and then converted to roundwood equivalents, (2) some industrial roundwood does not make it into industrial uses delineated by Howard and Westby (2013) that are the basis of FAO calculations, and (3) some nonindustrial roundwood finds its way into industrial uses that are the basis for the Howard and Westby (2013) data. Furthermore, trade volumes shown in figure 1 are the roundwood equivalent of all forest products traded (traded logs and wood chips and the roundwood equivalent of derived products).

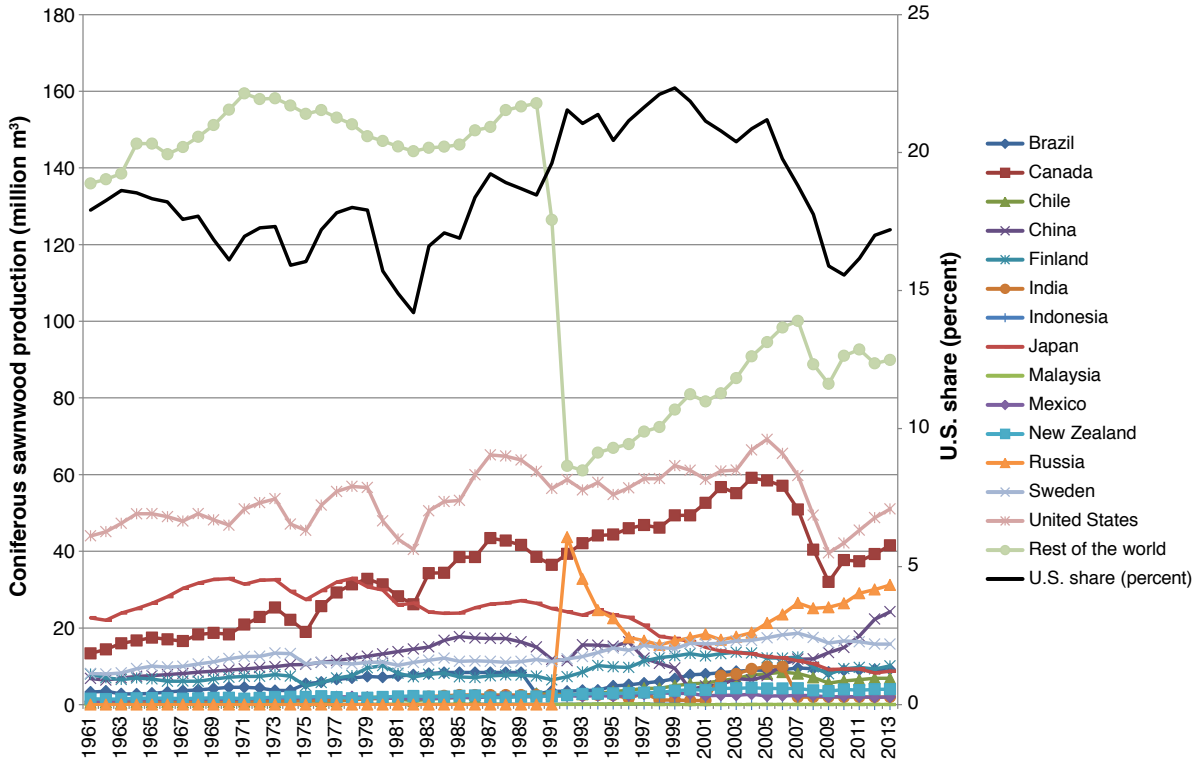

Figure 21—Coniferous sawnwood production by country and rest of the world with U.S. share of global output, 1961-2013 (Source: Food and Agricultural Organization of the United Nations 2014a). The discontinuity in the rest of the world output reflects the separate reporting of the Russian Federation States and remaining former Soviet States beginning in 1992.

Nonconiferous Sawnwood Production Share

Like coniferous sawnwood, the United States has been a world leader in production of nonconiferous (hardwood) sawnwood (lumber) since 1961 (fig. 22). The U.S. share of global markets grew from <15 percent in the early 1980s to a peak of 39.6 percent in 2000. Its subsequent decline to about 18 percent reflects multiple factors. One factor is the rapid increase in production in China, which rose from <3 million m^3 to over 36 million m^3 between 2000 and 2013, and since 2009 leads all countries in nonconiferous sawnwood production. Another factor is the offshoring of the U.S. furniture sector, largely to China (Schuler and Lawser 2007). Finally, the U.S. share has declined as the output of tropical hardwood sawnwood has expanded in Indonesia, Malaysia, and Brazil. Given these multiple overseas trends, there is little likelihood that the U.S. global share will return to its historical dominance, especially as long as China can obtain the imported wood needed to support its furniture sector and as other rapidly growing Asian economies and Brazil produce and consume tropical hardwood to manufacture furniture and other hardwood products to satisfy burgeoning domestic consumption. And although the United States, the European Union, and other countries have taken steps to limit global markets for illegally produced wood emerging from many of the world's largest hardwood producers (Prestemon 2015)—which should favor a rise in the global U.S. share—the ultimate effects of these measures on the U.S. share remain uncertain.

Plywood Production Share

The U.S. share of global production of plywood has been declining since the early 1960s, falling from over 52 percent in 1965 to approximately 11 percent by 2009, when it leveled off (fig. 23). The United States lost its lead in plywood production to China in 2003. Throughout nearly the entire 1961–2013 span of data, the United States has imported more plywood than it has exported. In the 1980s, total U.S. plywood exports grew to over 1 million m^3, thus achieving approximate parity with imports in the first half of the 1990s. But by 1998, exports were again on the decline, while the import quantity was increasing. The steep decline in the U.S. share of plywood output is linked in multiple ways to growth in Asia's economies over several decades. Beginning in 1981, Indonesia became a major net exporter of plywood, as net export quantity rose to 9.8 million m^3 in 1992 before declining throughout the 1990s and early 2000s. Indonesia's net export quantity eventually leveled off

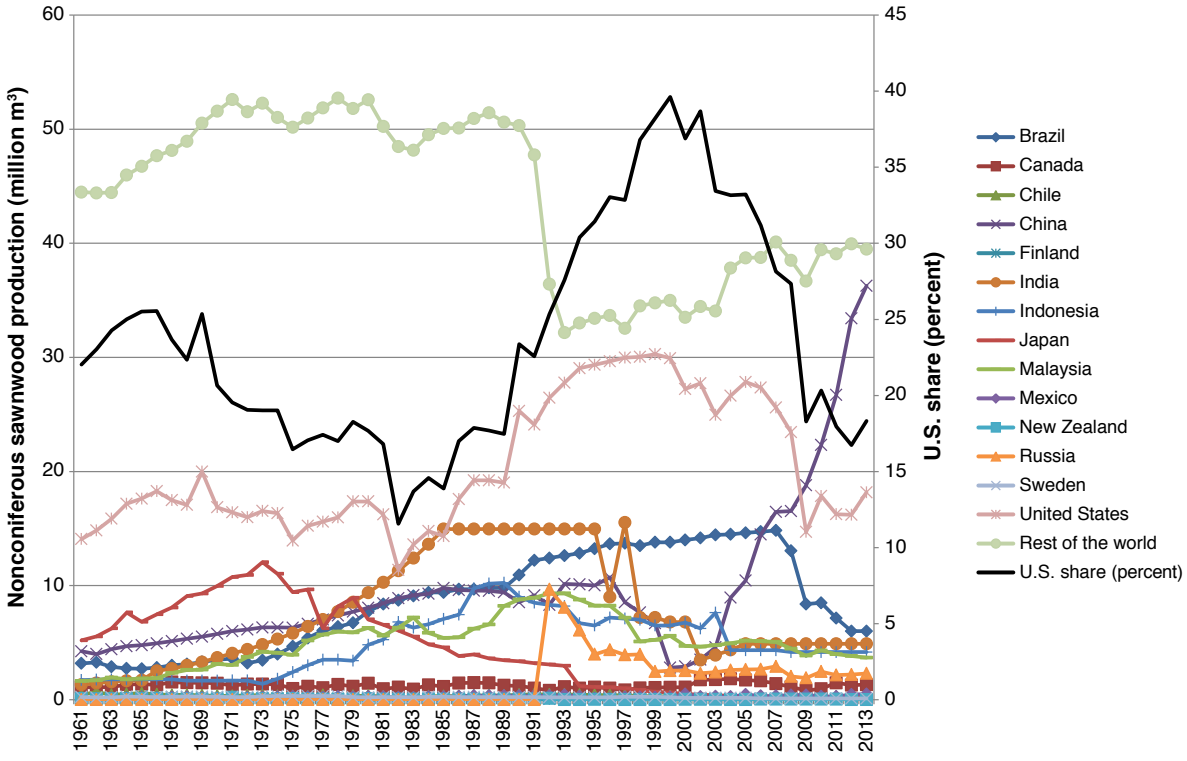

Figure 22—Nonconiferous sawnwood production by country and rest of the world with U.S. share of global output, 1961-2013 (Source: Food and Agricultural Organization of the United Nations 2014a). The discontinuity in the rest of the world output reflects the separate reporting of the Russian Federation States and remaining former Soviet States beginning in 1992.

around 3 million m³ after 2004. In the 1990s, Malaysia's net exports increased considerably and by 2003 had surpassed Indonesia's. In the late 1990s and early 2000s, China emerged as a major net exporter of plywood after spending the previous two decades as a net importer. In 2003, China became the world's largest consumer, and its production of plywood increased by ~4 million m³/yr between 2001 and 2009, settling above 40 million m³/yr by 2009.[3] Given that the U.S. market is shifting toward more production and consumption of OSB (fig. 8), it is highly unlikely that the U.S. global share of production of this product will increase from its pre-2007–2009 recession level of 20 percent. It is more likely that the U.S. level of plywood production and global share of plywood production will continue to shrink in the coming years.

Particleboard Production Share

The U.S. share of global production of particleboard has ranged between 13 and 26 percent and has declined since the turn of the century (fig. 24). The U.S. share rose from about 15 percent in the early 1960s to a peak of 26.3 percent in 1999, but it has since dropped to 14.4 percent in 2013. The United States was the world's single largest producer of particleboard from 1961 until surpassed by China in 2013. Since the 1980s, global production of particleboard has been rising steadily and at a rate faster than in the United States. This market remains dynamic, but it appears unlikely, given growth in particleboard production in China and the rest of the world, that the United States will realize substantial growth in its global market share in particleboard production.

Wood Pulp Production Share

The United States has been a world leader in wood pulp production, averaging over one third of the world's output from 1961 to 2000 (fig. 25). Since then, however, its share has dropped slowly but steadily to 28.3 percent in 2013. The decline in share is likely a long-run natural outgrowth of the United States' historical subordinate position to Canada, Finland, and Sweden in global markets, and lately to the emergence of Brazil as a dominant competitor in global markets in the past decade. Brazil became the second largest net exporter of wood pulp in the 2000s, and by 2013, Brazil's net export quantity of wood pulp had reached a historical

[3] Data since 2009 are estimated by the Food and Agricultural Organization of the United Nations. It is possible, therefore, that the 11.4-percent share for the United States in 2013 is an overestimate.

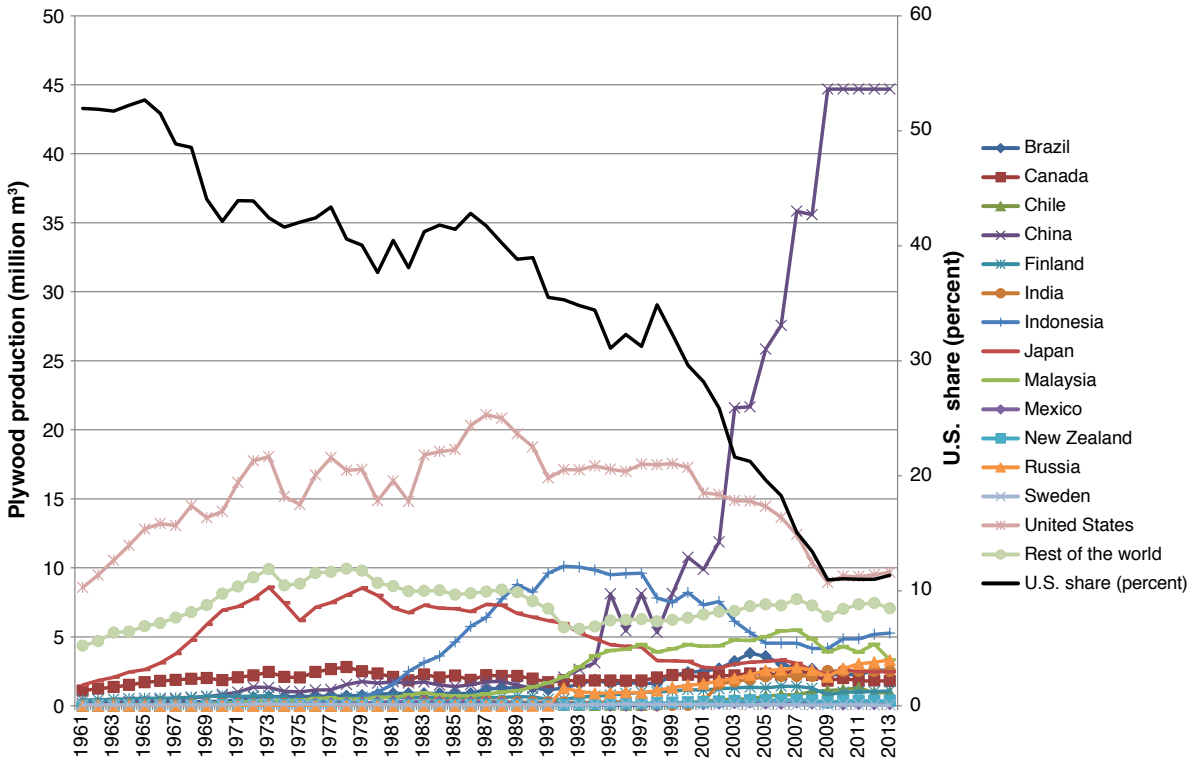

Figure 23—Plywood production by country and rest of the world with U.S. share of global output, 1961-2013 (Source: Food and Agricultural Organization of the United Nations 2014a). The discontinuity in the rest of the world output reflects the separate reporting of the Russian Federation States and remaining former Soviet States beginning in 1992.

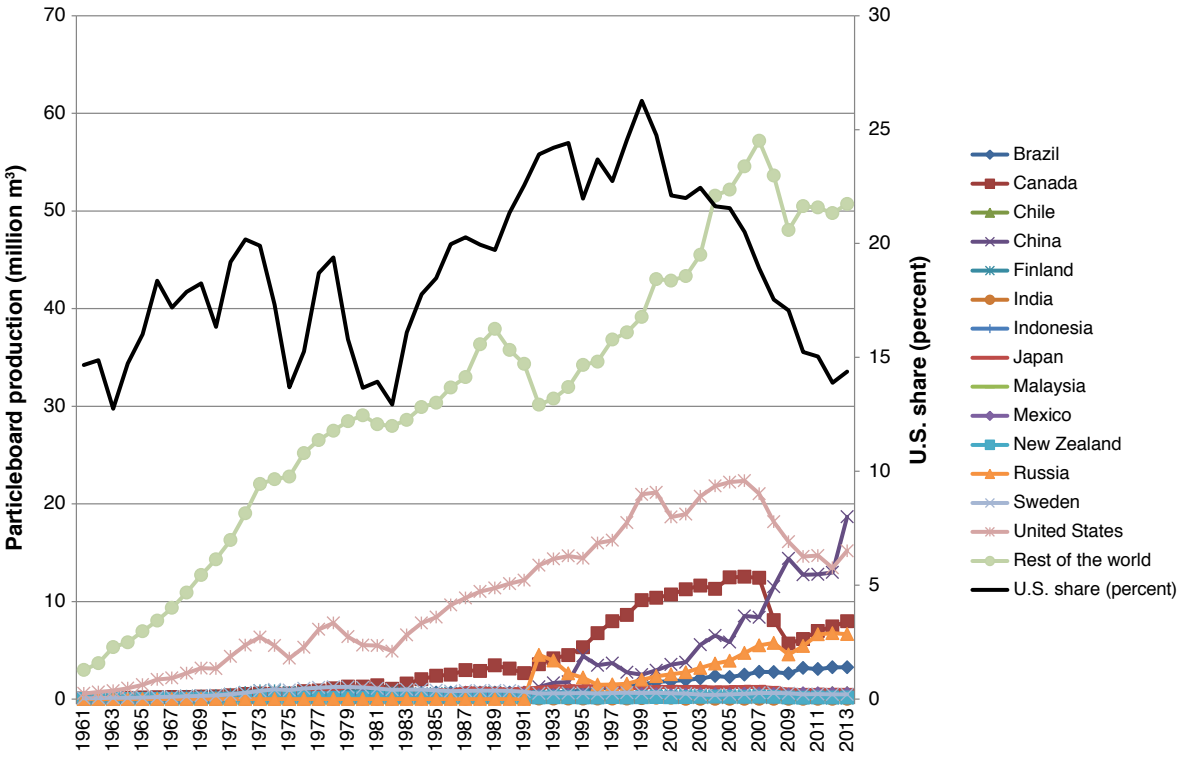

Figure 24—Particleboard production by country and rest of the world with U.S. share of global output, 1961-2013 (Source: Food and Agricultural Organization of the United Nations 2014a). The discontinuity in the rest of the world output reflects the separate reporting of the Russian Federation States and remaining former Soviet States beginning in 1992.

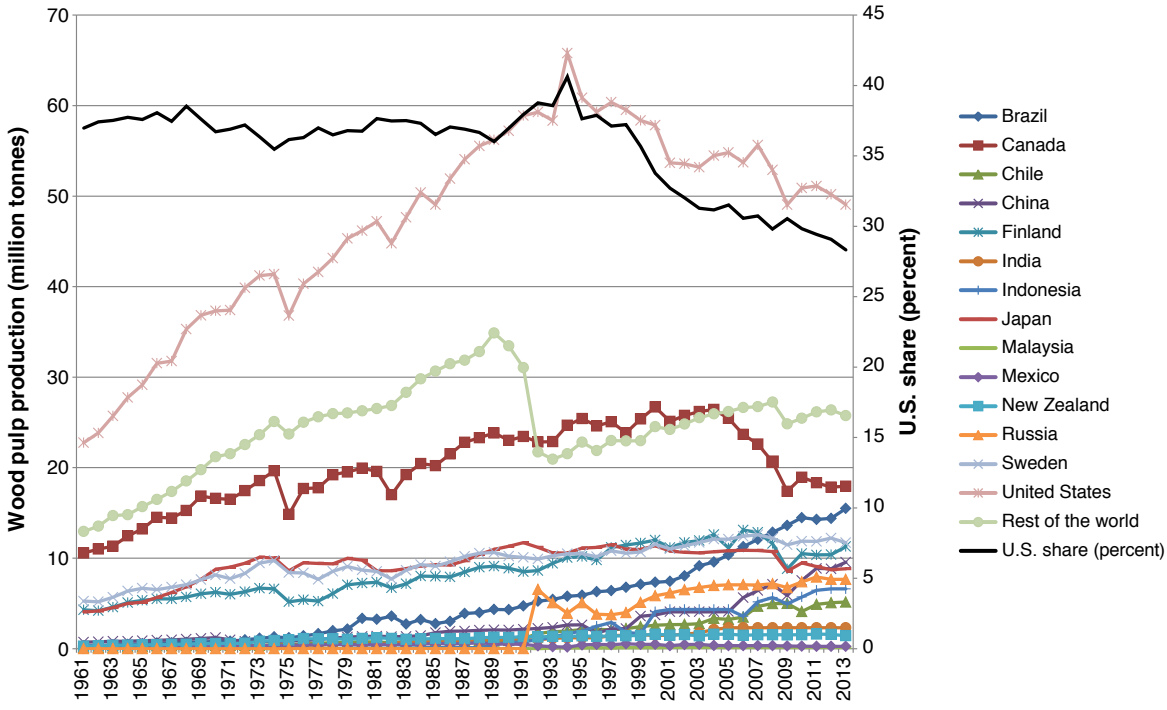

Figure 25—Wood pulp production by country and rest of the world with U.S. share of global output, 1961-2013 (Source: Food and Agricultural Organization of the United Nations 2014a). The discontinuity in the rest of the world output reflects the separate reporting of the Russian Federation States and remaining former Soviet States beginning in 1992.

peak at 9.4 million tonnes. The decline in U.S. share is most consistent with the declining domestic use of paper by the manufacturing sector as well as falling consumption of paper in print media. The United States has had a favorable balance of trade (positive net exports) in market pulp since 2007, and wood pulp exports have been increasing, even as domestic paper production in the United States has faded.

Total Paper and Paperboard Production Share

The United States has been a global leader in paper and paperboard production, but its global share of this production has been declining, from over 40 percent in the early 1960s to its 2013 share of 18.3 percent (fig. 26). Multiple factors have contributed to this decline. First, Canada, Finland, Sweden—the most competitive paper producers globally—and other countries in Europe (notably Germany, not shown in fig. 26) have maintained or increased their production of total paper and paperboard much more rapidly than the United States. Second, China's paper output has increased strongly, from <10 million tonnes in 1984 to over 100 million tonnes by the late 2000s, enabling it to surpass the United States in production by 2008. A large portion of production growth in China is explained by consumption growth. By the 1980s, China had become the world's third largest consumer of total paper and paperboard, importing far more than it exported at the time. By 2010, China had emerged as a net exporter of total paper and paperboard. Third, the rising use of electronic media has put downward pressure on consumption and hence has limited profit opportunities in printing and writing paper manufacture.

CONCLUSIONS

The U.S. forest products sector has undergone changes that are both cyclical (tied to markets in sectors that use wood and that fluctuate with the domestic economy) and long-term (linked to changes in multiple factors that are particular to output markets, evolution in tastes and preferences, changes in technology, and global economic growth). The overall trend in the U.S. share of global production has been negative in most categories, some evident since the 1960s, others emerging since the late 1990s. While government and industry decisionmakers are not powerless in the face of changes outside the sector, means of intervention to slow or reverse these changes are limited, and it seems unlikely that most long-run trends can be interrupted.

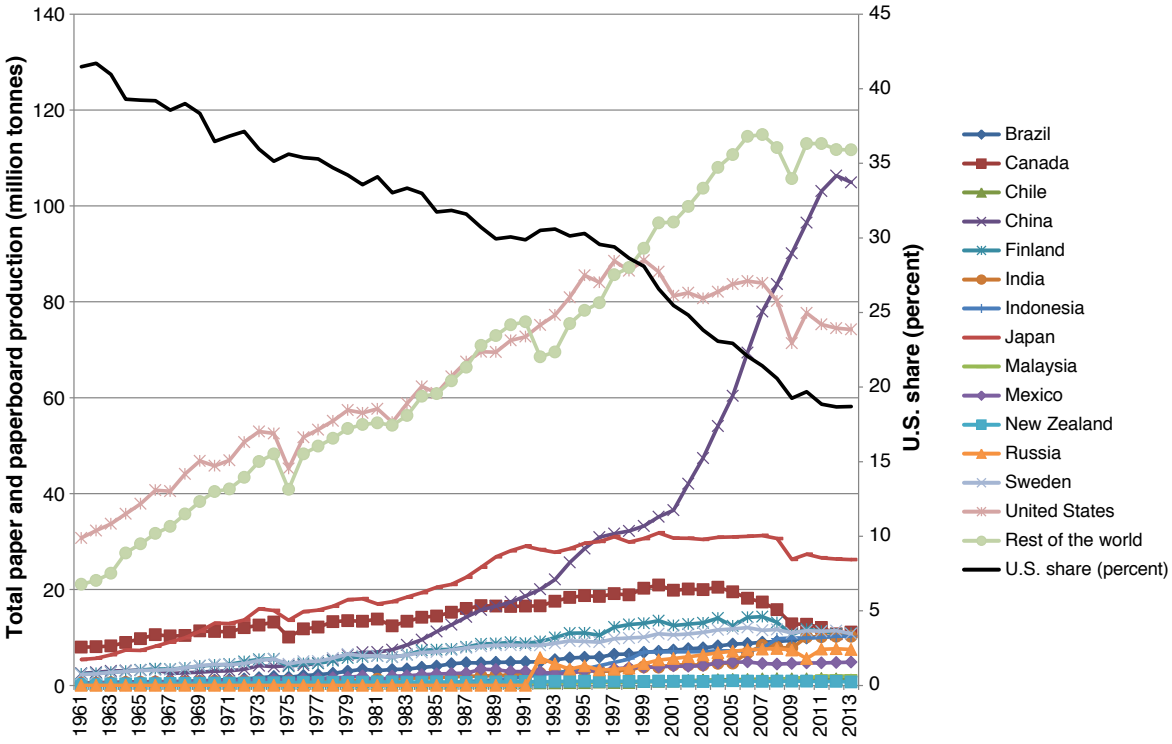

Figure 26—Paper and paperboard production by country and rest of the world with U.S. share of global output, 1961-2013 (Source: Food and Agricultural Organization of the United Nations 2014a). The discontinuity in the rest of the world output reflects the separate reporting of the Russian Federation States and remaining former Soviet States beginning in 1992.

Among these long-term, uninterruptable trends is the advance of engineered wood products. Data indicate (Skog and others 2012) that wood use per installed square footage of housing has decreased slightly over time, and some of this is attributable to engineered systems. But this has been offset by the strong upward trend in the size of new single-family housing. Another strong trend is the decline in industrial roundwood use in the paper sector, due to both recycling and the decline in use of paper in media. Finally, the apparent long-run decline in the manufacturing sector in the United States has implications for the use of paperboard. These trends have been reflected in closures of U.S. pulp and paper facilities, reducing domestic demand for wood fiber and the labor required to process it. Technological changes will continue to chip away at jobs in the paper and wood products industries.

Growth in forest products output outside of the United States is largely unaffected by domestic U.S. policy—except perhaps through efforts to discourage illegal fiber sourcing—so even steady output of forest products domestically is likely to result in downward pressure on U.S. global production share. In contrast, China and other rapidly industrializing economies such as Brazil and Russia have growing forest products sectors along with rapidly growing consumer demands for forest products, most of which will be produced within those countries. These countries are likely to export less or import more in the future in order to meet their demand growth. The wood furniture sector has moved to Asia, where a rapidly growing consumer base is located. Exports—particularly of hardwood logs, lumber, and plywood to furnish some of that region's furniture industry input demands—may provide a sustained or rising future market for domestic U.S. hardwood production. Investments in paper manufacturing will continue to focus on the rapidly growing manufacturing sector in Asia. Returning the United States to dominance in paper production appears highly unlikely, in spite of small recent increases in exports from the U.S. paper sector. However, opportunities may grow for market pulp exports to China, in particular, to supplement recycled fiber content in that nation's paper manufacturing sector.

The cyclical housing sector has long been the dominant factor in the U.S. solidwood products market. Recovery from a housing contraction deeper than any seen since World War II is slowly occurring, yet construction today is still well below historical averages. Further recovery will drive U.S. production and likely its global market share higher, but the composition of housing demands will influence the wood consumption associated with new housing construction. The more recent uptick in the share of multifamily housing units started (to 33 percent of all units in 2013) may not last, and the recent levels are not unprecedented, with shares exceeding 33 percent last seen from 1981 to 1986. Overall, construction is increasing, and projections (Skog and others 2012) indicate further recovery past the 1.00 million housing starts observed in 2014 (U.S. Census Bureau 2015).

An uncertain future demand for forest products output in the United States is the wood energy sector, and several studies have explored the effects of hypothetical growth in bioenergy, including by the USDA Forest Service (2012). However, long-anticipated demands for forest bioenergy feedstocks remain unrealized in the United States due to a number of factors, including declines in energy prices and confounding policy. Growth has been largely limited to wood pellets produced in the United States and exported to the European Union (primarily to the United Kingdom) to burn for electricity to meet targets described in the Renewable Energy Directive of the European Union (Abt and others 2014). While the production of wood pellets has more than doubled since 2011, it so far accounts for about 2 percent of total U.S. industrial roundwood output. Little growth in the use of wood to produce energy is evident in the United States, and continuing uncertainty in U.S. policy regarding wood bioenergy is unlikely to be quickly resolved. Combined with lower fossil fuel prices, this policy uncertainty makes large short-term increases in the use of wood to produce domestic energy unlikely.

New demands for wood fiber may also emerge from the biomaterials sector. Shatkin and others (2014) estimate that the annual U.S. market potential for nanocellulose is 6.4 million tonnes, particularly for paper and packaging applications but also in the construction, automobile manufacture, textiles, and personal care product industries. Cowie and others (2014) conclude that maximum forest area needed to supply the annual needs of domestic U.S. manufacturing of nanomaterials is 176,000 acres of plantation-grown trees or 352,000 acres of natural forest trees. Clearly, the potential of the sector is currently small, and making predictions of future uses in a new sector is difficult, especially where growth requires a series of technological innovations.

A key element of long-run futures is the potential decline or leveling of populations in Europe, North America, and Japan. We are already seeing a fading in the importance of Japan in world forest product markets due to its population decline and economic stasis. Important destinations for forest product exports in Europe have leveling populations and today are experiencing sluggish economic growth. We might, therefore, expect shrinking foreign markets there. Not unrelated, the steep declines in production and consumption of paper used in media experienced in the United States and Europe are likely to spread and accelerate in other countries as their economies expand. Anticipate, therefore, an ebbing global demand for the wood fiber that is needed in that sector. Increased rates of recycling are likely to further depress

the use of virgin wood fiber per unit of paper output. However, the growth of paper output in China, enabled in part by rapid growth in exported U.S. recovered paper, may also lead to a rising future market for U.S. exports of virgin fiber in the form of market pulp.

There are many uncertainties, and recent trends are not predictions of the future. However, adjustments in forest product manufacturing capacity and timber supplies occur somewhat slowly, so some trends are indeed likely to continue. Clearly, standing timber volumes in the United States are rising (Oswalt and others 2014)—with the net volume of growing stock on timberland increasing by 42 percent on public lands and 13 percent on private land between 1997 and 2012—and they are likely to rise into the future, particularly as a legacy of the recent cyclical downturns in the construction and manufacturing sectors. The increases imply low pressure on timber prices in the United States. Heavy demand growth in countries such as China is likely to bring higher global prices, particularly for inputs to the paper sector and furniture manufacturing. A likely result is expanded export opportunities to China and other emerging manufacturing economies, especially in Asia.

While the United States has shown movement toward trade balance in several product categories, much of this is due to declines in exports to the United States from Canada. It is not clear, at this point, how the loss of timber inventory to mountain pine beetle is affecting that country's ability to compete against domestic U.S. production. Canada's timber supply situation will continue to have important implications for U.S. production.

Another uncertainty is the future role of wood substitutes, especially in construction. Eastin and others (2001) document advances in the role of non-wood substitutes in construction. Wood is often a preferred building material for residential construction; other materials' inroads into this sector are limited by wood's ease of use and the high cost of its available substitutes. But opportunities might advance in the multifamily and the nonresidential categories of building construction, where steel, concrete, and plastic are dominant building materials. Substantial inroads into these categories would likely require altering building codes.

We also conjecture that policy initiatives could influence future consumption and production of forest products in the United States. One way to increase U.S. wood consumption would be to create policies and programs that stimulate or allow for greater rates of wood use in construction, particularly for multifamily and nonresidential construction. Policy might generally address existing building codes' treatment of wood frame structures. Presently, the International Building Code standards applied in the United States typically limit multifamily wood-frame structures to no more than 5 stories, 85 feet in height, and 270,000 square feet (Continuing Education Center 2014). Along these lines, the White House Rural Council has announced plans and funding to promote wood use in tall building construction (White House Rural Council 2014). Initiatives in Europe [e.g., the Forest-based Sector Technology Platform (FTP)] and Canada (e.g., Innovawood, a private sector initiative) to expand the use of wood in construction in those countries might also mean that wood production and export opportunities could expand, even in the midst of other declines in wood consumption. The treatment of forest products in renewable energy policies in both the United States and Europe could also influence overall wood consumption, and carbon accounting applied to forest biomass might favor wood use over substitute materials such as concrete and steel in current/future carbon credit markets.

This report focuses largely on the demand side of U.S. forest products markets, especially as influenced by international markets for secondary products. However, the overall scale of U.S. production and national comparative advantage also depends on its timber supply. Overall timber supply in the United States has grown in the last several decades, reflecting a strong investment in private forests in the South that has more than compensated for substantial declines in western supplies. Output from western regions is strongly influenced by public land policies, which have shifted away from timber production and toward nonmarket goods and services since the early 1990s. Policy changes leading to increased harvests from public lands would likely increase western and overall U.S. production and comparative advantage, mainly in the softwood sawnwood market.

Finally, global advances in policies and programs that demand or require sustainability certification for forest products traded on global markets have the potential to affect foreign markets for U.S. forest products. Whether U.S. producers fully embrace certification, how certified producers conform to the sustainability requirements of destination markets, and whether certification costs trend higher or lower will have implications for domestic U.S. timber growers and forest product manufacturers. In the longer run, we might expect that the strong resource endowment of the United States and its shift toward production from planted forests will continue to support a strong comparative advantage in wood products, especially if other countries reduce their timber inventories. The observed recent expansion in U.S. timber supply is one step (but not the only requirement) toward growing the U.S. market share over the long run.

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The United States' share of global industrial roundwood production has declined since the 1990s. We reviewed data from 1961-2013 to evaluate the extent of this decline for industrial roundwood and derived secondary forest products compared to other major producing countries. We find that the U.S. global share of industrial roundwood peaked at 28 percent in 1999 but then declined to 17 percent by 2012. We attribute the decline to a combination of cyclical factors, most notably the decline in U.S. construction, and long-term decline in U.S. paper manufacture that is connected to a reduction in the size of the U.S. manufacturing sector and waning demand for paper used in media. Prospects are for increased use of wood in construction as the housing market returns to long-run averages in the coming years, which should push the U.S. share to over 20 percent. However, the use of wood by the paper sector is not likely to experience a significant recovery, implying that it is unlikely that the United States will return to its 1990s levels of global market share in industrial roundwood production. Timber demands—not timber supplies—currently limit production growth in the United States. Increased wood demand by the construction sector might occur with changes in building codes, allowing for taller and larger wood-frame construction. The growth in wood use by the energy sector is another emerging prospect.

Keywords: Forest sector, industrial roundwood, market share, timber products.